ARDENT
CONSULTING ENGINEERS

COUNTRYSIDE PARTNERSHIPS PLC

BROOK FARM, DAWS HEATH ROAD, DAWS HEATH, ESSEX, SS7 2UG

FLOOD RISK ASSESSMENT & DRAINAGE STRATEGY

REPORT REF NO. W461-03
PROJECT NO. W461
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HEAD OFFICE: 3rd Floor, The Hallmark Building, 52-56 Leadenhall Street, London, EC3M 5JE T | 020 7680 4088
ESSEX: 1 - 2 Crescent Court, Billericay, Essex, CM12 9AQ T | 01277 657 677
KENT: Suite 10, Building 40, Churchill Business Centre, Kings Hill, Kent, ME19 4YU T | 01732 752 155
MIDLANDS: Office 3, The Garage Studios, 41-43 St Mary's Gate, Nottingham, NG1 1PU T | 0115 697 0940
SOUTH WEST: City Point, Temple Gate, Bristol, BS1 6PL T | 0117 456 4994
SUFFOLK: Suite 110, Suffolk Enterprise Centre, 44 Felaw Street, Ipswich, IP2 8SJ T | 01473 407 321

Email: enquiries@ardent-ce.co.uk

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-	DRAFT	FH/LE	BB	DRAFT	31/05/2022
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1. INTRODUCTION

1.1. Ardent Consulting Engineers (hereafter referred to as "Ardent") has been commissioned by Countryside Partnerships PLC to carry out a Flood Risk Assessment (FRA) for the proposed redevelopment of Brook Farm, Daws Heath Road (hereafter referred to as 'the site'). This FRA has been undertaken to support a Full Planning application. The development proposals include redevelopment of existing agricultural land to provide up to 173 residential units as a mixture of 2-bed, 3-bed, 4 bed and 5-bed houses with associated car parking, landscaping and sustainable drainage features

1.2. The contents of this FRA assess the implications of flood risk on the proposed development. This FRA has been prepared with specific reference to the requirements of National Planning Policy Framework (NPPF) updated in July 2021 and the Planning Practice Guidance (PPG), which superseded the Technical Guidance to the NPPF, in March 2014. This report also takes into consideration the requirements within the Non-statutory Technical Standards for Sustainable Drainage Systems (March 2015) and its Best Practice Guidance (July 2015).

1.3. This FRA and Drainage Strategy has been prepared to support a planning application to be submitted to Castle Point Borough Council (CPBC).

Site Location

1.4. The site, which occupies an area of approximately 18.92ha, is centred approximately on OS grid co-ordinates 581708mE, 188247mN and located immediately south of Daws Heath.

1.5. It is bounded by and accessed from Daws Heath Road to the west and bordered by the residential properties of Fairmead Avenue and Harseland Close to the north. The south-eastern boundary of the site is defined by Prittle Brook, a main river running west to east, which is also accompanied by semi-dense woodland. Agricultural land encompasses much of the southwest boundary.

1.6. The existing site is almost entirely comprised of arable farmland with a small number of grazing stock occupying land towards the far western boundary. The only existing buildings within the site boundary are a small cluster occupying around 3,850m^2 located to the southwest, which are agricultural in nature, and provide residence for the current landowner. Refer to **Figure 1-1** below for the site location.

Figure 1-1: Site Location Plan

Development Proposals

1.7. The proposals include the redevelopment of the site to provide 173 new dwellings with associated private gardens, parking, access roads, soft landscaping and drainage features. The eastern portion of the site is to be landscaped as open grassland and heathland, with an orchard proposed in the southern half of the site.

1.8. The proposed development is illustrated in **Figure1-2**; Refer to **Appendix A** for the full development proposals.

Figure 1-2: Proposed Development Layout

2. POLICY CONTEXT

National Planning Policy Framework

2.1. The National Planning Policy Framework (NPPF) was updated in July 2021; paragraph 159 to 169 inclusive, establishes the Planning Policy relating to flood risk management. The Technical Guide to the NPPF has been superseded by the Planning Practice Guidance (PPG) in March 2014

2.2. The main focus of the policy is to direct development towards areas of the lowest practicable flood risk and to ensure that all development is safe, without increasing flood risk elsewhere. The main considerations are:

- Applying the Sequential Test, and if necessary, apply the Exception Test;
- Safeguarding land from development that is required for current and future flood management;
- using opportunities provided by new development and improvements in green and other infrastructure to reduce the causes and impacts of flooding, (making as much use as possible of natural flood management techniques as part of an integrated approach to flood risk management); and
- Where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to relocate development, including housing, to more sustainable locations.

2.3. The Planning Practice Guidance (PPG) provides the methodology required to undertake the Sequential and Exception Tests.

Sustainable Drainage Systems - Non-statutory technical standards for sustainable drainage systems March 2015

2.4. The Non-statutory technical standards for sustainable drainage systems were published in March 2015. They should be used in conjunction with the Planning Practice Guidance. In addition, the Best

Practice Guidance for the Non-statutory technical standards was published in July 2015 by LASOO.

2.5. The Local Planning Authority (LPA) may set local requirements for planning permission that have the effect of more stringent requirements than these non-statutory technical standards.

2.6. In addition, SuDS should be designed in accordance with CIRIA 753 SuDS Manual, which represents current best practice.

South Essex Surface Water Management Plan (SWMP, 2012)

2.7. The South Essex SWMP includes the administrative areas of Basildon Borough Council, Castle Point Borough Council and Rochford District Council (referred to as 'South Essex' throughout the report). The document is a plan which outlines the preferred surface water management strategy for South Essex and includes consideration of flooding from sewers, drains, groundwater and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall.

2.8. Within the Surface Water Management Plan for the region, the site lies just within the eastern most extents of the Critical Drainage Area (CDA) 'CAS 3'. The focus of recommendations for this area is largely in relation to improving maintenance and assessing online storage in relation to Prittle Brook.

South Essex Level 1 Strategic Flood Risk Assessment (April, 2018)

2.9. A Strategic Flood Risk Assessment was completed by AECOM on behalf of South Essex

2.10. The SFRA summarizes:

- On the mainland area of the Castle Point Borough, the Prittle Brook and Benfleet Hall Sewer pose the most significant fluvial risk with the southern part of South Benfleet and Hadleigh located within Flood Zone 2 and 3 as well as a small area along the course of the Prittle Brook. High Ground and Embankments protect the area from flooding however the area is still at residual risk
- There is a high probability of surface water flooding within the Castle Point Borough. Surface water flood risk is highest on Canvey Island. A number of high risk flow paths are located in

the South Benfleet and Thundersley areas associated with the route of ordinary watercourses. Localised flooding within the Borough can be attributed to topographic depressions as well as insufficient capacity within watercourses. The management of the drainage system has also been found to be an exacerbating factor for previous surface water flooding events that have occurred within the Borough

2.11. The South Essex SFRA includes mapping of flood risk within the area.

Regional & Local Planning Policy

2.15. In the preparation of this report, specific reference is also made to the following regional and local planning policy pertinent to flood risk:

- Castle Point New Local Plan (specifically Policy CC 6, Page 177);
- Essex County Council Preliminary Flood Risk Assessment;
- South Essex Catchment Flood Management Plan;
- South Essex Water Cycle Study;
- South Essex Surface Water Management Plan (Phase 1-4)
- Castle Point Borough Council Stage 1 & 2 Strategic Flood Risk Assessment;
- Castle Point Flood Risk Sequential and Exception Test Report for Housing Site Options.

2.16. Collectively the above documents and supporting evidence base provide a strategy for not only assessing flood risk at a regional level but also guidance on the management of surface water on a site-specific basis. As well as relating to flood risk and drainage, the South Essex Water Cycle Study also summarises the recommendations necessary to meet the planned growth throughout the district in relation to potable water provision, including the general requirements for individual development sites.

Climate Change Allowances

2.17. The Planning Practice Guidance states that to allow for the predicted impacts of climate change on Peak River Flow Allowances, consideration should be given to the catchment within which the site is located. The site is located within the South Essex Management Catchment and as such the following allowances detailed in **Table 2-1** are applicable to the site.

Table 2-1: Combined Essex Management Catchment peak river flow allowances

	Central	Higher	Upper
2020s	6%	11%	22%
2050s	5%	11%	27%
2080s	17%	26%	48%

2.18. For 'more' vulnerable development the Planning Practice Guidance states that the central allowance should be used. Therefore, under the NPPF, an allowance of 17% would achieve the policy requirements in assessing the flood risk associated with the development.

2.19. The Planning Practice Guidance states that to allow for the predicted impacts of climate change on surface water runoff within the Combined Essex Management Catchment, the following increases detailed in **Table 2-2** below to rainfall intensity should be allowed for. For development with a lifetime beyond 2100, the upper end allowances should be used.

Table 2-2: Combined Essex Management Catchment Peak Rainfall Allowances

	Central	Upper
3.3% annual exceedance rainfall event		
2050s	20%	35%
2070s	20%	35%
1% annual exceedance rainfall event		
2050s	20%	45%
2070s	25%	40%

2.20. Therefore, under the NPPF an allowance of 45% for the effects of climate change for the 1% annual exceedance rainfall event would achieve the policy requirements in designing the drainage elements the proposed residential redevelopment.

Sequential Test Requirements

2.21. The aim of the sequential test is to steer new development to areas with the lowest risk of flooding from any source. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the basis for applying this test. The sequential approach should be used in areas known to be at risk now or in the future from any form of flooding.

2.22. As none of the developable area is located near the Flood Zones 2 or 3, a Sequential Test should not be required. This should be confirmed with the LPA.

Exception Test Requirements

2.23. Table 2 (Flood risk vulnerability classification) of the Planning Practice Guidance (PPG) classes the residential use as More Vulnerable, following a sequential approach all residential dwellings would be located in Flood Zone 1. However, given that none of the developable area is within Flood Zones 2 and 3, an Exception Test is not anticipated to be required, this should be confirmed with the LPA. This is in line with Table 3 (refer to **Figure 2-1** below) of the PPG.

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓*

Key:

✓ Development is appropriate

✗ Development should not be permitted.

Figure 2-1: Extract from the PPG - Table 3: Flood Risk Vulnerability

3. BASELINE CONDITIONS

Hydrology

3.1. The nearest designated watercourse as defined by the Environment Agency is Prittle Brook which defines much of the south-eastern boundary of the site and flows in a west to easterly direction.

3.2. Within the site itself the landscape is characterised by an interconnecting series of vegetated ditches. In places and as shown on the topographic survey, a number of tracks utilised for agricultural purposes necessitate these ditches to be culverted.

3.3. In terms of larger bodies of water, an existing pond is located at the south west of the site and west of the existing buildings.

Topography

3.4. A topographical survey for the site was undertaken in May 2015 by Countryside Partnerships PLC and is provided in **Appendix B.**

3.5. The site generally falls from north to south, with the western portion draining towards an existing ditch and the eastern part of the site draining to Prittle Brook to the south east. The eastern area slopes quite steeply from north to south at a gradient of circa 1 in 26 with the overall level difference being around 18m. Moving westwards, the slope trends in a north-west to south-east direction. There is a north-south watershed in the western part of the site and to the west of this the land falls north-east to south-west.

Ground Conditions

3.6. The geology for the southern extents of the site is characterised by subaerial slope superficial deposits, comprised of head – clay, silt, sand and gravels. These deposits are likely to be attributable to the encroachment of Prittle Brook along the southern boundary. Refer to Error! Reference source not found.**1** and **Figure 3-2** below for BGS B edrock and Superficial Deposits details respectively.

3.7. The bedrock geology at the site is a mixture of the Bagshot Formation for the northern extents primarily comprised of sand (locally clayey)

and the Claygate Member to the south, made up of clay, silt and sand. Both of these members are effectively a geological result of shallow seas characteristic of siliciclastic sediments (comprising of fragments or clasts of silicate minerals) deposited as mud, silt, sand and gravel.

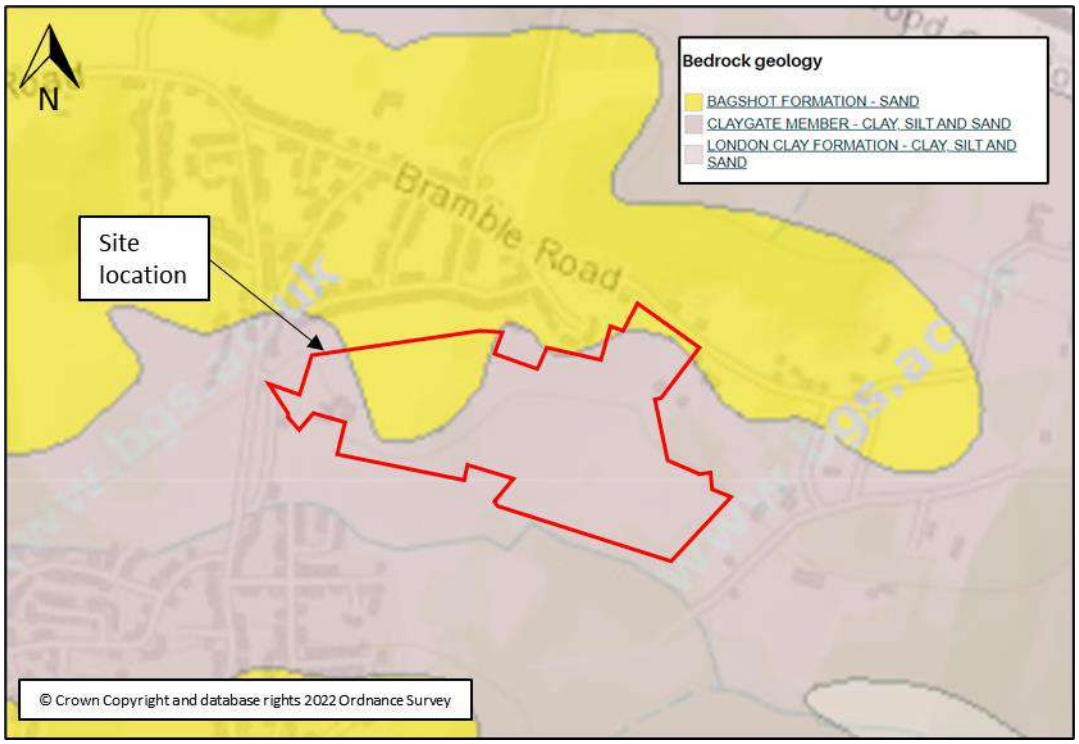

Figure 3 1: BGS Online Geology Mapping - Bedrock

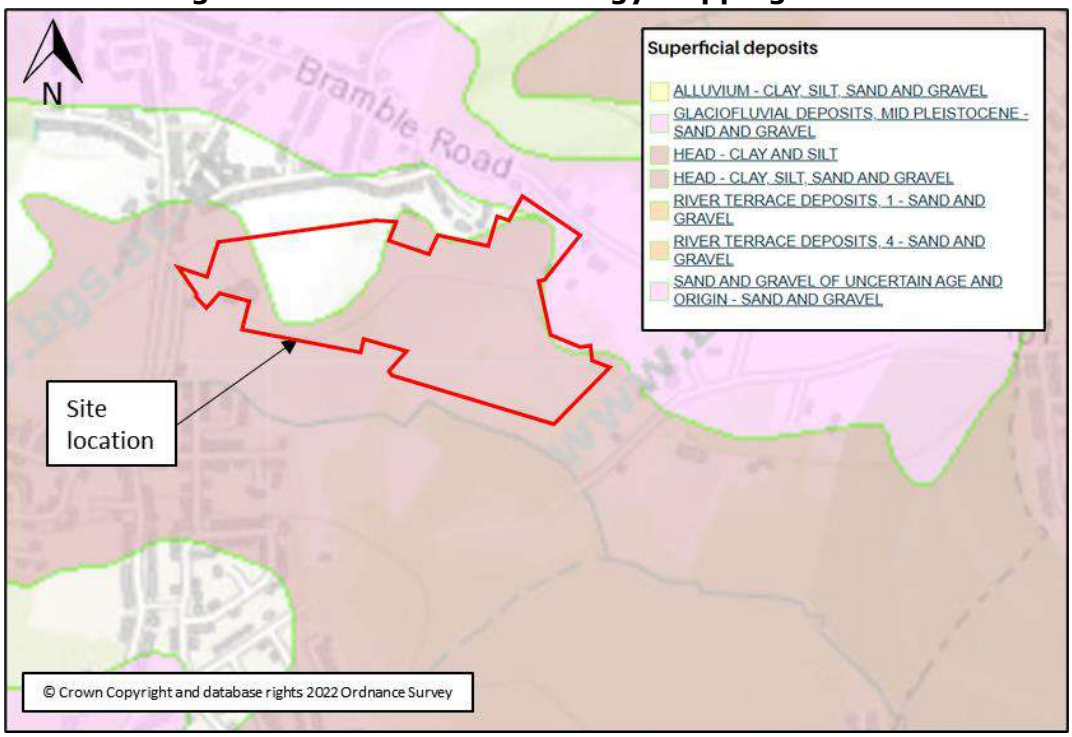

Figure 3-2: BGS Online Geology Mapping – Superficial Deposits

3.8. The nearest historic borehole log is located within Bramble Road immediately north of the site (dated 1973) and is summarised in **Table 3-1** below, groundwater was struck 8m below ground level.

Geological Classification	Lithology	Thickness (m)	Depth (m)
Soil	Silty Gravelly Clay	0.2	0.2
Sand and Gravel of Unknown Age	Clayey gravelly sand. Sand course; gravel course and fine angular flints and rounded Tertiaries	0.7	0.9
Bagshot Beds	Clayey silty fine sand. Soft, weathered mottled dark blue and pale greenish grey Interbedded silty clay and clayey fine sand. Finely laminated, moderate brown to yellowish orange	0.5 10.3	1.4 11.7
Claygate Beds	Very silty clay with rare fine sand, laminated	17.3	29.0
London Clay	Stiff olive grey clay	3.0+	32.0

Table 0-1: Existing Geology

3.9. The Environment Agency has classified the superficial deposits beneath the site as a combination of Secondary A and Secondary (Undifferentiated) Aquifers, with the bedrock geology classified as Secondary A.

3.10. Secondary A aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers

Existing Sewer Infrastructure

3.7. **Figure 3-3** below shows that there are both foul and surface water sewers within the vicinity of the site, which serve the residential developments to both the north and the south of the site. There are three foul water sewers within the site boundary to the south of the site comprising of; 1no. 15" sewer, 1no. 12" sewer and a third sewer which is 450mm. There is also a 6" foul sewer which crosses the site from north to south.

3.8. An Anglian Water surface water sewer discharges to a pond immediately north of the site which also ultimately discharges to the on-site ditches.

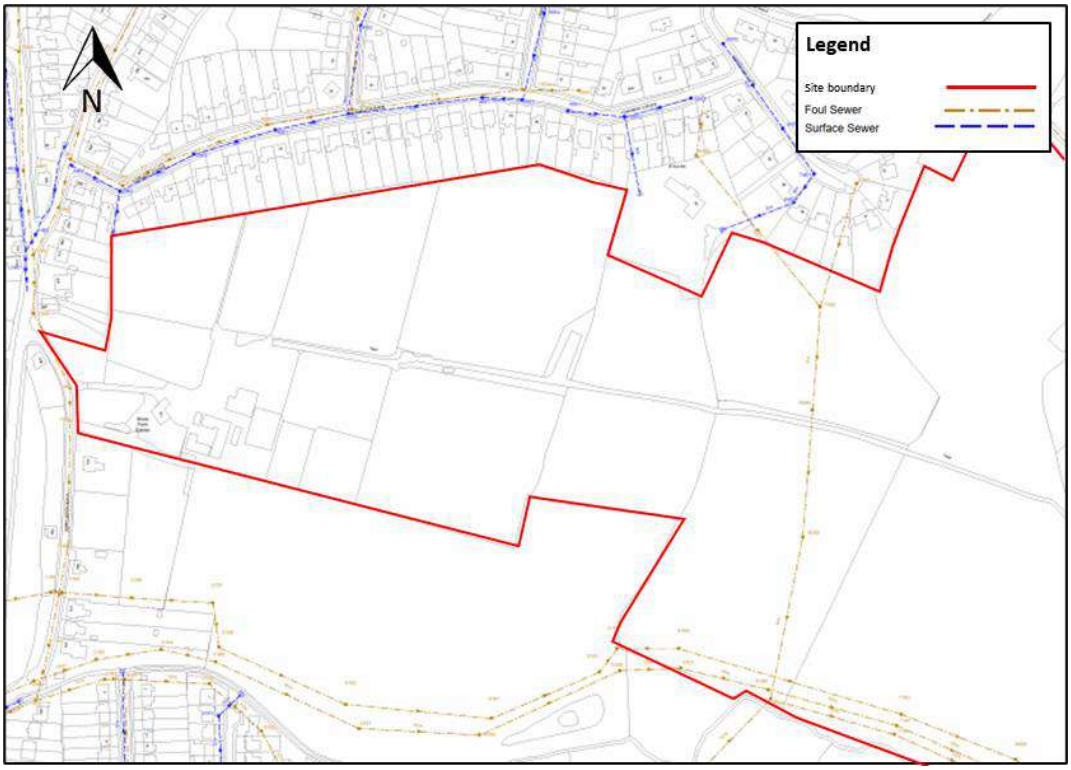

Figure 3-3: Existing Sewer Infrastructure

3.9. Refer to **Appendix C** for the Anglian Water Asset Plans.

4. SOURCES OF FLOODING

4.1. The NPPF requires flood risk from the following sources to be assessed, each of which are assessed separately below:

- Fluvial sources (river flooding);
- Tidal sources (flooding from the sea);
- Sewer Flooding;
- Groundwater sources;
- Pluvial sources (flooding resulting from overland flows);
- Artificial sources, canals, reservoirs etc.; and,
- It also requires the risk from increases in surface water discharge to be assessed (surface water management).

