Pump Farm, Lower Rainham

Flood Risk Assessment and Drainage Strategy

On behalf of **AC Goatham & Son**

Project Ref: 44538/2003 | Rev: 0 | Date: January 2019

Registered Office: Buckingham Court Kingsmead Business Park, London Road, High Wycombe, Buckinghamshire, HP11 1JU
Office Address: Unit 10, Connect 38, 1 Dover Place, Ashford TN23 1FB
T: +44 (0)123 352 7250 E: ashford@peterbrett.com

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	Name	Position	Signature	Date
Prepared by:	Andrew Hughes	Engineer		30.11.18
Reviewed by:	Scott Nicholson	Senior Engineer		07.01.19
Approved by:	Chris Downs	Director	CDowns	11.01.19
For and on behalf of Peter Brett Associates LLP				

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Executive Summary

This Flood Risk Assessment and Drainage Strategy (FRADS) accompanies a planning application for the redevelopment of agricultural land off Pump Lane, Lower Rainham, Kent with a provision of up to 1,250 residential units. This Proposed Development will also provide a local centre, an 80-bed care home and 60 bed extra care facility and a two-form entry primary school.

The FRADS will determine potential sources of flooding at the Site and their associated risk to life and property. It will determine the suitability of the Site for the Proposed Development in relation to flood risk and proposed appropriate drainage design and mitigation measures.

The Site is in the village of Lower Rainham, approximately 3km to the east of the town of Gillingham, Kent. It is centred at National Grid Reference TQ 809 674 with the nearest postcode being ME8 7AT. The Site is effectively divided into two main parcels of land, by Pump Lane, which traverses southwest to northeast through the Site.

The geology of the Site is generally Thanet Beds (stiff or very stiff, brown sand CLAY) over Seaford Chalk Formation. The groundwater is within the Seaford Chalk Formation, which has been identified as being a Principal Aquifer. The depth to the ground water varies from ~ 26m at the higher end of the site to ~ 8m at the lower.

There are no watercourses on the Site, but the Site is located within 300m of the marshes of Rainham Creek, which forms part of the Medway Estuary and Marshes SSSI.

The fluvial flood mapping for the Site confirms that it is in Flood Zone 1. Two potential up to medium risk surface water flow routes run through the centre of the western part of the Site in a north easterly direction. The Preliminary Flood Risk Assessment (PFRA) provides no evidence of historic groundwater flooding for the Site and goes ono to state that there is no evidence for there being a future risk across Medway and groundwater rebound is not believed to be an issue in the area.

From an overview of historic flooding in Medway, it was reported in the PFRA, there has been no fluvial, or other form of, flooding recorded on the Site.

As the Site will be residential its proposed use will be defined as ‘more vulnerable’ and as it lies within Flood Zone 1, this is identified as being compatible development, therefore, there is no need for a Sequential Test, or an Exception Test.

As the Site is in Flood Zone 1 there is no need for any fluvial based flood mitigation measures. As there are a couple up to potential medium probability surface flow routes through the Site the detail design of the SuDS will be undertaken to address these.

The currently proposed surface water drainage strategy is based on making a connection to the existing public surface water sewer network, with infiltration drainage to supplement, if site investigations during detail design shows this is viable. The proposed approach still makes use of the network of interconnected swales and attenuation basins with the new land form directing all surface water flowing on to Site, or originating on it, towards this system.

To help provide further surface water attenuation and reduce potable water demand it is be proposed that the development will use water butts, while consider the practicalities of rainwater harvesting and grey water recycling. At detail design a maintenance schedule will be developed, so that it can be put in place for the lifetime of the development to maintain any SuDS specified

It is proposed to discharge foul water into the existing public sewer.

This FRADS demonstrates that the Proposed Development is appropriate, and the proposed surface drainage strategy means there is no increase in flood risk elsewhere, thus meeting the requirements of the National Planning Policy Framework.

1 Introduction

1.1.1 Peter Brett Associates, now part of Stantec (PBA) have been appointed to undertake a Flood Risk Assessment and Drainage Strategy (FRADS) to accompany a planning application for redevelopment of land off Pump Lane with a provision of up to 1,250 residential units.

1.1.2 The FRADS will determine potential sources of flooding at the Site and their associated risk to life and property. It will determine the suitability of the Site for the Proposed Development in relation to flood risk and proposed appropriate drainage design and mitigation measures.

1.1.3 The Proposed Development will comprise of the following:

- Provision of:
  - Up to 1,250 residential units
  - A local centre
  - An 80-bed care home
  - A 60-bed extra care facility
  - A two-form entry primary school;
- Appropriate access; and
- Associated landscaping.

2 Existing Site and Proposals

2.1 Location and Context

2.1.1 The Site is in the village of Lower Rainham, approximately 3km to the east of the town of Gillingham, Kent. It is centred at National Grid Reference TQ 809 674 with the nearest postcode being ME8 7AT. The approximate Site boundary of the Proposed Development is shown in **Appendix A**.

2.1.2 The Site is bounded by Lower Bloors Lane to the east; Lower Rainham road and agricultural land to the north; agricultural land and residential property fronting on to Lower Twydall Lane to the west; and the South Eastern (Chatham to Sittingbourne) Railway line to the south. A former chalk pit is located adjacent to the western boundary of the Site.

2.1.3 The Site is effectively divided into two main parcels of land, by Pump Lane which traverses southwest to northeast through the Site. The first area, termed “Pump Farm”, is bounded by Pump Lane to the east and Lower Twydall Lane to the west. The second area, termed “Bloors Farm”, is bounded by Lower Bloors Lane to the east and Pump Lane to the west.

2.2 Topography

2.2.1 A topographic survey was produced by JC White in October 2018, drawings of which are presented in **Appendix B**. The Site falls from an elevation of circa 30m AOD in the south to circa 10m AOD in the north, at an average gradient of 1 in 37. Pump Lane, which runs roughly through the middle of the Site, lies in a narrow shallow valley. The former Lower Twydall Chalk Quarry associated access road leading to Lower Rainham Road also lie within a shallow valley feature.

2.3 Ground Conditions

2.3.1 A Phase 1 Ground Conditions Assessment has been prepared by PBA (2018) and provides an overview of expected ground conditions at the Site, as well as the potential to manage surface water by infiltration drainage.

Table 2.1 Summary of ground conditions (PBA, 2018)

Strata	Base level (m bgl)	Typical Description
Topsoil	0.3 - 0.5	n/a
Head Deposits	0.5 - 3.0	Loam. Locally thinning at northern boundary and probably absent to south of site.
Thanet Beds	2.0 - 6.0	Stiff or very stiff, brown sandy CLAY with gravel and occasional roots. Locally thinning to north of site.
Seaford Chalk Formation	>16.70	Firm chalk with fragments of hard chalk and flint.

NB: the final figure shows that chalk continues pass the end of the bore holes.

2.3.2 From the earliest available historical records both farms have been predominantly used as agricultural land since the mid nineteenth century.

2.3.3 Currently both farms are generally covered by orchards. Pump Farm contains several associated agricultural buildings, caravans for temporary workers on the north-eastern part of the site and a large water tank. On Bloors Farm there is a large segmental steel circular water storage tank on a concrete plinth and local to it a borehole used for water abstraction. Both farms have an active irrigation system for watering the orchards.

2.4 Groundwater

2.4.1 Groundwater levels recorded in close proximity to the Lower Twydall Chalk Pit landfill taken from the 2015 annual monitoring report (Ground and Environmental Services Limited (GES) 2015) and are presented in the PBA Ground Conditions Assessment report (PBA, 2018). During 2015 Groundwater levels ranged between 3.33mAOD and 3.99mAOD in the higher parts of the Site e.g. borehole BH1, to the south of the landfill site; and between 1.99mAOD and 2.14mAOD in the lower parts of the Site e.g. borehole BH3a, to the north of the landfill site closest to Lower Rainham Road.

2.4.2 When considering the GES 2015 report water monitoring borehole BH2A, with starting ground level as 14.56m AOD (i.e. towards the northern lower end of the Site), found chalk at 2.5m below the ground and encountered ground water at 12.8m below ground, therefore, there is an unsaturated chalk band of 10.3m.

2.4.3 The groundwater is within the Seaford Chalk Formation, which has been identified as being a Principal Aquifer.

2.4.4 There are no Groundwater Source Protection Zones within 500m of the Site.

2.5 Surface Watercourses

There are no watercourses on the Site, but the Site is located within 300m of the marshes of Rainham Creek, which forms part of the Medway Estuary and Marshes SSSI.

3 Reference Documents and Methodology

3.1 Policy Context

3.1.1 PBA have prepared this FRADS following national, regional and local planning policy guidance documents regarding flood risk and drainage. A summary of the main policy requirements is presented below:

- The **Flood and Water Management Act (2010)** (HM Government, 2010) became law in 2010 and aims to create a simpler and more effective means of managing flood risk and coastal erosion. The Acts sets out which bodies are responsible for managing flood risk in England and Wales. The EA has a strategic role while local authorities have a leadership role in local flood risk management. Local authorities in turn rely on information from other public and private bodies, such as Internal Drainage Boards, water companies and emergency services, which have a duty to cooperate and share information to assist a coordinated approach to flood risk management.

- The revised **National Planning Policy Framework** (MHCLG, 2018), issued by the Ministry of Housing, Communities and Local Government in July 2018, sets out the government's planning policies for England and how these are expected to be applied. Climate change, flood risk, water quality and biodiversity are covered.

- **Planning Practice Guidance** (DCLG, last updated 2018) brings together planning practice guidance for England and it provides advice on how planning can take account of the risks associated with flooding and coastal change in plan-making and the planning application process. This includes demonstrating how flood risk will be managed now and over the lifetime of the development, taking climate change into account.

- **Medway Council Local Plan** (MC, 2003) does not contain any specific policies related to surface water flood risk and drainage.

- The **MC Strategic Flood Risk Assessment** (SFRA) [Mott MacDonald, 2006], its Addendum (Scott Wilson, 2011) and the High-Level Appraisal of Potential Solutions to Manage Flood Risk in the Urban Medway (Scott Wilson, 2011) makes a number of recommendations related to flood risk and drainage throughout Medway and these are:

    - 2.2.2. The Local Planning Authority will expect the developer to provide an assessment of flood risk, including runoff implications which is appropriate to the nature and scale of the development and the risks involved. This assessment should be submitted with the planning application.

    - 3.2.9. Medway Council promote SuDS as the normal drainage practice, where appropriate, for all new developments.

    - 3.2.9. SuDS are favoured over traditional piped networks as they mimic natural flow patterns; reducing the developments flood risk; minimising pollution arising from surface water runoff which could enter a watercourse or groundwater; maintaining a groundwater recharge and/or enhancing the quality of wildlife habitats, amenity and landscapes.

- The **MC SFRA Addendum** made the following additional recommendations:

    - 6.10. SuDS should be encouraged and could count towards 'reducing flood risk'.

- 6.8. By installing SuDS without arranging for their adoption or maintenance, there is a risk that they will eventually cease to operate as designed and could therefore present a flood risk to the development and/or neighbouring property.

- There is no guidance given in relation to minimum surface water runoff rates, although there is reference to best practice guidance.

- **MC Preliminary Flood Risk Assessment** (MC, 2011) this a high-level overview of flood risk from local flood sources, including surface water, groundwater, ordinary watercourses and canals. The Environment Agency (EA) has used a national methodology, which has been set out by Department for Environment, Food and Rural Affairs (Defra), to identify indicative Flood Risk Areas across England. Of the ten indicative Flood Risk Areas that have been identified nationally, one is located within Medway Council's administrative area. Here is a summary of the findings from this assessment that relate to this Site:

    - From an overview of historic flooding in Medway, none has been recorded on the Site.

    - The EA's Areas Susceptible to Groundwater Flooding (AStGWF) is a strategic scale map showing groundwater flood areas on a 1km square grid. It was developed specifically for use in PFRA and only provides a high-level view of the wider areas which might be at risk from groundwater flooding. It does show that there is a potential for groundwater flooding on the Site. However, in common with the majority of flooding datasets showing areas which may experience groundwater emergence, it covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

    - There is no local information available that provides evidence on future groundwater flood risk across Medway and groundwater rebound is not believed to be an issue in the area.

- **Surface Water Management Plan Final Revision** (SWMP) (AECOM, 2016) investigates the risks of surface water flooding and proposes a surface water management strategy for MC. Surface water flooding is defined as flooding from sewers, drains, groundwater, runoff from land, small watercourses and ditches, which occurs as a result of heavy rainfall. The aim of this SWMP was to understand and resolve complex, high risk surface water flooding problems in urbanised areas. A high-level assessment of the risk of this type of flooding was undertaken within Medway using previous modelling results included in the Local Flood Risk Management Strategy and the EA's updated Flood Map for Surface Water. This process was to determine the level of probable future risk, prioritise higher risk areas for further investigation and identify 'quick win' flood mitigation actions. This identified four priority areas for further consideration and three settlements to be assessed at the intermediate level. The Lower Rainham area was not identified as a high-risk area by this process.

3.2 Methodology

3.2.1 The following documentation has been considered in the preparation of this FRADS:

- **Defra guidance** (Defra, 2015a) on the preparation and assessment of Flood Risk Assessments and any relevant standing advice relating to vulnerable development and development within critical drainage areas (if applicable).

- The EA has released an update of their 2011 document **Adapting to Climate Change: Advice to Flood & Coastal Risk Management Authorities**. The update (EA, 2016) reflects an assessment completed by the EA between 2013 and 2015 using updated climate change data to produce more representative climate change allowances for

England. The document provides a range of climate change allowances for peak rainfall intensities between 20% and 40%, rather than 30% as previously recommended through the NPPF. The Drainage Strategy has been designed to provide for a 20% increase from climate change, with consideration given to a 40% increase and the effect it would have.

- The EA published its **Approach to Groundwater Protection** (EA, 2018), an update to the previous GP3 document, to outline their approach to management and protection of groundwater in England and Wales. It provides guidance for landowners and developers whose activities may impact upon groundwater. Given the sensitive hydrogeology of the Site, guidance within this document has informed the Drainage Strategy.

- In March 2015, Defra published **Non-statutory technical standards for sustainable drainage systems** (Defra, 2015b). This document contains technical standards for the design, maintenance and operation of SuDS. Its purpose is to guide decision makers considering new surface water drainage schemes.

- The method of disposing surface water from sites is prioritised within the **Building Regulations Requirement Part H3**. It requires that rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following, listed in order of priority: i) an adequate soakaway or some other adequate infiltration system, or where that is not reasonably practicable; ii) a watercourse, or where that is not practicable; iii) a sewer.

- Best practice sustainable urban drainage design advice is given in The **SUDS Manual** (CIRIA, 2015). SuDS drainage can be in a variety of forms, including infiltration trenches, swales, permeable surfaces, detention basins and green roofs.

- **Flood estimation for small catchments** (Institute of Hydrology, 1994) provides flood estimation equations for deriving catchment runoff rates and volumes. This has been used to determine the existing rate of surface water runoff for parts of the Site.

- **Water. People. Places. A guide for master planning sustainable drainage into developments** (AECOM, 2013) has been prepared by the South East England Lead Local Flood Authorities (LLFAs). The guidance outlines the process for integrating SuDS into the master planning of large and small developments. The LLFAs expect this guidance to be used as part of the initial planning and design process for all types of development. It states that consideration of the movement of water and its interaction with space at the earliest stage of design is crucial to the success of SuDS and allows the developer to maximise wider benefits.

- **Sewers for Adoption** (WRc, 2012) contains guidance for the design and construction of sewers that will be adopted by Sewerage Undertakers in England and Wales in accordance with Section 104 of the Water Industry Act 1991. The proposed drainage strategy has been progressed in consideration of the design requirements with this guide.

3.3 Consultations

3.3.1 A Pre-Application written response was received from MC dated 19th November 2018, resulting from a meeting with MC. This contained a section on Flood and Drainage, which has been used to inform the development of this FRADS.

3.3.2 Even though the Gov.UK website identified that the Site is in Flood Zone 1, the EA were contacted to get Product 4 data, as it is more accurate and up to date, to confirm this position (See Section 4).

4 Flood Risk Assessment

4.1 Fluvial Flooding

4.1.1 The Gov.UK online flood map for planning, replicated in **Figure 4.1**, shows the central and southern parts of the Site to be within Flood Zone 1. Land within this zone is described as having a less than 1 in 1,000 annual probability of river, or sea flooding (<0.1%).

4.1.2 **Figure 4.1** also shows an extract of a detailed 'Product 4' flood risk assessment provided by the EA (EA ref KSL 99588 JM, Sep 18, full report in **Appendix C**). This also shows the Site is in Flood Zone 1.

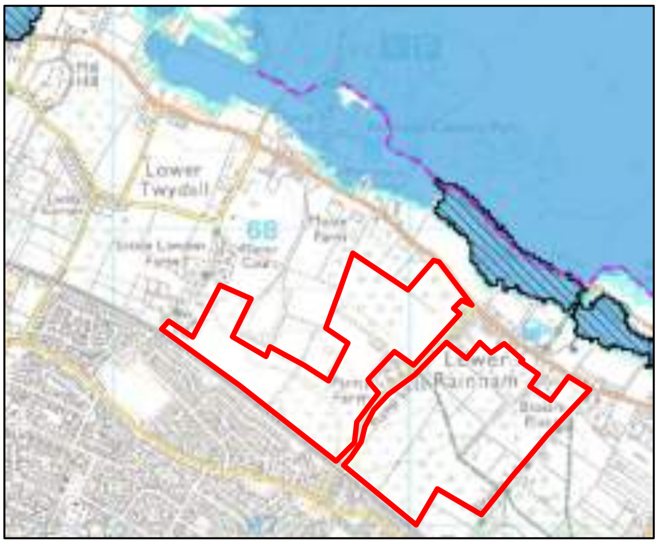


Figure 4.1. EA flood maps showing approximate site application boundary

4.1.3 There are no watercourses on the Site, with the closest one being the Medway Estuary.

4.1.4 From an overview of historic flooding in Medway, it was reported in the PFRA, there has been no fluvial flooding recorded on the Site.

4.1.5 Therefore, it is assessed that there is a low risk of fluvial flooding on the Site.

4.2 Surface Water Flooding

4.2.1 The Gov.UK online surface water flood map (EA, 2018) is presented in **Figure 4.2** and shows the potential route of surface water exceedance flow paths local to the Site.

4.2.2 Several surface water flow paths are located adjacent to the Site, with zones of medium (1 in 30 to 1 in 1000 annual probability) to high (less than 1 in 30 annual probability) flood risk running in a north-easterly direction, e.g. along Pump Lane. There is a more limited extent flow path, of medium to high flood risk, starting mainly on the bridle way before running in a north-easterly direction along Lower Bloor Lane.

4.2.3 Two potential up to medium risk flow routes are identified running through the centre of the western part of the Site, i.e. Pump Farm, in a north-easterly direction, crossing neighbouring agricultural land and the B2004 Lower Rainham Road, prior to reaching the Rainham Creek Marshes.

4.2.4 From an overview of historic flooding in Medway, it was reported in the PFRA, there has been no surface water flooding recorded on the Site.

4.2.5 Therefore, it is assessed that there is a low risk of surface water flooding on the Bloors Farm site with low to medium on the Pump Farm site.

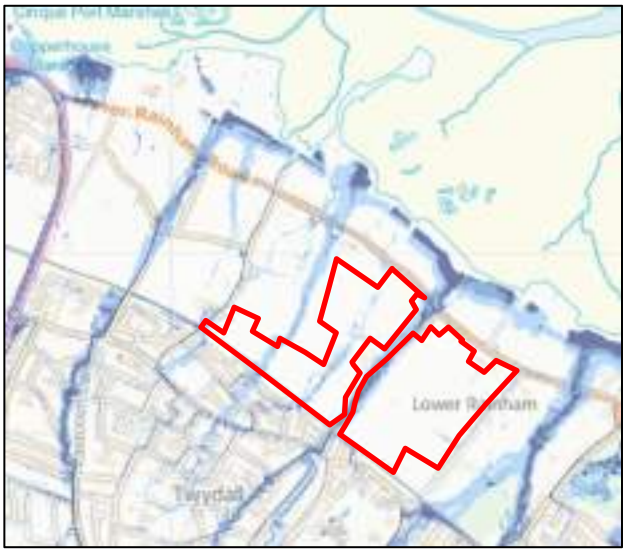


Figure 4.2 EA flood risk from surface water map (EA, 2018)

4.3 Groundwater Flooding

4.3.1 The PFRA provides a high-level view of the general areas that might be at risk from groundwater flooding. It does show that there is a potential for groundwater flooding on the Site. However, in common with the majority of datasets showing areas which may experience groundwater emergence, it covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

4.3.2 The PFRA provides no evidence of historic groundwater flooding for the Site and goes on to state that there is no evidence for there being a future risk across Medway and groundwater rebound is not believed to be an issue in the area.

4.3.3 From a review of the available geotechnical information (see Section 2.4), the depth to the ground water varies from ~ 26m at the higher southwestern end of the Site to ~ 8m at the lower north-eastern end.

4.3.4 From an overview of historic flooding in Medway, it was reported in the PFRA, there has been no groundwater flooding recorded on the Site.