Flood Zone Designation

4.2. Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences. The NPPF Planning Practice Guidance defines Flood Zones as follows:

- **Flood Zone 1: Low Probability**. Land having a less than 1 in 1,000 annual probability of river or sea flooding.
- **Flood 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.
- **Flood 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.
- **Flood 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

Fluvial / Tidal Flooding

4.3. According to the Environment Agency's indicative flood map for planning, as illustrated below, the site almost entirely within Flood Zone 1; a very low risk of fluvial flooding which corresponds to an annual flood probability of less than 0.1% (less than 1 in 1000-year return period).

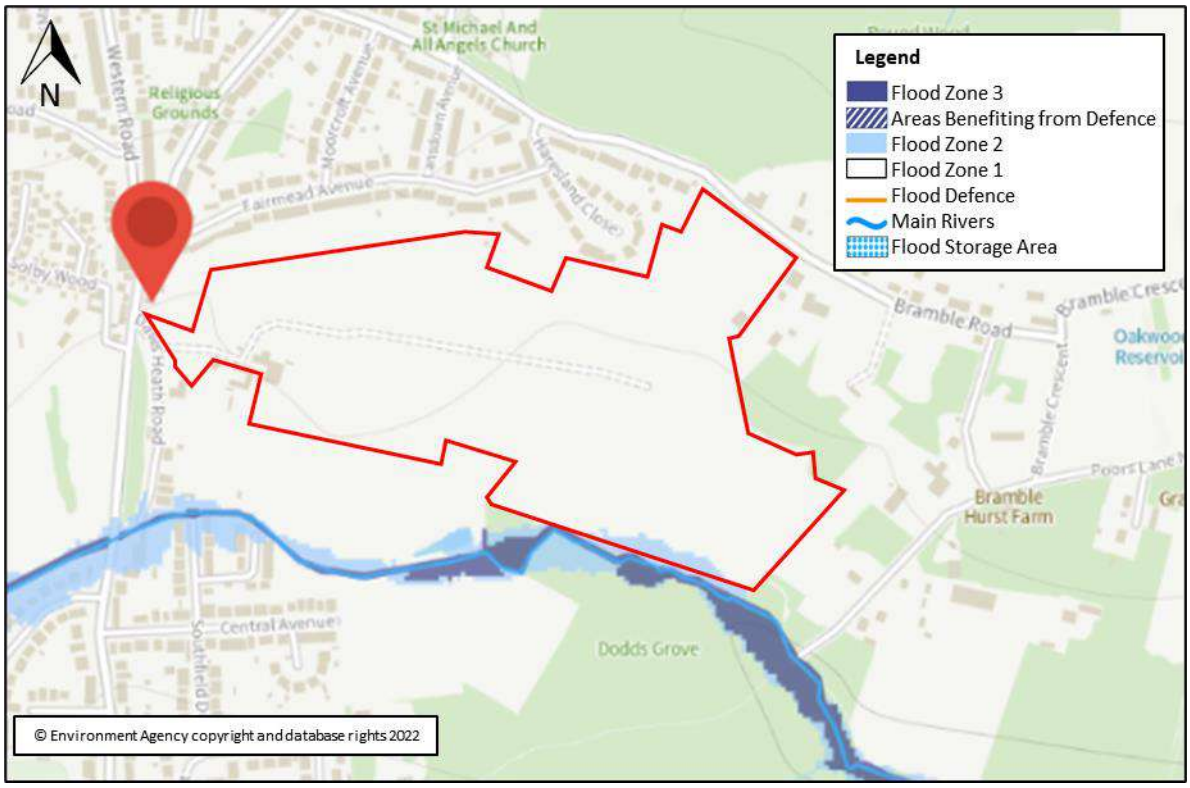

Figure 4-1: Environment Agency Flood Map for Planning

4.4. The nearest areas at risk of fluvial flooding are associated with Prittle Brook along the southwest boundary of the site where there are small areas of the site within Flood Zone 2 and Flood Zone 3. Notwithstanding, the nearest proposed developable areas of the site to these extents are approximately 200m north and elevated by circa 8m.

4.5. Given the above, fluvial flooding is not considered to pose a risk to the development.

4.6. There are no rivers or coastlines which are influenced by tidal flooding close to the site. Given the above, tidal flooding is not considered to pose a risk to the site.

Pluvial Flooding

4.7. A majority of the site is classified as having a very low risk of flooding as a result of surface water. There are two notable flow paths flowing north to south shown to be, partially, at medium-high risk of flooding. These are attributable to topography and the existing ditch network which passes through the site. The drainage proposals for the development are not only seeking to retain existing ditches but also provide additional storage features, which will seek to alleviate surface water flooding extents. Existing ditches will be maintained as part of the ongoing management plan for the development.

4.8. Following implementation of the proposed surface water drainage strategy and minor ground re-profiling, flooding from pluvial sources is considered low.

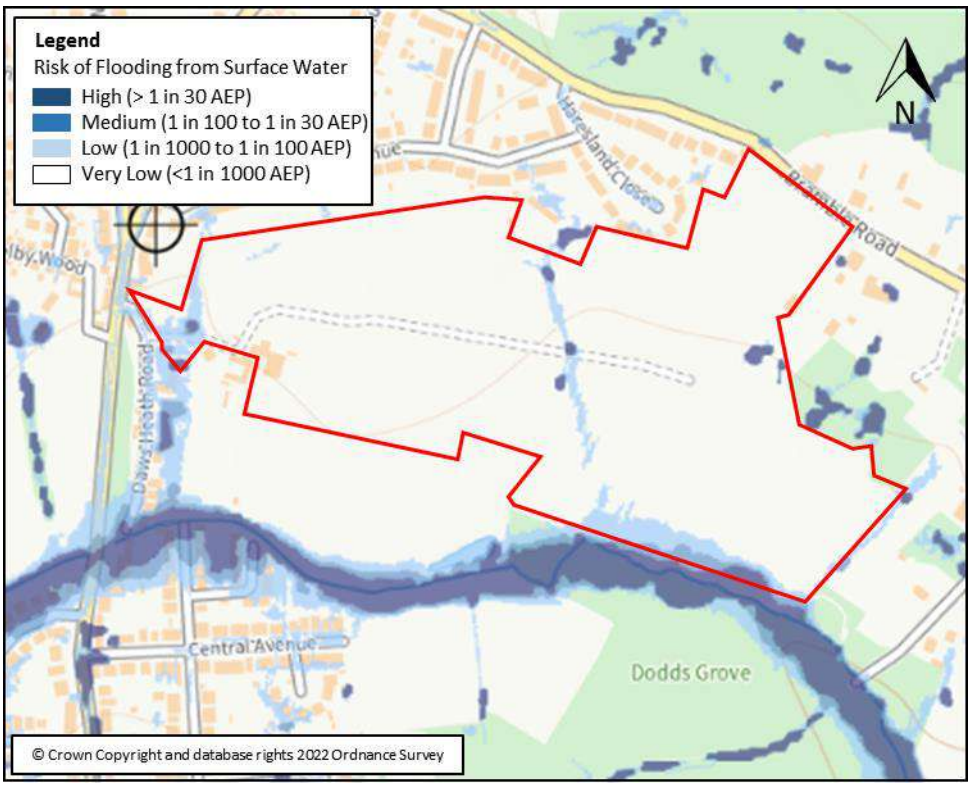

Figure 4-2: Environment Agency Flood Map for Surface Water

Groundwater Flooding

4.9. The Environment Agency's Areas Susceptible to Ground Water Flooding (AStGWf) map is provided in Appendix A of the South Essex SFRA (refer to **Figure 4-3** below). The AStGWf is a strategic scale map showing groundwater flood areas on a 1km square grid. The map displays the Site to be in a grid area with 25-50% chance of emergence of groundwater flooding.

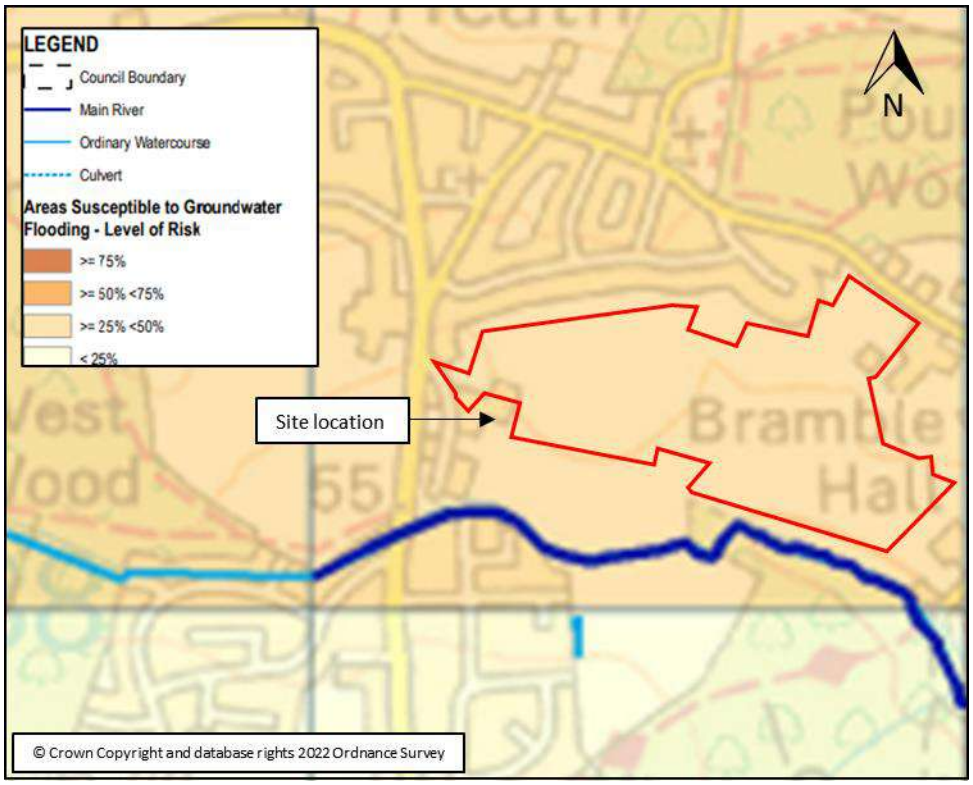

Figure 4-3: SFRA Ground Water Mapping

4.10. As outlined within the South Essex SFRA for the area, the predominant solid geology underlying the Castle Point Borough is London Clay. The presence of the above soils effectively creates an impermeable barrier to prevent groundwater rising to the surface and therefore significantly reduces risk of flooding.

4.11. Nevertheless, the location of Prittle Brook along the south west boundary gives rise to river terrace deposits that carry with them a higher risk of groundwater ingress.

4.12. Local boreholes located near the site show ground water at a depth of approximately 8m below ground. It is considered that groundwater would only pose a risk to sub ground level development. Since the development does not propose any below ground construction, groundwater is not seen as a flood risk to the development.

4.13. The EA has developed Groundwater Source Protection Zones (SPZ) to assist in assessing the risk to groundwater supplies taken from abstraction points. The application site is not located within a groundwater SPZ.

Sewer Flooding

4.14. During heavy rainfall, flooding from the sewer may occur if:

- The rainfall event exceeds the capacity of the sewer/drainage system;
- The system becomes blocked by debris or sediment; or
- The system surcharges due to high water levels in receiving watercourses.

4.15. As part of the South Essex SFRA Anglian Water provided an extract from their DG5 Flood Register for the study area, which records historic internal and external sewer flooding events. Due to data protection requirements the data has not been provided at individual property level; rather the register comprises the number of properties within four digit postcode areas that have experienced flooding either internally or externally within the last 10 years There are between 6-10 recorded incidents of sewer flooding in the SS7 2 postcode.

4.16. The risk of sewer flooding is assessed low.

Artificial Sources

4.17. According to the Environment Agency's Flood risk from reservoir map, the Site is not in an area at risk of flooding from artificial sources.

4.18. The site is therefore considered to be at a 'very low' risk of flooding from artificial sources.

5. PROPOSED SURFACE WATER DRAINAGE STRATEGY

Existing Surface Water Discharge

5.1. The planning redline boundary equates to 18.92ha of predominantly greenfield land with a proposed developable area of approximately 6.42ha. Based on the topography of the Site, the site will be split into 4 catchments. The greenfield runoff generated onsite currently flows overland into the existing ditches to the west, running through the site and the EA main river Prittle Brook in the southeast corner of the site.

5.2. The existing greenfield runoff rates from the existing catchments have been determined using the ICP SuDS Mean Annual Flow Method. The catchment size has been based upon the proposed developable area of 6.42ha, thereby excluding any large areas proposed as open green spaces which will continue to drain freely at greenfield rate. As detailed below, the Site has been split into four separate catchments areas to accommodate the Peak Greenfield Runoff rates are presented in **Table 5-1** below with an approximate existing catchment map in **Figure 5-1**. Greenfield runoff calculations can be found in **Appendix D**.

Table 5-1: Greenfield Discharge rates

	Size (Ha)	Existing Greenfield Run-off rate (l/s)			
Catchment reference		Qbar	1 in 1 year	1 in 30 year	1 in 100 year
Catchment 1	3.24	11.0	9.4	24.9	34.3
Catchment 2	1.70	5.8	4.9	13.1	48.5
Catchment 3	0.67	2.3	1.9	5.2	7.3
Catchment 4	0.81	3.0	2.3	6.2	8.8

Figure 5-1: Catchment Areas

Proposed Sustainable Drainage Systems (SuDS)

5.3. DEFRA's Non-statutory technical guidance for Sustainable Drainage Systems and CIRIA Guidance C753 "The SuDS Manual" have been used to determine the appropriate SuDS Strategy, which considers the spatial and environmental constraints of the Site.

5.4. Under the NPPF and its Planning Practice Guidance an allowance of 45% for the effects of climate change will achieve the policy requirements for the proposed development.

5.5. In accordance with the NPPF Planning Practice Guidance, surface water runoff should be disposed of according to the following hierarchy:

- into the ground (infiltration);
- to a surface water body;
- to a surface water sewer, highway drain, or another drainage system; or
- to a combined sewer.

5.6. As discussed in **Section 3**, The Site is underlain by Claygate Member and Bagshot formation, which characteristically have poor infiltration potential and thus considered infiltration for the site will not be possible or appropriate.

Figure 5-2: Proposed Catchment Areas

5.7. Due to the topography of the site and the available space, it is proposed to discharge surface water runoff from catchment 1 into the existing ditch to the west of the site and the rest of the site to discharge to the existing catchment 3 and 4 into the watercourse running west to east towards the Prittle Brook. Refer to **Figure 5-2** for the proposed catchment areas.

5.8. Surface water will be attenuated within a series of cascading Sustainable Urban Drainage features prior to being discharged to the existing ditch network at a restricted rate.

5.9. The constraints and opportunities for the use of SuDS techniques are appraised using the Management Train approach outlined in CIRIA C753 'The SuDS Manual' in **Table 5-2** below.

Table 5-2: Existing and Proposed Areas

Type:	**Infiltration Devices** (Source Control)
Constraints:	Underlying geology is underlain by Claygate member which has limited infiltration potential
Opportunities:	None due to underlying geology
Type:	**Lined Permeable Paving** (Source Control)
Constraints:	Can only be provided within non-adoptable areas. Additional maintenance requirements over more traditional SuDs features.
Opportunities:	Use of lined permeable paving can be provided if additional treatment and storage is required.
Type:	**Rainwater Harvesting** (Source Control)
Constraints:	The benefits of rainwater harvesting on a specific design storm event cannot be quantified, due to the seasonal availability of storage within the structure.

Opportunities:	It is difficult to quantify contribution, and therefore not included within calculations as part of this surface water management strategy
Type:	**Attenuation Basins**
Constraints:	In order to provide practicable attenuation benefits 1:3 side-slope swales tend to require a significant land requirement. Greater land take is also required due to the steep nature of the site.
Opportunities:	The proposed landscaped area areas around the edge of the development could provide basins for storage.
Type:	**GreenRoofs**
Constraints:	Subject to Architect's design.
Opportunities:	None due to the proposed pitched roofs of the dwellings.
Type:	**Attenuation Tanks** (end of pipe treatment)
Constraints:	None
Opportunities:	Should additional attenuation be required this could be achieved by use of oversized sewers or geo-cellular storage attenuation.

5.10. After consideration of the CIRIA C753 SuDS Management Train approach, the most viable SuDS options for this site is a solution combining a series of cascading attenuation basins and highway swales where possible. Refer to **Drawing No. W461-011 & W461-012** in **Appendix E** for the proposed surface water drainage strategy.

Proposed surface water runoff rates

5.11. The proposed discharge rates for the site are proposed to be restricted to a maximum of the 1 in 1 year greenfield rates for all storm events up to and including the 1 in 100 year plus 45% climate change event. For a breakdown of the existing and the proposed rates, refer to **Table 5-3**.

Table 5-3: Proposed & Existing Rates

Return Period	**1:1**			**1:100**			**1:100 + 45% CC**		
Catchment reference	**Exis. (l/s)**	**Prop. (l/s)**	**Red. %**	**Exis. (l/s)**	**Prop. (l/s)**	**Red. %**	**Exis. (l/s)**	**Prop. (l/s)**	**Red. %**
1	9.4	9.4	0	34.3	9.4	73	n/a	9.4	n/a
2	4.9	0	100	48.5	0	100	n/a	0	n/a
3*	1.9	1.9	0	7.3	1.9	74	n/a	1.9	n/a
4*	2.3	2.3	0	8.8	2.3	74	n/a	2.3	n/a

*Discharge location combined, split across the 2 catchments

5.12. MicroDrainage modelling results show there is no flooding on the Site during rainfall events up to the 1 in 100 year including 45% climate

change rainfall event. MicroDrainage modelling results are included in **Appendix F.**

Long Term Storage and Urban Creep

5.13. It is proposed to restrict discharge rates from the development site to a discharge rate equal to the 1 in 1 year greenfield rates for the proposed catchments. As such, the Long-Term Storage would not required in accordance with the recommendations of The SuDS Manual (C753).

5.14. It is proposed to develop the site for a residential use. As such, 10% urban creep on houses and garages only have been considered for this development.

Overland Flow Routes

5.15. The surface water drainage strategy has been designed to ensure minimal flooding occurs as a result of the 1 in 100-year rainfall event (including an allowance for climate change). Any minor flooding would be contained within the extent of the highway.

5.16. Site levels will be designed to ensure that exceedance flows are directed towards the proposed drainage network and away from buildings. Exceedance flows will be directed to the proposed surface water basins, the watercourses and ditches.

5.17. There is substantial volume provided within the freeboard of each basin, however, should the capacity of the surface water basins be exceeded during an extreme rainfall event, surface water would flow towards existing watercourses and ditches. Exceedance routes can be seen on drawing W461-011 & W461-012, within **Appendix G**.

Water Quality

5.18. An assessment of the water quality of surface water runoff has been carried out in line with CIRIA C753 requirements, refer to **Appendix H**.