4.3.5 Therefore, it is assessed that there is a low risk of groundwater flooding on the Site.

4.4 Flood Risk from Failure of Infrastructure

Sewers

4.4.1 There is an 1800mm precast concrete (CP) foul sewer crossing the Site from west to east, which lies within the footprint of the school site, the village centre and the residential area in the north west corner of the site, as shown on the latest proposed Masterplan. There are foul and combined rising mains running within the carriageway of Lower Rainham Road to the north of the Site, but the Site is up-hill of this sewer.

4.4.2 A combined sewer runs within the western side of the Site, close to and generally following the line of Pump Lane, from the south of the Site to Russett Farm, where it then connects to the foul sewer at the rear of 326 Pump Lane. There are also foul and combined sewers shown running within the carriageway of Pump Lane.

4.4.3 The SFRA and PFRA do not identify that there has been any historic sewer flooding.

Reservoirs

4.4.4 The Gov.UK online *flood risk from reservoir map* indicates the residual flood risk from the failure of reservoirs or other 'perched' water bodies above 25,000m^3 in volume. This confirms that there are no reservoirs close enough to impact the Site in the event of a reservoir breach.

Water Mains

4.4.5 There have been no reported issues with water mains bursting and causing flooding.

4.5 Summary of Flood Risk

4.5.1 The following table provides an overview of the flood risk to the Site, based on the information obtained and detailed in Section 3.

Table 4.1 Summary of sources of flood risk

Source of Flooding	Risk of Flooding to Site	Comment/Justification	Source of data	Mitigation requirements for new development (see Section 5)	Risk of Flooding to Site after mitigation
Fluvial / Tidal	Low/Negligible	The Site is in Flood Zone 1. There is no historic evidence of flooding.	Gov.UK online map for planning EA Product 4 data	n/a	Low/Negligible
Surface Water	Low/Negligible – Medium	There are two potential flow routes running through the centre of the Pump Farm part of the Site, with up to a medium risk. However, there is no historic evidence of flooding.	Gov.UK online Long-Term Flood Risk Map MC PFRA	The overall SuDS approach for the Site is to have a proposed network of swales and attenuation basins, which will also deal with the potential low/medium risk flow routes.	Low/Negligible
Groundwater	Low/Negligible	There is high-level information identifying that there might be a groundwater flooding risk. However, there is no evidence of historic groundwater flooding and it is stated that there is no evidence for there being a future risk across Medway.	MC PFRA	n/a	Low/Negligible
Sewers	Low/Negligible	There is a foul sewer crossing the Site and a combined sewer running along the edge of Pump Lane. There has been no recorded related flooding incidents.	MC SFRA / PFRA	n/a	Low/Negligible
Infrastructure	Low/Negligible	No reservoirs or flood defences close to the Site. There have been no reported issues with water mains bursting and causing flooding	Gov.UK online flood risk from reservoir map	n/a	Low/Negligible

Key:		
	Green	**Low/Negligible Risk** – No noticeable impact to site & not considered to be a constraint to development
	Amber	**Medium Risk** – Issue requires consideration but not a significant constraint to development
	Red	**High Risk** – Major constraint to development requiring active consideration in mitigation proposals

4.6 Flood Risk Vulnerability

4.6.1 NPPF PPG ‘Flood Risk and Coastal Change’ Table 2 confirms the *‘Flood risk vulnerability classification’* of a site, depending upon the proposed usage. This classification is subsequently applied to PPG Table 3 to determine whether:

- The proposed development is suitable for the flood zone in which it is located, and;
- Whether an Exception Test is required for the proposed development.

4.6.2 As the Site will be residential its proposed use is considered by the EA to be ‘more vulnerable’ as defined in NPPF Table 2. As the Site lies within Flood Zone 1, Table 3 of the NPPF ‘Flood Risk and Coastal Change’ guidance says that this form of development is compatible and is permitted.

4.7 Sequential and Exception Tests

4.7.1 The NPPF states that where relevant, the Sequential Test should be applied first to guide development to Flood Zone 1, then Zone 2, and then Zone 3.

4.7.2 As the Site is in Flood Zone 1 there is no need for a Sequential Test, or an Exception Test.

5 Flood Mitigation Strategy

5.1.1 The Proposed Development will comprise of the following:

- Up to 1,250 residential units
- A local centre
- An 80-bed care home
- A 60-bed extra care facility
- A two-form entry primary school
- Appropriate access; and
- Associated landscaping.

5.1.2 As the Site is located in Flood Zone 1, the development will be at a low probability of fluvial flooding, therefore, there is no need for a Flood Mitigation Strategy to address this type of flooding.

5.1.3 There is also generally low risk of surface water flooding across the Site, while there are two limited up to medium probability flow routes on the Pump Farm section of the Site. The overall SuDS approach for the Site will be developed based on a proposed network of interconnected swales and attenuation basins, potentially with infiltration features. The site land form will be developed to direct all surface water flowing on to Site, or originating on site, towards this SuDS system (see Section 6).

5.1.4 To help provide further surface attenuation and reduce potable water demand it is be proposed that the development will use water butts, while consider the practicalities of rainwater harvesting and grey water recycling.

6 Surface Water Drainage Strategy

6.1 Introduction and Design Approach

6.1.1 This section outlines a strategy for managing surface water runoff from the development in accordance with national and regional policy requirements, and best practice guidance. The strategy intends to mitigate the risk of surface water flooding on the Site and avoid increasing flood risk downstream.

6.1.2 The described strategy should not be taken as the fixed solution, as detailed design, further investigations and the relevant consents will be required prior to construction.

Impermeable Area

6.1.3 The Proposed Masterplan has been produced by PRC and is presented in **Appendix A**. This has been used to sub-divide the development into sub-catchments, as shown on the Drainage Strategy Plan in **Appendix E**.

6.1.4 The existing extent of impermeable surfaces is assumed to be zero. **Table 6.1** presents a breakdown of the proposed impermeable area by the respective development uses on the masterplan. Based on previous experience with similar developments, residential, care and village centre areas (including for minor access roads both within and between sub-sites) are assumed to comprise of 65% impermeable area, whilst the school impermeable area has been assumed as 80%. The proposed open spaces are anticipated to retain the same greenfield drainage characteristics as existing. It is clear that the Proposed Development will result in a considerable net gain of impermeable surfaces, which will have negative implications for on-site and downstream flood risk if left unmitigated.

Table 6.1 Proposed impermeable areas

Development Use	Gross Development Area (ha)	Impermeable Area %	Net Impermeable Area (ha)
Residential	32.145	65	20.894
Care	1.250	65	0.813
Village Centre	0.639	65	0.415
School	2.603	80	2.083
Total	**36.637**	**-**	**24.205**

Hierarchy of Surface Water Disposal

6.1.5 As identified in Section 3.2.1 the method of disposing surface water from sites is prioritised within the Building Regulations Requirement Part H3. It requires that rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following, listed in order of priority: i) infiltration, or where that is not reasonably practicable; ii) a watercourse, or where that is not practicable; iii) a sewer. The following sections considers the use of each in turn for the proposed development.

Consideration of Infiltration Drainage

6.1.6 Based on the ground conditions and groundwater information presented in **Sections 2 & 3**, it is envisaged that the final drainage solution could incorporate infiltration; however, it is proposed to undertake ground investigation including infiltration tests as part of the detail design, therefore, currently no infiltration is assumed for sizing of the system.

6.1.7 As recommended in the PBA Ground Conditions Assessment report (2018) if infiltration is shown to be a viable option at detail design, consideration will be given to the risk of solution features and man-made cavities in the appropriate design and siting of any infiltration system. Any soakaways will be carefully located away from housing, roads and primary infrastructure and located in lower risk soft landscaping areas. If such soakaways are located in areas of intensively used public open space, then the position of such soakaways will be protected by landscaping features. It is being recommended, rather than adoption of shallow soakaways discharging into areas where overlying Thanet Beds are present, consideration should be given to the use of deep bored, or trench soakaways discharging into competent chalk strata, to reduce the risk of ground collapse due to fines (very small particles within a soil of various sizes particles) migrating into widened fissures, or open voids within the underlying chalk.

6.1.8 The form of infiltration system will be based on a proposed network of interconnected swales and attenuation basins, with deep bored, or trench infiltration features as shown on the drainage strategy plan in **Appendix E**.

Consideration of Connection to Surface Watercourse

6.1.9 Should infiltration rates on the Site not be sufficient to control all surface water runoff from the Site, best practice guidance would then require developments to assess making a connection to an off-site water body. In this case the closest surface water body for off-site disposal is the River Medway; however, as there are likely to be significant third party and environmental impacts due to providing a new sewer easement and outfall to the Medway, this option is not seen as being viable, so has been discounted.

Consideration of Connection to Sewer

6.1.10 In consideration of the above, it is currently proposed to make a connection to the existing public sewer network, with infiltration drainage to supplement the drainage strategy subject to further site investigations during detail design. The proposed approach still makes use of the network of interconnected swales and attenuation basins as shown on the drainage strategy plan in **Appendix E** with the new land form directing all surface water flowing on to Site, or originating on site, towards this system.

6.1.11 Existing sewer records were provided by Southern Water on 21st June 2016. The records show that surface water sewers are present within the adjacent Lower Rainham Road and Pump Lane. The most logical place of connection would be an existing manhole in the north-eastern corner of the Site (SWS MH2754). This proposed point of connection comprises an existing manhole chamber connecting a 1500mm diameter concrete drainage pipe. Upstream the pipe drains the Pump Farm buildings and the neighbouring Chapel House. Downstream the pipe connects to a wider drainage system at the junction of Pump Farm and Lower Rainham Road, before draining northward along an access track to an outfall at Rainham Creek Marshes.

Existing and Design Rate of Runoff from the Site

6.1.12 Government guidance expects the post-developed rate of runoff into a watercourse to be no greater than the pre-developed rate with the same rainfall event. Therefore, applying the typical Greenfield runoff rate, the new development site’s runoff will be attenuated to achieve this figure up to the 1 in 100 (1%) Annual Exceedance Probability rain storm event. The industry standard software (Microdrainage) has been used to estimate the Greenfield runoff rates as presented in **Table 6.2** below (see model outputs in **Appendix D**).

Table 6.2 Greenfield runoff rates

AEP Event	Runoff Rate (l/s/ha)
100%	2.00
Q_{BAR}	2.4
3.33%	5.4
1%	7.6

Storage Attenuation Requirements

6.1.13 The masterplan has been used to sub-divide the proposed development into sub-catchments, as shown on the drainage strategy plan in **Appendix E**. The proposed attenuation storage for each sub-catchment has been modelled using Microdrainage Source Control (see model outputs in **Appendix D**). The results are summarised in **Table 6.3**. Some of the development areas will be drained to multiple attenuation basins and so have been further sub-divided in the Table to show the individual runoff rates and storage volumes for each basin. For this assessment, a 20% allowance for climate change, in accordance with the latest guidance from the EA (EA, 2016), has been adopted. The impact of a 40% event would be considered through detailed design stages to ensure that flooding of buildings or off-site property does not occur.

Table 6.3 Storage Volume Requirements

Catchment	Gross Development Area (ha)	Net Impermeable Area (ha)	Proposed Maximum Discharge (l/s)	Proposed Storage Volume (m^3)
A1	3.789	2.463	18.7	1325
A2 (inc. outfall)	1.150	0.748	183.9 (5.7)*	300
B1	1.787	1.162	8.8	620
B2	1.314	0.854	6.5	445
B3 (inc. care)	1.526	0.992	7.5	530
C	8.342	5.422	41.2	2850
D	9.962	6.475	49.2	3500
E1	4.047	2.631	20.0	1380
E2	2.117	1.376	10.5	750
SCHOOL	2.603	2.082	15.8	1150
Total	**36.637**	**24.205**	**183.9**	**12,850**

**Catchment A2 drains to an outfall basin which will be used to capture flows from site wide basins prior to final site outfall. Surface water from this pond would drain at the site wide rate of 183.9 l/s rather than the catchment-specific rate of 5.7 l/s (shown above in brackets for information only)*

6.2 Proposed System

6.2.1 The proposed Drainage Strategy plan is presented in **Appendix E**. The arrangement and levels of the drainage components may need to be reviewed at detailed design.

Catchment Drainage

6.2.2 The proposed development is sub-divided into various development plots. Surface water runoff from each of these will be managed within their own set of attenuation basins. These would be concentrated in the ecological corridors around the edge of the Site and within the area of green separation between the development areas. Each basin outfall chamber will be fitted with an orifice plate or vortex flow control unit to control runoff to the pre-developed greenfield runoff rate (e.g. see rates in **Table 6.3** above); thereby avoiding the need for one large pond at the bottom of the Site.

6.2.3 It is envisaged that surface water from the basins would be conveyed to the site outfall via a swale network. To prevent erosion, runoff velocities within the swales during extreme events would be restricted to a maximum of 2.0m/s to avoid erosion. It is anticipated that check dams would be incorporated into the swale network where proposed longitudinal gradients exceed 3%. In some cases, where it is not possible to incorporate swales due to proposed levels or gradients, a traditional piped system would be used.

6.2.4 The Ground Conditions Assessment (2018) indicates that the potentially highly permeable chalk aquifer is overlain by circa 2m to 6m of low permeability clays. Therefore, it would be the intention to install deep bore, or trench, soakaways within or adjacent to the attenuation basins. Indicative locations are presented in the drainage strategy plan. Inclusion of deep bore soakaways would allow more surface water runoff to be discharged to ground rather than to an offsite sewer, whilst also reducing the risk of near surface ground instability. In accordance with CIRIA guidance (CIRIA, 2002), soakaways would be placed a minimum of 10m away from any structure, depending on the chalk density, and spaced a minimum of 10m apart to avoid influencing one another.

6.2.5 As already mentioned, further investigation is required to rely on infiltration drainage as a strategy, so the proposed system in this report focusses on an assumed no-infiltration system, with infiltration drainage to be incorporated through the detailed design stages. Depending upon the rate and extent of infiltration possible found during site investigations, the indicative attenuation basin sizes presented in the drainage strategy plan may be reduced.

Site Outfall

6.2.6 It is proposed that the last attenuation pond would be fitted with a flow control device to restrict the discharge rate from the Site to the pre-development runoff rate. Surface water would outfall to MH2754 at this controlled rate, eventually discharging to the River Medway via an existing outfall.

6.2.7 A Feasibility Capacity Check has been submitted to Southern Water to ascertain the likely improvements required (if any) to connect to the sewer system.

Exceedance

6.2.8 Consideration has been given to extreme rainfall events. It is possible that the capacity of the proposed drainage system may be surpassed during events greater than the 1 in 100 year +20% climate change rainfall event, for which the system has been designed (e.g. a 40% climate change allowance).

6.2.9 Therefore, it is proposed during detailed design that the land form will be modified to handle 1 in 100 year + 40% climate change exceedance flows from the development so they would be held in the lower parts of the Site, landscaped areas, retained greenspace areas and carriageway low points, thus avoiding flooding of buildings and being held until capacity within the drainage infrastructure becomes available again.

SuDS Maintenance

6.2.10 At detail design a maintenance schedule will be developed, so that it can be put in place for the lifetime of the development to maintain any SuDS specified. This will include the frequency of maintenance based on guidance in the CIRIA SuDS Manual, as well as details of who will be carrying out the maintenance.

7 Foul Water Drainage Strategy

7.1 Introduction and Design Approach

7.1.1 This section outlines indicative proposals for managing foul water drainage. The design is intended to provide a viable drainage solution whilst mitigating the risk of foul water flooding and environmental damage.

7.2 Off-site Foul Drainage Capacity

7.2.1 Asset records provided by the local WaSC, Southern Water (**Appendix B**), indicate the closest public foul sewer to be an existing 225mm diameter combined sewer running through the centre of the Site along Pump Lane. A second 1500mm diameter foul sewer runs through the Site from north-west to south-east.

7.2.2 A Feasibility Capacity Check has been submitted to Southern Water to ascertain the likely improvements required (if any) to connect to the sewer system.

7.3 Proposed Foul Drainage System

7.3.1 Based on the above information, it is proposed that foul water will discharge via a connection into the existing public sewer. Further consultation with Southern Water is required to ascertain the most appropriate place of connection, with potential pumping of foul drainage required for lower parts of the Site.

7.3.2 The proposed layout of the foul drainage outfall is shown in the drainage strategy plan in **Appendix E**.

8 Conclusions and Recommendations

8.1.1 This Flood Risk Assessment and Drainage Strategy (FRADS) accompanies a planning application for redevelopment of land off Pump Lane, Lower Rainham, Kent with a provision of up to 1,250 residential units.

8.1.2 The flood mapping data show that the Site lies within Flood Zone 1.

8.1.3 As the Site will be residential its proposed use is defined as 'more vulnerable' and as it lies within Flood Zone 1, this is identified as being compatible development, therefore, there is no need for a Sequential Test, or an Exception Test.

8.1.4 As the Site is in Flood Zone 1 there is no need for any fluvial based flood mitigation measures.

8.1.5 As there are a couple up to potential medium probability surface flow routes through the Site the detail design of the SuDS will be undertaken to address these.

8.1.6 The current surface water drainage strategy is based on making a connection to the existing public surface water sewer network, with infiltration drainage to supplement if site investigations during detail design shows this is viable. A Feasibility Capacity Check has been submitted to Southern Water to ascertain the likely improvements required (if any) to connect to the sewer system.

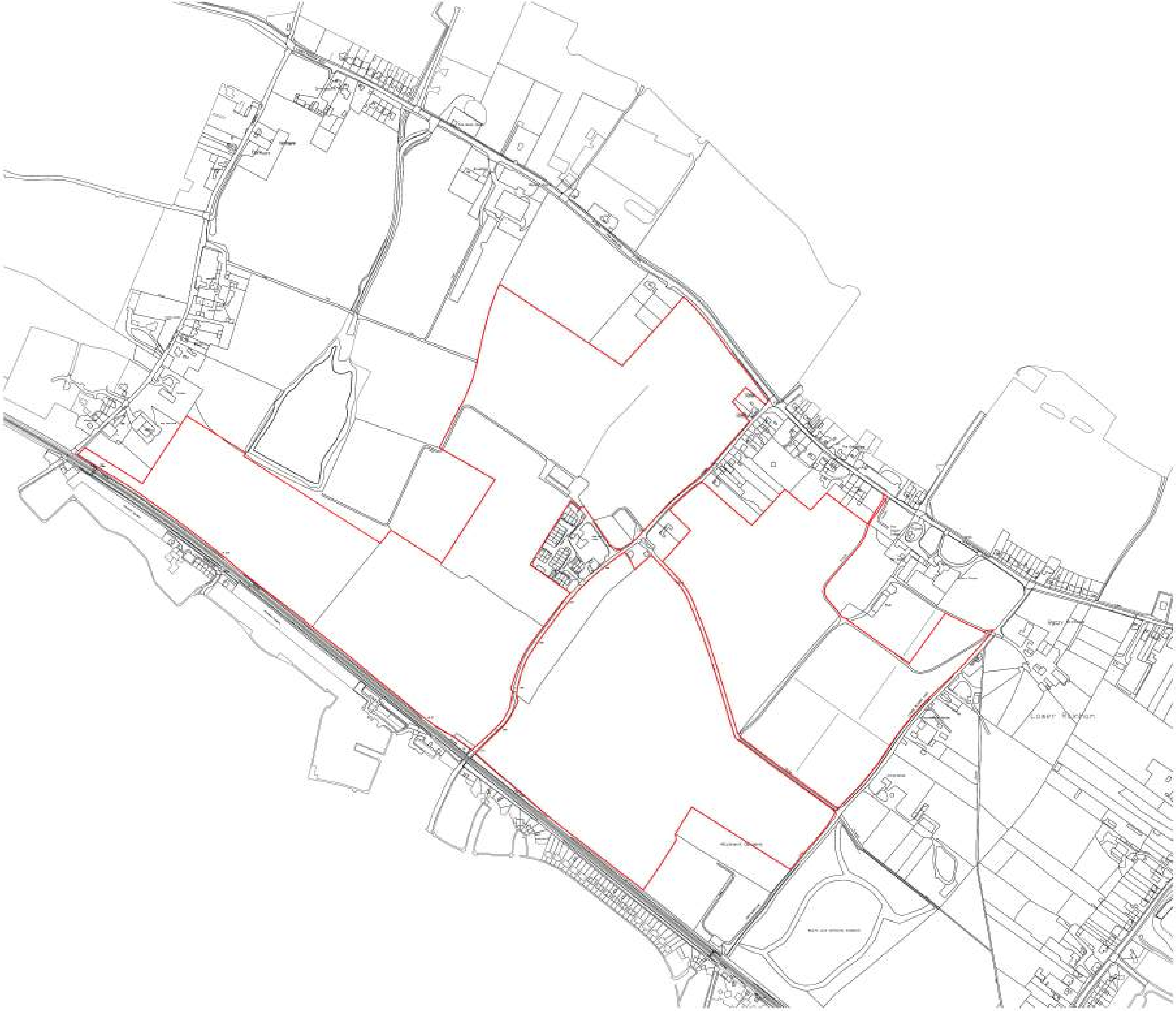
8.1.7 The surface water drainage strategy still makes use of the proposed network of interconnected swales and attenuation basins with the new land form directing all surface water flowing on to site, or originating on site, towards this system.