5.19. In determining the necessary SuDS treatment methods, reference is made to Table 26.2, Table 26.3 and Table 26.4 of the SuDS Manual (CIRIA C753), which have been duplicated in **Appendix G**. The tables outline the 'Simple Index Approach' which sets out the water treatment criteria in relation to land use and SuDS performance evidence. To ensure sufficient treatment is proposed for surface waters, the total pollution mitigation index of the selected SuDS methods must equal or exceed the pollution hazard index for the site.

5.20. Based upon the proposed estate road layout within the development, it is anticipated that the majority of the roads within the development parcels will accommodate less than 300 traffic movements per day, apart from the initial access to the site which will be deemed as 'low' to 'medium'.

5.21. As the calculations demonstrate, a series of cascading basins provide sufficient treatment for the development. It has therefore been demonstrated that adequate treatment is provided within the proposed SuDS network prior to discharge of run-off into the existing watercourses. In addition to the basins considered within the pollution assessment, additional roadside swales will be incorporated to provide additional source control and treatment.

Maintenance and Management of System

5.22. The maintenance of all SuDS components will be in accord with the best practices and the CIRIA C753 The SuDS Manual. The recommended Operation and Maintenance requirements for the proposed swales and detention basin are outlined in the Management Plan in **Appendix H**.

5.23. A management company will be appointed to maintain any parts of the network which are not to be offered for adoption to Anglian Water.

Half Drain Time

5.24. The half drain time for the development, after a 1 in 30 year plus climate change event, can be seen within **Table 5-4**. The half drain time requirements set out within the ECC Sustainable Drainage

Systems Design Guide (February 2020), is to half drain within 24 hours for a 1 in 30 year plus climate change storm event. If the half drain time is not met, then the basin must accommodate a 1 in 10 year storm directly after the 1 in 30 year storm.

Table 5-3: Half Drain Times

Basin	Discharge rate (l/s)	Total Volume after storm (m^3)	Half Drain Time (hours)	Does it meet the 24 hour half drain time?	Freeboard after 1:30 year + CC storm (mm)	Freeboard after a 1:10 year storm and 1 in 30 year (mm)
1A & 1B	9.4	83	1.3	Yes	587	n/a
2A	180	759	0.6	Yes	560	n/a
2B	20	1499	10.4	Yes	526	n/a
2C	4.2	2398	79.3	No	495	74
4	1.3	303	32.4	No	486	203

5.25. Basin 1A, 1B, 2A and 2B can be seen to half drain greatly under the 24-hour requirement.

5.26. Basin 2C & 4 do not meet the half drain time requirement, half draining within 79.3 and 32.4 hours respectively. As per the ECC SuDS Design Guide, if the half drain time of 24 hours cannot be achieved after a 1 in 30 year plus climate change event, then a 1 in 10 year storm event must be accommodate directly after a 1 in 30 year storm event. The freeboard within Basin after a 1:30 year storm event will be 495mm for Basin 2C and 486mm for Basin 4. A 1 in 10 year storm has been run after the 30 year storm and shows that a freeboard of 74mm and 203mm are still provided. For further calculations on the storm events, refer to **Appendix F**.

6. PROPOSED FOUL WATER DRAINAGE STRATEGY

6.1. The existing site is currently greenfield land, and thus has no foul water flows associated with the site.

6.2. Based on the Sewerage Sector Guidance Appendix C of 0.05 l/s per dwelling, the peak foul flow rate for the proposed development is calculated to be 8.65l/s.

6.3. There is currently a 150mm dia. foul sewer running through the eastern half of the development. It is proposed that a small section of the existing sewer will be diverted through the development.

6.4. It is proposed that foul flows from the development will discharge into the existing Anglian Water foul sewers within the development boundary.

6.5. Under the Ofwat Charging agreement, from April 2020, existing sewer networks are obliged to accommodate flows from new developments and Anglian Water have confirmed capacity within their network. Refer to **Appendix I** for the confirmation of capacity.

6.6. For the foul drainage strategy, refer to **Appendix E**.

7. CONCLUSIONS

7.1. This FRA has been produced to support the planning application for the proposed residential development at Brook Farm.

7.2. The proposal includes the redevelopment of the site to provide 173 new dwellings with associated private gardens, parking, access roads, soft landscaping and drainage features.

7.3. The proposed developable areas of the site are assessed to be within Flood Zone 1 and therefore not at risk of flooding from fluvial or tidal sources.

7.4. Flood risk from reservoirs and artificial sources, pluvial sources, overland flows and groundwater are all considered to be low following the application of mitigation measures and the proposed surface water drainage strategy.

7.5. The drainage strategy set out in this report has been undertaken to accommodate all of the flows from the existing site and discharge at the 1 in 1 year greenfield rate for all events up to and including the 1 in 100 year + 45% climate change. The proposal is to discharge a portion of the site to the existing ditch on the western edge and the remainder of the site to discharge to the existing ditch running through the centre of the site prior to discharging to the EA Main River in the southeaster corner of the site.

7.6. The drainage strategy is suitable to protect the site and surrounding areas from surface water flooding for all events up to and including the 1 in 100-year storm event including a 45% allowance for climate change.

7.7. The peak foul flow rate for the proposed development is calculated to be 8.65l/s. It is proposed that foul flows from the development will discharge into the Anglian Water foul sewer running through the site. Confirmation of capacity has been received from Anglian Water for a connection to their 150mm diameter sewer within the site boundary.

7.8. In conclusion, this FRA demonstrates that the proposals are consistent with the aims of NPPF, PPG and ECC SuDS Guidance. The site would not be at risk of flooding or increase the flood risk to others.

Appendix A
Development Proposals

POUND WOOD
NATURE RESERVE

FAIRMEAD AVENUE

DAWS HEATH ROAD

BRAMBLE ROAD

Site
Entrance

Size 3

Size 5

Note; Please refer to landscape strategy for further information

1:1000
0m 10m 30m 60m

DAP

BROOK FARM
PROP SITE LAYOUT PLAN
BROOK FARM
DAWS HEATH ROAD

COUNTRYSIDE PARTNERSHIPS
17.05.2022 1:1000@A0 PROJECT 1762

300.04

Appendix B

Topographical Survey

N

Path (um)

Path (um)

BRAMBLE ROAD

Track

STN_13
581669.306
188323.397
59.095

STN_5
581772.815
188295.351
56.645

STN_7
581867.821
188384.511
62.407

STN_6
581849.172
188260.201
59.665

WATER

LEGEND

- SURVEY STATION
- UNDEFINED COVER
- GULLY
- WASH OUT
- SIGN POST
- LAMP COLUMN
- STOP COCK
- FIRE HYDRANT
- TREE
- UNIDENTIFIED ROUND COVER
- TELEGRAPH POLE
- VEGETATION
- KERB BACK
- BACK OF FOOTPATH
- DROPPED KERB
- WALL
- POST & WIRE FENCE
- GATE
- VEGETATION EDGE
- TOP OF BANK
- BOTT OF BANK
- C.B. FENCE

NOTE:
CONTROL FROM GPS WITH SCALE FACTOR REMOVED.
A SELECTION OF THE LARGER TREES HAVE BEEN SURVEYED.
BOUNDARY FENCES HAVE BEEN SURVEYED WHERE ACCESS IS AVAILABLE
OTHERWISE THE PHYSICAL BOUNDARY HAS BEEN RECORDED.
DITCHES HAVE BEEN SURVEYED WHERE ACCESS IS AVAILABLE.

M:\Planning & Design Templates\bsl-and-uass_2012.jpg

FS 53054 ISO 9001:2008
EMS 61920 ISO 14001:2004

COUNTRYSIDE
Places People Love
Countryside House
The Drive, Brentwood
Essex, CM13 3AT
01277 260000
countryside-properties.com

date: 30/05/14
scale: @A1 1/500
drawn by: LH
checked:

I Information
PL Planning
T Tender
C Construction
P Preliminary

project: DAWS HEATH RD
HADLEIGH
ESSEX

drawing: BROOK FARM
TOPOGRAPHIC
SURVEY

drawing no: SURV1826

sheet no: Sheet 3 of 4

rev:

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NOTE:
CONTROL FROM GPS WITH SCALE FACTOR REMOVED.
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HADLEIGH
ESSEX

drawing: BROOK FARM
TOPOGRAPHIC
SURVEY

drawing no: **SURV1826**

sheet no: Sheet 4 of 4

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N

FAIRMEAD AVENUE

FAIRMEAD AVENUE

DAWS HEATH ROAD

DAWS HEATH ROAD

68.0m

Hall

Brook Farm Stables

Pond

Track

LB

STN_17 581164.402 188514.082 65.339

STN_18 581178.943 188428.836 61.299

STN_14 581230.211 188352.734 58.623

STN_15 581204.144 188337.070 58.619

STN_16 581236.197 188334.974 58.520

STN_19 581159.338 188265.152 56.928

STN_9 581367.584 188370.532 62.688

STN_11 581356.535 188361.450 63.756

STN_10 581367.407 188310.184 62.502

NOTE:
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LEGEND

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project: DAWS HEATH RD HADLEIGH ESSEX

drawing: BROOK FARM TOPOGRAPHIC SURVEY

drawing no: SURV1826

sheet no: Sheet 1 of 4

rev:

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N

FAIRMEAD AVENUE

52

56

64

76

16

22

26

20

3

El Sub Sta

Pond

Track

STN_1
581417.847
188347.909
65.772

STN_2
581505.212
188246.139
65.267

STN_3
581641.392
188315.322
57.664

STN_4
581540.345
188330.450
63.152

STN_12
581439.947
188358.392
66.389

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drawn by: LH
checked:

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PL Planning
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project: DAWS HEATH RD
HADLEIGH
ESSEX

drawing: BROOK FARM
TOPOGRAPHIC
SURVEY

drawing no: SURV1826

sheet no: Sheet 2 of 4

rev:

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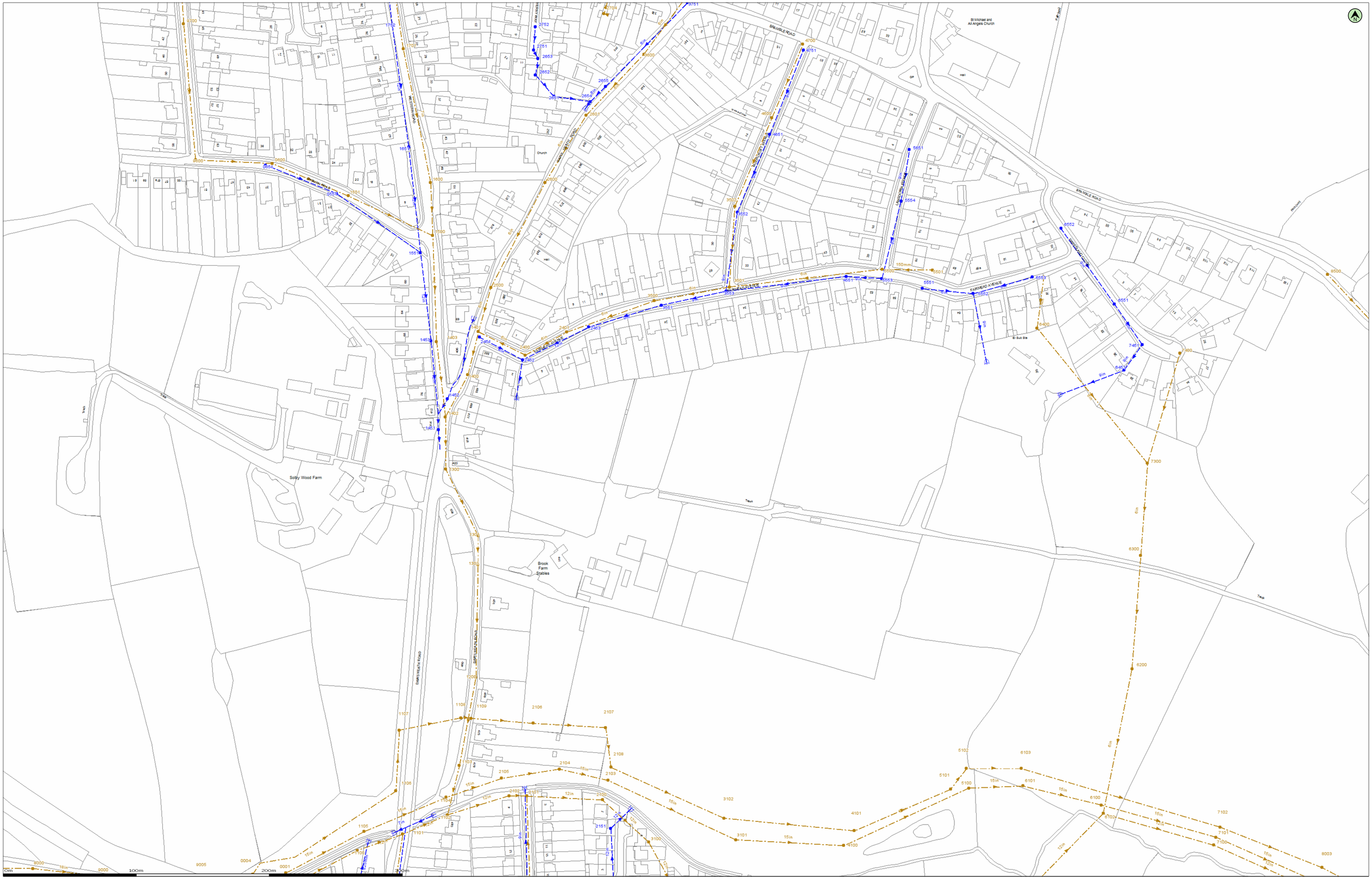
Appendix C

Asset Location Plan



(c) Crown Copyright and database rights 2011 Ordnance Survey 100018507 | Date: 18/06/14 | Scale: 1:1250 | Map Centre: 581355,188409 | Data updated: 01/05/14 | Our Ref: 102425 - 1 | Wastewater Plan A1

- Foul Sewer
- Surface Sewer
- Combined Sewer
- Final Effluent
- Rising Main (Colour denotes effluent type)
- Private Sewer (Colour denotes effluent type)
- Decommissioned Sewer (Colour denotes effluent type)
- Outfall (Colour denotes effluent type)
- Inlet (Colour denotes effluent type)
- Manhole (Colour denotes effluent type)
- Sewage Treatment Works
- Pumping Station

william.bayston@cpplc.com

Daws Heath

love every drop anglianwater

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
0001	581054	188083	F	-	-	-
0004	581030	188082	F	-	-	-
0600	581044	188616	F	-	-	-
1100	581108	188100	F	-	-	-
1101	581142	188112	F	-	-	-
1102	581176	188127	F	-	-	-
1103	581185	188164	F	-	-	-
1104	581175	188140	F	-	-	-
1105	581113	188114	F	-	-	-
1106	581137	188145	F	-	-	-
1107	581140	188190	F	-	-	-
1108	581186	188200	F	-	-	-
1109	581194	188199	F	-	-	-
1200	581197	188230	F	-	-	-
1300	581175	188386	F	-	-	-
1301	581199	188337	F	-	-	2.05
1302	581199	188315	F	-	-	2.08
1400	581191	188457	F	-	-	-
1401	581199	188490	F	-	-	-
1402	581174	188426	F	-	-	-
1403	581168	188482	F	-	-	-
1500	581165	188562	F	-	-	-
1501	581101	188592	F	-	-	-
1600	581163	188601	F	-	-	-
1701	581143	188702	F	-	-	-
2100	581292	188138	F	-	-	-
2101	581236	188141	F	-	-	-
2102	581222	188141	F	-	-	-
2103	581297	188153	F	-	-	-
2104	581260	188161	F	-	-	-
2105	581217	188154	F	-	-	-
2106	581241	188196	F	-	-	-
2107	581295	188192	F	-	-	-
2108	581299	188163	F	-	-	-
2400	581234	188472	F	-	-	-
2401	581265	188489	F	-	-	-
2500	581208	188523	F	-	-	-
2600	581249	188602	F	-	-	-
2601	581280	188652	F	-	-	-
2704	581294	188728	F	-	-	-
3100	581327	188106	F	-	-	-
3101	581393	188108	F	-	-	-
3102	581384	188124	F	-	-	-
3500	581331	188513	F	-	-	-
3501	581388	188523	F	-	-	-
3502	581392	188584	F	-	-	-
3600	581324	188698	F	-	-	-
4100	581474	188104	F	-	-	-
4101	581482	188115	F	-	-	-
4600	581420	188650	F	-	-	-
4700	581443	188705	F	-	-	-
5100	581568	188147	F	-	-	-
5101	581554	188146	F	-	-	-
5102	581566	188162	F	-	-	-
5500	581503	188536	F	-	-	-
5501	581540	188536	F	-	-	-
6100	581667	188134	F	-	-	-
6101	581608	188149	F	-	-	-
6102	581669	188128	F	-	-	-
6103	581607	188162	F	-	-	-
6200	581690	188237	F	-	-	-
6300	581697	188322	F	-	-	-
6400	581619	188492	F	-	-	-
7100	581752	188104	F	-	-	-
7101	581753	188110	F	-	-	-
7102	581756	188118	F	-	-	-
7300	581702	188391	F	-	-	-
7400	581726	188473	F	-	-	-
8000	580865	188087	F	-	-	-
8003	581833	188087	F	-	-	-
8500	581837	188533	F	-	-	1.8
9000	580912	188081	F	-	-	-
9600	580987	188619	F	-	-	-
9700	580978	188721	F	-	-	-
0551	581093	188593	S	-	-	-
0651	581039	188615	S	-	-	-
1451	581169	188416	S	-	-	-
1452	581176	188439	S	-	-	-
1453	581164	188483	S	-	-	-
1551	581156	188549	S	-	-	-
1651	581147	188628	S	-	-	-
1752	581135	188720	S	-	-	-
2151	581299	188117	S	-	-	-
2451	581200	188485	S	-	-	1.49
2452	581232	188468	S	-	-	1.83
2453	581282	188493	S	-	-	1.66
2651	581256	188666	S	-	-	-
2652	581242	188682	S	-	-	-
2653	581244	188695	S	-	-	-
2654	581283	188662	S	-	-	-
2655	581295	188674	S	-	-	-
2751	581241	188701	S	-	-	-
2752	581242	188718	S	-	-	-
3551	581337	188510	S	-	-	1.91
3552	581394	188579	S	-	-	1.82
3553	581385	188520	S	-	-	1.4
3751	581357	188737	S	-	-	0.76
4551	581476	188531	S	-	-	1.8
4651	581418	188638	S	-	-	1.35
4751	581443	188701	S	-	-	1.22
5551	581533	188522	S	-	-	1.68
5552	581571	188518	S	-	-	1.6
5553	581502	188530	S	-	-	1.32

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
5554	581517	188588	S	-	-	1.73
5651	581523	188626	S	-	-	1.42
6451	581684	188461	S	-	-	1
6551	581677	188510	S	-	-	1.65
6552	581637	188567	S	-	-	1.45
6553	581615	188531	S	-	-	1.45
7451	581698	188480	S	-	-	1.55

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Appendix D

Existing Greenfield Runoff Calculations

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.450
Area (ha)	1.000	Urban	0.000
SAAR (mm)	565	Region Number	Region 6

Results l/s

QBAR Rural	3.4
QBAR Urban	3.4
Q1 year	2.9
Q1 year	2.9
Q30 years	7.7
Q100 years	10.9

Appendix E

Preliminary Drainage Strategy

N

CATCHMENT 1
DEVELOPABLE AREA: 3.24ha
PERCENTAGE IMPERMEABLE: 60%
IMPERMEABLE AREA: 1.94ha
MINIMUM STORAGE REQUIRED: 1315m³

GREENFIELD RUNOFF RUNOFF RATES
1 IN 1 EVENT: 9.4l/s
1 IN 100 EVENT: 34.3l/s

CATCHMENT 2
DEVELOPABLE AREA: 1.70ha
PERCENTAGE IMPERMEABLE: 60%
IMPERMEABLE AREA: 1.02ha
MINIMUM STORAGE REQUIRED: 688m³

GREENFIELD RUNOFF RUNOFF RATES
1 IN 1 EVENT: 4.9l/s
1 IN 100 EVENT: 18.5l/s

CATCHMENT 3
DEVELOPABLE AREA: 0.28ha
PERCENTAGE IMPERMEABLE: 60%
IMPERMEABLE AREA: 0.17ha
MINIMUM STORAGE REQUIRED: 113m³

GREENFIELD RUNOFF RUNOFF RATES
1 IN 1 EVENT: 0.8l/s
1 IN 100 EVENT: 3.0l/s

CATCHMENT 1

CATCHMENT 2

CATCHMENT 3

BASIN 1A
TOTAL CONTRIBUTING IMPERMEABLE AREA: 0.27ha
VOLUME (EXCLUDING 300mm FREEBOARD): 126m³
TOP OF BASIN AREA: 278m²
BOTTOM OF BASIN AREA: 31m²
PROPOSED BASIN IL: 57.98mAOD
DISCHARGE RATE: 9.4l/s FOR ALL STORM EVENTS

BASIN 1B
TOTAL CONTRIBUTING IMPERMEABLE AREA (EXCLUDING ADDITIONAL FLOWS FROM UPSTREAM): 0ha
VOLUME (EXCLUDING 300mm FREEBOARD): 110m³
TOP OF BASIN AREA: 235m²
BOTTOM OF BASIN AREA: 36m²
PROPOSED BASIN IL: 57.82mAOD
DISCHARGE RATE: 9.4 l/s FOR ALL STORM EVENTS

BASIN 2A
TOTAL CONTRIBUTING IMPERMEABLE AREA: 3.08ha
VOLUME (EXCLUDING 300mm FREEBOARD): 1029m³
TOP OF BASIN AREA: 1216m²
BOTTOM OF BASIN AREA: 643m²
PROPOSED BASIN IL: 56.09mAOD
DISCHARGE RATE: 180l/s FOR ALL STORM EVENTS

DRAINAGE ROUTE SUBJECT TO AGREEMENT WITH ANGLIAN WATER. REDUCED EASEMENT WIDTH LIKELY REQUIRED DUE TO NARROW ROUTE BETWEEN HOUSE AND GARAGE

PROPOSED OUTFALL INTO EXISTING DITCH AT 9.4 l/s
PROPOSED OUTFALL IL: 57.75
DITCH LEVEL: 57.63

FOR CONTINUATION SEE W461-012

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE RELEVANT SPECIFICATION AND ALL OTHER RELATED DRAWINGS ISSUED BY THE ENGINEER.
2. DO NOT SCALE FROM THIS DRAWING. WORK FROM FIGURED DIMENSIONS ONLY.
3. ALL DIMENSIONS SHOWN ON THIS DRAWING ARE IN METERS UNLESS OTHERWISE STATED.
4. ALL DIMENSIONS, LEVEL AND SURVEY GRID CO-ORDINATES ARE TO BE CHECKED ON SITE AND THE ENGINEER NOTIFIED IMMEDIATELY OF ANY DISCREPANCIES PRIOR TO THE COMMENCEMENT OF WORKS.
5. NO DEVIATION FROM THE DETAILS SHOWN ON THIS DRAWING IS PERMITTED WITHOUT PRIOR PERMISSION FROM THE ENGINEER.
6. ANY WORKS OUTSIDE RED SITE BOUNDARY ARE FOR INFORMATION PURPOSES ONLY. UNLESS SPECIFICALLY NOTED, ALL WORKS OUTSIDE THE SITE BOUNDARY WILL BE UNDERTAKEN BY OTHERS UNDER A SEPARATE.
7. ALL EXISTING SERVICE ROUTES HAVE BEEN TRANSCRIBED FROM THE RESPECTIVE UNDERTAKERS RECORDS AND AS SUCH NO RESPONSIBILITY IS ACCEPTED BY ARDENT CONSULTING ENGINEERS FOR THE ACCURACY OF ROUTES SHOWN.
8. THE AVOIDANCE AND PROTECTION OF SERVICES DURING THE WORKS IS THE RESPONSIBILITY OF THE CONTRACTOR.
9. THE CONTRACTOR IS REMINDED OF HIS OBLIGATION TO VERIFY THE ROUTE OF ALL SERVICES ON SITE PRIOR TO THE COMMENCEMENT OF THE WORKS.
10. THE CONTRACTOR SHOULD ALLOW FOR ANY NECESSARY LIAISON WITH THE STATUTORY UTILITIES DURING THE COURSE OF THE WORKS TO AVOID ANY DISRUPTION TO RETAINED SERVICES.
11. THE CONTRACTOR SHOULD NOTE THAT THE SERVICES SHOWN ARE NOT TO BE CONSIDERED EXHAUSTIVE. PRIVATE SERVICES MAY BE PRESENT WITHIN THE LIMIT OF WORKS AND CARE SHOULD BE TAKEN TO LOCATE AND AVOID THESE DURING CONSTRUCTION.

ALL INFORMATION REGARDING DRAINAGE IS INDICATIVE ONLY AND FOR INFORMATION ONLY.

SITE LAYOUT IS BASED UPON DAP ARCHITECTURE PROPOSED SITE LAYOUT PLAN, REF. 1762_300_03, DATED 22/05/2022.

TOPOGRAPHICAL SURVEY IS BASED UPON DRAWING BROOK FARM TOPOGRAPHIC SURVEY REV B, REF. SURV1826 DATED 30/11/21.

KEY

- SITE BOUNDARY
- PROPOSED SURFACE WATER SEWER AND MANHOLE
- PROPOSED ATTENUATION BASIN
- PROPOSED SWALE
- PROPOSED HEADWALL
- PROPOSED FOUL WATER SEWER AND MANHOLE
- PROPOSED REMOVAL OF EXISTING SEWER
- EX FW EXISTING FOUL WATER SEWER
- EXISTING WATERCOURSE
- EXISTING EA MAIN RIVER
- EXISTING CATCHMENT 1
- EXISTING CATCHMENT 2
- EXISTING CATCHMENT 3
- EXISTING CATCHMENT 4
- BASIN 1 CATCHMENT
- BASIN 2 CATCHMENT
- BASIN 4 CATCHMENT
- EXCEEDANCE ROUTE
- FFL: xxxx PROPOSED FINISHED FLOOR LEVEL

FOR PLANNING

NOT FOR CONSTRUCTION

0m 10m 50m
Scale: 1:1000 @ A0

Rev	Description	Drn	Chk	App	Date
A	EXCEEDANCE ROUTES & FFLs ADDED	AW	AW	BB	30.05.22

ARDENT CONSULTING ENGINEERS
Third Floor
The Hallmark Building
52-56 Leadenhall Street
London
EC3M 5JE
Tel: 020 7680 4088
Web: www.ardent-ce.co.uk
E-mail: enquiries@ardent-ce.co.uk

Client: COUNTRYSIDE PARTNERSHIPS PLC

Project Title: LAND AT BROOK FARM, HADLEIGH

Drawing Title: PROPOSED DRAINAGE STRATEGY (SHEET 1 OF 2)

A0 Scale	Date	Designed by
1:1000	MAY 2022	AW
Drawn by	Checked by	Approved by
AW	AW	BB
Drawing Number		Rev
W461-011		A

File Location: y:\ardent projects\w461 - land at brook farm, hadleigh\technical\acad\drawings\w461-011-012 proposed drainage strategy.dwg

CATCHMENT 3
DEVELOPABLE AREA: 0.67ha
PERCENTAGE IMPERMEABLE: 60%
IMPERMEABLE AREA: 0.40ha
MINIMUM STORAGE REQUIRED: 271m³

GREENFIELD RUNOFF RUNOFF RATES
1 IN 1 EVENT: 1.9l/s
1 IN 100 EVENT: 7.3l/s

CATCHMENT 4
DEVELOPABLE AREA: 0.81ha
PERCENTAGE IMPERMEABLE: 60%
IMPERMEABLE AREA: 0.49ha
MINIMUM STORAGE REQUIRED: 333m³

GREENFIELD RUNOFF RUNOFF RATES
1 IN 1 EVENT: 2.3l/s
1 IN 100 EVENT: 8.8l/s

CATCHMENT 2

CATCHMENT 3

CATCHMENT 4

BASIN 4
TOTAL CONTRIBUTING IMPERMEABLE AREA: 0.49ha
VOLUME (EXCLUDING 300mm FREEBOARD): 386m³
TOP OF BASIN AREA: 556m²
BOTTOM OF BASIN AREA: 191m²
PROPOSED BASIN IL: 56.00
DISCHARGE RATE: 1.3 l/s FOR ALL STORM EVENTS

BASIN 2A
TOTAL CONTRIBUTING IMPERMEABLE AREA: 3.08ha
VOLUME (EXCLUDING 300mm FREEBOARD): 1029m³
TOP OF BASIN AREA: 1216m²
BOTTOM OF BASIN AREA: 643m²
PROPOSED BASIN IL: 56.09mAOD
DISCHARGE RATE: 180l/s FOR ALL STORM EVENTS

BASIN 2B
TOTAL CONTRIBUTING IMPERMEABLE AREA (EXCLUDING ADDITIONAL FLOWS FROM UPSTREAM): 0ha
VOLUME (EXCLUDING 300mm FREEBOARD): 1923m³
TOP OF BASIN AREA: 2123m²
BOTTOM OF BASIN AREA: 1283m²
PROPOSED BASIN IL: 52.50
DISCHARGE RATE: 20 l/s FOR ALL STORM EVENTS

BASIN 2C
TOTAL CONTRIBUTING IMPERMEABLE AREA (EXCLUDING ADDITIONAL FLOWS FROM UPSTREAM): 0ha
VOLUME (EXCLUDING 300mm FREEBOARD): 2946m³
TOP OF BASIN AREA: 3093m²
BOTTOM OF BASIN AREA: 2056m²
PROPOSED BASIN IL: 52.05
DISCHARGE RATE: 4.2 l/s FOR ALL STORM EVENTS (COMBINED CATCHMENT 3 & 4 1:1 GREENFIELD RATES)

PROPOSED OUTFALL INTO EXISTING DITCH AT 4.2 l/s
PROPOSED OUTFALL IL: 51.95
DITCH LEVEL: 51.83

FOR CONTINUATION SEE W461-011

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE RELEVANT SPECIFICATION AND ALL OTHER RELATED DRAWINGS ISSUED BY THE ENGINEER.
2. DO NOT SCALE FROM THIS DRAWING. WORK FROM FIGURED DIMENSIONS ONLY.
3. ALL DIMENSIONS SHOWN ON THIS DRAWING ARE IN METERS UNLESS OTHERWISE STATED.
4. ALL DIMENSIONS, LEVEL AND SURVEY GRID CO-ORDINATES ARE TO BE CHECKED ON SITE AND THE ENGINEER NOTIFIED IMMEDIATELY OF ANY DISCREPANCIES PRIOR TO THE COMMENCEMENT OF WORKS.
5. NO DEVIATION FROM THE DETAILS SHOWN ON THIS DRAWING IS PERMITTED WITHOUT PRIOR PERMISSION FROM THE ENGINEER.
6. ANY WORKS OUTSIDE RED SITE BOUNDARY ARE FOR INFORMATION PURPOSES ONLY. UNLESS SPECIFICALLY NOTED, ALL WORKS OUTSIDE THE SITE BOUNDARY WILL BE UNDERTAKEN BY OTHERS UNDER A SEPARATE.
7. ALL EXISTING SERVICE ROUTES HAVE BEEN TRANSCRIBED FROM THE RESPECTIVE UNDERTAKERS RECORDS AND AS SUCH NO RESPONSIBILITY IS ACCEPTED BY ARDENT CONSULTING ENGINEERS FOR THE ACCURACY OF ROUTES SHOWN.
8. THE AVOIDANCE AND PROTECTION OF SERVICES DURING THE WORKS IS THE RESPONSIBILITY OF THE CONTRACTOR.
9. THE CONTRACTOR IS REMINDED OF HIS OBLIGATION TO VERIFY THE ROUTE OF ALL SERVICES ON SITE PRIOR TO THE COMMENCEMENT OF THE WORKS.
10. THE CONTRACTOR SHOULD ALLOW FOR ANY NECESSARY LIAISON WITH THE STATUTORY UTILITIES DURING THE COURSE OF THE WORKS TO AVOID ANY DISRUPTION TO RETAINED SERVICES.
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ALL INFORMATION REGARDING DRAINAGE IS INDICATIVE ONLY AND FOR INFORMATION ONLY.

SITE LAYOUT IS BASED UPON DAP ARCHITECTURE PROPOSED SITE LAYOUT PLAN, REF. 1762_300_03, DATED 22/05/2022.

TOPOGRAPHICAL SURVEY IS BASED UPON DRAWING BROOK FARM TOPOGRAPHIC SURVEY REV B, REF. SURV1826 DATED 30/11/21.

KEY

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- PROPOSED FOUL WATER SEWER AND MANHOLE
- PROPOSED REMOVAL OF EXISTING SEWER
- EX FW — EXISTING FOUL WATER SEWER
- EXISTING WATERCOURSE
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- EXISTING CATCHMENT 1
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- EXISTING CATCHMENT 4
- BASIN 1 CATCHMENT
- BASIN 2 CATCHMENT
- BASIN 4 CATCHMENT
- EXCEEDANCE ROUTE
- FFL: xxxx — PROPOSED FINISHED FLOOR LEVEL

FOR PLANNING

NOT FOR CONSTRUCTION

0m 10m 50m
Scale: 1:1000 @ A0

Rev	Description	Drn	Chk	App	Date
A	EXCEEDANCE ROUTES & FFLs ADDED	AW	AW	BB	30.05.22

ARDENT CONSULTING ENGINEERS
Third Floor
The Hallmark Building
52-56 Leadenhall Street
London
EC3M 5JE
Tel: 020 7680 4088
Web: www.ardent-ce.co.uk
E-mail: enquiries@ardent-ce.co.uk

Client
COUNTRYSIDE PARTNERSHIPS PLC

Project Title:
LAND AT BROOK FARM, HADLEIGH

Drawing Title:
PROPOSED DRAINAGE STRATEGY (SHEET 2 OF 2)

A0 Scale	Date	Designed by
1:1000	MAY 2022	AW
Drawn by	Checked by	Approved by
AW	AW	BB
Drawing Number		Rev
W461-012		A

File Location: y:\ardent projects\w461 - land at brook farm, hadleigh\technical\ acad\ drawings\ w461-011-012 proposed drainage strategy.dwg

Appendix F

Microdrainage Simulations

Cascade Summary of Results for W461 - Basin 1A.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	W461 - Basin 1B.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.821	0.821	9.3	60.4	O K
30 min Summer	0.929	0.929	9.3	76.2	O K
60 min Summer	0.988	0.988	9.3	85.8	O K
120 min Summer	0.982	0.982	9.3	84.7	O K
180 min Summer	0.955	0.955	9.3	80.3	O K
240 min Summer	0.925	0.925	9.3	75.5	O K
360 min Summer	0.861	0.861	9.3	66.0	O K
480 min Summer	0.793	0.793	9.3	56.7	O K
600 min Summer	0.709	0.709	9.3	46.4	O K
720 min Summer	0.626	0.626	9.3	37.4	O K
960 min Summer	0.473	0.473	9.3	23.7	O K
1440 min Summer	0.248	0.248	9.1	9.3	O K
2160 min Summer	0.140	0.140	7.6	4.5	O K
2880 min Summer	0.114	0.114	6.0	3.5	O K
4320 min Summer	0.091	0.091	4.3	2.7	O K
5760 min Summer	0.079	0.079	3.4	2.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.993	0.0	70.4	24
30 min Summer	90.986	0.0	92.1	37
60 min Summer	56.713	0.0	114.8	64
120 min Summer	34.148	0.0	138.3	104
180 min Summer	25.042	0.0	152.1	136
240 min Summer	19.977	0.0	161.8	170
360 min Summer	14.486	0.0	176.0	238
480 min Summer	11.532	0.0	186.8	308
600 min Summer	9.655	0.0	195.5	368
720 min Summer	8.347	0.0	202.8	428
960 min Summer	6.629	0.0	214.8	540
1440 min Summer	4.783	0.0	232.5	756
2160 min Summer	3.446	0.0	251.2	1100
2880 min Summer	2.728	0.0	265.1	1468
4320 min Summer	1.960	0.0	285.8	2204
5760 min Summer	1.549	0.0	301.1	2936

Cascade Summary of Results for W461 - Basin 1A.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	0.071	0.071	2.8	2.1	O K
8640 min Summer	0.065	0.065	2.5	1.9	O K
10080 min Summer	0.061	0.061	2.2	1.7	O K
15 min Winter	0.879	0.879	9.3	68.7	O K
30 min Winter	0.995	0.995	9.3	87.0	O K
60 min Winter	1.065	1.065	9.3	99.3	O K
120 min Winter	1.066	1.066	9.3	99.5	O K
180 min Winter	1.032	1.032	9.3	93.5	O K
240 min Winter	0.993	0.993	9.3	86.6	O K
360 min Winter	0.904	0.904	9.3	72.4	O K
480 min Winter	0.803	0.803	9.3	58.1	O K
600 min Winter	0.666	0.666	9.3	41.7	O K
720 min Winter	0.534	0.534	9.3	28.7	O K
960 min Winter	0.302	0.302	9.3	12.1	O K
1440 min Winter	0.140	0.140	7.6	4.5	O K
2160 min Winter	0.107	0.107	5.5	3.3	O K
2880 min Winter	0.092	0.092	4.4	2.7	O K
4320 min Winter	0.075	0.075	3.1	2.2	O K
5760 min Winter	0.066	0.066	2.5	1.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.289	0.0	313.3	3672
8640 min Summer	1.110	0.0	323.6	4360
10080 min Summer	0.977	0.0	332.5	4968
15 min Winter	138.993	0.0	78.8	24
30 min Winter	90.986	0.0	103.2	37
60 min Winter	56.713	0.0	128.6	64
120 min Winter	34.148	0.0	154.9	116
180 min Winter	25.042	0.0	170.4	146
240 min Winter	19.977	0.0	181.2	184
360 min Winter	14.486	0.0	197.1	258
480 min Winter	11.532	0.0	209.2	332
600 min Winter	9.655	0.0	219.0	392
720 min Winter	8.347	0.0	227.2	446
960 min Winter	6.629	0.0	240.5	540
1440 min Winter	4.783	0.0	260.3	736
2160 min Winter	3.446	0.0	281.3	1100
2880 min Winter	2.728	0.0	297.0	1460
4320 min Winter	1.960	0.0	320.1	2136
5760 min Winter	1.549	0.0	337.2	2904

Cascade Summary of Results for W461 - Basin 1A.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Winter	0.059	0.059	2.1	1.7	O K
8640 min Winter	0.054	0.054	1.8	1.5	O K
10080 min Winter	0.051	0.051	1.6	1.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.289	0.0	350.9	3560
8640 min Winter	1.110	0.0	362.4	4256
10080 min Winter	0.977	0.0	372.4	5048

Cascade Rainfall Details for W461 - Basin 1A.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.407	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.270

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.090	4	8	0.090	8	12	0.090

Cascade Model Details for W461 - Basin 1A.SRCX

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	26.0	1.200	215.0	1.500	278.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0139-9400-1200-9400
Design Head (m)	1.200
Design Flow (l/s)	9.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	139
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	9.4	Kick-Flo®	0.769	7.6
Flush-Flo™	0.355	9.3	Mean Flow over Head Range	-	8.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.0	1.200	9.4	3.000	14.5	7.000	21.7
0.200	8.8	1.400	10.1	3.500	15.6	7.500	22.5
0.300	9.3	1.600	10.8	4.000	16.6	8.000	23.2
0.400	9.3	1.800	11.4	4.500	17.6	8.500	23.9
0.500	9.2	2.000	12.0	5.000	18.5	9.000	24.5
0.600	8.9	2.200	12.5	5.500	19.4	9.500	25.2
0.800	7.8	2.400	13.0	6.000	20.2		
1.000	8.6	2.600	13.5	6.500	21.0		