8.1.8 To help provide further surface attenuation and reduce potable water demand it is be proposed that the development will use water butts, while consider the practicalities of rainwater harvesting and grey water recycling. At detailed design a maintenance schedule will be developed, so that it can be put in place for the lifetime of the development to maintain any SuDS specified

8.1.9 It is proposed to discharge foul water into the existing public sewer. A Feasibility Capacity Check has been submitted to Southern Water to ascertain the likely improvements required (if any) to connect to the sewer system.

8.1.10 In conclusion, this FRADS demonstrates that the Proposed Development is appropriate and the proposed surface drainage strategy mean there is no increase in flood risk elsewhere, thus meeting the requirements of the NPPF.

Appendix A Site Location and Proposals



Client:
A. C. GOATHAM & SON

Project:
PUMP FARM & SLOOR FARM
LOWER RAINHAM, KENT

Drawing Title:
Site Location Plan

Scale @ A0	Date
1:2000	03 SEPT 2018

Job No.	Stage	Drawing No.	Rev.
1047	PL	003	P2

PRC

Architecture
Planning
Master Planning
Urban Design
Interiors
Landscape

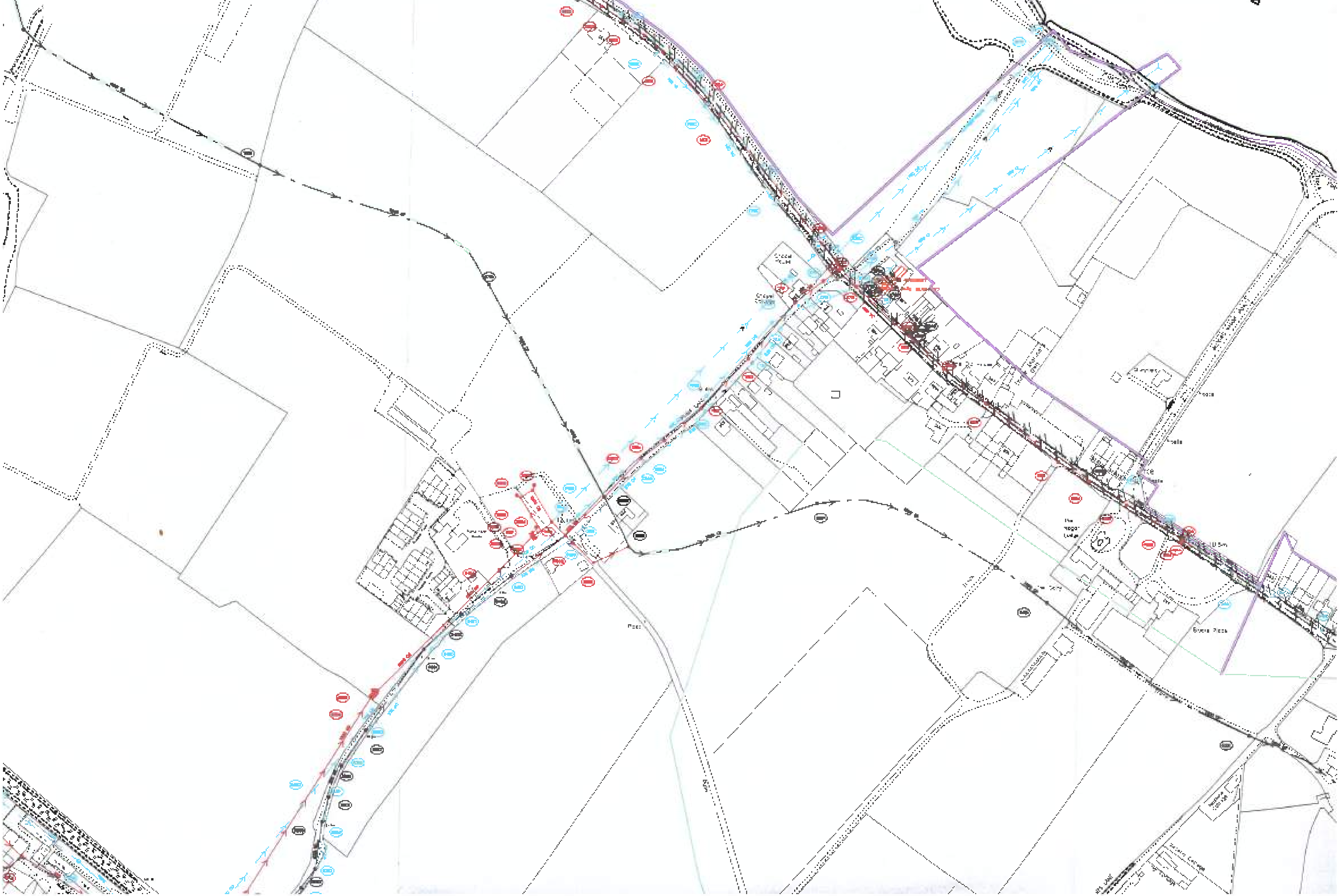
Appendix B Existing Site Information

- **Topographic Survey**
- **Existing Public Sewer records**

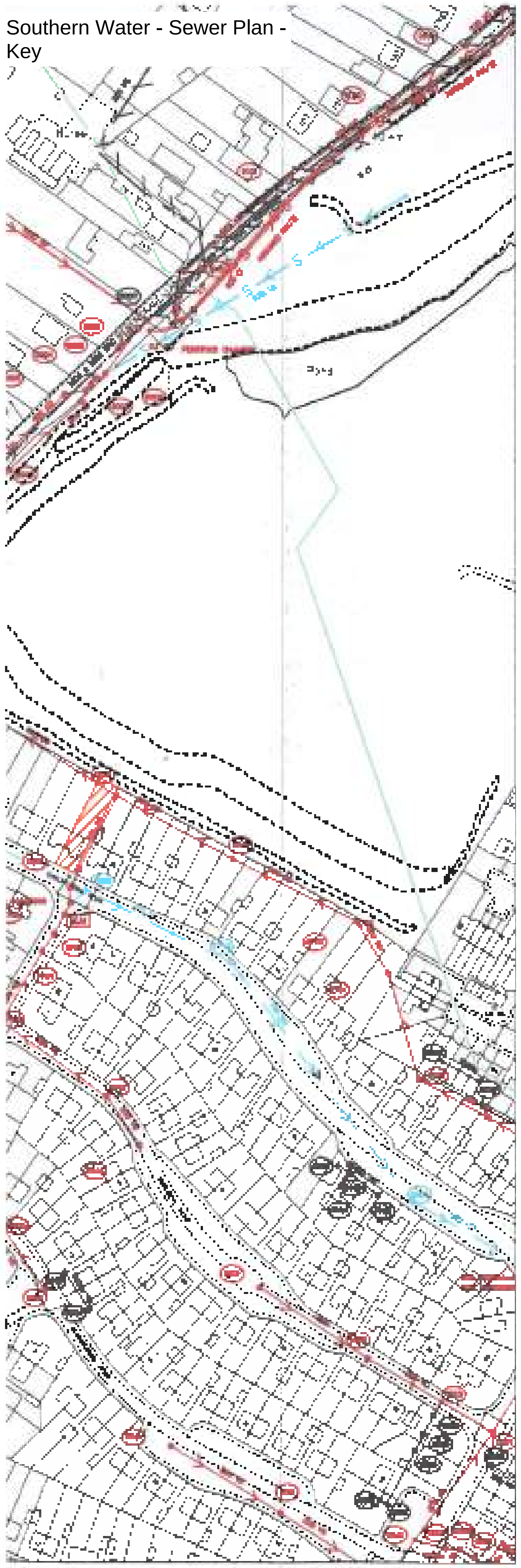
ORIGINAL SHEET SIZE A0

PLAN 0

Southern Water - Sewer Plan Extract



Southern Water - Sewer Plan - Key



1301X	6.88	5.37	300	VC	CIRC	*
1302X	39.445	37.905	150	UNK	CIRC	*
1303X	39.863		225	UNK	CIRC	*
1401X	35.356	32.486	300	UNK	CIRC	*
1401X	6.49		300	VC	CIRC	*
1402X	6.71		375	VC	CIRC	
1452X	6.51		150	VC	CIRC	
145CX	6.47	4.86	300	VC	CIRC	
1501X	33.987	31.537	300	UNK	CIRC	*
1501X	58.458		300	UNK	CIRC	*
1502X	57.587	54.967	150	UNK	CIRC	*
1502X	32.329	30.169	375	UNK	CIRC	*
1503X	33.874	32.394	150	UNK	CIRC	*
1503X	58.33		225	UNK	CIRC	*
1504X			UNK	VC	CIRC	*
1504X	56.133	53.653	225	UNK	CIRC	*
1505X	56.33		150	UNK	CIRC	
1551X	58.385	54.915	675	UNK	CIRC	
1552X	56.269	53.869	675	UNK	CIRC	
1553X	52.269		675	UNK	CIRC	
1554X	55.141	52.761	675	UNK	CIRC	
1601X	29.855	27.865	300	VC	CIRC	*
1601X	9.71	7.32	225	VC	CIRC	*
1601X	32.4	31.15	225	VC	CIRC	*
1601X	54.867		450	UNK	CIRC	*
1602X	8.79	6.59	225	VC	CIRC	*
1602X	28.93	27.17	300	VC	CIRC	*
1602X	54.83	52.77	300	UNK	CIRC	*
1603X	31.134	29.734	375	UNK	CIRC	*
1603X	57.545	55.605	150	UNK	CIRC	*
1604X	31.22		150	UNK	CIRC	*
1604Y	31.22		525	UNK	CIRC	*
1604X	56.789		225	UNK	CIRC	*
1605X			UNK	VC	CIRC	
1606X			UNK	VC	CIRC	
1600X			225	UNK	CIRC	*
1600X			150	UNK	CIRC	*
1650X			UNK	VC	CIRC	
1650X	29.938	27.858	375	CO	CIRC	*
1650X	9.7	7.33	525	CO	CIRC	*

2751X	21.79	19.79	375	CO	CIRC	*
2752X			675	UNK	CIRC	*
2752X	7.19		700	CO	CIRC	*
2754X	7.39	3.2	1500	CO	CIRC	
2755X	7.08		1700	CO	CIRC	
275CX	7.47	4.86	225	VC	CIRC	
2750X			1500	CO	CIRC	
2752X			750	UNK	CIRC	
276CX	7.35	5.43	150	VC	CIRC	
2801X	50.86	48.07	150	UNK	CIRC	
2802X			UNK	VC	CIRC	
2803X			UNK	VC	CIRC	
2804X			UNK	VC	CIRC	
2805X			UNK	VC	CIRC	
2901X	47.346	45.196	150	UNK	CIRC	
2900X			150	UNK	CIRC	
2950X	48.689	46.939	225	UNK	CIRC	
3001X	43.259		225	UNK	CIRC	*
3001X	15.7	13.96	300	VC	CIRC	*
3002Y	42.036		225	UNK	CIRC	*
3002X	14.85		300	VC	CIRC	*
3000X			300	VC	CIRC	
3002X			225	UNK	CIRC	
3050X	15.62	13.82	450	CO	CIRC	
3051X	15.62	13.91	300	CO	CIRC	
3052X	15.08		300	CO	CIRC	
3053X	14.63	12.75	300	CO	CIRC	
3101X	40.052	37.312	225	UNK	CIRC	
3102X	13.28	10.34	1500	CP	CIRC	
3106X	41.452	39.692	150	UNK	CIRC	
3150X	13.37		UNK	UNK	CIRC	*
3150X	38.854	35.924	525	UNK	CIRC	*
3151X	13.35		UNK	UNK	CIRC	
3150X			300	CO	CIRC	
3201X	35.918	34.908	150	UNK	CIRC	
3202X	38.61	34.74	225	UNK	CIRC	
3203X	35.558	34.188	225	UNK	CIRC	
3204X	34.6	33.31	225	UNK	CIRC	
3205X	38.438	35.508	225	UNK	CIRC	
3250X	37.106	35.616	150	UNK	CIRC	

4751X	45.677	43.437	225	UNK	CIRC	
4801X	41.273	38.313	225	UNK	CIRC	
4802X	43.301	41.871	150	UNK	CIRC	
4804X			UNK	VC	CIRC	
4805X			UNK	VC	CIRC	
480DX			225	UNK	CIRC	
4851X	40.586	37.446	750	UNK	CIRC	
485DX			225	UNK	CIRC	
4901X	39.513	37.893	225	UNK	CIRC	
4902X	40.139	37.789	225	UNK	CIRC	
4903X	37.109	35.289	225	UNK	CIRC	
4904X	38.006	37.256	100	UNK	CIRC	
4905X	37.822		150	UNK	CIRC	
4906Y	38.585		225	UNK	CIRC	
490DX			300	UNK	CIRC	
4902X			150	UNK	CIRC	
4950X	37.937	35.537	750	UNK	CIRC	
4951X	36.782	34.502	750	UNK	CIRC	
5001X	35.812	34.202	300	UNK	CIRC	*
5001X	13.28	10.25	1500	CP	CIRC	*
5002X	35.34	33.93	300	UNK	CIRC	
5003X	36.754	34.764	225	UNK	CIRC	
5004X	32.85		375	UNK	CIRC	
5005X	32.126	30.355	375	UNK	CIRC	
5050X	33.812	31.482	750	UNK	CIRC	
5101X	34.136	32.836	150	UNK	CIRC	
5102X	34.907	32.987	225	UNK	CIRC	
5150X	36.083	33.253	525	UNK	CIRC	
5151X	34.003	31.813	450	UNK	CIRC	
5152X			525	UNK	CIRC	
5201X	31.919	30.539	150	UNK	CIRC	*
5201X	6.61	2.38	525	CI	CIRC	*
5202X	31.977		300	UNK	CIRC	*
5202X	6.68	2.18	525	CI	CIRC	*
5203X	7.94	6.41	100	VC	CIRC	*
5203X	34.341	32.631	150	UNK	CIRC	*
5204X	33.308	31.748	150	UNK	CIRC	*
5204X	7.76	1.9	525	CI	CIRC	*
5205X	32.884	31.314	225	UNK	CIRC	
5206X	32.644	30.884	225	UNK	CIRC	

LINE STYLES / COLOURS

- Brown: Foul; Foul Syphon Sewer; Foul Vacuum Main; Foul Rising Main
- Red: Combined; Combined Syphon Sewer; Combined Rising Main; Lateral Drain
- Orange: Building Over Agreement Area
- Dark Blue: Treated Effluent
- Purple: Sludge; Sewer Catchment; Section 104 Area
- Light Blue: Surface Water; Surface Water Rising Main
- Yellow: Private
- Green: Access Shaft

MATERIALS

AK Alkathene; BAC Bonded Asbestos Cement; BRC Brick (Common); BRE Brick (Engineering); CC Concrete Box Culvert; CI Cast Iron; CO Concrete (In-Situ); CP Concrete (Pre-Cast); CSB Concrete Segments (bolted); CSU Concrete Segments (unbolted); DI Ductile Iron; GRC Glass Reinforced Concrete; GRP Glass Reinforced Plastic; MAC Masonry in regular Courses; MAR Masonry in random Courses; PE Polyethylene; PF Pitch Fibre; PP Polypropylene; PVC Polyvinyl Chloride; RPM Reinforced Plastic Matrix; SI Spun Iron; ST Steel; VC Vitrified Clay; XXX Other; ZZZ Unknown

LEGEND - SEWERS

Manhole (SW); Manhole (F&C); Lamp hole (SW); Lamp hole (F&C); Pumping Station (SW); Pumping Station (F&C); Side entry manhole (SW); Side entry Manhole (F&C); Blind shaft (SW); Blind shaft (F&C); Ejector station (SW); Ejector station (F&C); Watertight door (SW); Watertight door (F&C); Flushing ch. Mh-s (SW); Flushing ch. Mh-s (F&C); Flushing ch. Nc-s (SW); Flushing ch. Nc-s (F&C)

Washout (SW); Washout (F&C); Rodding Eye (SW); Rodding Eye (F&C); Gauging point (SW); Gauging point (F&C); Interceptor chamber (SW); Interceptor chamber (F&C); Storm Tank (SW); Storm Tank (F&C); Vortex chamber (SW); Vortex chamber (F&C); Outfall; Penstock chamber; Storm Overflow; Backdrop manhole

Other (s); Other; Change of sewer (s); Change of sewer; Reflux valve; Flap valve; Cascade; Anode; Valve; Closed Valve; Air Valve; Hatch box (SW); Hatch box (F&C); Direction arrow; Emptying valve; Catchpit; Soakaway; Inlet; Balancing Pond

Wastewater treatment works; Marine treatment works; Outfall headworks; Vent; Vent column; Tidal storage tank; Blank end; Head of Public Sewer; Micro Pumping Station

SHAPES (S)

A Arched; B Barrel; C Circular; E Egg; H Horseshoe; R Rectangular; S Square; T Trapezoidal; U U Shape; X Other

NODE REFERENCING SYSTEM

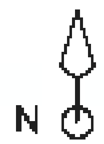
- 1st digit: hundred metre easting identifier
- 2nd digit: hundred metre northing identifier
- 3rd digit: sewer type identifier 0-4 = Foul/Combined, 5-9 = Surface Water
- 4th digit: next sequential node

WARNING: BAC pipes are constructed of Bonded Asbestos Cement

WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement

O.S. Ref.	TQ8087SE	Drawn by:	rghandes
Scale:	1:2500	Date:	13/09/2018

Title: 308466_Pump Farm And Bloors Fa



Southern Water

The information contained on this plan is provided as a guide to the approximate position of existing public sewers. The accuracy thereof cannot be guaranteed.

THIS INFORMATION MUST BE TREATED WITH CAUTION AND THE ACTUAL POSITION OF THE PUBLIC SEWERS MUST BE ESTABLISHED ON SITE, IN ALL CASES.

Southern Water must be informed before lifting manhole covers or excavating trial holes.

502045

Appendix C EA Product 4

Flood risk assessments: Climate change allowances

Its essential landuse planning decisions are based on the latest evidence and quality site specific Flood Risk Assessments. A key part of this is using the latest climate change allowances and using local evidence and data.

We encourage early pre applications discussions and you should complete this form and email back to kslplanning@environment-agency.gov.uk for sites in high risk flood zones. You should also discuss proposed developments with the local planning authority and refer to their local plan flood risk policies and Strategic Flood Risk Assessment. Guidance on producing a Flood Risk Assessment.

To obtain the latest flood map and data please email our customers and engagement team kslenquiries@environment-agency.gov.uk

1) The climate change allowances

The National Planning Practice Guidance refers planners, developers and advisors to the Environment Agency guidance on considering climate change in Flood Risk Assessments (FRAs). This guidance was updated in February 2016 and is available on Gov.uk and should be read in conjunction with this document. The guidance can be used for planning applications, local plans, neighbourhood plans and other projects. It provides climate change allowances for peak river flow, peak rainfall, sea level rise, wind speed and wave height. The guidance provides a range of allowances to assess fluvial flooding, rather than a single national allowance. It advises on what allowances to use for assessment based on vulnerability classification, flood zone and development lifetime. For proposed development in the tidal Thames flood zone you should continue to use the Thames Estuary 2100 (TE2100) plan and latest flood models.

2) Assessment of climate change impacts on fluvial flooding

Table A below indicates the level of technical assessment of climate change impacts on fluvial flooding appropriate for new developments depending on their scale and location. This should be used as **a guide only**. Ultimately, the agreed approach should be based on expert local knowledge of flood risk conditions, local sensitivities and other influences. **For these reasons we recommend that applicants and / or their consultants should contact the Environment Agency at the pre-planning application stage to confirm the assessment approach, on a case by case basis**. **Table A** defines three possible approaches to account for flood risk impacts due to climate change, in new development proposals:

- **Basic:** Developer can add an allowance to the 'design flood' (i.e. 1% annual probability) peak levels to account for potential climate change impacts.
- **Intermediate:** Developer can use existing modelled flood and flow data to construct a stage-discharge rating curve, which can be used to interpolate a flood level based on the required peak flow allowance to apply to the 'design flood' flow. See Appendix 1.
- **Detailed:** Perform detailed hydraulic modelling, through either re-running Environment Agency hydraulic models (if available) or construction of a new model by the developer.

Table A – Indicative guide to assessment approach

vulnerability classification	flood zone	development type		
		minor	small-major	large-major
essential infrastructure	Zone 2	Detailed		
	Zone 3a	Detailed		
	Zone 3b	Detailed		
highly vulnerable	Zone 2	Intermediate/ Basic	Intermediate/ Basic	Detailed
	Zone 3a	Not appropriate development		
	Zone 3b	Not appropriate development		
more vulnerable	Zone 2	Basic	Basic	Intermediate/ Basic
	Zone 3a	Basic	Detailed	Detailed
	Zone 3b	Not appropriate development		
less vulnerable	Zone 2	Basic	Basic	Intermediate/ Basic
	Zone 3a	Basic	Basic	Detailed
	Zone 3b	Not appropriate development		
water compatible	Zone 2	None		
	Zone 3a	Intermediate/ Basic		
	Zone 3b	Detailed		

Notes:

- Minor: 1-9 dwellings/ less than 0.5 ha | Office / light industrial under 1ha | General industrial under 1 ha | Retail under 1 ha | Gypsy/traveller site between 0 and 9 pitches
- Small-Major: 10 to 30 dwellings | Office / light industrial 1ha to 5ha | General industrial 1ha to 5ha | Retail over 1ha to 5ha | Gypsy/traveller site over 10 to 30 pitches
- Large-Major: 30+ dwellings | Office / light industrial 5ha+ | General industrial 5ha+ | Retail 5ha+ | Gypsy/traveller site over 30+ pitches | any other development that creates a non residential building or development over 1000 sq m.