Cascade Summary of Results for W461 - Basin 1B.SRCX

Upstream Structures	Outflow To	Overflow To
W461 - Basin 1A.SRCX	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.212	0.212	8.8	6.8	O K
30 min Summer	0.212	0.212	8.8	6.8	O K
60 min Summer	0.212	0.212	8.8	6.9	O K
120 min Summer	0.212	0.212	8.8	6.9	O K
180 min Summer	0.212	0.212	8.8	6.9	O K
240 min Summer	0.212	0.212	8.8	6.8	O K
360 min Summer	0.215	0.215	8.8	7.0	O K
480 min Summer	0.224	0.224	8.9	7.3	O K
600 min Summer	0.232	0.232	8.9	7.7	O K
720 min Summer	0.245	0.245	9.0	8.3	O K
960 min Summer	0.259	0.259	9.1	8.9	O K
1440 min Summer	0.215	0.215	8.8	7.0	O K
2160 min Summer	0.142	0.142	7.5	4.2	O K
2880 min Summer	0.116	0.116	6.0	3.3	O K
4320 min Summer	0.092	0.092	4.4	2.5	O K
5760 min Summer	0.080	0.080	3.4	2.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.993	0.0	70.3	128
30 min Summer	90.986	0.0	92.1	175
60 min Summer	56.713	0.0	114.8	222
120 min Summer	34.148	0.0	138.3	274
180 min Summer	25.042	0.0	152.1	314
240 min Summer	19.977	0.0	161.8	350
360 min Summer	14.486	0.0	176.0	416
480 min Summer	11.532	0.0	186.8	470
600 min Summer	9.655	0.0	195.5	500
720 min Summer	8.347	0.0	202.8	536
960 min Summer	6.629	0.0	214.8	622
1440 min Summer	4.783	0.0	232.4	798
2160 min Summer	3.446	0.0	251.2	1108
2880 min Summer	2.728	0.0	265.1	1472
4320 min Summer	1.960	0.0	285.7	2196
5760 min Summer	1.549	0.0	301.1	2904

Cascade Summary of Results for W461 - Basin 1B.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	0.071	0.071	2.8	1.9	O K
8640 min Summer	0.066	0.066	2.5	1.7	O K
10080 min Summer	0.061	0.061	2.2	1.6	O K
15 min Winter	0.212	0.212	8.8	6.8	O K
30 min Winter	0.212	0.212	8.8	6.9	O K
60 min Winter	0.212	0.212	8.8	6.9	O K
120 min Winter	0.213	0.213	8.8	6.9	O K
180 min Winter	0.213	0.213	8.8	6.9	O K
240 min Winter	0.212	0.212	8.8	6.9	O K
360 min Winter	0.212	0.212	8.8	6.8	O K
480 min Winter	0.221	0.221	8.9	7.2	O K
600 min Winter	0.241	0.241	9.0	8.1	O K
720 min Winter	0.263	0.263	9.1	9.1	O K
960 min Winter	0.249	0.249	9.0	8.4	O K
1440 min Winter	0.143	0.143	7.6	4.2	O K
2160 min Winter	0.108	0.108	5.5	3.0	O K
2880 min Winter	0.092	0.092	4.4	2.5	O K
4320 min Winter	0.076	0.076	3.2	2.0	O K
5760 min Winter	0.066	0.066	2.5	1.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.289	0.0	313.3	3672
8640 min Summer	1.110	0.0	323.6	4400
10080 min Summer	0.977	0.0	332.5	5048
15 min Winter	138.993	0.0	78.8	146
30 min Winter	90.986	0.0	103.2	196
60 min Winter	56.713	0.0	128.6	248
120 min Winter	34.148	0.0	154.9	304
180 min Winter	25.042	0.0	170.4	344
240 min Winter	19.977	0.0	181.2	378
360 min Winter	14.486	0.0	197.1	444
480 min Winter	11.532	0.0	209.2	498
600 min Winter	9.655	0.0	219.0	516
720 min Winter	8.347	0.0	227.2	544
960 min Winter	6.629	0.0	240.5	598
1440 min Winter	4.783	0.0	260.3	744
2160 min Winter	3.446	0.0	281.3	1104
2880 min Winter	2.728	0.0	297.0	1468
4320 min Winter	1.960	0.0	320.0	2200
5760 min Winter	1.549	0.0	337.2	2920

Cascade Summary of Results for W461 - Basin 1B.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Winter	0.060	0.060	2.1	1.6	O K
8640 min Winter	0.055	0.055	1.8	1.4	O K
10080 min Winter	0.051	0.051	1.6	1.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.289	0.0	350.9	3600
8640 min Winter	1.110	0.0	362.4	4376
10080 min Winter	0.977	0.0	372.4	4992

Cascade Rainfall Details for W461 - Basin 1B.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.407	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Cascade Model Details for W461 - Basin 1B.SRCX

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	24.0	1.200	184.0	1.500	235.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0136-9400-1350-9400
Design Head (m)	1.350
Design Flow (l/s)	9.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	136
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.350	9.4	Kick-Flo®	0.852	7.6
Flush-Flo™	0.398	9.4	Mean Flow over Head Range	-	8.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.9	1.200	8.9	3.000	13.7	7.000	20.6
0.200	8.7	1.400	9.6	3.500	14.8	7.500	21.2
0.300	9.3	1.600	10.2	4.000	15.7	8.000	21.9
0.400	9.4	1.800	10.8	4.500	16.6	8.500	22.6
0.500	9.3	2.000	11.3	5.000	17.5	9.000	23.2
0.600	9.1	2.200	11.8	5.500	18.3	9.500	23.8
0.800	8.1	2.400	12.3	6.000	19.1		
1.000	8.2	2.600	12.8	6.500	19.8		

Cascade Summary of Results for W461 - Basin 2A.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	W461 - Basin 2B.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	58.309	0.859	179.8	680.7	O K
30 min Summer	58.485	1.035	179.8	854.7	O K
60 min Summer	58.570	1.120	179.8	943.1	O K
120 min Summer	58.559	1.109	179.8	931.5	O K
180 min Summer	58.495	1.045	179.8	865.2	O K
240 min Summer	58.411	0.961	179.8	780.0	O K
360 min Summer	58.249	0.799	179.8	624.2	O K
480 min Summer	58.115	0.665	179.7	503.8	O K
600 min Summer	58.013	0.563	177.9	416.3	O K
720 min Summer	57.940	0.490	174.6	355.5	O K
960 min Summer	57.867	0.417	154.7	297.2	O K
1440 min Summer	57.794	0.344	117.5	241.1	O K
2160 min Summer	57.736	0.286	87.2	197.6	O K
2880 min Summer	57.702	0.252	70.0	172.2	O K
4320 min Summer	57.660	0.210	50.9	142.3	O K
5760 min Summer	57.635	0.185	40.2	124.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.957	0.0	827.6	22
30 min Summer	94.236	0.0	1084.6	34
60 min Summer	58.739	0.0	1355.0	54
120 min Summer	35.368	0.0	1632.1	88
180 min Summer	25.936	0.0	1795.5	122
240 min Summer	20.691	0.0	1909.9	156
360 min Summer	15.003	0.0	2077.4	218
480 min Summer	11.944	0.0	2205.0	276
600 min Summer	10.000	0.0	2307.7	332
720 min Summer	8.645	0.0	2394.0	388
960 min Summer	6.865	0.0	2534.8	502
1440 min Summer	4.954	0.0	2743.1	742
2160 min Summer	3.569	0.0	2966.6	1104
2880 min Summer	2.825	0.0	3131.1	1472
4320 min Summer	2.030	0.0	3373.0	2204
5760 min Summer	1.604	0.0	3556.3	2936

Cascade Summary of Results for W461 - Basin 2A.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	57.618	0.168	33.6	112.3	O K
8640 min Summer	57.605	0.155	28.9	103.3	O K
10080 min Summer	57.595	0.145	25.5	96.4	O K
15 min Winter	58.405	0.955	179.8	774.2	O K
30 min Winter	58.598	1.148	179.8	972.7	O K
60 min Winter	58.690	1.240	182.9	1073.6	Flood Risk
120 min Winter	58.658	1.208	180.6	1037.5	Flood Risk
180 min Winter	58.563	1.113	179.8	935.5	O K
240 min Winter	58.438	0.988	179.8	807.5	O K
360 min Winter	58.189	0.739	179.8	569.7	O K
480 min Winter	58.006	0.556	177.6	409.8	O K
600 min Winter	57.902	0.452	170.4	324.7	O K
720 min Winter	57.858	0.408	150.4	290.1	O K
960 min Winter	57.802	0.352	121.5	247.0	O K
1440 min Winter	57.739	0.289	88.8	200.1	O K
2160 min Winter	57.690	0.240	64.5	163.9	O K
2880 min Winter	57.661	0.211	51.1	143.0	O K
4320 min Winter	57.626	0.176	36.9	118.4	O K
5760 min Winter	57.605	0.155	29.1	103.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.336	0.0	3700.9	3664
8640 min Summer	1.149	0.0	3821.9	4376
10080 min Summer	1.012	0.0	3925.2	5136
15 min Winter	143.957	0.0	927.3	23
30 min Winter	94.236	0.0	1215.1	34
60 min Winter	58.739	0.0	1517.8	58
120 min Winter	35.368	0.0	1828.1	94
180 min Winter	25.936	0.0	2011.1	132
240 min Winter	20.691	0.0	2139.3	168
360 min Winter	15.003	0.0	2327.0	228
480 min Winter	11.944	0.0	2469.9	282
600 min Winter	10.000	0.0	2584.9	328
720 min Winter	8.645	0.0	2681.6	386
960 min Winter	6.865	0.0	2839.4	508
1440 min Winter	4.954	0.0	3072.7	748
2160 min Winter	3.569	0.0	3322.8	1108
2880 min Winter	2.825	0.0	3507.1	1472
4320 min Winter	2.030	0.0	3778.3	2204
5760 min Winter	1.604	0.0	3983.2	2936

Cascade Summary of Results for W461 - Basin 2A.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Winter	57.591	0.141	24.4	93.9	O K
8640 min Winter	57.580	0.130	20.9	86.4	O K
10080 min Winter	57.572	0.122	18.4	80.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.336	0.0	4145.2	3672
8640 min Winter	1.149	0.0	4280.8	4352
10080 min Winter	1.012	0.0	4396.9	5136

Cascade Rainfall Details for W461 - Basin 2A.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.407	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 3.080

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	1.027	4	8	1.027	8	12	1.027

Cascade Model Details for W461 - Basin 2A.SRCX

Storage is Online Cover Level (m) 58.950

Tank or Pond Structure

Invert Level (m) 57.450

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	643.0	1.200	1092.0	1.500	1216.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0502-1800-1200-1800
Design Head (m)	1.200
Design Flow (l/s)	180.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	502
Invert Level (m)	57.450
Minimum Outlet Pipe Diameter (mm)	Site Specific Design (Contact Hydro International)
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	180.0	Kick-Flo®	1.029	167.0
Flush-Flo™	0.685	179.8	Mean Flow over Head Range	-	135.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	12.6	1.200	180.0	3.000	281.8	7.000	427.3
0.200	46.5	1.400	194.1	3.500	303.9	7.500	442.1
0.300	94.3	1.600	207.1	4.000	324.5	8.000	456.4
0.400	146.6	1.800	219.4	4.500	343.8	8.500	470.2
0.500	175.2	2.000	231.0	5.000	362.1	9.000	483.6
0.600	178.9	2.200	242.1	5.500	379.5	9.500	496.7
0.800	178.3	2.400	252.6	6.000	396.1		
1.000	169.3	2.600	262.7	6.500	412.0		

Cascade Summary of Results for W461 - Basin 2B.SRCX

Upstream Structures	Outflow To	Overflow To
W461 - Basin 2A.SRCX W461 - Basin 4.SRCX	W461 - Basin 2C.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	52.959	0.459	20.0	643.1	O K
30 min Summer	53.108	0.608	20.0	874.3	O K
60 min Summer	53.257	0.757	20.0	1119.1	O K
120 min Summer	53.404	0.904	20.0	1372.8	O K
180 min Summer	53.484	0.984	20.0	1516.4	O K
240 min Summer	53.537	1.037	20.0	1614.0	O K
360 min Summer	53.592	1.092	20.0	1715.9	O K
480 min Summer	53.613	1.113	20.0	1756.7	O K
600 min Summer	53.619	1.119	20.0	1768.3	O K
720 min Summer	53.616	1.116	20.0	1762.5	O K
960 min Summer	53.598	1.098	20.0	1727.5	O K
1440 min Summer	53.555	1.055	20.0	1646.8	O K
2160 min Summer	53.485	0.985	20.0	1519.6	O K
2880 min Summer	53.415	0.915	20.0	1392.9	O K
4320 min Summer	53.259	0.759	20.0	1122.4	O K
5760 min Summer	53.115	0.615	20.0	886.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.957	0.0	852.2	120
30 min Summer	94.236	0.0	1100.6	152
60 min Summer	58.739	0.0	1474.5	190
120 min Summer	35.368	0.0	1756.1	238
180 min Summer	25.936	0.0	1923.8	270
240 min Summer	20.691	0.0	2040.6	302
360 min Summer	15.003	0.0	2210.1	392
480 min Summer	11.944	0.0	2337.2	502
600 min Summer	10.000	0.0	2437.6	614
720 min Summer	8.645	0.0	2520.0	728
960 min Summer	6.865	0.0	2647.0	864
1440 min Summer	4.954	0.0	2775.7	1118
2160 min Summer	3.569	0.0	3285.1	1524
2880 min Summer	2.825	0.0	3447.2	1940
4320 min Summer	2.030	0.0	3670.8	2728
5760 min Summer	1.604	0.0	4106.2	3456

Cascade Summary of Results for W461 - Basin 2B.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	52.994	0.494	20.0	696.2	O K
8640 min Summer	52.896	0.396	20.0	548.2	O K
10080 min Summer	52.822	0.322	19.9	439.4	O K
15 min Winter	53.018	0.518	20.0	732.8	O K
30 min Winter	53.181	0.681	20.0	992.8	O K
60 min Winter	53.346	0.846	20.0	1272.1	O K
120 min Winter	53.502	1.002	20.0	1549.6	O K
180 min Winter	53.588	1.088	20.0	1709.1	O K
240 min Winter	53.647	1.147	20.0	1820.3	O K
360 min Winter	53.714	1.214	20.1	1949.4	Flood Risk
480 min Winter	53.740	1.240	20.3	2002.3	Flood Risk
600 min Winter	53.751	1.251	20.4	2022.8	Flood Risk
720 min Winter	53.751	1.251	20.4	2024.0	Flood Risk
960 min Winter	53.735	1.235	20.3	1991.6	Flood Risk
1440 min Winter	53.680	1.180	20.0	1885.0	O K
2160 min Winter	53.591	1.091	20.0	1715.4	O K
2880 min Winter	53.494	0.994	20.0	1535.8	O K
4320 min Winter	53.267	0.767	20.0	1137.1	O K
5760 min Winter	53.047	0.547	20.0	778.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.336	0.0	4265.5	4144
8640 min Summer	1.149	0.0	4382.6	4824
10080 min Summer	1.012	0.0	4452.2	5472
15 min Winter	143.957	0.0	948.5	130
30 min Winter	94.236	0.0	1226.3	164
60 min Winter	58.739	0.0	1639.7	206
120 min Winter	35.368	0.0	1958.2	248
180 min Winter	25.936	0.0	2145.2	282
240 min Winter	20.691	0.0	2274.9	312
360 min Winter	15.003	0.0	2462.3	390
480 min Winter	11.944	0.0	2601.6	498
600 min Winter	10.000	0.0	2709.9	608
720 min Winter	8.645	0.0	2796.3	718
960 min Winter	6.865	0.0	2916.1	932
1440 min Winter	4.954	0.0	2901.6	1176
2160 min Winter	3.569	0.0	3657.9	1636
2880 min Winter	2.825	0.0	3838.5	2096
4320 min Winter	2.030	0.0	4090.6	2948
5760 min Winter	1.604	0.0	4594.1	3640

Cascade Summary of Results for W461 - Basin 2B.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Winter	52.878	0.378	20.0	521.6	O K
8640 min Winter	52.767	0.267	19.6	360.6	O K
10080 min Winter	52.707	0.207	18.8	276.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.336	0.0	4762.4	4264
8640 min Winter	1.149	0.0	4874.5	4848
10080 min Winter	1.012	0.0	4961.1	5312

Cascade Rainfall Details for W461 - Basin 2B.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.407	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Cascade Model Details for W461 - Basin 2B.SRCX

Storage is Online Cover Level (m) 54.000

Tank or Pond Structure

Invert Level (m) 52.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1283.0	1.200	1945.0	1.500	2123.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0196-2000-1200-2000
Design Head (m)	1.200
Design Flow (l/s)	20.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	196
Invert Level (m)	52.500
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	20.0	Kick-Flo®	0.827	16.8
Flush-Flo™	0.376	20.0	Mean Flow over Head Range	-	17.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.8	1.200	20.0	3.000	31.0	7.000	46.7
0.200	18.3	1.400	21.5	3.500	33.4	7.500	48.2
0.300	19.8	1.600	22.9	4.000	35.6	8.000	49.8
0.400	20.0	1.800	24.3	4.500	37.7	8.500	51.3
0.500	19.7	2.000	25.5	5.000	39.6	9.000	52.7
0.600	19.4	2.200	26.7	5.500	41.5	9.500	54.1
0.800	17.4	2.400	27.8	6.000	43.3		
1.000	18.3	2.600	28.9	6.500	45.0		

Cascade Summary of Results for W461 - Basin 2C.SRCX

Upstream Structures	Outflow To	Overflow To
W461 - Basin 2B.SRCX W461 - Basin 2A.SRCX W461 - Basin 4.SRCX	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	52.332	0.282	4.1	604.6	O K
30 min Summer	52.427	0.377	4.2	820.3	O K
60 min Summer	52.524	0.474	4.2	1046.5	O K
120 min Summer	52.621	0.571	4.2	1278.6	O K
180 min Summer	52.678	0.628	4.2	1419.0	O K
240 min Summer	52.719	0.669	4.2	1519.6	O K
360 min Summer	52.779	0.729	4.2	1671.1	O K
480 min Summer	52.824	0.774	4.2	1786.2	O K
600 min Summer	52.859	0.809	4.2	1876.5	O K
720 min Summer	52.888	0.838	4.2	1951.9	O K
960 min Summer	52.934	0.884	4.2	2074.0	O K
1440 min Summer	52.989	0.939	4.2	2220.6	O K
2160 min Summer	53.065	1.015	4.2	2426.4	O K
2880 min Summer	53.109	1.059	4.2	2548.6	O K
4320 min Summer	53.165	1.115	4.2	2703.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.957	0.0	311.5	856
30 min Summer	94.236	0.0	312.1	1090
60 min Summer	58.739	0.0	666.0	1366
120 min Summer	35.368	0.0	649.3	1690
180 min Summer	25.936	0.0	635.7	1882
240 min Summer	20.691	0.0	623.0	2018
360 min Summer	15.003	0.0	599.2	2234
480 min Summer	11.944	0.0	589.3	2384
600 min Summer	10.000	0.0	587.1	2504
720 min Summer	8.645	0.0	583.8	2610
960 min Summer	6.865	0.0	575.3	2792
1440 min Summer	4.954	0.0	554.7	2880
2160 min Summer	3.569	0.0	1178.9	3532
2880 min Summer	2.825	0.0	1162.2	3912
4320 min Summer	2.030	0.0	1114.5	4604

Cascade Summary of Results for W461 - Basin 2C.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
5760 min Summer	53.161	1.111	4.2	2692.4	O K
7200 min Summer	53.140	1.090	4.2	2633.3	O K
8640 min Summer	53.116	1.066	4.2	2565.9	O K
10080 min Summer	53.093	1.043	4.2	2502.5	O K
15 min Winter	52.369	0.319	4.2	687.8	O K
30 min Winter	52.474	0.424	4.2	930.3	O K
60 min Winter	52.581	0.531	4.2	1182.1	O K
120 min Winter	52.689	0.639	4.2	1446.9	O K
180 min Winter	52.755	0.705	4.2	1609.8	O K
240 min Winter	52.801	0.751	4.2	1727.6	O K
360 min Winter	52.866	0.816	4.2	1894.5	O K
480 min Winter	52.914	0.864	4.2	2020.7	O K
600 min Winter	52.952	0.902	4.2	2121.6	O K
720 min Winter	52.984	0.934	4.2	2206.0	O K
960 min Winter	53.032	0.982	4.2	2334.6	O K
1440 min Winter	53.034	0.984	4.2	2340.9	O K
2160 min Winter	53.178	1.128	4.2	2740.2	O K
2880 min Winter	53.226	1.176	4.2	2878.0	O K
4320 min Winter	53.296	1.246	4.3	3077.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	1.604	0.0	2352.9	5880
7200 min Summer	1.336	0.0	2314.5	7192
8640 min Summer	1.149	0.0	2257.1	7792
10080 min Summer	1.012	0.0	2183.8	8536
15 min Winter	143.957	0.0	313.3	941
30 min Winter	94.236	0.0	311.3	1215
60 min Winter	58.739	0.0	659.3	1548
120 min Winter	35.368	0.0	638.4	1894
180 min Winter	25.936	0.0	618.1	2104
240 min Winter	20.691	0.0	601.0	2256
360 min Winter	15.003	0.0	600.8	2440
480 min Winter	11.944	0.0	599.0	2586
600 min Winter	10.000	0.0	595.6	2712
720 min Winter	8.645	0.0	591.4	2822
960 min Winter	6.865	0.0	581.3	2880
1440 min Winter	4.954	0.0	559.7	2880
2160 min Winter	3.569	0.0	1217.3	3756
2880 min Winter	2.825	0.0	1198.0	4148
4320 min Winter	2.030	0.0	1150.3	4728

Cascade Summary of Results for W461 - Basin 2C.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
5760 min Winter	53.306	1.256	4.3	3107.4	Flood Risk
7200 min Winter	53.289	1.239	4.3	3057.2	Flood Risk
8640 min Winter	53.264	1.214	4.2	2985.8	Flood Risk
10080 min Winter	53.236	1.186	4.2	2903.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Winter	1.604	0.0	2475.8	5800
7200 min Winter	1.336	0.0	2437.3	7112
8640 min Winter	1.149	0.0	2379.5	8360
10080 min Winter	1.012	0.0	2306.2	9472

Cascade Rainfall Details for W461 - Basin 2C.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.407	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Cascade Model Details for W461 - Basin 2C.SRCX

Storage is Online Cover Level (m) 53.550

Tank or Pond Structure

Invert Level (m) 52.050

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2056.0	1.200	2876.0	1.500	3093.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0094-4200-1200-4200
Design Head (m)	1.200
Design Flow (l/s)	4.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	94
Invert Level (m)	52.050
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	4.2	Kick-Flo®	0.742	3.4
Flush-Flo™	0.358	4.2	Mean Flow over Head Range	-	3.7

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	4.2	3.000	6.4	7.000	9.6
0.200	3.9	1.400	4.5	3.500	6.9	7.500	9.9
0.300	4.2	1.600	4.8	4.000	7.4	8.000	10.2
0.400	4.2	1.800	5.1	4.500	7.8	8.500	10.5
0.500	4.1	2.000	5.3	5.000	8.2	9.000	10.8
0.600	3.9	2.200	5.6	5.500	8.6	9.500	11.1
0.800	3.5	2.400	5.8	6.000	8.9		
1.000	3.9	2.600	6.0	6.500	9.3		

Cascade Summary of Results for W461 - Basin 4.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	W461 - Basin 2B.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.537	0.537	1.0	131.1	O K
30 min Summer	0.664	0.664	1.0	171.3	O K
60 min Summer	0.782	0.782	1.1	212.3	O K
120 min Summer	0.891	0.891	1.1	252.8	O K
180 min Summer	0.947	0.947	1.2	275.3	O K
240 min Summer	0.983	0.983	1.2	289.8	O K
360 min Summer	1.029	1.029	1.2	309.1	O K
480 min Summer	1.059	1.059	1.2	322.1	O K
600 min Summer	1.080	1.080	1.2	330.9	O K
720 min Summer	1.094	1.094	1.2	337.2	O K
960 min Summer	1.111	1.111	1.3	344.7	O K
1440 min Summer	1.118	1.118	1.3	348.2	O K
2160 min Summer	1.100	1.100	1.2	339.9	O K
2880 min Summer	1.075	1.075	1.2	328.9	O K
4320 min Summer	1.027	1.027	1.2	308.4	O K
5760 min Summer	0.984	0.984	1.2	290.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.957	0.0	81.2	27
30 min Summer	94.236	0.0	79.1	42
60 min Summer	58.739	0.0	166.8	72
120 min Summer	35.368	0.0	170.4	130
180 min Summer	25.936	0.0	175.5	190
240 min Summer	20.691	0.0	179.8	250
360 min Summer	15.003	0.0	185.2	370
480 min Summer	11.944	0.0	188.4	488
600 min Summer	10.000	0.0	190.5	608
720 min Summer	8.645	0.0	191.7	726
960 min Summer	6.865	0.0	192.8	966
1440 min Summer	4.954	0.0	191.5	1442
2160 min Summer	3.569	0.0	362.7	2060
2880 min Summer	2.825	0.0	362.2	2392
4320 min Summer	2.030	0.0	348.6	3120
5760 min Summer	1.604	0.0	565.1	3936

Cascade Summary of Results for W461 - Basin 4.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	0.945	0.945	1.2	274.2	O K
8640 min Summer	0.907	0.907	1.1	259.1	O K
10080 min Summer	0.870	0.870	1.1	244.9	O K
15 min Winter	0.588	0.588	1.0	146.9	O K
30 min Winter	0.725	0.725	1.0	192.0	O K
60 min Winter	0.852	0.852	1.1	238.1	O K
120 min Winter	0.969	0.969	1.2	284.0	O K
180 min Winter	1.030	1.030	1.2	309.6	O K
240 min Winter	1.069	1.069	1.2	326.3	O K
360 min Winter	1.120	1.120	1.3	348.9	O K
480 min Winter	1.154	1.154	1.3	364.2	O K
600 min Winter	1.177	1.177	1.3	375.1	O K
720 min Winter	1.194	1.194	1.3	383.0	O K
960 min Winter	1.215	1.215	1.3	393.2	Flood Risk
1440 min Winter	1.231	1.231	1.3	400.8	Flood Risk
2160 min Winter	1.223	1.223	1.3	396.9	Flood Risk
2880 min Winter	1.198	1.198	1.3	384.8	O K
4320 min Winter	1.143	1.143	1.3	359.2	O K
5760 min Winter	1.089	1.089	1.2	335.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.336	0.0	587.5	4760
8640 min Summer	1.149	0.0	602.0	5616
10080 min Summer	1.012	0.0	575.6	6448
15 min Winter	143.957	0.0	79.6	27
30 min Winter	94.236	0.0	81.8	41
60 min Winter	58.739	0.0	168.6	70
120 min Winter	35.368	0.0	177.5	128
180 min Winter	25.936	0.0	184.4	188
240 min Winter	20.691	0.0	188.6	246
360 min Winter	15.003	0.0	193.7	364
480 min Winter	11.944	0.0	196.8	480
600 min Winter	10.000	0.0	198.6	598
720 min Winter	8.645	0.0	199.6	714
960 min Winter	6.865	0.0	200.2	948
1440 min Winter	4.954	0.0	198.0	1404
2160 min Winter	3.569	0.0	381.5	2072
2880 min Winter	2.825	0.0	379.7	2684
4320 min Winter	2.030	0.0	365.1	3332
5760 min Winter	1.604	0.0	632.4	4264

Cascade Summary of Results for W461 - Basin 4.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Winter	1.036	1.036	1.2	312.2	O K
8640 min Winter	0.985	0.985	1.2	290.5	O K
10080 min Winter	0.934	0.934	1.2	269.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.336	0.0	655.1	5184
8640 min Winter	1.149	0.0	640.3	6056
10080 min Winter	1.012	0.0	610.3	6960

Cascade Rainfall Details for W461 - Basin 4.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.407	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.490

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.163	4	8	0.163	8	12	0.163

Cascade Model Details for W461 - Basin 4.SRCX

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	191.0	1.200	473.0	1.500	556.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0051-1300-1200-1300
Design Head (m)	1.200
Design Flow (l/s)	1.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	51
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	1.3	Kick-Flo®	0.459	0.8
Flush-Flo™	0.227	1.0	Mean Flow over Head Range	-	1.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.9	1.200	1.3	3.000	2.0	7.000	2.9
0.200	1.0	1.400	1.4	3.500	2.1	7.500	3.0
0.300	1.0	1.600	1.5	4.000	2.2	8.000	3.1
0.400	1.0	1.800	1.6	4.500	2.4	8.500	3.2
0.500	0.9	2.000	1.6	5.000	2.5	9.000	3.3
0.600	1.0	2.200	1.7	5.500	2.6	9.500	3.4
0.800	1.1	2.400	1.8	6.000	2.7		
1.000	1.2	2.600	1.8	6.500	2.8		

Cascade Summary of Results for W461 - Basin 1A.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	W461 - Basin 1B.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.708	0.708	9.3	46.3	O K
30 min Summer	0.801	0.801	9.3	57.8	O K
60 min Summer	0.843	0.843	9.3	63.5	O K
120 min Summer	0.825	0.825	9.3	61.1	O K
180 min Summer	0.794	0.794	9.3	56.9	O K
240 min Summer	0.756	0.756	9.3	52.0	O K
360 min Summer	0.670	0.670	9.3	42.1	O K
480 min Summer	0.585	0.585	9.3	33.3	O K
600 min Summer	0.501	0.501	9.3	25.9	O K
720 min Summer	0.422	0.422	9.3	19.8	O K
960 min Summer	0.291	0.291	9.3	11.5	O K
1440 min Summer	0.157	0.157	8.4	5.2	O K
2160 min Summer	0.117	0.117	6.2	3.6	O K
2880 min Summer	0.100	0.100	5.0	3.0	O K
4320 min Summer	0.081	0.081	3.6	2.4	O K
5760 min Summer	0.071	0.071	2.9	2.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	110.898	0.0	56.1	23
30 min Summer	71.990	0.0	72.9	36
60 min Summer	44.676	0.0	90.5	62
120 min Summer	26.913	0.0	109.0	98
180 min Summer	19.798	0.0	120.3	132
240 min Summer	15.855	0.0	128.4	164
360 min Summer	11.566	0.0	140.5	228
480 min Summer	9.243	0.0	149.7	290
600 min Summer	7.763	0.0	157.2	350
720 min Summer	6.729	0.0	163.5	406
960 min Summer	5.368	0.0	173.9	518
1440 min Summer	3.899	0.0	189.5	738
2160 min Summer	2.829	0.0	206.2	1100
2880 min Summer	2.252	0.0	218.9	1456
4320 min Summer	1.631	0.0	237.8	2200
5760 min Summer	1.296	0.0	252.0	2936

Cascade Summary of Results for W461 - Basin 1A.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	0.064	0.064	2.4	1.8	O K
8640 min Summer	0.059	0.059	2.1	1.7	O K
10080 min Summer	0.055	0.055	1.8	1.6	O K
15 min Winter	0.764	0.764	9.3	53.0	O K
30 min Winter	0.863	0.863	9.3	66.3	O K
60 min Winter	0.913	0.913	9.3	73.8	O K
120 min Winter	0.896	0.896	9.3	71.2	O K
180 min Winter	0.857	0.857	9.3	65.4	O K
240 min Winter	0.807	0.807	9.3	58.5	O K
360 min Winter	0.675	0.675	9.3	42.6	O K
480 min Winter	0.538	0.538	9.3	29.0	O K
600 min Winter	0.404	0.404	9.3	18.5	O K
720 min Winter	0.288	0.288	9.3	11.4	O K
960 min Winter	0.158	0.158	8.4	5.2	O K
1440 min Winter	0.117	0.117	6.2	3.6	O K
2160 min Winter	0.094	0.094	4.5	2.8	O K
2880 min Winter	0.081	0.081	3.6	2.4	O K
4320 min Winter	0.067	0.067	2.6	1.9	O K
5760 min Winter	0.059	0.059	2.1	1.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.085	0.0	263.6	3624
8640 min Summer	0.937	0.0	273.3	4384
10080 min Summer	0.828	0.0	281.8	5056
15 min Winter	110.898	0.0	62.9	24
30 min Winter	71.990	0.0	81.6	36
60 min Winter	44.676	0.0	101.3	62
120 min Winter	26.913	0.0	122.1	104
180 min Winter	19.798	0.0	134.7	140
240 min Winter	15.855	0.0	143.8	180
360 min Winter	11.566	0.0	157.4	246
480 min Winter	9.243	0.0	167.7	308
600 min Winter	7.763	0.0	176.1	362
720 min Winter	6.729	0.0	183.1	410
960 min Winter	5.368	0.0	194.8	502
1440 min Winter	3.899	0.0	212.2	736
2160 min Winter	2.829	0.0	231.0	1088
2880 min Winter	2.252	0.0	245.1	1432
4320 min Winter	1.631	0.0	266.3	2176
5760 min Winter	1.296	0.0	282.3	2928

Cascade Summary of Results for W461 - Basin 1A.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Winter	0.054	0.054	1.7	1.5	O K
8640 min Winter	0.050	0.050	1.5	1.4	O K
10080 min Winter	0.046	0.046	1.3	1.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.085	0.0	295.2	3584
8640 min Winter	0.937	0.0	306.1	4304
10080 min Winter	0.828	0.0	315.7	5136

Cascade Rainfall Details for W461 - Basin 1A.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.407	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.270

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.090	4	8	0.090	8	12	0.090

Cascade Model Details for W461 - Basin 1A.SRCX

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	26.0	1.200	215.0	1.500	278.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0139-9400-1200-9400
Design Head (m)	1.200
Design Flow (l/s)	9.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	139
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	9.4	Kick-Flo®	0.769	7.6
Flush-Flo™	0.355	9.3	Mean Flow over Head Range	-	8.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.0	1.200	9.4	3.000	14.5	7.000	21.7
0.200	8.8	1.400	10.1	3.500	15.6	7.500	22.5
0.300	9.3	1.600	10.8	4.000	16.6	8.000	23.2
0.400	9.3	1.800	11.4	4.500	17.6	8.500	23.9
0.500	9.2	2.000	12.0	5.000	18.5	9.000	24.5
0.600	8.9	2.200	12.5	5.500	19.4	9.500	25.2
0.800	7.8	2.400	13.0	6.000	20.2		
1.000	8.6	2.600	13.5	6.500	21.0		

Cascade Summary of Results for W461 - Basin 1B.SRCX

Upstream Structures	Outflow To	Overflow To
W461 - Basin 1A.SRCX	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.211	0.211	8.8	6.8	O K
30 min Summer	0.212	0.212	8.8	6.8	O K
60 min Summer	0.212	0.212	8.8	6.8	O K
120 min Summer	0.212	0.212	8.8	6.8	O K
180 min Summer	0.212	0.212	8.8	6.9	O K
240 min Summer	0.217	0.217	8.8	7.0	O K
360 min Summer	0.235	0.235	9.0	7.8	O K
480 min Summer	0.244	0.244	9.0	8.2	O K
600 min Summer	0.249	0.249	9.0	8.4	O K
720 min Summer	0.249	0.249	9.0	8.4	O K
960 min Summer	0.226	0.226	8.9	7.4	O K
1440 min Summer	0.158	0.158	8.2	4.7	O K
2160 min Summer	0.119	0.119	6.2	3.4	O K
2880 min Summer	0.101	0.101	5.0	2.8	O K
4320 min Summer	0.082	0.082	3.6	2.2	O K
5760 min Summer	0.072	0.072	2.9	1.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	110.898	0.0	56.1	98
30 min Summer	71.990	0.0	72.9	136
60 min Summer	44.676	0.0	90.4	176
120 min Summer	26.913	0.0	109.0	224
180 min Summer	19.798	0.0	120.3	260
240 min Summer	15.855	0.0	128.4	290
360 min Summer	11.566	0.0	140.5	338
480 min Summer	9.243	0.0	149.7	380
600 min Summer	7.763	0.0	157.2	424
720 min Summer	6.729	0.0	163.5	470
960 min Summer	5.368	0.0	173.9	560
1440 min Summer	3.899	0.0	189.5	750
2160 min Summer	2.829	0.0	206.2	1104
2880 min Summer	2.252	0.0	218.8	1460
4320 min Summer	1.631	0.0	237.8	2164
5760 min Summer	1.296	0.0	252.0	2936

Cascade Summary of Results for W461 - Basin 1B.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	0.065	0.065	2.4	1.7	O K
8640 min Summer	0.060	0.060	2.1	1.6	O K
10080 min Summer	0.056	0.056	1.8	1.4	O K
15 min Winter	0.212	0.212	8.8	6.8	O K
30 min Winter	0.212	0.212	8.8	6.8	O K
60 min Winter	0.212	0.212	8.8	6.8	O K
120 min Winter	0.212	0.212	8.8	6.8	O K
180 min Winter	0.212	0.212	8.8	6.8	O K
240 min Winter	0.212	0.212	8.8	6.9	O K
360 min Winter	0.237	0.237	9.0	7.9	O K
480 min Winter	0.255	0.255	9.1	8.7	O K
600 min Winter	0.259	0.259	9.1	8.9	O K
720 min Winter	0.237	0.237	9.0	7.9	O K
960 min Winter	0.165	0.165	8.3	5.0	O K
1440 min Winter	0.119	0.119	6.2	3.4	O K
2160 min Winter	0.094	0.094	4.5	2.6	O K
2880 min Winter	0.082	0.082	3.6	2.2	O K
4320 min Winter	0.068	0.068	2.6	1.8	O K
5760 min Winter	0.060	0.060	2.1	1.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.085	0.0	263.6	3672
8640 min Summer	0.937	0.0	273.3	4288
10080 min Summer	0.828	0.0	281.8	5000
15 min Winter	110.898	0.0	62.9	112
30 min Winter	71.990	0.0	81.6	154
60 min Winter	44.676	0.0	101.3	196
120 min Winter	26.913	0.0	122.1	246
180 min Winter	19.798	0.0	134.7	284
240 min Winter	15.855	0.0	143.8	316
360 min Winter	11.566	0.0	157.4	362
480 min Winter	9.243	0.0	167.7	390
600 min Winter	7.763	0.0	176.1	426
720 min Winter	6.729	0.0	183.1	458
960 min Winter	5.368	0.0	194.8	522
1440 min Winter	3.899	0.0	212.2	742
2160 min Winter	2.829	0.0	231.0	1104
2880 min Winter	2.252	0.0	245.1	1464
4320 min Winter	1.631	0.0	266.3	2180
5760 min Winter	1.296	0.0	282.2	2936

Cascade Summary of Results for W461 - Basin 1B.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Winter	0.054	0.054	1.8	1.4	O K
8640 min Winter	0.050	0.050	1.5	1.3	O K
10080 min Winter	0.047	0.047	1.3	1.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.085	0.0	295.2	3656
8640 min Winter	0.937	0.0	306.1	4296
10080 min Winter	0.828	0.0	315.6	5136

Cascade Rainfall Details for W461 - Basin 1B.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.407	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Cascade Model Details for W461 - Basin 1B.SRCX

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	24.0	1.200	184.0	1.500	235.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0136-9400-1350-9400
Design Head (m)	1.350
Design Flow (l/s)	9.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	136
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.350	9.4	Kick-Flo®	0.852	7.6
Flush-Flo™	0.398	9.4	Mean Flow over Head Range	-	8.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.9	1.200	8.9	3.000	13.7	7.000	20.6
0.200	8.7	1.400	9.6	3.500	14.8	7.500	21.2
0.300	9.3	1.600	10.2	4.000	15.7	8.000	21.9
0.400	9.4	1.800	10.8	4.500	16.6	8.500	22.6
0.500	9.3	2.000	11.3	5.000	17.5	9.000	23.2
0.600	9.1	2.200	11.8	5.500	18.3	9.500	23.8
0.800	8.1	2.400	12.3	6.000	19.1		
1.000	8.2	2.600	12.8	6.500	19.8		

Cascade Summary of Results for W461 - Basin 2A.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	W461 - Basin 2B.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	57.835	0.385	139.1	272.4	O K
30 min Summer	57.888	0.438	164.3	313.6	O K
60 min Summer	57.905	0.455	171.9	327.7	O K
120 min Summer	57.887	0.437	164.1	313.5	O K
180 min Summer	57.858	0.408	150.7	290.5	O K
240 min Summer	57.832	0.382	137.3	269.9	O K
360 min Summer	57.790	0.340	115.4	238.2	O K
480 min Summer	57.761	0.311	99.9	215.7	O K
600 min Summer	57.738	0.288	88.3	199.0	O K
720 min Summer	57.720	0.270	79.1	185.8	O K
960 min Summer	57.693	0.243	65.9	166.3	O K
1440 min Summer	57.659	0.209	50.4	141.7	O K
2160 min Summer	57.629	0.179	38.0	120.4	O K
2880 min Summer	57.610	0.160	30.9	107.1	O K
4320 min Summer	57.587	0.137	22.9	90.8	O K
5760 min Summer	57.572	0.122	18.4	80.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	60.278	0.0	344.4	21
30 min Summer	38.832	0.0	444.8	29
60 min Summer	24.003	0.0	552.6	46
120 min Summer	14.465	0.0	666.4	78
180 min Summer	10.672	0.0	737.7	108
240 min Summer	8.577	0.0	790.6	140
360 min Summer	6.291	0.0	869.9	200
480 min Summer	5.045	0.0	930.2	262
600 min Summer	4.250	0.0	979.5	322
720 min Summer	3.693	0.0	1021.3	382
960 min Summer	2.957	0.0	1090.5	504
1440 min Summer	2.161	0.0	1194.9	744
2160 min Summer	1.578	0.0	1311.2	1108
2880 min Summer	1.262	0.0	1398.1	1472
4320 min Summer	0.921	0.0	1528.8	2204
5760 min Summer	0.736	0.0	1631.8	2936