The assessment approach should be agreed with the Environment Agency as part of pre-planning application discussions to avoid any wasted work.

3) Specific local considerations in Kent and South London

Where the Environment Agency and the applicant and / or their consultant has agreed that a '**basic**´ level of assessment is appropriate the figures in Table B below can be used as a precautionary allowance for potential climate change impacts on peak 'design' (i.e. 1% annual probability) fluvial flood level rather than undertaking detailed modelling.

Table B – Local precautionary allowances for potential climate change impacts

River basin	Central	Higher Central	Upper
Thames	500mm	700mm	1000mm
South East	700mm	850mm	1400mm

For proposed developments in the tidal Thames flood zone you should continue to use the Thames Estuary 2100 (TE2100) plan and latest flood models.

4) Fluvial food risk mitigation

Read the guidance on Gov.uk to find out which allowances to use to **assess** the impact of climate change on flood risk.

For planning consultations where we are a statutory consultee and our Flood risk standing advice **does not** apply we use the following benchmarks to inform flood risk **mitigation** for different vulnerability classifications. **These are a guide only**.

We recommend you contact us at the pre-planning application stage to confirm this on a case by case basis. We can provide you with a free basic opinion and more detailed advice is subject to cost recovery.

For planning consultations where we are not a statutory consultee or our Flood risk Standing advice applies we recommend local planning authorities and developers use these benchmarks but we do not expect to be consulted.

- For development classed as '**Essential Infrastructure**' our benchmark for flood risk mitigation is for it to be designed to the '**upper end**' climate change allowance for the epoch that most closely represents the lifetime of the development, including decommissioning.

- For **highly vulnerable** in flood zone 2, the '**higher central'** climate change allowance is our minimum benchmark for flood risk mitigation. In sensitive locations it may be necessary to use the **upper end** allowance.

- For **more vulnerable developments** in flood zone 2, the '**central**' climate change allowance is our minimum benchmark for flood risk mitigation, and in flood zone 3 the '**higher central**' climate change allowance is our minimum benchmark for flood risk mitigation. In sensitive locations it may be necessary to use the **higher central** (in flood zone 2) and the **upper end** allowance (in flood zone 3).

- For **water compatible** or **less vulnerable** development (e.g. commercial), the '**central**' climate change allowance for the epoch that most closely represents the lifetime of the development is our minimum benchmark for flood risk mitigation. In sensitive locations it may be necessary to use the **higher central** (particularly in flood zone 3) to inform built in resilience.

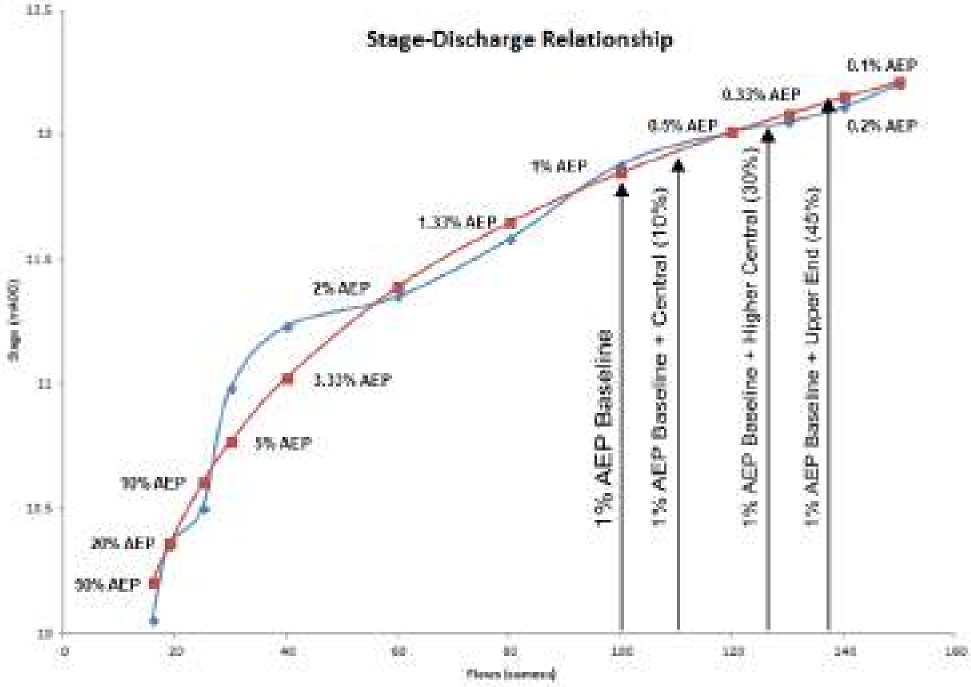
There may be circumstances where local evidence supports the use of other data or allowances. Where you think this is the case we may want to check this data and how you propose to use it.

Appendix 1 – Further information on the Intermediate approach

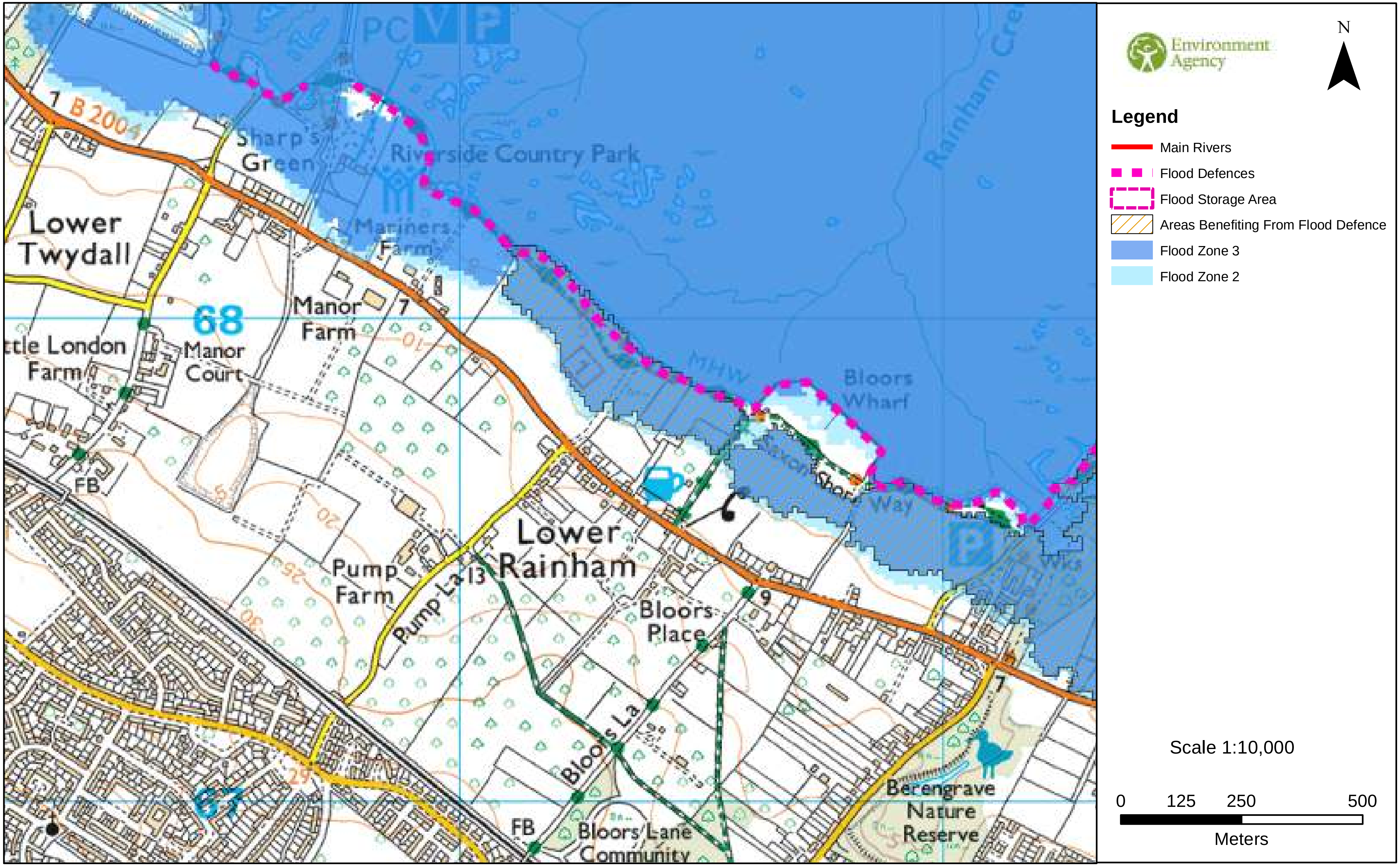
1) The methodology the chart is based on does not produce an accurate stage-discharge rating and is a simplified methodology for producing flood levels that can be applied in low risk small-scale development situations;

2) The method should not be applied where there is existing detailed modelled climate change outputs that use the new allowances. In such circumstances, the ‘with climate change’ modelled scenarios should be applied.

An example stage-discharge relationship is shown below:

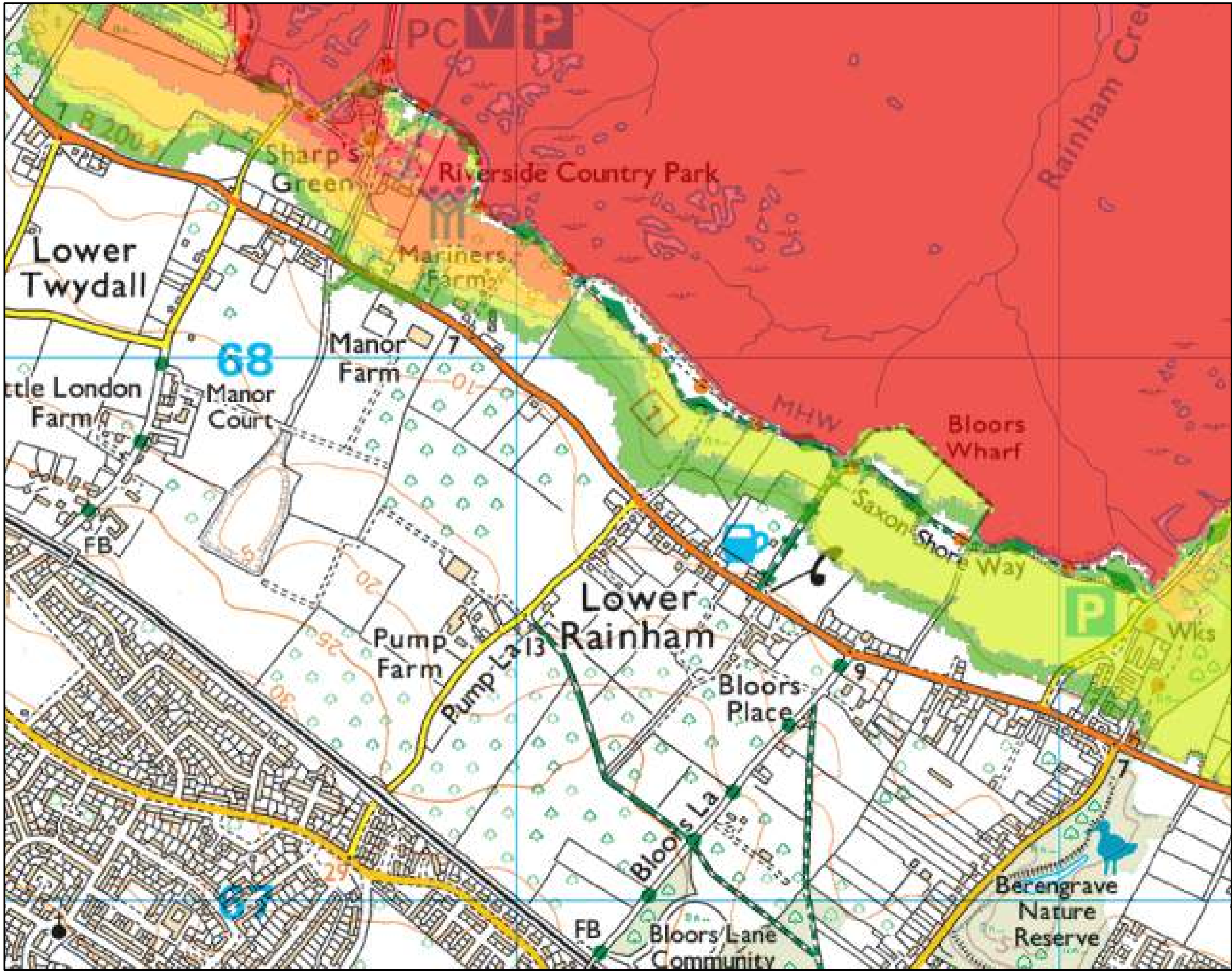


Flood Map centred on Pump & Bloor Farm, near 483 Lower Rainham, Gillingham, ME8 7TN.
Created 17/09/2018 (Ref KSL 99588 JM)



Contact us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506. Email:enquiries@environment-agency.gov.uk

Modelled Maximum Defended Scenario - Still Water Flood Extents Map centred on Pump & Bloor Farm, near 483 Lower Rainham, Gillingham, ME8 7TN. Created 17/09/2018 (Ref KSL 99588 JM)



Environment Agency

N

Legend

Main Rivers

Defended Scenario - Still Water

AEP (%)

- 5% AEP (2012)
- 1.3% AEP (2012)
- 0.5% AEP (2012)
- 0.1% AEP (2012)
- 0.5% AEP (2070)
- 0.5% AEP (2115)

Defended Scenario

Still Water

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

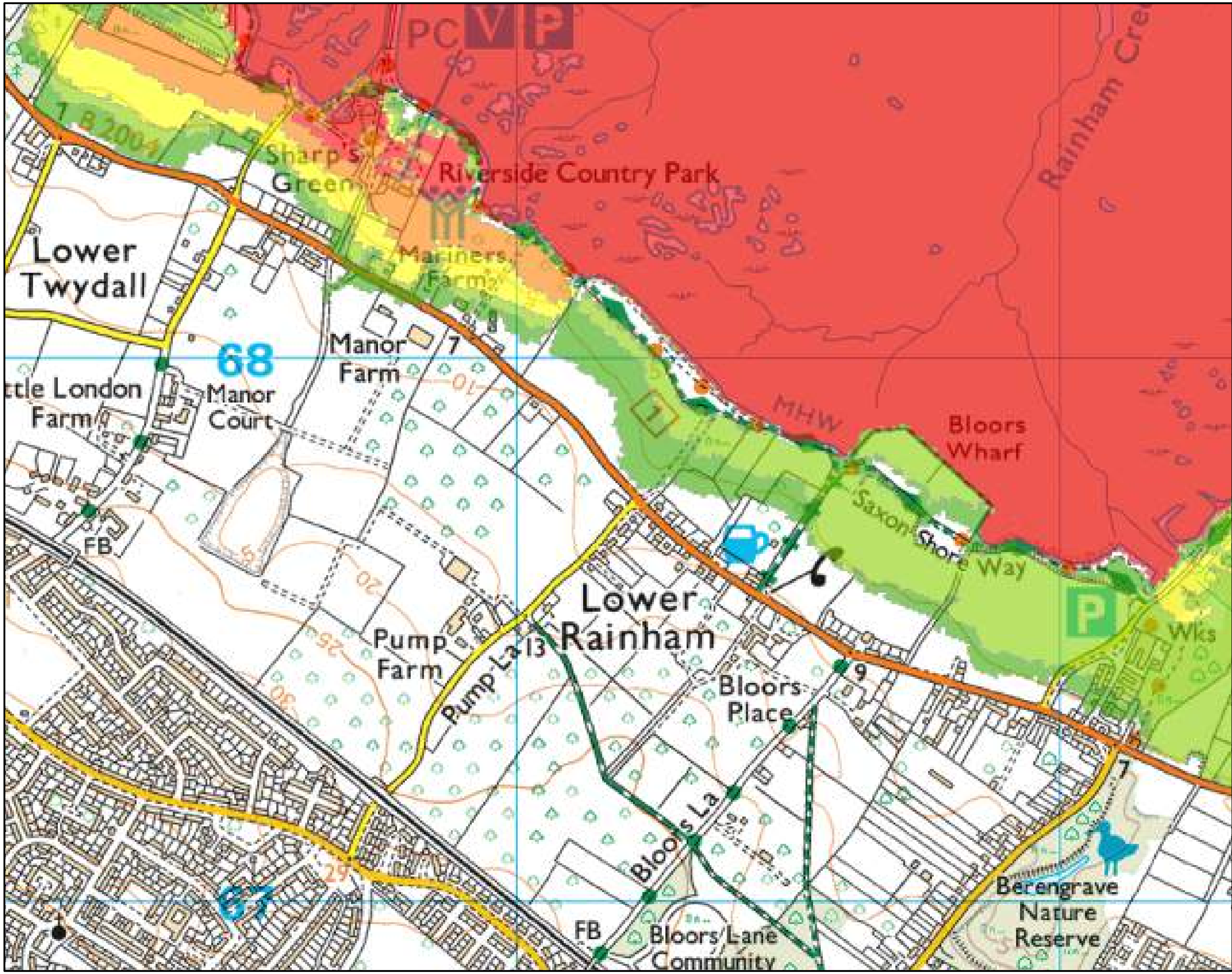
Scale 1:10,000

0 125 250 500

Meters

Contact us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506. Email:enquiries@environment-agency.gov.uk

Modelled Maximum Defended Scenario - Wave Overtopping Flood Extents Map centred on Pump & Bloor Farm, near 483 Lower Rainham, Gillingham, ME8 7TN. Created 17/09/2018 (Ref KSL 99588 JM)



Environment Agency

N

Legend

Main Rivers

Defended Scenario - Wave Overtopping

AEP (%)

- 5% AEP (2012)
- 1.3% AEP (2012)
- 0.5% AEP (2012)
- 0.1% AEP (2012)
- 0.5% AEP (2115)

Defended Scenario

Wave Overtopping

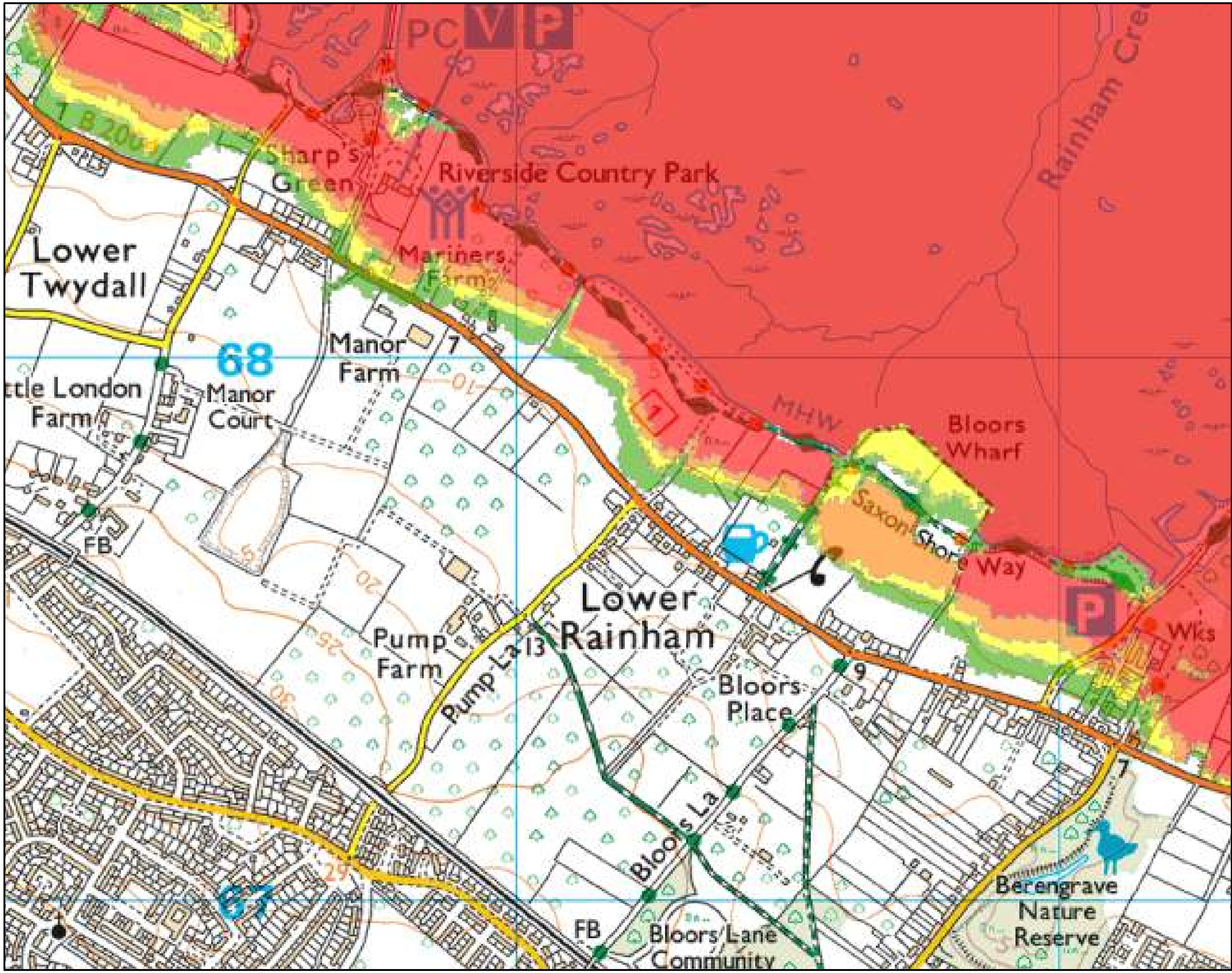
Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occuring in any given year.

Scale 1:10,000

0 125 250 500

Meters

Modelled Maximum Undefended Flood Extents Map centred on Pump & Bloor Farm, near 483 Lower Rainham, Gillingham, ME8 7TN. Created 17/09/2018 (Ref KSL 99588 JM)



Environment Agency

N

Legend

Main Rivers

Undefended Scenario

AEP (%)

- 5% AEP (2012)
- 0.5% AEP (2012)
- 0.1% AEP (2012)
- 0.5% AEP (2070)
- 0.5% AEP (2115)

Undefended Scenario

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

Scale 1:10,000

0 125 250 500

Meters

Contact us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506. Email:enquiries@environment-agency.gov.uk

From:	KSL Enquiries
To:	Chris Downs
Subject:	KSL 99588 JM - Pump & Bloor Farm Development Site: Product Request 3
Date:	18 September 2018 17:27:59
Attachments:	image001.png image005.jpg image006.png image007.png image008.png

Dear Chris

RE: KSL 99588 JM - Pump & Bloor Farm Development Site: Product Request 3

Thank you for your enquiry which was received on 10 September 2018.

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

As your site is located in flood zone 1, the area flood team was not able to produce a Product 3 or 4 for you. However, please find attached four maps with three showing modelling maximum flood extents, which hopefully will be of use in lieu of a Product 3/4. These show that your site is beyond the flooding extents for all scenarios: undefended scenario, defended scenario, still water or defended scenario wave overtopping. We do not have a record of historic flooding for the area. Please refer to the Open Government Licence which explains the permitted use of this information.

Please be aware that the Environment Agency supply data, but we do not interpret it for use in a flood risk assessment. Flood risk assessments should be completed by a suitably competent and qualified person.

You may be interested in the following guidance / information which is publically available:

- **'Planning practice guidance'** – provides information about planning considerations in areas at risk of flooding. http://planningguidance.planningportal.gov.uk/
- **'Flood risk assessment for planning applications'** – information about completing flood risk assessments. https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications
- **'Site-specific flood risk assessment: Checklist'** – a checklist to help ensure you have considered all the relevant factors in your flood risk assessment. https://www.gov.uk/guidance/flood-risk-and-coastal-change#Site-Specific-Flood-Risk-Assessment-checklist-section
- **Climate change allowance guidance – (for a product 4 including fluvial information)**
  We attach a copy of the Kent and South London guidance. The guidance will vary slightly from area to area. This is due to the different characteristics of river basins in each area.

We recommend that you discuss your proposals with the local planning council at the earliest opportunity. They will be able to advise you on a wide range of planning matters in addition to flood risk.

Environment Agency pre-application service

We are able to supply a preliminary opinion outlining the key environmental issues and opportunities, which is free of charge. For more detailed advice, guidance, review of draft report, meetings etc we can organise a cost recovery agreement which is charged at £84 per hour.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297018/LIT_9015_c2822b.pdf

We encourage early discussions to ensure environmental issues and opportunities are considered early in the planning process. If you would like a free preliminary opinion or our cost recovery service, please complete the form via the link and email back to KSLPLANNING@environment-agency.gov.uk

I trust this information is of use. If you have any further questions, please contact us and we will be happy to help.

Please note: The data provided in this flood data product does not include the new climate change allowances published on gov.uk on 19/02/2016. See further note within the data product.

If you have any further queries or if you'd like us to review the information we have provided under the Freedom of Information Act 2000 and Environmental Information Regulations 2004, please contact us within two months and we will happily do this for you.

We would be really grateful if you could spare five minutes to help us improve our service. Please click on the link below and fill in our survey – we use every piece of feedback we receive:http://www.smartsurvey.co.uk/s/EnvironmentAgencyCustomerSurvey/?a=KSL

Kind regards

Jessica

Jessica Mayall
Customers and Engagement Officer
Kent, South London and East Sussex

Environment Agency | 0207 7140521 | Orchard House | Endeavour Park | London Road | Addington | West Malling | ME19 5SH

For general enquiries please call | 0208 474 6848

Email_footer_419x75 copy

From: Chris Downs [mailto:cdowns@peterbrett.com]
Sent: 10 September 2018 16:36
To: KSL Enquiries <KSLE@environment-agency.gov.uk>
Subject: Pump & Bloor Farm Development Site: Product Request 3

Good Afternoon,

Please could I request Products 3 data for the Pump and Bloors Farm proposed development Site (approximate site boundary shown in red).

cid:image005.jpg@01D44E89.18631620

We are aware the Site is shown on the Flood Map for Planning as being in FZ 1, but as the Site is greater than 1 ha an FRA needs to be provided with a Planning Application, within which we want to refer to an EA Produce data response.

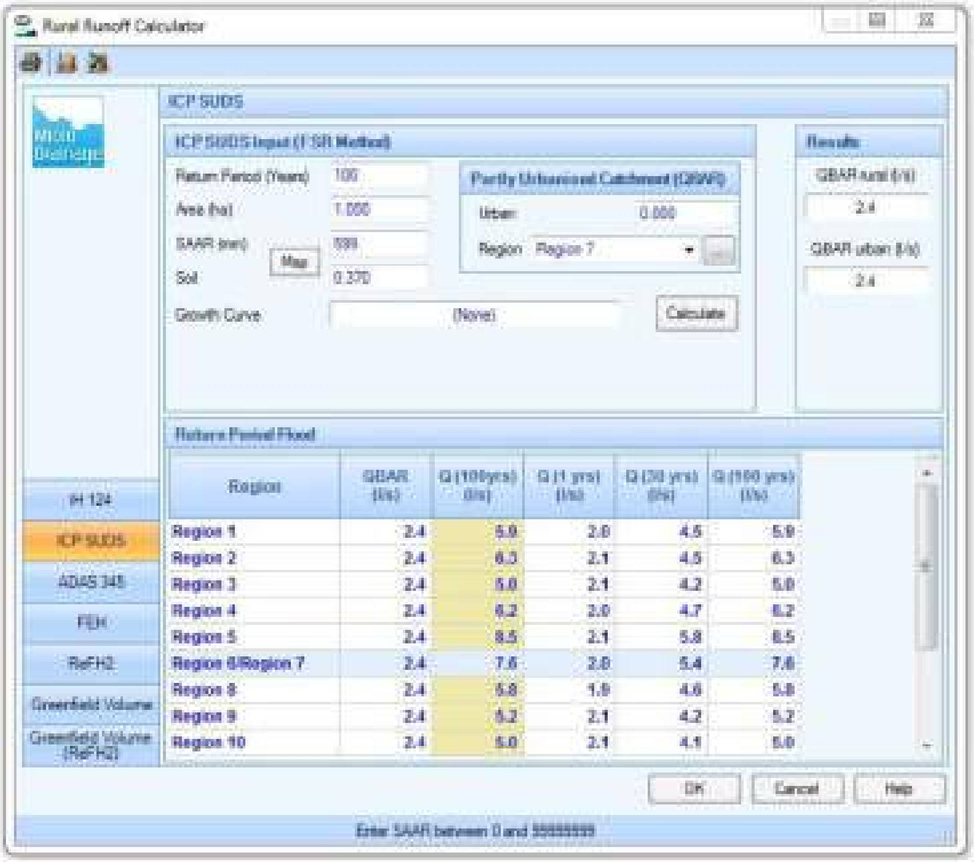
Kind regards,

Chris Downs
Director of Water
For and on behalf of Peter Brett Associates LLP - Ashford

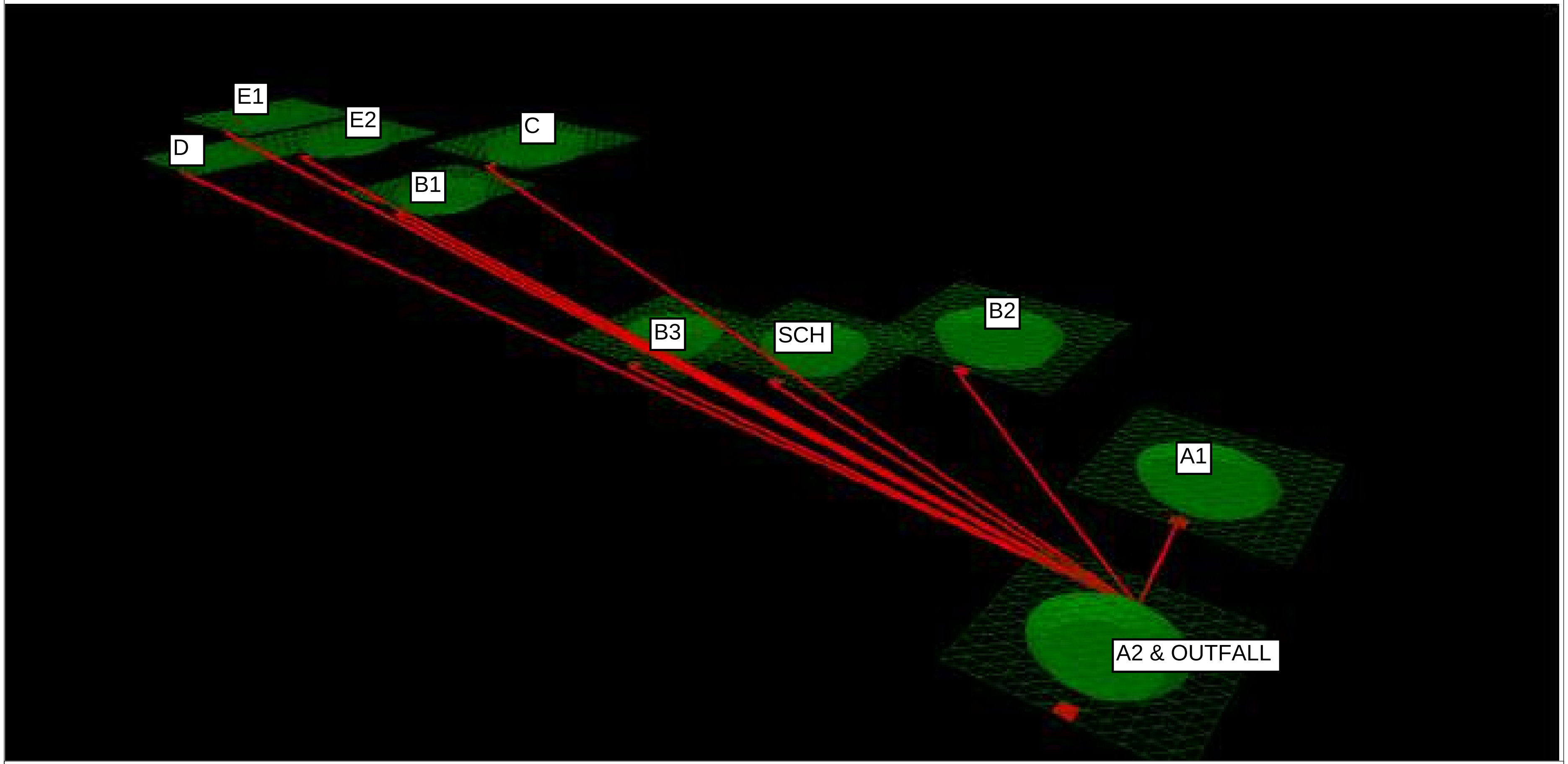
m 07469118531
e cdowns@peterbrett.com
w peterbrett.com

Appendix D Hydraulic Calculations

PUMP AND BLOORS FARM
GREENFIELD RUNOFF RATE



Peter Brett Associates		Page 1
30 Tower View Kings Hill West Malling ME19 4PR		
Date 04/12/2018 15:00 File Cascade pump.casx	Designed by ahughes Checked by	
Micro Drainage	Source Control 2018.1	



Cascade Summary of Results for Area A1.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	10.451	0.451	13.5	538.5	O K
30 min Summer	10.576	0.576	15.4	700.5	O K
60 min Summer	10.695	0.695	17.1	860.3	O K
120 min Summer	10.799	0.799	18.4	1004.4	Flood Risk
180 min Summer	10.845	0.845	19.0	1070.4	Flood Risk
240 min Summer	10.868	0.868	19.2	1102.6	Flood Risk
360 min Summer	10.884	0.884	19.4	1126.3	Flood Risk
480 min Summer	10.885	0.885	19.5	1127.3	Flood Risk
600 min Summer	10.884	0.884	19.4	1125.1	Flood Risk
720 min Summer	10.880	0.880	19.4	1119.9	Flood Risk
960 min Summer	10.869	0.869	19.3	1103.7	Flood Risk
1440 min Summer	10.836	0.836	18.9	1056.5	Flood Risk
15 min Winter	10.502	0.502	14.3	603.5	O K
30 min Winter	10.640	0.640	16.3	785.8	O K
60 min Winter	10.771	0.771	18.1	966.2	Flood Risk
120 min Winter	10.887	0.887	19.5	1130.4	Flood Risk
180 min Winter	10.940	0.940	20.1	1207.6	Flood Risk
240 min Winter	10.967	0.967	20.4	1247.3	Flood Risk
360 min Winter	10.991	0.991	20.6	1281.7	Flood Risk
480 min Winter	10.994	0.994	20.7	1287.1	Flood Risk
600 min Winter	10.988	0.988	20.6	1276.9	Flood Risk
720 min Winter	10.981	0.981	20.5	1267.2	Flood Risk
960 min Winter	10.964	0.964	20.3	1242.1	Flood Risk
1440 min Winter	10.914	0.914	19.8	1169.7	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	501.8	19
30 min Summer	77.747	0.0	661.9	34
60 min Summer	48.611	0.0	876.4	64
120 min Summer	29.354	0.0	1060.5	122
180 min Summer	21.556	0.0	1168.9	182
240 min Summer	17.210	0.0	1244.6	242
360 min Summer	12.501	0.0	1355.9	360
480 min Summer	9.962	0.0	1439.9	422
600 min Summer	8.347	0.0	1507.1	482
720 min Summer	7.221	0.0	1563.0	544
960 min Summer	5.740	0.0	1652.4	674
1440 min Summer	4.148	0.0	1775.0	952
15 min Winter	118.417	0.0	563.6	19
30 min Winter	77.747	0.0	740.9	33
60 min Winter	48.611	0.0	983.0	62
120 min Winter	29.354	0.0	1189.1	120
180 min Winter	21.556	0.0	1310.4	178
240 min Winter	17.210	0.0	1395.0	236
360 min Winter	12.501	0.0	1519.4	348
480 min Winter	9.962	0.0	1613.3	456
600 min Winter	8.347	0.0	1688.2	550
720 min Winter	7.221	0.0	1750.3	572
960 min Winter	5.740	0.0	1849.4	722
1440 min Winter	4.148	0.0	1980.8	1026

Cascade Rainfall Details for Area A1.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	0.400	Longest Storm (mins)	1440
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 2.463

Time From:	**(mins) To:**	**Area (ha)**
0	4	2.463

Cascade Model Details for Area A1.srcx

Storage is Online Cover Level (m) 11.000

Tank or Pond Structure

Invert Level (m) 10.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1114.1	1.000	1485.7

Orifice Outflow Control

Diameter (m) 0.101 Discharge Coefficient 0.600 Invert Level (m) 10.000

Cascade Summary of Results for Area B1.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	16.443	0.443	5.7	254.4	O K
30 min Summer	16.568	0.568	6.5	331.2	O K
60 min Summer	16.687	0.687	7.1	407.4	O K
120 min Summer	16.793	0.793	7.7	477.3	Flood Risk
180 min Summer	16.843	0.843	7.9	510.4	Flood Risk
240 min Summer	16.868	0.868	8.1	527.6	Flood Risk
360 min Summer	16.891	0.891	8.2	542.6	Flood Risk
480 min Summer	16.894	0.894	8.2	544.9	Flood Risk
600 min Summer	16.892	0.892	8.2	543.9	Flood Risk
720 min Summer	16.889	0.889	8.2	541.8	Flood Risk
960 min Summer	16.880	0.880	8.1	535.1	Flood Risk
1440 min Summer	16.851	0.851	8.0	515.7	Flood Risk
15 min Winter	16.494	0.494	6.0	285.1	O K
30 min Winter	16.631	0.631	6.8	371.5	O K
60 min Winter	16.764	0.764	7.5	457.5	Flood Risk
120 min Winter	16.882	0.882	8.1	537.0	Flood Risk
180 min Winter	16.939	0.939	8.4	575.5	Flood Risk
240 min Winter	16.969	0.969	8.5	596.3	Flood Risk
360 min Winter	16.998	0.998	8.7	616.6	Flood Risk
480 min Winter	17.007	1.007	8.7	622.8	FLOOD
600 min Winter	17.004	1.004	8.7	621.1	FLOOD
720 min Winter	16.995	0.995	8.7	615.1	Flood Risk
960 min Winter	16.982	0.982	8.6	605.6	Flood Risk
1440 min Winter	16.940	0.940	8.4	576.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	240.6	19
30 min Summer	77.747	0.0	313.8	34
60 min Summer	48.611	0.0	416.3	64
120 min Summer	29.354	0.0	503.2	122
180 min Summer	21.556	0.0	554.3	182
240 min Summer	17.210	0.0	590.0	242
360 min Summer	12.501	0.0	642.4	360
480 min Summer	9.962	0.0	681.9	466
600 min Summer	8.347	0.0	713.3	512
720 min Summer	7.221	0.0	739.3	572
960 min Summer	5.740	0.0	780.1	696
1440 min Summer	4.148	0.0	830.6	968
15 min Winter	118.417	0.0	269.2	19
30 min Winter	77.747	0.0	349.4	33
60 min Winter	48.611	0.0	466.6	62
120 min Winter	29.354	0.0	563.8	120
180 min Winter	21.556	0.0	620.9	178
240 min Winter	17.210	0.0	660.8	236
360 min Winter	12.501	0.0	719.2	350
480 min Winter	9.962	4.6	763.1	460
600 min Winter	8.347	2.8	797.9	566
720 min Winter	7.221	0.0	826.4	650
960 min Winter	5.740	0.0	870.1	742
1440 min Winter	4.148	0.0	917.9	1052

Cascade Model Details for Area B1.srcx

Storage is Online Cover Level (m) 17.000

Tank or Pond Structure

Invert Level (m) 16.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	539.7	1.000	700.2

Orifice Outflow Control

Diameter (m) 0.065 Discharge Coefficient 0.600 Invert Level (m) 16.000

Cascade Summary of Results for Area B2.srcx

Upstream Structures	**Outflow To**	**Overflow To**
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	**Max Level (m)**	**Max Depth (m)**	**Max Control (l/s)**	**Max Volume (m³)**	**Status**
15 min Summer	10.905	0.605	5.0	186.3	O K
30 min Summer	11.052	0.752	5.6	242.1	O K
60 min Summer	11.185	0.885	6.1	296.9	O K
120 min Summer	11.297	0.997	6.4	345.8	Flood Risk
180 min Summer	11.345	1.045	6.6	367.7	Flood Risk
240 min Summer	11.368	1.068	6.7	378.0	Flood Risk
360 min Summer	11.382	1.082	6.7	384.7	Flood Risk
480 min Summer	11.380	1.080	6.7	383.7	Flood Risk
600 min Summer	11.375	1.075	6.7	381.6	Flood Risk
720 min Summer	11.369	1.069	6.7	378.6	Flood Risk
960 min Summer	11.352	1.052	6.6	370.8	Flood Risk
1440 min Summer	11.309	1.009	6.5	351.2	Flood Risk
15 min Winter	10.966	0.666	5.2	208.8	O K
30 min Winter	11.125	0.825	5.8	271.7	O K
60 min Winter	11.270	0.970	6.4	333.7	Flood Risk
120 min Winter	11.393	1.093	6.8	389.8	Flood Risk
180 min Winter	11.447	1.147	6.9	415.8	Flood Risk
240 min Winter	11.474	1.174	7.0	428.8	Flood Risk
360 min Winter	11.495	1.195	7.1	439.6	Flood Risk
480 min Winter	11.497	1.197	7.1	440.3	Flood Risk
600 min Winter	11.488	1.188	7.0	435.7	Flood Risk
720 min Winter	11.478	1.178	7.0	430.9	Flood Risk
960 min Winter	11.456	1.156	7.0	420.2	Flood Risk
1440 min Winter	11.397	1.097	6.8	391.9	Flood Risk