Cascade Summary of Results for W461 - Basin 2A.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	57.561	0.111	15.5	73.6	O K
8640 min Summer	57.553	0.103	13.4	68.3	O K
10080 min Summer	57.547	0.097	11.9	64.0	O K
15 min Winter	57.872	0.422	157.3	301.4	O K
30 min Winter	57.929	0.479	174.0	347.1	O K
60 min Winter	57.938	0.488	174.5	354.0	O K
120 min Winter	57.892	0.442	166.3	317.3	O K
180 min Winter	57.848	0.398	145.5	282.5	O K
240 min Winter	57.813	0.363	127.5	255.5	O K
360 min Winter	57.764	0.314	101.5	218.2	O K
480 min Winter	57.731	0.281	84.4	193.7	O K
600 min Winter	57.707	0.257	72.7	176.3	O K
720 min Winter	57.689	0.239	64.0	163.2	O K
960 min Winter	57.663	0.213	52.0	144.4	O K
1440 min Winter	57.631	0.181	38.6	121.5	O K
2160 min Winter	57.603	0.153	28.4	102.3	O K
2880 min Winter	57.586	0.136	22.8	90.7	O K
4320 min Winter	57.566	0.116	16.7	76.5	O K
5760 min Winter	57.553	0.103	13.4	68.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	0.619	0.0	1714.0	3672
8640 min Summer	0.537	0.0	1783.7	4408
10080 min Summer	0.476	0.0	1843.8	5136
15 min Winter	60.278	0.0	386.2	21
30 min Winter	38.832	0.0	498.6	30
60 min Winter	24.003	0.0	619.2	48
120 min Winter	14.465	0.0	746.6	80
180 min Winter	10.672	0.0	826.4	112
240 min Winter	8.577	0.0	885.7	144
360 min Winter	6.291	0.0	974.5	206
480 min Winter	5.045	0.0	1042.1	266
600 min Winter	4.250	0.0	1097.3	328
720 min Winter	3.693	0.0	1144.2	388
960 min Winter	2.957	0.0	1221.7	510
1440 min Winter	2.161	0.0	1338.7	752
2160 min Winter	1.578	0.0	1468.8	1112
2880 min Winter	1.262	0.0	1566.1	1476
4320 min Winter	0.921	0.0	1712.7	2204
5760 min Winter	0.736	0.0	1827.8	2920

Cascade Summary of Results for W461 - Basin 2A.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Winter	57.544	0.094	11.2	61.9	O K
8640 min Winter	57.538	0.088	9.8	57.5	O K
10080 min Winter	57.532	0.082	8.6	53.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.619	0.0	1919.8	3600
8640 min Winter	0.537	0.0	1998.0	4384
10080 min Winter	0.476	0.0	2065.7	5136

Cascade Rainfall Details for W461 - Basin 2A.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.407	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 3.080

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	1.027	4	8	1.027	8	12	1.027

Cascade Model Details for W461 - Basin 2A.SRCX

Storage is Online Cover Level (m) 58.950

Tank or Pond Structure

Invert Level (m) 57.450

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	643.0	1.200	1092.0	1.500	1216.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0502-1800-1200-1800
Design Head (m)	1.200
Design Flow (l/s)	180.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	502
Invert Level (m)	57.450
Minimum Outlet Pipe Diameter (mm)	Site Specific Design (Contact Hydro International)
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	180.0	Kick-Flo®	1.029	167.0
Flush-Flo™	0.685	179.8	Mean Flow over Head Range	-	135.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	12.6	1.200	180.0	3.000	281.8	7.000	427.3
0.200	46.5	1.400	194.1	3.500	303.9	7.500	442.1
0.300	94.3	1.600	207.1	4.000	324.5	8.000	456.4
0.400	146.6	1.800	219.4	4.500	343.8	8.500	470.2
0.500	175.2	2.000	231.0	5.000	362.1	9.000	483.6
0.600	178.9	2.200	242.1	5.500	379.5	9.500	496.7
0.800	178.3	2.400	252.6	6.000	396.1		
1.000	169.3	2.600	262.7	6.500	412.0		

Cascade Summary of Results for W461 - Basin 2B.SRCX

Upstream Structures	Outflow To	Overflow To
W461 - Basin 2A.SRCX W461 - Basin 4.SRCX	W461 - Basin 2C.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	52.674	0.174	15.8	230.3	O K
30 min Summer	52.728	0.228	19.2	305.9	O K
60 min Summer	52.792	0.292	19.8	396.0	O K
120 min Summer	52.856	0.356	20.0	488.4	O K
180 min Summer	52.888	0.388	20.0	536.1	O K
240 min Summer	52.906	0.406	20.0	561.8	O K
360 min Summer	52.918	0.418	20.0	579.9	O K
480 min Summer	52.921	0.421	20.0	584.3	O K
600 min Summer	52.920	0.420	20.0	583.1	O K
720 min Summer	52.916	0.416	20.0	577.8	O K
960 min Summer	52.904	0.404	20.0	559.9	O K
1440 min Summer	52.871	0.371	20.0	510.7	O K
2160 min Summer	52.818	0.318	19.9	433.9	O K
2880 min Summer	52.773	0.273	19.6	369.2	O K
4320 min Summer	52.712	0.212	18.9	283.1	O K
5760 min Summer	52.684	0.184	16.8	244.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	60.278	0.0	363.0	90
30 min Summer	38.832	0.0	472.3	97
60 min Summer	24.003	0.0	621.6	120
120 min Summer	14.465	0.0	750.4	162
180 min Summer	10.672	0.0	830.1	208
240 min Summer	8.577	0.0	888.6	258
360 min Summer	6.291	0.0	974.9	344
480 min Summer	5.045	0.0	1039.0	406
600 min Summer	4.250	0.0	1089.6	470
720 min Summer	3.693	0.0	1131.2	536
960 min Summer	2.957	0.0	1197.4	668
1440 min Summer	2.161	0.0	1293.1	930
2160 min Summer	1.578	0.0	1503.7	1308
2880 min Summer	1.262	0.0	1600.8	1668
4320 min Summer	0.921	0.0	1740.2	2352
5760 min Summer	0.736	0.0	1884.8	3064

Cascade Summary of Results for W461 - Basin 2B.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	52.666	0.166	14.9	219.4	O K
8640 min Summer	52.653	0.153	13.4	202.0	O K
10080 min Summer	52.643	0.143	12.2	188.7	O K
15 min Winter	52.695	0.195	17.9	260.2	O K
30 min Winter	52.761	0.261	19.5	351.7	O K
60 min Winter	52.833	0.333	19.9	455.1	O K
120 min Winter	52.905	0.405	20.0	561.0	O K
180 min Winter	52.942	0.442	20.0	615.8	O K
240 min Winter	52.962	0.462	20.0	646.1	O K
360 min Winter	52.977	0.477	20.0	668.9	O K
480 min Winter	52.975	0.475	20.0	666.9	O K
600 min Winter	52.970	0.470	20.0	658.8	O K
720 min Winter	52.962	0.462	20.0	646.6	O K
960 min Winter	52.940	0.440	20.0	612.6	O K
1440 min Winter	52.883	0.383	20.0	528.8	O K
2160 min Winter	52.801	0.301	19.8	409.3	O K
2880 min Winter	52.739	0.239	19.3	320.2	O K
4320 min Winter	52.682	0.182	16.6	241.7	O K
5760 min Winter	52.657	0.157	13.9	207.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	0.619	0.0	1978.1	3776
8640 min Summer	0.537	0.0	2055.2	4504
10080 min Summer	0.476	0.0	2116.2	5216
15 min Winter	60.278	0.0	409.0	88
30 min Winter	38.832	0.0	529.4	100
60 min Winter	24.003	0.0	697.1	122
120 min Winter	14.465	0.0	840.2	166
180 min Winter	10.672	0.0	928.4	212
240 min Winter	8.577	0.0	992.7	260
360 min Winter	6.291	0.0	1086.6	362
480 min Winter	5.045	0.0	1155.1	444
600 min Winter	4.250	0.0	1209.2	504
720 min Winter	3.693	0.0	1254.5	576
960 min Winter	2.957	0.0	1328.6	720
1440 min Winter	2.161	0.0	1438.2	996
2160 min Winter	1.578	0.0	1683.6	1376
2880 min Winter	1.262	0.0	1791.3	1712
4320 min Winter	0.921	0.0	1941.4	2384
5760 min Winter	0.736	0.0	2111.8	3096

Cascade Summary of Results for W461 - Basin 2B.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Winter	52.642	0.142	12.0	186.6	O K
8640 min Winter	52.631	0.131	10.6	171.8	O K
10080 min Winter	52.622	0.122	9.5	160.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.619	0.0	2216.8	3808
8640 min Winter	0.537	0.0	2304.0	4536
10080 min Winter	0.476	0.0	2374.6	5280

Cascade Rainfall Details for W461 - Basin 2B.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.407	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Cascade Model Details for W461 - Basin 2B.SRCX

Storage is Online Cover Level (m) 54.000

Tank or Pond Structure

Invert Level (m) 52.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1283.0	1.500	2123.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0196-2000-1200-2000
Design Head (m)	1.200
Design Flow (l/s)	20.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	196
Invert Level (m)	52.500
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	20.0	Kick-Flo®	0.827	16.8
Flush-Flo™	0.376	20.0	Mean Flow over Head Range	-	17.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.8	1.200	20.0	3.000	31.0	7.000	46.7
0.200	18.3	1.400	21.5	3.500	33.4	7.500	48.2
0.300	19.8	1.600	22.9	4.000	35.6	8.000	49.8
0.400	20.0	1.800	24.3	4.500	37.7	8.500	51.3
0.500	19.7	2.000	25.5	5.000	39.6	9.000	52.7
0.600	19.4	2.200	26.7	5.500	41.5	9.500	54.1
0.800	17.4	2.400	27.8	6.000	43.3		
1.000	18.3	2.600	28.9	6.500	45.0		

Cascade Summary of Results for W461 - Basin 2C.SRCX

Upstream Structures	Outflow To	Overflow To
W461 - Basin 2B.SRCX W461 - Basin 2A.SRCX W461 - Basin 4.SRCX	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	53.137	0.082	4.0	157.0	O K
30 min Summer	53.179	0.124	4.1	245.3	O K
60 min Summer	53.221	0.166	4.1	335.6	O K
120 min Summer	53.263	0.208	4.2	430.3	Flood Risk
180 min Summer	53.287	0.232	4.3	487.9	Flood Risk
240 min Summer	53.305	0.250	4.3	529.9	Flood Risk
360 min Summer	53.330	0.275	4.3	592.0	Flood Risk
480 min Summer	53.348	0.293	4.3	638.4	Flood Risk
600 min Summer	53.363	0.308	4.4	675.2	Flood Risk
720 min Summer	53.374	0.319	4.4	705.6	Flood Risk
960 min Summer	53.393	0.338	4.4	753.5	Flood Risk
1440 min Summer	53.415	0.360	4.4	813.4	Flood Risk
2160 min Summer	53.424	0.369	4.5	837.4	Flood Risk
2880 min Summer	53.418	0.363	4.5	822.8	Flood Risk
4320 min Summer	53.405	0.350	4.4	785.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	60.278	0.0	337.2	496
30 min Summer	38.832	0.0	341.8	564
60 min Summer	24.003	0.0	620.7	652
120 min Summer	14.465	0.0	692.5	766
180 min Summer	10.672	0.0	694.7	850
240 min Summer	8.577	0.0	695.0	918
360 min Summer	6.291	0.0	693.4	1030
480 min Summer	5.045	0.0	690.4	1126
600 min Summer	4.250	0.0	686.7	1214
720 min Summer	3.693	0.0	682.5	1294
960 min Summer	2.957	0.0	673.2	1444
1440 min Summer	2.161	0.0	652.2	1744
2160 min Summer	1.578	0.0	1348.4	2276
2880 min Summer	1.262	0.0	1319.9	2752
4320 min Summer	0.921	0.0	1240.0	3516

Cascade Summary of Results for W461 - Basin 2C.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
5760 min Summer	53.390	0.335	4.4	747.1	Flood Risk
7200 min Summer	53.376	0.321	4.4	709.0	Flood Risk
8640 min Summer	53.361	0.306	4.4	671.1	Flood Risk
10080 min Summer	53.346	0.291	4.3	633.3	Flood Risk
15 min Winter	53.155	0.100	4.0	193.9	O K
30 min Winter	53.201	0.146	4.1	291.4	O K
60 min Winter	53.246	0.191	4.2	391.2	O K
120 min Winter	53.290	0.235	4.3	495.3	Flood Risk
180 min Winter	53.317	0.262	4.3	559.6	Flood Risk
240 min Winter	53.336	0.281	4.3	607.3	Flood Risk
360 min Winter	53.364	0.309	4.4	678.0	Flood Risk
480 min Winter	53.384	0.329	4.4	731.1	Flood Risk
600 min Winter	53.400	0.345	4.4	773.6	Flood Risk
720 min Winter	53.413	0.358	4.4	808.9	Flood Risk
960 min Winter	53.434	0.379	4.5	865.3	Flood Risk
1440 min Winter	53.461	0.406	4.5	941.5	Flood Risk
2160 min Winter	53.476	0.421	4.5	985.2	Flood Risk
2880 min Winter	53.474	0.419	4.5	977.4	Flood Risk
4320 min Winter	53.455	0.400	4.5	923.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	0.736	0.0	1883.2	4304
7200 min Summer	0.619	0.0	1978.0	5120
8640 min Summer	0.537	0.0	2053.9	5936
10080 min Summer	0.476	0.0	2114.9	6744
15 min Winter	60.278	0.0	340.0	518
30 min Winter	38.832	0.0	344.8	599
60 min Winter	24.003	0.0	693.1	702
120 min Winter	14.465	0.0	701.4	828
180 min Winter	10.672	0.0	704.1	914
240 min Winter	8.577	0.0	704.8	986
360 min Winter	6.291	0.0	703.8	1104
480 min Winter	5.045	0.0	701.2	1204
600 min Winter	4.250	0.0	697.8	1292
720 min Winter	3.693	0.0	694.0	1374
960 min Winter	2.957	0.0	685.4	1522
1440 min Winter	2.161	0.0	665.8	1798
2160 min Winter	1.578	0.0	1380.8	2296
2880 min Winter	1.262	0.0	1354.7	2884
4320 min Winter	0.921	0.0	1281.8	3708

Cascade Summary of Results for W461 - Basin 2C.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
5760 min Winter	53.437	0.382	4.5	873.5	Flood Risk
7200 min Winter	53.417	0.362	4.5	817.7	Flood Risk
8640 min Winter	53.395	0.340	4.4	759.1	Flood Risk
10080 min Winter	53.372	0.317	4.4	698.7	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Winter	0.736	0.0	2111.5	4616
7200 min Winter	0.619	0.0	2216.5	5520
8640 min Winter	0.537	0.0	2302.6	6408
10080 min Winter	0.476	0.0	2326.7	7264

Cascade Rainfall Details for W461 - Basin 2C.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.407	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Cascade Model Details for W461 - Basin 2C.SRCX

Storage is Online Cover Level (m) 53.550

Tank or Pond Structure

Invert Level (m) 53.055

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1832.0	0.495	3093.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0094-4200-1200-4200
Design Head (m)	1.200
Design Flow (l/s)	4.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	94
Invert Level (m)	52.050
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	4.2	Kick-Flo®	0.742	3.4
Flush-Flo™	0.358	4.2	Mean Flow over Head Range	-	3.7

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	4.2	3.000	6.4	7.000	9.6
0.200	3.9	1.400	4.5	3.500	6.9	7.500	9.9
0.300	4.2	1.600	4.8	4.000	7.4	8.000	10.2
0.400	4.2	1.800	5.1	4.500	7.8	8.500	10.5
0.500	4.1	2.000	5.3	5.000	8.2	9.000	10.8
0.600	3.9	2.200	5.6	5.500	8.6	9.500	11.1
0.800	3.5	2.400	5.8	6.000	8.9		
1.000	3.9	2.600	6.0	6.500	9.3		

Cascade Summary of Results for W461 - Basin 4.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	W461 - Basin 2B.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.252	0.252	1.0	54.3	O K
30 min Summer	0.315	0.315	1.0	69.6	O K
60 min Summer	0.375	0.375	1.0	85.1	O K
120 min Summer	0.431	0.431	1.0	100.6	O K
180 min Summer	0.462	0.462	1.0	109.3	O K
240 min Summer	0.482	0.482	1.0	115.0	O K
360 min Summer	0.507	0.507	1.0	122.1	O K
480 min Summer	0.520	0.520	1.0	126.1	O K
600 min Summer	0.528	0.528	1.0	128.4	O K
720 min Summer	0.531	0.531	1.0	129.4	O K
960 min Summer	0.531	0.531	1.0	129.4	O K
1440 min Summer	0.519	0.519	1.0	125.9	O K
2160 min Summer	0.499	0.499	1.0	119.9	O K
2880 min Summer	0.477	0.477	1.0	113.6	O K
4320 min Summer	0.429	0.429	1.0	99.8	O K
5760 min Summer	0.381	0.381	1.0	86.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	60.278	0.0	53.2	26
30 min Summer	38.832	0.0	67.9	41
60 min Summer	24.003	0.0	87.2	70
120 min Summer	14.465	0.0	105.1	130
180 min Summer	10.672	0.0	116.2	190
240 min Summer	8.577	0.0	124.3	248
360 min Summer	6.291	0.0	136.2	366
480 min Summer	5.045	0.0	144.7	486
600 min Summer	4.250	0.0	150.8	604
720 min Summer	3.693	0.0	154.4	724
960 min Summer	2.957	0.0	154.8	960
1440 min Summer	2.161	0.0	148.3	1230
2160 min Summer	1.578	0.0	208.0	1608
2880 min Summer	1.262	0.0	221.6	2020
4320 min Summer	0.921	0.0	241.7	2812
5760 min Summer	0.736	0.0	259.5	3576

Cascade Summary of Results for W461 - Basin 4.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	0.337	0.337	1.0	75.3	O K
8640 min Summer	0.296	0.296	1.0	64.9	O K
10080 min Summer	0.259	0.259	1.0	55.8	O K
15 min Winter	0.280	0.280	1.0	60.9	O K
30 min Winter	0.348	0.348	1.0	78.2	O K
60 min Winter	0.414	0.414	1.0	95.7	O K
120 min Winter	0.477	0.477	1.0	113.4	O K
180 min Winter	0.511	0.511	1.0	123.4	O K
240 min Winter	0.533	0.533	1.0	130.0	O K
360 min Winter	0.561	0.561	1.0	138.5	O K
480 min Winter	0.577	0.577	1.0	143.5	O K
600 min Winter	0.587	0.587	1.0	146.5	O K
720 min Winter	0.593	0.593	1.0	148.3	O K
960 min Winter	0.596	0.596	1.0	149.4	O K
1440 min Winter	0.586	0.586	1.0	146.3	O K
2160 min Winter	0.560	0.560	1.0	138.3	O K
2880 min Winter	0.533	0.533	1.0	130.0	O K
4320 min Winter	0.469	0.469	1.0	111.3	O K
5760 min Winter	0.392	0.392	1.0	89.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	0.619	0.0	272.5	4328
8640 min Summer	0.537	0.0	283.6	5096
10080 min Summer	0.476	0.0	293.0	5760
15 min Winter	60.278	0.0	59.4	26
30 min Winter	38.832	0.0	75.2	41
60 min Winter	24.003	0.0	97.7	70
120 min Winter	14.465	0.0	117.5	128
180 min Winter	10.672	0.0	129.7	186
240 min Winter	8.577	0.0	138.6	244
360 min Winter	6.291	0.0	150.8	360
480 min Winter	5.045	0.0	157.4	476
600 min Winter	4.250	0.0	158.9	592
720 min Winter	3.693	0.0	158.2	706
960 min Winter	2.957	0.0	155.4	930
1440 min Winter	2.161	0.0	149.1	1358
2160 min Winter	1.578	0.0	232.9	1696
2880 min Winter	1.262	0.0	248.0	2164
4320 min Winter	0.921	0.0	268.5	3108
5760 min Winter	0.736	0.0	290.6	3872