Storm Event	**Rain (mm/hr)**	**Flooded Volume (m³)**	**Discharge Volume (m³)**	**Time-Peak (mins)**
15 min Summer	118.417	0.0	185.2	19
30 min Summer	77.747	0.0	242.8	34
60 min Summer	48.611	0.0	309.7	64
120 min Summer	29.354	0.0	374.1	122
180 min Summer	21.556	0.0	412.1	182
240 min Summer	17.210	0.0	438.7	242
360 min Summer	12.501	0.0	478.0	360
480 min Summer	9.962	0.0	507.7	428
600 min Summer	8.347	0.0	531.6	484
720 min Summer	7.221	0.0	551.7	546
960 min Summer	5.740	0.0	584.2	676
1440 min Summer	4.148	0.0	630.8	952
15 min Winter	118.417	0.0	207.4	19
30 min Winter	77.747	0.0	271.5	33
60 min Winter	48.611	0.0	346.9	62
120 min Winter	29.354	0.0	419.1	120
180 min Winter	21.556	0.0	461.6	178
240 min Winter	17.210	0.0	491.4	236
360 min Winter	12.501	0.0	535.3	348
480 min Winter	9.962	0.0	568.6	456
600 min Winter	8.347	0.0	595.3	554
720 min Winter	7.221	0.0	617.7	576
960 min Winter	5.740	0.0	653.9	724
1440 min Winter	4.148	0.0	704.3	1026

Cascade Model Details for Area B2.srcx

Storage is Online Cover Level (m) 11.500

Tank or Pond Structure

Invert Level (m) 10.300

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	253.1	1.200	496.8

Orifice Outflow Control

Diameter (m) 0.056 Discharge Coefficient 0.600 Invert Level (m) 10.300

Cascade Summary of Results for Area B3.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	7.680	0.580	5.0	216.9	O K
30 min Summer	7.825	0.725	5.7	282.3	O K
60 min Summer	7.958	0.858	6.2	347.0	O K
120 min Summer	8.073	0.973	6.6	406.0	Flood Risk
180 min Summer	8.126	1.026	6.8	433.8	Flood Risk
240 min Summer	8.152	1.052	6.9	448.1	Flood Risk
360 min Summer	8.174	1.074	6.9	460.2	Flood Risk
480 min Summer	8.176	1.076	6.9	461.4	Flood Risk
600 min Summer	8.173	1.073	6.9	459.7	Flood Risk
720 min Summer	8.168	1.068	6.9	457.2	Flood Risk
960 min Summer	8.156	1.056	6.9	450.2	Flood Risk
1440 min Summer	8.121	1.021	6.8	431.5	Flood Risk
15 min Winter	7.739	0.639	5.3	243.1	O K
30 min Winter	7.897	0.797	5.9	316.7	O K
60 min Winter	8.043	0.943	6.5	389.8	Flood Risk
120 min Winter	8.169	1.069	6.9	457.3	Flood Risk
180 min Winter	8.227	1.127	7.1	489.7	Flood Risk
240 min Winter	8.257	1.157	7.2	507.2	Flood Risk
360 min Winter	8.287	1.187	7.3	524.0	Flood Risk
480 min Winter	8.295	1.195	7.3	528.8	Flood Risk
600 min Winter	8.291	1.191	7.3	526.8	Flood Risk
720 min Winter	8.282	1.182	7.3	521.1	Flood Risk
960 min Winter	8.265	1.165	7.2	511.4	Flood Risk
1440 min Winter	8.218	1.118	7.1	484.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	212.4	19
30 min Summer	77.747	0.0	277.0	34
60 min Summer	48.611	0.0	358.8	64
120 min Summer	29.354	0.0	433.4	122
180 min Summer	21.556	0.0	477.4	182
240 min Summer	17.210	0.0	508.2	242
360 min Summer	12.501	0.0	553.4	360
480 min Summer	9.962	0.0	587.7	466
600 min Summer	8.347	0.0	615.1	514
720 min Summer	7.221	0.0	637.9	572
960 min Summer	5.740	0.0	674.3	700
1440 min Summer	4.148	0.0	720.9	968
15 min Winter	118.417	0.0	237.6	19
30 min Winter	77.747	0.0	308.2	33
60 min Winter	48.611	0.0	401.9	62
120 min Winter	29.354	0.0	485.5	120
180 min Winter	21.556	0.0	534.7	178
240 min Winter	17.210	0.0	569.1	236
360 min Winter	12.501	0.0	619.6	350
480 min Winter	9.962	0.0	657.8	460
600 min Winter	8.347	0.0	688.2	566
720 min Winter	7.221	0.0	713.4	656
960 min Winter	5.740	0.0	752.6	742
1440 min Winter	4.148	0.0	795.6	1052

Cascade Model Details for Area B3.srcx

Storage is Online Cover Level (m) 8.300

Tank or Pond Structure

Invert Level (m) 7.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	316.1	1.200	583.8

Orifice Outflow Control

Diameter (m) 0.057 Discharge Coefficient 0.600 Invert Level (m) 7.100

Cascade Summary of Results for Area C.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	22.428	0.428	41.2	1177.7	O K
30 min Summer	22.553	0.553	41.2	1531.7	O K
60 min Summer	22.674	0.674	41.2	1880.7	O K
120 min Summer	22.783	0.783	41.2	2200.4	Flood Risk
180 min Summer	22.833	0.833	41.2	2348.0	Flood Risk
240 min Summer	22.857	0.857	41.2	2419.5	Flood Risk
360 min Summer	22.874	0.874	41.2	2471.6	Flood Risk
480 min Summer	22.872	0.872	41.2	2464.8	Flood Risk
600 min Summer	22.865	0.865	41.2	2443.7	Flood Risk
720 min Summer	22.856	0.856	41.2	2417.8	Flood Risk
960 min Summer	22.835	0.835	41.2	2354.5	Flood Risk
1440 min Summer	22.782	0.782	41.2	2199.2	Flood Risk
15 min Winter	22.479	0.479	41.2	1321.2	O K
30 min Winter	22.618	0.618	41.2	1720.5	O K
60 min Winter	22.754	0.754	41.2	2116.8	Flood Risk
120 min Winter	22.877	0.877	41.2	2479.3	Flood Risk
180 min Winter	22.934	0.934	41.2	2648.0	Flood Risk
240 min Winter	22.962	0.962	41.2	2734.2	Flood Risk
360 min Winter	22.986	0.986	41.2	2807.2	Flood Risk
480 min Winter	22.989	0.989	41.2	2815.2	Flood Risk
600 min Winter	22.980	0.980	41.2	2786.8	Flood Risk
720 min Winter	22.964	0.964	41.2	2739.3	Flood Risk
960 min Winter	22.936	0.936	41.2	2655.9	Flood Risk
1440 min Winter	22.864	0.864	41.2	2441.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	1106.2	19
30 min Summer	77.747	0.0	1469.7	33
60 min Summer	48.611	0.0	1924.2	64
120 min Summer	29.354	0.0	2329.9	122
180 min Summer	21.556	0.0	2568.8	182
240 min Summer	17.210	0.0	2735.6	242
360 min Summer	12.501	0.0	2981.5	360
480 min Summer	9.962	0.0	3167.5	458
600 min Summer	8.347	0.0	3316.5	510
720 min Summer	7.221	0.0	3441.1	572
960 min Summer	5.740	0.0	3642.3	696
1440 min Summer	4.148	0.0	3931.8	970
15 min Winter	118.417	0.0	1246.2	19
30 min Winter	77.747	0.0	1651.5	33
60 min Winter	48.611	0.0	2159.0	62
120 min Winter	29.354	0.0	2613.0	120
180 min Winter	21.556	0.0	2880.4	178
240 min Winter	17.210	0.0	3067.0	236
360 min Winter	12.501	0.0	3342.0	350
480 min Winter	9.962	0.0	3550.0	460
600 min Winter	8.347	0.0	3716.5	564
720 min Winter	7.221	0.0	3855.6	648
960 min Winter	5.740	0.0	4079.8	742
1440 min Winter	4.148	0.0	4398.9	1052

Cascade Model Details for Area C.srcx

Storage is Online Cover Level (m) 23.000

Tank or Pond Structure

Invert Level (m) 22.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2677.6	1.000	3022.3

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0271-4120-1000-4120
Design Head (m)	1.000
Design Flow (l/s)	41.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	271
Invert Level (m)	22.000
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	41.2	Kick-Flo®	0.770	36.3
Flush-Flo™	0.420	41.2	Mean Flow over Head Range	-	33.5

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)	Depth (m)	Flow (l/s)
0.100	8.6	0.800	37.0	2.000	57.5	4.000	80.5	7.000	105.8
0.200	27.9	1.000	41.2	2.200	60.2	4.500	85.3	7.500	109.4
0.300	40.3	1.200	45.0	2.400	62.8	5.000	89.8	8.000	112.9
0.400	41.2	1.400	48.4	2.600	65.3	5.500	94.0	8.500	116.3
0.500	40.9	1.600	51.7	3.000	70.0	6.000	98.1	9.000	119.6
0.600	40.1	1.800	54.7	3.500	75.5	6.500	102.0	9.500	122.8

Cascade Summary of Results for Area D.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	15.300	0.500	49.2	1405.8	O K
30 min Summer	15.445	0.645	49.2	1828.2	O K
60 min Summer	15.586	0.786	49.2	2244.3	O K
120 min Summer	15.714	0.914	49.2	2624.8	Flood Risk
180 min Summer	15.772	0.972	49.2	2800.0	Flood Risk
240 min Summer	15.800	1.000	49.2	2884.4	Flood Risk
360 min Summer	15.820	1.020	49.2	2944.8	Flood Risk
480 min Summer	15.816	1.016	49.2	2934.6	Flood Risk
600 min Summer	15.807	1.007	49.2	2905.6	Flood Risk
720 min Summer	15.795	0.995	49.2	2871.3	Flood Risk
960 min Summer	15.768	0.968	49.2	2790.0	Flood Risk
1440 min Summer	15.703	0.903	49.2	2594.4	Flood Risk
15 min Winter	15.359	0.559	49.2	1577.2	O K
30 min Winter	15.522	0.722	49.2	2053.8	O K
60 min Winter	15.681	0.881	49.2	2526.4	O K
120 min Winter	15.824	1.024	49.2	2958.4	Flood Risk
180 min Winter	15.890	1.090	49.2	3159.0	Flood Risk
240 min Winter	15.923	1.123	49.2	3261.1	Flood Risk
360 min Winter	15.951	1.151	49.2	3346.7	Flood Risk
480 min Winter	15.954	1.154	49.2	3354.9	Flood Risk
600 min Winter	15.942	1.142	49.2	3319.7	Flood Risk
720 min Winter	15.923	1.123	49.2	3260.8	Flood Risk
960 min Winter	15.888	1.088	49.2	3154.1	Flood Risk
1440 min Winter	15.801	1.001	49.2	2889.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	1336.6	19
30 min Summer	77.747	0.0	1772.4	33
60 min Summer	48.611	0.0	2306.8	64
120 min Summer	29.354	0.0	2792.1	122
180 min Summer	21.556	0.0	3077.9	182
240 min Summer	17.210	0.0	3277.5	242
360 min Summer	12.501	0.0	3571.9	360
480 min Summer	9.962	0.0	3794.7	466
600 min Summer	8.347	0.0	3973.3	514
720 min Summer	7.221	0.0	4122.8	574
960 min Summer	5.740	0.0	4364.5	702
1440 min Summer	4.148	0.0	4714.1	980
15 min Winter	118.417	0.0	1504.3	19
30 min Winter	77.747	0.0	1990.3	33
60 min Winter	48.611	0.0	2587.7	62
120 min Winter	29.354	0.0	3130.6	120
180 min Winter	21.556	0.0	3450.5	178
240 min Winter	17.210	0.0	3673.9	236
360 min Winter	12.501	0.0	4003.2	350
480 min Winter	9.962	0.0	4252.3	460
600 min Winter	8.347	0.0	4451.9	566
720 min Winter	7.221	0.0	4618.8	656
960 min Winter	5.740	0.0	4888.3	742
1440 min Winter	4.148	0.0	5273.4	1054

Cascade Model Details for Area D.srcx

Storage is Online Cover Level (m) 16.000

Tank or Pond Structure

Invert Level (m) 14.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2742.2	1.200	3090.9

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0290-4920-1200-4920
Design Head (m)	1.200
Design Flow (l/s)	49.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	290
Invert Level (m)	14.800
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	49.2	Kick-Flo®	0.899	42.8
Flush-Flo™	0.463	49.2	Mean Flow over Head Range	-	40.6

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)	Depth (m)	Flow (l/s)
0.100	9.0	0.800	46.0	2.000	62.9	4.000	88.1	7.000	115.7
0.200	29.9	1.000	45.1	2.200	65.9	4.500	93.3	7.500	119.7
0.300	47.5	1.200	49.2	2.400	68.7	5.000	98.2	8.000	123.5
0.400	49.0	1.400	53.0	2.600	71.5	5.500	102.9	8.500	127.3
0.500	49.1	1.600	56.5	3.000	76.6	6.000	107.4	9.000	130.9
0.600	48.6	1.800	59.8	3.500	82.6	6.500	111.6	9.500	134.4

Cascade Summary of Results for Area E1.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	18.325	0.525	20.0	570.2	O K
30 min Summer	18.474	0.674	20.0	741.2	O K
60 min Summer	18.617	0.817	20.0	909.5	O K
120 min Summer	18.742	0.942	20.0	1059.8	Flood Risk
180 min Summer	18.797	0.997	20.0	1125.6	Flood Risk
240 min Summer	18.821	1.021	20.0	1155.5	Flood Risk
360 min Summer	18.835	1.035	20.0	1172.4	Flood Risk
480 min Summer	18.826	1.026	20.0	1161.8	Flood Risk
600 min Summer	18.812	1.012	20.0	1144.6	Flood Risk
720 min Summer	18.797	0.997	20.0	1126.0	Flood Risk
960 min Summer	18.764	0.964	20.0	1085.6	Flood Risk
1440 min Summer	18.692	0.892	20.0	999.3	O K
15 min Winter	18.386	0.586	20.0	639.8	O K
30 min Winter	18.552	0.752	20.0	833.0	O K
60 min Winter	18.713	0.913	20.0	1024.1	Flood Risk
120 min Winter	18.853	1.053	20.0	1194.8	Flood Risk
180 min Winter	18.916	1.116	20.0	1272.5	Flood Risk
240 min Winter	18.946	1.146	20.0	1310.4	Flood Risk
360 min Winter	18.969	1.169	20.0	1338.7	Flood Risk
480 min Winter	18.967	1.167	20.0	1336.2	Flood Risk
600 min Winter	18.951	1.151	20.0	1316.7	Flood Risk
720 min Winter	18.929	1.129	20.0	1288.3	Flood Risk
960 min Winter	18.888	1.088	20.0	1237.5	Flood Risk
1440 min Winter	18.792	0.992	20.0	1120.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	564.5	19
30 min Summer	77.747	0.0	744.2	33
60 min Summer	48.611	0.0	949.2	64
120 min Summer	29.354	0.0	1147.4	122
180 min Summer	21.556	0.0	1264.4	182
240 min Summer	17.210	0.0	1346.1	242
360 min Summer	12.501	0.0	1466.8	360
480 min Summer	9.962	0.0	1558.4	464
600 min Summer	8.347	0.0	1632.0	512
720 min Summer	7.221	0.0	1693.8	572
960 min Summer	5.740	0.0	1794.2	702
1440 min Summer	4.148	0.0	1940.9	980
15 min Winter	118.417	0.0	633.5	19
30 min Winter	77.747	0.0	834.2	33
60 min Winter	48.611	0.0	1063.8	62
120 min Winter	29.354	0.0	1285.7	120
180 min Winter	21.556	0.0	1416.6	178
240 min Winter	17.210	0.0	1508.1	236
360 min Winter	12.501	0.0	1643.2	350
480 min Winter	9.962	0.0	1745.7	460
600 min Winter	8.347	0.0	1828.0	566
720 min Winter	7.221	0.0	1897.1	654
960 min Winter	5.740	0.0	2009.2	742
1440 min Winter	4.148	0.0	2172.3	1054

Cascade Model Details for Area E1.srcx

Storage is Online Cover Level (m) 19.000

Tank or Pond Structure

Invert Level (m) 17.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1040.5	1.200	1259.3

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)	17.800
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)	Depth (m)	Flow (l/s)
0.100	6.8	0.800	17.4	2.000	25.5	4.000	35.6	7.000	46.7
0.200	18.3	1.000	18.3	2.200	26.7	4.500	37.7	7.500	48.2
0.300	19.8	1.200	20.0	2.400	27.8	5.000	39.6	8.000	49.8
0.400	20.0	1.400	21.5	2.600	28.9	5.500	41.5	8.500	51.3
0.500	19.7	1.600	22.9	3.000	31.0	6.000	43.3	9.000	52.7
0.600	19.4	1.800	24.3	3.500	33.4	6.500	45.0	9.500	54.1

Cascade Summary of Results for Area E2.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	18.432	0.432	6.6	301.3	O K
30 min Summer	18.554	0.554	7.6	392.4	O K
60 min Summer	18.671	0.671	8.4	482.8	O K
120 min Summer	18.777	0.777	9.1	565.7	Flood Risk
180 min Summer	18.826	0.826	9.4	605.2	Flood Risk
240 min Summer	18.852	0.852	9.5	625.8	Flood Risk
360 min Summer	18.874	0.874	9.6	644.1	Flood Risk
480 min Summer	18.878	0.878	9.7	647.1	Flood Risk
600 min Summer	18.877	0.877	9.7	646.1	Flood Risk
720 min Summer	18.874	0.874	9.6	643.9	Flood Risk
960 min Summer	18.865	0.865	9.6	636.5	Flood Risk
1440 min Summer	18.837	0.837	9.4	614.1	Flood Risk
15 min Winter	18.481	0.481	7.0	337.7	O K
30 min Winter	18.616	0.616	8.0	440.1	O K
60 min Winter	18.747	0.747	8.9	542.1	Flood Risk
120 min Winter	18.865	0.865	9.6	636.5	Flood Risk
180 min Winter	18.921	0.921	9.9	682.3	Flood Risk
240 min Winter	18.951	0.951	10.1	707.1	Flood Risk
360 min Winter	18.980	0.980	10.2	731.5	Flood Risk
480 min Winter	18.989	0.989	10.3	739.3	Flood Risk
600 min Winter	18.987	0.987	10.3	737.5	Flood Risk
720 min Winter	18.979	0.979	10.2	730.7	Flood Risk
960 min Winter	18.966	0.966	10.2	719.9	Flood Risk
1440 min Winter	18.925	0.925	9.9	686.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	282.0	19
30 min Summer	77.747	0.0	368.1	34
60 min Summer	48.611	0.0	491.3	64
120 min Summer	29.354	0.0	594.0	122
180 min Summer	21.556	0.0	654.4	182
240 min Summer	17.210	0.0	696.5	242
360 min Summer	12.501	0.0	758.3	360
480 min Summer	9.962	0.0	804.9	466
600 min Summer	8.347	0.0	841.8	512
720 min Summer	7.221	0.0	872.4	572
960 min Summer	5.740	0.0	920.2	696
1440 min Summer	4.148	0.0	979.0	968
15 min Winter	118.417	0.0	315.6	19
30 min Winter	77.747	0.0	410.0	33
60 min Winter	48.611	0.0	550.8	62
120 min Winter	29.354	0.0	665.6	120
180 min Winter	21.556	0.0	733.1	178
240 min Winter	17.210	0.0	780.2	236
360 min Winter	12.501	0.0	849.1	350
480 min Winter	9.962	0.0	900.8	460
600 min Winter	8.347	0.0	941.7	566
720 min Winter	7.221	0.0	975.1	650
960 min Winter	5.740	0.0	1026.2	742
1440 min Winter	4.148	0.0	1082.3	1052