Cascade Summary of Results for W461 - Basin 4.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Winter	0.322	0.322	1.0	71.6	O K
8640 min Winter	0.261	0.261	1.0	56.3	O K
10080 min Winter	0.209	0.209	1.0	44.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.619	0.0	305.3	4616
8640 min Winter	0.537	0.0	317.7	5352
10080 min Winter	0.476	0.0	328.3	5960

Cascade Rainfall Details for W461 - Basin 4.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.407	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.490

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.163	4	8	0.163	8	12	0.163

Cascade Model Details for W461 - Basin 4.SRCX

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	191.0	1.200	473.0	1.500	556.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0051-1300-1200-1300
Design Head (m)	1.200
Design Flow (l/s)	1.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	51
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	1.3	Kick-Flo®	0.459	0.8
Flush-Flo™	0.227	1.0	Mean Flow over Head Range	-	1.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.9	1.200	1.3	3.000	2.0	7.000	2.9
0.200	1.0	1.400	1.4	3.500	2.1	7.500	3.0
0.300	1.0	1.600	1.5	4.000	2.2	8.000	3.1
0.400	1.0	1.800	1.6	4.500	2.4	8.500	3.2
0.500	0.9	2.000	1.6	5.000	2.5	9.000	3.3
0.600	1.0	2.200	1.7	5.500	2.6	9.500	3.4
0.800	1.1	2.400	1.8	6.000	2.7		
1.000	1.2	2.600	1.8	6.500	2.8		

Appendix G
SuDS Treatment Table Indices

Pollution hazard indices for different land use classifications (land use shaded grey applicable for the development)

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, home zones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7
Sites with heavy pollution (e.g. haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways	High	0.8	0.8	0.9

Indicative SuDS mitigation indices for discharges to surface waters (SuDS components shaded grey applicable to this development)

	Mitigation indices		
Type of SuDS component	**TSS**	**Metals**	**Hydrocarbons**
Filter strip	0.4	0.4	0.5
Filter drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Bio retention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond	0.7	0.7	0.5
Wetland	0.8	0.8	0.8
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Indicative SuDS mitigation indices for discharges to surface waters

Catchment 1

For surface water discharge from Residential Parking Areas and Low Traffic Roads <300 traffic movements/day			
	Required mitigation indices		
Source	**TSS**	**Metals**	**Hydrocarbons**
Medium – Catchment 1	0.7	0.6	0.7
Medium – Catchment 2	0.7	0.6	0.7
Low – Catchment 4	0.5	0.4	0.4
Catchment 1 - Drainage Network			
Basin 1A	0.5	0.5	0.6
Basin 1B	0.5 x 0.5	0.5 x 0.5	0.6 x 0.5
Check	+0.05	+0.15	+0.2
Catchment 2 - Drainage Network			
Basin 2A	0.5	0.5	0.6
Basin 2B	0.5 x 0.5	0.5 x 0.5	0.6 x 0.5
Basin 2C	0.5 x 0.5	0.5 x 0.5	0.6 x 0.5
Check	+0.3	+0.4	+0.5
Catchment 4 - Drainage Network			
Basin 4	0.5	0.5	0.6
Basin 2B	0.5 x 0.5	0.5 x 0.5	0.6 x 0.5
Basin 2C	0.5 x 0.5	0.5 x 0.5	0.6 x 0.5
Check	+0.5	+0.6	+0.8

Total SuDS mitigation index = mitigation index$_1$ + (0.5 x mitigation index$_2$)

Appendix H

Maintenance Schedule

Maintenance and Management

The attenuation basins and swale would be maintained by a management company set up by the developer. As construction has not yet commenced, the process of finalising the management company contract has not yet commenced. The developer will ensure that the measures as outlined below form part of the management company contract details, for the ongoing maintenance of all SuDS features on site.

The indicative maintenance requirements for each proposed SuDS component is given below. Taken from CIRIA report C753 "The SuDS Manual".

Drainage Pipes

Maintenance schedule	Required action	Typical frequency
Regular Maintenance	Remove sediment and debris from inspection chambers and hydrobrake chambers	Annually
	Cleaning of gutters and any filters on downpipes	Annually
	Remove any root ingress	As required
Occasional Maintenance	CCTV survey of drains to check alignment, cracking and joint displacement	10 year intervals

Detention Basins

MAINTENANCE SCHEDULE	REQUIRED ACTION	FREQUENCY
Regular Maintenance	Litter and debris removal	Monthly (or as required)
	Cut the grass – for spillways and access routes	Monthly (during growing season, or as required)
	Cut the meadow grass in and around the basin	Half yearly (spring, before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)

	Inspect inlets, outlets and overflows for evidence of blockage and clear if required	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility structure for all silt accumulation. Establish appropriate silt removal frequencies	Monthly (for first year) then annually or as required
	Check any mechanical devices e.g. penstocks	Half yearly
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlet, outlet and forebay	Annually or as required
	Manage wetland plants in outlet pool – where provided	Annually
Occasional Maintenance	Re-seed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin where required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Realign rip-rap	As required
	Repair / rehabilitate inlets, outlets and overflows	As required

Swale

Maintenance Period	Maintenance Task	Frequency
Regular Maintenance	Remove litter and debris	Monthly, or as required
	Cut the grass – to retain grass height within specified design range	Monthly (during growing season) or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional Maintenance	Reseed areas of poor vegetation growth; alter plant types to better suit conditions, if required	As required or if bare soil is exposed over > 10% of the filter strip area
Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required

	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

Appendix I

Anglian Water Capacity Confirmation

Pre-Planning Assessment Report

Brook Farm, Hadleigh

InFlow Reference: PPE-0147837

Assessment Type: Used Water

Report published: 30/05/2022

Thank you for submitting a pre-planning enquiry.

This has been produced for COUNTRYSIDE PROPERTY PLC.

Your reference number is **PPE-0147837**.

This report can be submitted as a drainage strategy for the development should it seek planning permission.

If you have any questions upon receipt of this report, you can submit a further question via InFlow. Alternatively, please contact the Planning & Capacity team on **07929 786 955** or email planningliaison@anglianwater.co.uk

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Section 1 - Proposed development

The response within this report has been based on the following information which was submitted as part of your application:

List of planned developments	
Type of development	**No. Of units**
Dwellings	173

The anticipated residential build rate is:

Year	Y1	Y2	Y3	Y4
Build rate	50	50	50	23

Development type: Greenfield

Planning application status: Unknown

Site grid reference number: TQ8158188282

The comments contained within this report relate to the public water mains and sewers indicated on our records.

Your attention is drawn to the disclaimer in the useful information section of this report.

Section 2 - Assets affected

Our records indicate that we have the following types of assets within or overlapping the boundary of your development site as listed in the table below.

Additionally, it is highly recommended that you carry out a thorough investigation of your proposed working area to establish whether any unmapped public or private sewers and lateral drains are in existence. We are unable to permit development either over or within the easement strip without our prior consent. The extent of the easement is provided in the table below. Please be aware that the existing water mains/public sewers should be located in highway or open space and not in private gardens. This is to ensure available access for any future maintenance and repair and this should be taken into consideration when planning your site layout.

Water and Used water easement information		
Asset type	Pipe size (mm)	Total easement required (m)
Sewer mains	6	3.00 m either side of the centre line
Sewer mains	450	3.50 m either side of the centre line
Sewer mains	9	3.00 m either side of the centre line
Sewer mains	15	3.00 m either side of the centre line
Sewer mains	12	3.00 m either side of the centre line

If it is not possible to avoid our assets then these may need to be diverted in accordance with Section 185 of the Water Industry Act (1991). You will need to make a formal application if you would like a diversion to be considered.

Due to the private sewer transfer in October 2011 many newly adopted public used water assets and their history are not indicated on our records. You also need to be aware that your development site may contain private water mains, drains or other assets not shown on our records. These are private assets and not the responsibility of Anglian Water but that of the landowner.

Section 3 - Water recycling services

In examining the used water system we assess the ability for your site to connect to the public sewerage network without causing a detriment to the operation of the system. We also assess the receiving water recycling centre and determine whether the water recycling centre can cope with the increased flow and effluent quality arising from your development.

Water recycling centre

The foul drainage from the proposed development is in the catchment of Southend Water Recycling Centre, which currently has capacity to treat the flows from your development site.

Anglian Water cannot reserve capacity andthe available capacity at the water recycling centre can be reduced at any time due to growth, environmental and regulation driven changes.

Used water network

Our assessment has been based on development flows connecting to the nearest foul water sewer of the same size or greater pipe diameter to that required to drain the site. The infrastructure to convey foul water flows to the receiving sewerage network is assumed to be the responsibility of the developer. Conveyance to the connection point is considered as Onsite Work and includes all work carried out upstream from of the point of connection, including making the connection to our existing network. This connection point has been determined in reference to the calculated discharge flow and on this basis, a 150mm internal diameter pipe is required to drain the development site. The nearest practicable connection is to the 150mm diameter sewer downstream of manhole 6300 at National Grid Reference NGR TQ 81699 88317. Anglian water has assessed the impact of gravity flows from the planned development to the public foul sewerage network. We can confirm that this is acceptable as the foul sewerage system, at present, has available capacity for your site. Please note that Anglian Water will request a suitably worded condition at planning application stage to ensure this strategy is implemented to mitigate the risk of flooding.

It is assumed that the developer will provide the necessary infrastructure to convey flows from the site to the network. Consequently, this report does not include any costs for the conveyance of flows.

Surface water disposal

You indicated on the Pre-Planning Application form that a connection to the public surface water sewer network is not required as infiltration techniques can be utilised. Therefore a capacity assessment has not been made on the public surface water network.

As you may be aware, Anglian Water will consider the adoption of SuDs provided that they meet the criteria outline in our SuDs adoption manual. This can be found on our website. We will adopt features located in public open space that are designed and constructed, in conjunction with the Local Authority and Lead Local Flood Authority (LLFA), to the criteria within our SuDs adoption manual. Specifically, developers must be able to demonstrate:

1. Effective upstream source control,
2. Effective exceedance design, and
3. Effective maintenance schedule demonstrating than the assets can be maintained both now and in the future with adequate access.

If you wish to look at the adoption of any SuDs then an expression of interest form can be found on our website

As the proposed method of surface water disposal is not relevant to Anglian Water; we suggest that you contact the relevant Local Authority, Lead Local Flood Authority, the Environment Agency or the Internal Drainage Board, as appropriate.

Trade Effluent

We note that you do not have any trade effluent requirements. Should this be required in the future you will need our written formal consent. This is in accordance with Section 118 of the Water Industry Act (1991).

Used Water Budget Costs

Your development site will be required to pay an Infrastructure charge for each new property connecting to the public water and sewerage network that benefits from Full planning permission. The infrastructure charge replaces the zonal charge as previously identified.

You will be required to pay an infrastructure charge upon connection for each new plot on your development site. The infrastructure charge are types of charges set out in Section 146(2) of the Water Industry Act 1991.

The charge should be paid by anyone who wishes to build or develop a property and is payable upon request of connection.

• The Infrastructure Charge is based on the cost of any reinforcement and upgrades to our existing network ("Network Reinforcements"), whether designed to address strategic or local capacity issues. For more information on our Infrastructure Charge, please see the 'Useful Information' section of this report.

Infrastructure charges are raised on a standard basis of one charge per new connection (one for water and one for sewerage).

The Water Recycling Infrastructure charge for your dwellings is:

Infrastructure charge	Number of units	Total
£ 490	173	£84,770.00

Please note that you should also budget for infrastructure charges on non-household premises where applicable and these will be calculated according to the number and type of water fittings in the premises. This is called the "relevant multiplier" method of calculating the charge and the relevant multiplier will be applied to the figures set out in our 2022-23 Developer Charging Arrangements to arrive at the amount payable. Details of the relevant multiplier for each fitting can be found on our website.

Section 4 - Map of Proposed Point of Connection(s)

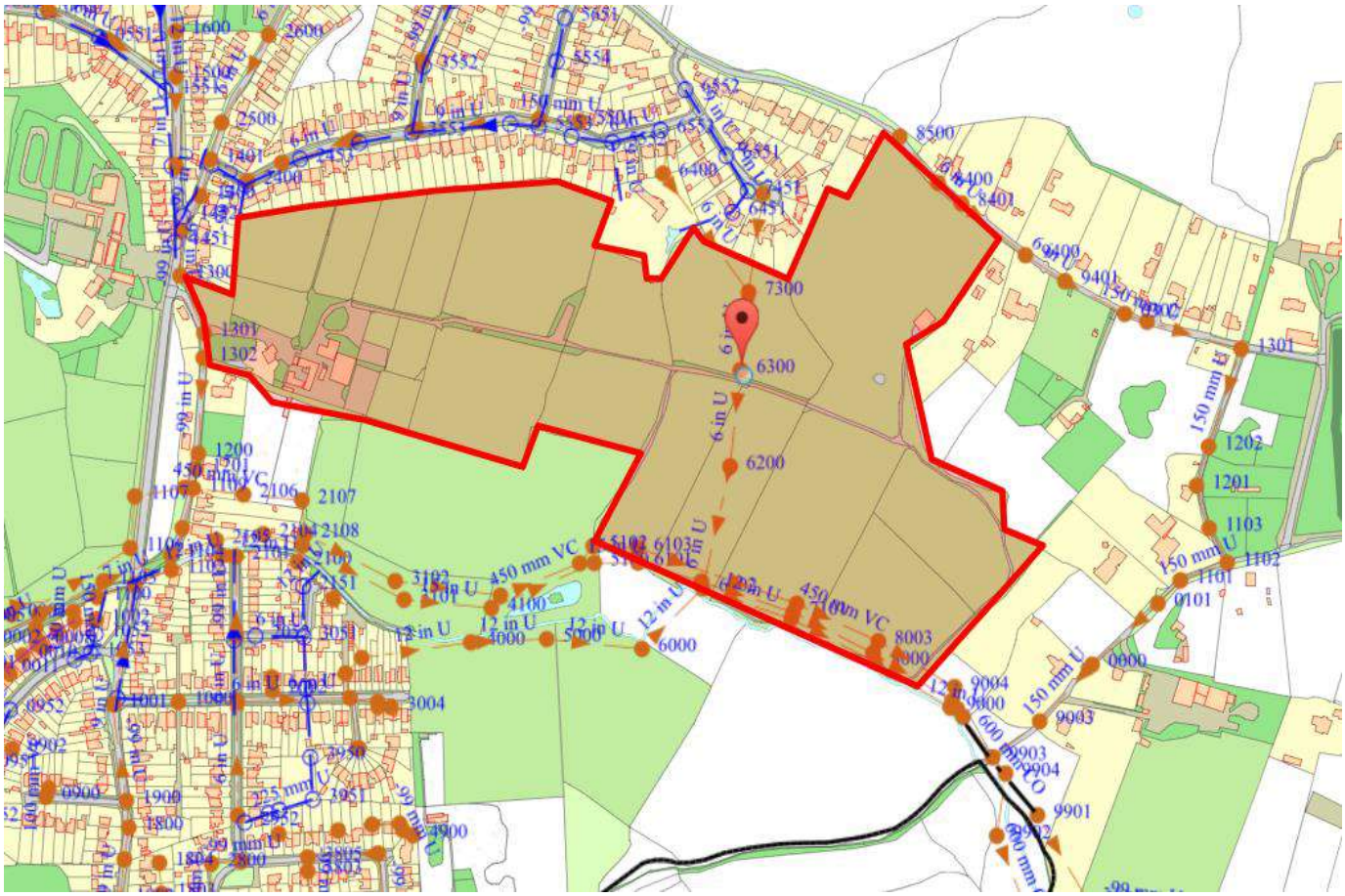

Figure 1: Showing your water recycling foul point of connection

Section 5 - Useful information

Water Industry Act – Key used water sections

Section 98:

This provides you with the right to requisition a new public sewer. The new public sewer can be constructed by Anglian Water on your behalf. Alternatively, you can construct the sewer yourself under section 30 of the Anglian Water Authority Act 1977.

Section 102:

This provides you with the right to have an existing sewerage asset vested by us. It is your responsibility to bring the infrastructure to an adoptable condition ahead of the asset being vested.

Section 104:

This provides you with the right to have a design technically vetted and an agreement reached that will see us adopt your assets following their satisfactory construction and connection to the public sewer.

Section 106:

This provides you with the right to have your constructed sewer connected to the public sewer.

Section 185

This provides you with the right to have a public sewerage asset diverted.

Details on how to make a formal application for a new sewer, new connection or diversion are available on our website or via our Development Services team on **0345 60 66 087**.

Sustainable drainage systems

Many existing urban drainage systems can cause problems of flooding, pollution or damage to the environment and are not resilient to climate change in the long term. .

Our preferred method of surface water disposal is through the use of Sustainable Drainage Systems or SuDS.

SuDS are a range of techniques that aim to mimic the way surface water drains in natural systems within urban areas. For more information on SuDS, please visit our website

We recommend that you contact the Local Authority and Lead Local Flood Authority (LLFA) for your site to discuss your application.

Private sewer transfers

Sewers and lateral drains connected to the public sewer on the 1 July 2011 transferred into Water Company ownership on the 1 October 2011. This follows the implementation of the Floods and Water Management Act (FWMA). This included sewers and lateral drains that were subject to an existing Section 104 Adoption Agreement and those that were not. There were exemptions and the main non-transferable assets were as follows:

Surface water sewers and lateral drains that do not discharge to the public sewer, e.g. those that discharged to a watercourse.

Foul sewers and lateral drains that discharged to a privately owned sewage treatment/collection facility.

Pumping stations and rising mains will transfer between 1 October 2011 and 1 October 2016.

The implementation of Section 42 of the FWMA will ensure that future private sewers will not be created. It is anticipated that all new sewer applications will need to have an approved section 104 application ahead of a section 106 connection.

It is anticipated that all new sewer applications will need to have an approved Section104 application ahead of a Section 106 connection

Encroachment

Anglian Water operates a risk based approach to development encroaching close to our used water infrastructure. We assess the issue of encroachment if you are planning to build within 400 metres of a water recycling centre or, within 15 metres to 100 metres of a pumping station. We have more information available on our website

Locating our assets

Maps detailing the location of our water and used water infrastructure including both underground assets and above ground assets such as pumping stations and recycling centres are available from digdat

All requests from members of the public or non-statutory bodies for maps showing the location of our assets will be subject to an appropriate administrative charge.

We have more information on our website

Charging arrangements

Our charging arrangements and summary for this year's water and used water connection and infrastructure charges can be found on our website

Section 6 - Disclaimer

The information provided in this report is based on data currently held by Anglian Water Services Limited ('Anglian Water') or provided by a third party. Accordingly, the information in this report is provided with no guarantee of accuracy, timeliness, completeness and is without indemnity or warranty of any kind (express or implied).

This report should not be considered in isolation and does not nullify the need for the enquirer to make additional appropriate searches, inspections and enquiries. Anglian Water supports the plan led approach to sustainable development that is set out in the National Planning Policy Framework ('NPPF') and any infrastructure needs identified in this report must be considered in the context of current, adopted and/or emerging local plans. Where local plans are absent, silent or have expired these needs should be considered against the definition of sustainability holistically as set out in the NPPF.

Whilst the information in this report is based on the presumption that proposed development obtains planning permission, nothing in this report confirms that planning permission will be granted or that Anglian Water will be bound to carry out the works/proposals contained within this report.

No liability whatsoever, including liability for negligence is accepted by Anglian Water or its partners, employees or agents, for any error or omission, or for the results obtained from the use of this report and/or its content.

Furthermore, in no event will any of those parties be liable to the applicant or any third party for any decision made or action taken as a result of reliance on this report.

This report is valid from the date issued and the enquirer is advised to resubmit their request for an up to date report should there be a delay in submitting any subsequent application for water supply/sewer connection(s). Our pre-planning reports are valid for 12 months, however please note Anglian Water cannot reserve capacity and available capacity in our network can be reduced at any time due to increased requirements from existing businesses and houses as well as from new housing and new commercial developments.