Cascade Model Details for Area E2.srcx

Storage is Online Cover Level (m) 19.000

Tank or Pond Structure

Invert Level (m) 18.000

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	661.6	1.000	838.2

Orifice Outflow Control

Diameter (m) 0.071 Discharge Coefficient 0.600 Invert Level (m) 18.000

Cascade Summary of Results for School.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	11.307	0.507	9.8	456.1	O K
30 min Summer	11.452	0.652	11.2	594.0	O K
60 min Summer	11.593	0.793	12.5	731.1	O K
120 min Summer	11.719	0.919	13.5	857.1	Flood Risk
180 min Summer	11.778	0.978	13.9	917.5	Flood Risk
240 min Summer	11.809	1.009	14.1	949.2	Flood Risk
360 min Summer	11.837	1.037	14.3	978.0	Flood Risk
480 min Summer	11.843	1.043	14.4	983.6	Flood Risk
600 min Summer	11.841	1.041	14.4	982.2	Flood Risk
720 min Summer	11.838	1.038	14.4	979.1	Flood Risk
960 min Summer	11.828	1.028	14.3	968.4	Flood Risk
1440 min Summer	11.796	0.996	14.1	935.7	Flood Risk
15 min Winter	11.365	0.565	10.4	511.1	O K
30 min Winter	11.526	0.726	11.9	666.1	O K
60 min Winter	11.683	0.883	13.2	820.7	O K
120 min Winter	11.824	1.024	14.3	964.2	Flood Risk
180 min Winter	11.891	1.091	14.7	1034.1	Flood Risk
240 min Winter	11.928	1.128	15.0	1072.3	Flood Risk
360 min Winter	11.964	1.164	15.2	1110.4	Flood Risk
480 min Winter	11.977	1.177	15.3	1123.1	Flood Risk
600 min Winter	11.975	1.175	15.3	1121.4	Flood Risk
720 min Winter	11.966	1.166	15.2	1111.7	Flood Risk
960 min Winter	11.950	1.150	15.1	1095.5	Flood Risk
1440 min Winter	11.903	1.103	14.8	1046.5	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	425.0	19
30 min Summer	77.747	0.0	554.2	34
60 min Summer	48.611	0.0	742.7	64
120 min Summer	29.354	0.0	897.9	122
180 min Summer	21.556	0.0	989.2	182
240 min Summer	17.210	0.0	1052.8	242
360 min Summer	12.501	0.0	1146.1	360
480 min Summer	9.962	0.0	1216.2	468
600 min Summer	8.347	0.0	1271.9	518
720 min Summer	7.221	0.0	1317.8	576
960 min Summer	5.740	0.0	1388.8	702
1440 min Summer	4.148	0.0	1473.9	970
15 min Winter	118.417	0.0	475.5	19
30 min Winter	77.747	0.0	616.8	33
60 min Winter	48.611	0.0	832.6	62
120 min Winter	29.354	0.0	1006.2	120
180 min Winter	21.556	0.0	1108.2	178
240 min Winter	17.210	0.0	1179.1	236
360 min Winter	12.501	0.0	1283.1	350
480 min Winter	9.962	0.0	1360.9	460
600 min Winter	8.347	0.0	1422.3	566
720 min Winter	7.221	0.0	1472.0	656
960 min Winter	5.740	0.0	1547.9	742
1440 min Winter	4.148	0.0	1626.1	1052

Cascade Model Details for School.srcx

Storage is Online Cover Level (m) 12.000

Tank or Pond Structure

Invert Level (m) 10.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	858.4	1.200	1058.1

Orifice Outflow Control

Diameter (m) 0.083 Discharge Coefficient 0.600 Invert Level (m) 10.800

Cascade Summary of Results for Final Pond with Area A2.srcx

Upstream Structures	Outflow To	Overflow To
Area A1.srcx	(None)	(None)
Area B1.srcx		
Area B2.srcx		
Area B3.srcx		
Area C.srcx		
Area D.srcx		
Area E1.srcx		
Area E2.srcx		
School.srcx		

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	7.382	0.482	172.8	169.7	O K
30 min Summer	7.492	0.592	177.0	216.5	O K
60 min Summer	7.590	0.690	177.6	261.1	O K
120 min Summer	7.650	0.750	177.6	289.9	Flood Risk
180 min Summer	7.665	0.765	177.6	297.1	Flood Risk
240 min Summer	7.666	0.766	177.6	297.8	Flood Risk
360 min Summer	7.654	0.754	177.6	291.6	Flood Risk
480 min Summer	7.632	0.732	177.6	281.1	Flood Risk
600 min Summer	7.607	0.707	177.6	269.1	Flood Risk
720 min Summer	7.583	0.683	177.6	257.8	O K
960 min Summer	7.545	0.645	177.6	240.6	O K
1440 min Summer	7.493	0.593	177.0	217.0	O K
15 min Winter	7.428	0.528	175.1	188.8	O K
30 min Winter	7.550	0.650	177.6	242.9	O K
60 min Winter	7.657	0.757	177.6	293.2	Flood Risk
120 min Winter	7.753	0.853	177.6	341.5	Flood Risk
180 min Winter	7.823	0.923	177.6	378.2	Flood Risk
240 min Winter	7.856	0.956	177.6	396.3	Flood Risk
360 min Winter	7.889	0.989	177.6	414.1	Flood Risk
480 min Winter	7.899	0.999	178.1	420.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	4999.8	18
30 min Summer	77.747	0.0	6596.4	32
60 min Summer	48.611	0.0	8638.0	62
120 min Summer	29.354	0.0	10450.7	106
180 min Summer	21.556	0.0	11518.3	142
240 min Summer	17.210	0.0	12263.5	182
360 min Summer	12.501	0.0	13361.2	254
480 min Summer	9.962	0.0	14191.0	320
600 min Summer	8.347	0.0	14854.5	380
720 min Summer	7.221	0.0	15408.1	434
960 min Summer	5.740	0.0	16294.8	560
1440 min Summer	4.148	0.0	17523.8	820
15 min Winter	118.417	0.0	5616.5	18
30 min Winter	77.747	0.0	7387.8	32
60 min Winter	48.611	0.0	9687.1	60
120 min Winter	29.354	0.0	11715.5	120
180 min Winter	21.556	0.0	12910.0	208
240 min Winter	17.210	0.0	13743.4	262
360 min Winter	12.501	0.0	14970.3	368
480 min Winter	9.962	0.0	15896.6	482

Cascade Summary of Results for Final Pond with Area A2.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
600 min Winter	7.894	0.994	177.6	417.3	Flood Risk
720 min Winter	7.874	0.974	177.6	406.0	Flood Risk
960 min Winter	7.656	0.756	177.6	292.7	Flood Risk
1440 min Winter	7.479	0.579	176.7	210.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
600 min Winter	8.347	0.0	16635.7	598
720 min Winter	7.221	0.0	17250.1	716
960 min Winter	5.740	0.0	18229.3	896
1440 min Winter	4.148	0.0	19537.8	836

Cascade Model Details for Final Pond with Area A2.srcx

Storage is Online Cover Level (m) 7.900

Tank or Pond Structure

Invert Level (m) 6.900

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	295.0	1.000	560.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0503-1782-1000-1782
Design Head (m)	1.000
Design Flow (l/s)	178.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	503
Invert Level (m)	6.900
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)	1.000	178.1	Kick-Flo®	0.905	169.6
Flush-Flo™	0.658	177.6	Mean Flow over Head Range	-	126.6

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)	Depth (m)	Flow (l/s)
0.100	12.6	0.800	175.0	2.000	250.0	4.000	351.2	7.000	462.6
0.200	46.5	1.000	178.1	2.200	261.9	4.500	372.2	7.500	478.6
0.300	94.5	1.200	194.7	2.400	273.3	5.000	392.0	8.000	494.1
0.400	147.0	1.400	209.9	2.600	284.3	5.500	410.8	8.500	509.1
0.500	173.8	1.600	224.1	3.000	305.0	6.000	428.8	9.000	523.6
0.600	177.2	1.800	237.4	3.500	328.9	6.500	446.0	9.500	537.8

Cascade Summary of Results for Area A1.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	10.427	0.427	11.6	539.7	O K
30 min Summer	10.550	0.550	13.4	703.0	O K
60 min Summer	10.671	0.671	14.9	865.4	O K
120 min Summer	10.780	0.780	16.1	1014.9	Flood Risk
180 min Summer	10.832	0.832	16.7	1086.5	Flood Risk
240 min Summer	10.859	0.859	17.0	1124.3	Flood Risk
360 min Summer	10.883	0.883	17.2	1158.5	Flood Risk
480 min Summer	10.888	0.888	17.3	1165.3	Flood Risk
600 min Summer	10.888	0.888	17.3	1164.7	Flood Risk
720 min Summer	10.886	0.886	17.2	1161.9	Flood Risk
960 min Summer	10.878	0.878	17.2	1150.7	Flood Risk
1440 min Summer	10.852	0.852	16.9	1114.0	Flood Risk
15 min Winter	10.476	0.476	12.3	604.8	O K
30 min Winter	10.614	0.614	14.2	788.3	O K
60 min Winter	10.749	0.749	15.8	971.4	Flood Risk
120 min Winter	10.871	0.871	17.1	1141.3	Flood Risk
180 min Winter	10.930	0.930	17.7	1224.1	Flood Risk
240 min Winter	10.962	0.962	18.0	1269.3	Flood Risk
360 min Winter	10.993	0.993	18.3	1314.3	Flood Risk
480 min Winter	11.004	1.004	18.4	1329.3	FLOOD
600 min Winter	11.003	1.003	18.4	1327.2	FLOOD
720 min Winter	10.995	0.995	18.3	1316.0	Flood Risk
960 min Winter	10.983	0.983	18.2	1298.8	Flood Risk
1440 min Winter	10.942	0.942	17.8	1241.8	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	488.5	19
30 min Summer	77.747	0.0	640.4	34
60 min Summer	48.611	0.0	869.5	64
120 min Summer	29.354	0.0	1052.2	122
180 min Summer	21.556	0.0	1159.6	182
240 min Summer	17.210	0.0	1234.4	242
360 min Summer	12.501	0.0	1343.9	360
480 min Summer	9.962	0.0	1426.1	466
600 min Summer	8.347	0.0	1491.3	512
720 min Summer	7.221	0.0	1545.0	572
960 min Summer	5.740	0.0	1628.3	696
1440 min Summer	4.148	0.0	1730.6	968
15 min Winter	118.417	0.0	547.8	19
30 min Winter	77.747	0.0	714.6	33
60 min Winter	48.611	0.0	975.4	62
120 min Winter	29.354	0.0	1179.8	120
180 min Winter	21.556	0.0	1299.8	178
240 min Winter	17.210	0.0	1383.2	236
360 min Winter	12.501	0.0	1505.2	350
480 min Winter	9.962	5.7	1596.6	460
600 min Winter	8.347	3.6	1668.7	566
720 min Winter	7.221	0.0	1727.2	650
960 min Winter	5.740	0.0	1816.6	742
1440 min Winter	4.148	0.0	1918.0	1052

Cascade Rainfall Details for Area A1.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	0.400	Longest Storm (mins)	1440
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 2.463

Time From:	**(mins) To:**	**Area (ha)**
0	4	2.463

Cascade Model Details for Area A1.srcx

Storage is Online Cover Level (m) 11.000

Tank or Pond Structure

Invert Level (m) 10.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1222.5	1.000	1427.3

Orifice Outflow Control

Diameter (m) 0.095 Discharge Coefficient 0.600 Invert Level (m) 10.000

Cascade Summary of Results for Area B1.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	16.443	0.443	5.7	254.4	O K
30 min Summer	16.568	0.568	6.5	331.2	O K
60 min Summer	16.687	0.687	7.1	407.4	O K
120 min Summer	16.793	0.793	7.7	477.3	Flood Risk
180 min Summer	16.843	0.843	7.9	510.4	Flood Risk
240 min Summer	16.868	0.868	8.1	527.6	Flood Risk
360 min Summer	16.891	0.891	8.2	542.6	Flood Risk
480 min Summer	16.894	0.894	8.2	544.9	Flood Risk
600 min Summer	16.892	0.892	8.2	543.9	Flood Risk
720 min Summer	16.889	0.889	8.2	541.8	Flood Risk
960 min Summer	16.880	0.880	8.1	535.1	Flood Risk
1440 min Summer	16.851	0.851	8.0	515.7	Flood Risk
15 min Winter	16.494	0.494	6.0	285.1	O K
30 min Winter	16.631	0.631	6.8	371.5	O K
60 min Winter	16.764	0.764	7.5	457.5	Flood Risk
120 min Winter	16.882	0.882	8.1	537.0	Flood Risk
180 min Winter	16.939	0.939	8.4	575.5	Flood Risk
240 min Winter	16.969	0.969	8.5	596.3	Flood Risk
360 min Winter	16.998	0.998	8.7	616.6	Flood Risk
480 min Winter	17.007	1.007	8.7	622.8	FLOOD
600 min Winter	17.004	1.004	8.7	621.1	FLOOD
720 min Winter	16.995	0.995	8.7	615.1	Flood Risk
960 min Winter	16.982	0.982	8.6	605.6	Flood Risk
1440 min Winter	16.940	0.940	8.4	576.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	240.6	19
30 min Summer	77.747	0.0	313.8	34
60 min Summer	48.611	0.0	416.3	64
120 min Summer	29.354	0.0	503.2	122
180 min Summer	21.556	0.0	554.3	182
240 min Summer	17.210	0.0	590.0	242
360 min Summer	12.501	0.0	642.4	360
480 min Summer	9.962	0.0	681.9	466
600 min Summer	8.347	0.0	713.3	512
720 min Summer	7.221	0.0	739.3	572
960 min Summer	5.740	0.0	780.1	696
1440 min Summer	4.148	0.0	830.6	968
15 min Winter	118.417	0.0	269.2	19
30 min Winter	77.747	0.0	349.4	33
60 min Winter	48.611	0.0	466.6	62
120 min Winter	29.354	0.0	563.8	120
180 min Winter	21.556	0.0	620.9	178
240 min Winter	17.210	0.0	660.8	236
360 min Winter	12.501	0.0	719.2	350
480 min Winter	9.962	4.6	763.1	460
600 min Winter	8.347	2.8	797.9	566
720 min Winter	7.221	0.0	826.4	650
960 min Winter	5.740	0.0	870.1	742
1440 min Winter	4.148	0.0	917.9	1052

Cascade Rainfall Details for Area B1.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	0.400	Longest Storm (mins)	1440
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.162

Time From:	**(mins) To:**	**Area (ha)**
0	4	1.162

Cascade Model Details for Area B1.srcx

Storage is Online Cover Level (m) 17.000

Tank or Pond Structure

Invert Level (m) 16.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	539.7	1.000	700.2

Orifice Outflow Control

Diameter (m) 0.065 Discharge Coefficient 0.600 Invert Level (m) 16.000

Cascade Summary of Results for Area B2.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	10.906	0.606	4.5	186.6	O K
30 min Summer	11.054	0.754	5.0	242.8	O K
60 min Summer	11.189	0.889	5.4	298.3	O K
120 min Summer	11.304	1.004	5.8	348.7	Flood Risk
180 min Summer	11.355	1.055	5.9	372.3	Flood Risk
240 min Summer	11.381	1.081	6.0	384.2	Flood Risk
360 min Summer	11.401	1.101	6.1	393.9	Flood Risk
480 min Summer	11.402	1.102	6.1	394.4	Flood Risk
600 min Summer	11.399	1.099	6.1	392.7	Flood Risk
720 min Summer	11.394	1.094	6.1	390.3	Flood Risk
960 min Summer	11.380	1.080	6.0	383.8	Flood Risk
1440 min Summer	11.343	1.043	5.9	366.8	Flood Risk
15 min Winter	10.967	0.667	4.7	209.2	O K
30 min Winter	11.127	0.827	5.2	272.4	O K
60 min Winter	11.273	0.973	5.7	335.2	Flood Risk
120 min Winter	11.399	1.099	6.1	392.9	Flood Risk
180 min Winter	11.457	1.157	6.2	420.5	Flood Risk
240 min Winter	11.487	1.187	6.3	435.1	Flood Risk
360 min Winter	11.514	1.214	6.4	448.9	FLOOD
480 min Winter	11.521	1.221	6.4	452.4	FLOOD
600 min Winter	11.517	1.217	6.4	450.1	FLOOD
720 min Winter	11.506	1.206	6.4	444.8	FLOOD
960 min Winter	11.489	1.189	6.3	436.2	Flood Risk
1440 min Winter	11.439	1.139	6.2	411.9	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	184.3	19
30 min Summer	77.747	0.0	240.7	34
60 min Summer	48.611	0.0	309.4	64
120 min Summer	29.354	0.0	373.8	122
180 min Summer	21.556	0.0	411.8	182
240 min Summer	17.210	0.0	438.3	242
360 min Summer	12.501	0.0	477.4	360
480 min Summer	9.962	0.0	507.0	458
600 min Summer	8.347	0.0	530.8	510
720 min Summer	7.221	0.0	550.6	570
960 min Summer	5.740	0.0	582.4	694
1440 min Summer	4.148	0.0	624.9	968
15 min Winter	118.417	0.0	206.2	19
30 min Winter	77.747	0.0	268.1	33
60 min Winter	48.611	0.0	346.7	62
120 min Winter	29.354	0.0	418.7	120
180 min Winter	21.556	0.0	461.2	178
240 min Winter	17.210	0.0	490.8	236
360 min Winter	12.501	7.1	534.6	350
480 min Winter	9.962	10.6	567.6	460
600 min Winter	8.347	8.3	594.0	566
720 min Winter	7.221	3.0	616.0	648
960 min Winter	5.740	0.0	650.8	742
1440 min Winter	4.148	0.0	691.5	1050

Cascade Rainfall Details for Area B2.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	0.400	Longest Storm (mins)	1440
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.854

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.854

Cascade Model Details for Area B2.srcx

Storage is Online Cover Level (m) 11.500

Tank or Pond Structure

Invert Level (m) 10.300

Depth (m)	Area (m^2)	Depth (m)	Area (m^2)
0.000	253.1	1.200	496.8

Orifice Outflow Control

Diameter (m) 0.053 Discharge Coefficient 0.600 Invert Level (m) 10.300

Cascade Summary of Results for Area B3.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	7.680	0.580	5.0	216.9	O K
30 min Summer	7.825	0.725	5.7	282.3	O K
60 min Summer	7.958	0.858	6.2	347.0	O K
120 min Summer	8.073	0.973	6.6	406.0	Flood Risk
180 min Summer	8.126	1.026	6.8	433.8	Flood Risk
240 min Summer	8.152	1.052	6.9	448.1	Flood Risk
360 min Summer	8.174	1.074	6.9	460.2	Flood Risk
480 min Summer	8.176	1.076	6.9	461.4	Flood Risk
600 min Summer	8.173	1.073	6.9	459.7	Flood Risk
720 min Summer	8.168	1.068	6.9	457.2	Flood Risk
960 min Summer	8.156	1.056	6.9	450.2	Flood Risk
1440 min Summer	8.121	1.021	6.8	431.5	Flood Risk
15 min Winter	7.739	0.639	5.3	243.1	O K
30 min Winter	7.897	0.797	5.9	316.7	O K
60 min Winter	8.043	0.943	6.5	389.8	Flood Risk
120 min Winter	8.169	1.069	6.9	457.3	Flood Risk
180 min Winter	8.227	1.127	7.1	489.7	Flood Risk
240 min Winter	8.257	1.157	7.2	507.2	Flood Risk
360 min Winter	8.287	1.187	7.3	524.0	Flood Risk
480 min Winter	8.295	1.195	7.3	528.8	Flood Risk
600 min Winter	8.291	1.191	7.3	526.8	Flood Risk
720 min Winter	8.282	1.182	7.3	521.1	Flood Risk
960 min Winter	8.265	1.165	7.2	511.4	Flood Risk
1440 min Winter	8.218	1.118	7.1	484.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	212.4	19
30 min Summer	77.747	0.0	277.0	34
60 min Summer	48.611	0.0	358.8	64
120 min Summer	29.354	0.0	433.4	122
180 min Summer	21.556	0.0	477.4	182
240 min Summer	17.210	0.0	508.2	242
360 min Summer	12.501	0.0	553.4	360
480 min Summer	9.962	0.0	587.7	466
600 min Summer	8.347	0.0	615.1	514
720 min Summer	7.221	0.0	637.9	572
960 min Summer	5.740	0.0	674.3	700
1440 min Summer	4.148	0.0	720.9	968
15 min Winter	118.417	0.0	237.6	19
30 min Winter	77.747	0.0	308.2	33
60 min Winter	48.611	0.0	401.9	62
120 min Winter	29.354	0.0	485.5	120
180 min Winter	21.556	0.0	534.7	178
240 min Winter	17.210	0.0	569.1	236
360 min Winter	12.501	0.0	619.6	350
480 min Winter	9.962	0.0	657.8	460
600 min Winter	8.347	0.0	688.2	566
720 min Winter	7.221	0.0	713.4	656
960 min Winter	5.740	0.0	752.6	742
1440 min Winter	4.148	0.0	795.6	1052

Cascade Rainfall Details for Area B3.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	0.400	Longest Storm (mins)	1440
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.992

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.992

Cascade Model Details for Area B3.srcx

Storage is Online Cover Level (m) 8.300

Tank or Pond Structure

Invert Level (m) 7.100

Depth (m)	Area (m^2)	Depth (m)	Area (m^2)
0.000	316.1	1.200	583.8

Orifice Outflow Control

Diameter (m) 0.057 Discharge Coefficient 0.600 Invert Level (m) 7.100

Cascade Summary of Results for Area C.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	22.428	0.428	41.2	1177.7	O K
30 min Summer	22.553	0.553	41.2	1531.7	O K
60 min Summer	22.674	0.674	41.2	1880.7	O K
120 min Summer	22.783	0.783	41.2	2200.4	Flood Risk
180 min Summer	22.833	0.833	41.2	2348.0	Flood Risk
240 min Summer	22.857	0.857	41.2	2419.5	Flood Risk
360 min Summer	22.874	0.874	41.2	2471.6	Flood Risk
480 min Summer	22.872	0.872	41.2	2464.8	Flood Risk
600 min Summer	22.865	0.865	41.2	2443.7	Flood Risk
720 min Summer	22.856	0.856	41.2	2417.8	Flood Risk
960 min Summer	22.835	0.835	41.2	2354.5	Flood Risk
1440 min Summer	22.782	0.782	41.2	2199.2	Flood Risk
15 min Winter	22.479	0.479	41.2	1321.2	O K
30 min Winter	22.618	0.618	41.2	1720.5	O K
60 min Winter	22.754	0.754	41.2	2116.8	Flood Risk
120 min Winter	22.877	0.877	41.2	2479.3	Flood Risk
180 min Winter	22.934	0.934	41.2	2648.0	Flood Risk
240 min Winter	22.962	0.962	41.2	2734.2	Flood Risk
360 min Winter	22.986	0.986	41.2	2807.2	Flood Risk
480 min Winter	22.989	0.989	41.2	2815.2	Flood Risk
600 min Winter	22.980	0.980	41.2	2786.8	Flood Risk
720 min Winter	22.964	0.964	41.2	2739.3	Flood Risk
960 min Winter	22.936	0.936	41.2	2655.9	Flood Risk
1440 min Winter	22.864	0.864	41.2	2441.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	1106.2	19
30 min Summer	77.747	0.0	1469.7	33
60 min Summer	48.611	0.0	1924.2	64
120 min Summer	29.354	0.0	2329.9	122
180 min Summer	21.556	0.0	2568.8	182
240 min Summer	17.210	0.0	2735.6	242
360 min Summer	12.501	0.0	2981.5	360
480 min Summer	9.962	0.0	3167.5	458
600 min Summer	8.347	0.0	3316.5	510
720 min Summer	7.221	0.0	3441.1	572
960 min Summer	5.740	0.0	3642.3	696
1440 min Summer	4.148	0.0	3931.8	970
15 min Winter	118.417	0.0	1246.2	19
30 min Winter	77.747	0.0	1651.5	33
60 min Winter	48.611	0.0	2159.0	62
120 min Winter	29.354	0.0	2613.0	120
180 min Winter	21.556	0.0	2880.4	178
240 min Winter	17.210	0.0	3067.0	236
360 min Winter	12.501	0.0	3342.0	350
480 min Winter	9.962	0.0	3550.0	460
600 min Winter	8.347	0.0	3716.5	564
720 min Winter	7.221	0.0	3855.6	648
960 min Winter	5.740	0.0	4079.8	742
1440 min Winter	4.148	0.0	4398.9	1052

Cascade Rainfall Details for Area C.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	0.400	Longest Storm (mins)	1440
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 5.422

Time From:	**(mins) To:**	**Area (ha)**
0	4	5.422

Cascade Model Details for Area C.srcx

Storage is Online Cover Level (m) 23.000

Tank or Pond Structure

Invert Level (m) 22.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2677.6	1.000	3022.3

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0271-4120-1000-4120
Design Head (m)	1.000
Design Flow (l/s)	41.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	271
Invert Level (m)	22.000
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	41.2	Kick-Flo®	0.770	36.3
Flush-Flo™	0.420	41.2	Mean Flow over Head Range	-	33.5

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)	Depth (m)	Flow (l/s)
0.100	8.6	0.800	37.0	2.000	57.5	4.000	80.5	7.000	105.8
0.200	27.9	1.000	41.2	2.200	60.2	4.500	85.3	7.500	109.4
0.300	40.3	1.200	45.0	2.400	62.8	5.000	89.8	8.000	112.9
0.400	41.2	1.400	48.4	2.600	65.3	5.500	94.0	8.500	116.3
0.500	40.9	1.600	51.7	3.000	70.0	6.000	98.1	9.000	119.6
0.600	40.1	1.800	54.7	3.500	75.5	6.500	102.0	9.500	122.8

Cascade Summary of Results for Area D.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	15.300	0.500	49.2	1405.8	O K
30 min Summer	15.445	0.645	49.2	1828.2	O K
60 min Summer	15.586	0.786	49.2	2244.3	O K
120 min Summer	15.714	0.914	49.2	2624.8	Flood Risk
180 min Summer	15.772	0.972	49.2	2800.0	Flood Risk
240 min Summer	15.800	1.000	49.2	2884.4	Flood Risk
360 min Summer	15.820	1.020	49.2	2944.8	Flood Risk
480 min Summer	15.816	1.016	49.2	2934.6	Flood Risk
600 min Summer	15.807	1.007	49.2	2905.6	Flood Risk
720 min Summer	15.795	0.995	49.2	2871.3	Flood Risk
960 min Summer	15.768	0.968	49.2	2790.0	Flood Risk
1440 min Summer	15.703	0.903	49.2	2594.4	Flood Risk
15 min Winter	15.359	0.559	49.2	1577.2	O K
30 min Winter	15.522	0.722	49.2	2053.8	O K
60 min Winter	15.681	0.881	49.2	2526.4	O K
120 min Winter	15.824	1.024	49.2	2958.4	Flood Risk
180 min Winter	15.890	1.090	49.2	3159.0	Flood Risk
240 min Winter	15.923	1.123	49.2	3261.1	Flood Risk
360 min Winter	15.951	1.151	49.2	3346.7	Flood Risk
480 min Winter	15.954	1.154	49.2	3354.9	Flood Risk
600 min Winter	15.942	1.142	49.2	3319.7	Flood Risk
720 min Winter	15.923	1.123	49.2	3260.8	Flood Risk
960 min Winter	15.888	1.088	49.2	3154.1	Flood Risk
1440 min Winter	15.801	1.001	49.2	2889.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	1336.6	19
30 min Summer	77.747	0.0	1772.4	33
60 min Summer	48.611	0.0	2306.8	64
120 min Summer	29.354	0.0	2792.1	122
180 min Summer	21.556	0.0	3077.9	182
240 min Summer	17.210	0.0	3277.5	242
360 min Summer	12.501	0.0	3571.9	360
480 min Summer	9.962	0.0	3794.7	466
600 min Summer	8.347	0.0	3973.3	514
720 min Summer	7.221	0.0	4122.8	574
960 min Summer	5.740	0.0	4364.5	702
1440 min Summer	4.148	0.0	4714.1	980
15 min Winter	118.417	0.0	1504.3	19
30 min Winter	77.747	0.0	1990.3	33
60 min Winter	48.611	0.0	2587.7	62
120 min Winter	29.354	0.0	3130.6	120
180 min Winter	21.556	0.0	3450.5	178
240 min Winter	17.210	0.0	3673.9	236
360 min Winter	12.501	0.0	4003.2	350
480 min Winter	9.962	0.0	4252.3	460
600 min Winter	8.347	0.0	4451.9	566
720 min Winter	7.221	0.0	4618.8	656
960 min Winter	5.740	0.0	4888.3	742
1440 min Winter	4.148	0.0	5273.4	1054

Cascade Rainfall Details for Area D.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	0.400	Longest Storm (mins)	1440
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 6.475

Time From:	**(mins) To:**	**Area (ha)**
0	4	6.475

Cascade Model Details for Area D.srcx

Storage is Online Cover Level (m) 16.000

Tank or Pond Structure

Invert Level (m) 14.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2742.2	1.200	3090.9

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0290-4920-1200-4920
Design Head (m)	1.200
Design Flow (l/s)	49.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	290
Invert Level (m)	14.800
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	49.2	Kick-Flo®	0.899	42.8
Flush-Flo™	0.463	49.2	Mean Flow over Head Range	-	40.6

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)	Depth (m)	Flow (l/s)
0.100	9.0	0.800	46.0	2.000	62.9	4.000	88.1	7.000	115.7
0.200	29.9	1.000	45.1	2.200	65.9	4.500	93.3	7.500	119.7
0.300	47.5	1.200	49.2	2.400	68.7	5.000	98.2	8.000	123.5
0.400	49.0	1.400	53.0	2.600	71.5	5.500	102.9	8.500	127.3
0.500	49.1	1.600	56.5	3.000	76.6	6.000	107.4	9.000	130.9
0.600	48.6	1.800	59.8	3.500	82.6	6.500	111.6	9.500	134.4

Cascade Summary of Results for Area E1.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	18.325	0.525	20.0	570.2	O K
30 min Summer	18.474	0.674	20.0	741.2	O K
60 min Summer	18.617	0.817	20.0	909.5	O K
120 min Summer	18.742	0.942	20.0	1059.8	Flood Risk
180 min Summer	18.797	0.997	20.0	1125.6	Flood Risk
240 min Summer	18.821	1.021	20.0	1155.5	Flood Risk
360 min Summer	18.835	1.035	20.0	1172.4	Flood Risk
480 min Summer	18.826	1.026	20.0	1161.8	Flood Risk
600 min Summer	18.812	1.012	20.0	1144.6	Flood Risk
720 min Summer	18.797	0.997	20.0	1126.0	Flood Risk
960 min Summer	18.764	0.964	20.0	1085.6	Flood Risk
1440 min Summer	18.692	0.892	20.0	999.3	O K
15 min Winter	18.386	0.586	20.0	639.8	O K
30 min Winter	18.552	0.752	20.0	833.0	O K
60 min Winter	18.713	0.913	20.0	1024.1	Flood Risk
120 min Winter	18.853	1.053	20.0	1194.8	Flood Risk
180 min Winter	18.916	1.116	20.0	1272.5	Flood Risk
240 min Winter	18.946	1.146	20.0	1310.4	Flood Risk
360 min Winter	18.969	1.169	20.0	1338.7	Flood Risk
480 min Winter	18.967	1.167	20.0	1336.2	Flood Risk
600 min Winter	18.951	1.151	20.0	1316.7	Flood Risk
720 min Winter	18.929	1.129	20.0	1288.3	Flood Risk
960 min Winter	18.888	1.088	20.0	1237.5	Flood Risk
1440 min Winter	18.792	0.992	20.0	1120.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	564.5	19
30 min Summer	77.747	0.0	744.2	33
60 min Summer	48.611	0.0	949.2	64
120 min Summer	29.354	0.0	1147.4	122
180 min Summer	21.556	0.0	1264.4	182
240 min Summer	17.210	0.0	1346.1	242
360 min Summer	12.501	0.0	1466.8	360
480 min Summer	9.962	0.0	1558.4	464
600 min Summer	8.347	0.0	1632.0	512
720 min Summer	7.221	0.0	1693.8	572
960 min Summer	5.740	0.0	1794.2	702
1440 min Summer	4.148	0.0	1940.9	980
15 min Winter	118.417	0.0	633.5	19
30 min Winter	77.747	0.0	834.2	33
60 min Winter	48.611	0.0	1063.8	62
120 min Winter	29.354	0.0	1285.7	120
180 min Winter	21.556	0.0	1416.6	178
240 min Winter	17.210	0.0	1508.1	236
360 min Winter	12.501	0.0	1643.2	350
480 min Winter	9.962	0.0	1745.7	460
600 min Winter	8.347	0.0	1828.0	566
720 min Winter	7.221	0.0	1897.1	654
960 min Winter	5.740	0.0	2009.2	742
1440 min Winter	4.148	0.0	2172.3	1054

Cascade Rainfall Details for Area E1.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	0.400	Longest Storm (mins)	1440
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 2.631

Time From:	**(mins) To:**	**Area (ha)**
0	4	2.631

Cascade Model Details for Area E1.srcx

Storage is Online Cover Level (m) 19.000

Tank or Pond Structure

Invert Level (m) 17.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1040.5	1.200	1259.3

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)	17.800
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)	Depth (m)	Flow (l/s)
0.100	6.8	0.800	17.4	2.000	25.5	4.000	35.6	7.000	46.7
0.200	18.3	1.000	18.3	2.200	26.7	4.500	37.7	7.500	48.2
0.300	19.8	1.200	20.0	2.400	27.8	5.000	39.6	8.000	49.8
0.400	20.0	1.400	21.5	2.600	28.9	5.500	41.5	8.500	51.3
0.500	19.7	1.600	22.9	3.000	31.0	6.000	43.3	9.000	52.7
0.600	19.4	1.800	24.3	3.500	33.4	6.500	45.0	9.500	54.1

Cascade Summary of Results for Area E2.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	18.432	0.432	6.6	301.3	O K
30 min Summer	18.554	0.554	7.6	392.4	O K
60 min Summer	18.671	0.671	8.4	482.8	O K
120 min Summer	18.777	0.777	9.1	565.7	Flood Risk
180 min Summer	18.826	0.826	9.4	605.2	Flood Risk
240 min Summer	18.852	0.852	9.5	625.8	Flood Risk
360 min Summer	18.874	0.874	9.6	644.1	Flood Risk
480 min Summer	18.878	0.878	9.7	647.1	Flood Risk
600 min Summer	18.877	0.877	9.7	646.1	Flood Risk
720 min Summer	18.874	0.874	9.6	643.9	Flood Risk
960 min Summer	18.865	0.865	9.6	636.5	Flood Risk
1440 min Summer	18.837	0.837	9.4	614.1	Flood Risk
15 min Winter	18.481	0.481	7.0	337.7	O K
30 min Winter	18.616	0.616	8.0	440.1	O K
60 min Winter	18.747	0.747	8.9	542.1	Flood Risk
120 min Winter	18.865	0.865	9.6	636.5	Flood Risk
180 min Winter	18.921	0.921	9.9	682.3	Flood Risk
240 min Winter	18.951	0.951	10.1	707.1	Flood Risk
360 min Winter	18.980	0.980	10.2	731.5	Flood Risk
480 min Winter	18.989	0.989	10.3	739.3	Flood Risk
600 min Winter	18.987	0.987	10.3	737.5	Flood Risk
720 min Winter	18.979	0.979	10.2	730.7	Flood Risk
960 min Winter	18.966	0.966	10.2	719.9	Flood Risk
1440 min Winter	18.925	0.925	9.9	686.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	282.0	19
30 min Summer	77.747	0.0	368.1	34
60 min Summer	48.611	0.0	491.3	64
120 min Summer	29.354	0.0	594.0	122
180 min Summer	21.556	0.0	654.4	182
240 min Summer	17.210	0.0	696.5	242
360 min Summer	12.501	0.0	758.3	360
480 min Summer	9.962	0.0	804.9	466
600 min Summer	8.347	0.0	841.8	512
720 min Summer	7.221	0.0	872.4	572
960 min Summer	5.740	0.0	920.2	696
1440 min Summer	4.148	0.0	979.0	968
15 min Winter	118.417	0.0	315.6	19
30 min Winter	77.747	0.0	410.0	33
60 min Winter	48.611	0.0	550.8	62
120 min Winter	29.354	0.0	665.6	120
180 min Winter	21.556	0.0	733.1	178
240 min Winter	17.210	0.0	780.2	236
360 min Winter	12.501	0.0	849.1	350
480 min Winter	9.962	0.0	900.8	460
600 min Winter	8.347	0.0	941.7	566
720 min Winter	7.221	0.0	975.1	650
960 min Winter	5.740	0.0	1026.2	742
1440 min Winter	4.148	0.0	1082.3	1052

Cascade Rainfall Details for Area E2.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	0.400	Longest Storm (mins)	1440
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.376

Time From:	**(mins) To:**	**Area (ha)**
0	4	1.376

Cascade Model Details for Area E2.srcx

Storage is Online Cover Level (m) 19.000

Tank or Pond Structure

Invert Level (m) 18.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	661.6	1.000	838.2

Orifice Outflow Control

Diameter (m) 0.071 Discharge Coefficient 0.600 Invert Level (m) 18.000

Cascade Summary of Results for School.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Final Pond with Area A2.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	11.307	0.507	9.8	456.1	O K
30 min Summer	11.452	0.652	11.2	594.0	O K
60 min Summer	11.593	0.793	12.5	731.1	O K
120 min Summer	11.719	0.919	13.5	857.1	Flood Risk
180 min Summer	11.778	0.978	13.9	917.5	Flood Risk
240 min Summer	11.809	1.009	14.1	949.2	Flood Risk
360 min Summer	11.837	1.037	14.3	978.0	Flood Risk
480 min Summer	11.843	1.043	14.4	983.6	Flood Risk
600 min Summer	11.841	1.041	14.4	982.2	Flood Risk
720 min Summer	11.838	1.038	14.4	979.1	Flood Risk
960 min Summer	11.828	1.028	14.3	968.4	Flood Risk
1440 min Summer	11.796	0.996	14.1	935.7	Flood Risk
15 min Winter	11.365	0.565	10.4	511.1	O K
30 min Winter	11.526	0.726	11.9	666.1	O K
60 min Winter	11.683	0.883	13.2	820.7	O K
120 min Winter	11.824	1.024	14.3	964.2	Flood Risk
180 min Winter	11.891	1.091	14.7	1034.1	Flood Risk
240 min Winter	11.928	1.128	15.0	1072.3	Flood Risk
360 min Winter	11.964	1.164	15.2	1110.4	Flood Risk
480 min Winter	11.977	1.177	15.3	1123.1	Flood Risk
600 min Winter	11.975	1.175	15.3	1121.4	Flood Risk
720 min Winter	11.966	1.166	15.2	1111.7	Flood Risk
960 min Winter	11.950	1.150	15.1	1095.5	Flood Risk
1440 min Winter	11.903	1.103	14.8	1046.5	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	425.0	19
30 min Summer	77.747	0.0	554.2	34
60 min Summer	48.611	0.0	742.7	64
120 min Summer	29.354	0.0	897.9	122
180 min Summer	21.556	0.0	989.2	182
240 min Summer	17.210	0.0	1052.8	242
360 min Summer	12.501	0.0	1146.1	360
480 min Summer	9.962	0.0	1216.2	468
600 min Summer	8.347	0.0	1271.9	518
720 min Summer	7.221	0.0	1317.8	576
960 min Summer	5.740	0.0	1388.8	702
1440 min Summer	4.148	0.0	1473.9	970
15 min Winter	118.417	0.0	475.5	19
30 min Winter	77.747	0.0	616.8	33
60 min Winter	48.611	0.0	832.6	62
120 min Winter	29.354	0.0	1006.2	120
180 min Winter	21.556	0.0	1108.2	178
240 min Winter	17.210	0.0	1179.1	236
360 min Winter	12.501	0.0	1283.1	350
480 min Winter	9.962	0.0	1360.9	460
600 min Winter	8.347	0.0	1422.3	566
720 min Winter	7.221	0.0	1472.0	656
960 min Winter	5.740	0.0	1547.9	742
1440 min Winter	4.148	0.0	1626.1	1052

Cascade Rainfall Details for School.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	0.400	Longest Storm (mins)	1440
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 2.082

Time From:	**(mins) To:**	**Area (ha)**
0	4	2.082

Cascade Model Details for School.srcx

Storage is Online Cover Level (m) 12.000

Tank or Pond Structure

Invert Level (m) 10.800

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	858.4	1.200	1058.1

Orifice Outflow Control

Diameter (m) 0.083 Discharge Coefficient 0.600 Invert Level (m) 10.800

Cascade Summary of Results for Final Pond with Area A2.srcx

Upstream Structures	Outflow To	Overflow To
Area A1.srcx	(None)	(None)
Area B1.srcx		
Area B2.srcx		
Area B3.srcx		
Area C.srcx		
Area D.srcx		
Area E1.srcx		
Area E2.srcx		
School.srcx		

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	7.508	0.608	183.4	151.5	O K
30 min Summer	7.628	0.728	183.9	190.9	Flood Risk
60 min Summer	7.716	0.816	183.9	221.9	Flood Risk
120 min Summer	7.752	0.852	183.9	235.0	Flood Risk
180 min Summer	7.746	0.846	183.9	232.8	Flood Risk
240 min Summer	7.724	0.824	183.9	224.8	Flood Risk
360 min Summer	7.671	0.771	183.9	205.5	Flood Risk
480 min Summer	7.618	0.718	183.9	187.5	Flood Risk
600 min Summer	7.573	0.673	183.9	172.4	O K
720 min Summer	7.536	0.636	183.8	160.4	O K
960 min Summer	7.481	0.581	182.8	142.9	O K
1440 min Summer	7.411	0.511	180.1	122.0	O K
15 min Winter	7.569	0.669	183.9	171.0	O K
30 min Winter	7.704	0.804	183.9	217.5	Flood Risk
60 min Winter	7.805	0.905	183.9	255.2	Flood Risk
120 min Winter	7.853	0.953	183.9	274.1	Flood Risk
180 min Winter	7.863	0.963	183.9	277.8	Flood Risk
240 min Winter	7.859	0.959	183.9	276.3	Flood Risk
360 min Winter	7.806	0.906	183.9	255.5	Flood Risk
480 min Winter	7.650	0.750	183.9	198.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.417	0.0	4992.7	17
30 min Summer	77.747	0.0	6581.4	31
60 min Summer	48.611	0.0	8634.4	60
120 min Summer	29.354	0.0	10446.0	94
180 min Summer	21.556	0.0	11512.7	126
240 min Summer	17.210	0.0	12257.2	158
360 min Summer	12.501	0.0	13353.4	224
480 min Summer	9.962	0.0	14181.5	286
600 min Summer	8.347	0.0	14843.2	348
720 min Summer	7.221	0.0	15394.9	406
960 min Summer	5.740	0.0	16275.9	530
1440 min Summer	4.148	0.0	17483.5	778
15 min Winter	118.417	0.0	5607.1	17
30 min Winter	77.747	0.0	7368.0	31
60 min Winter	48.611	0.0	9683.0	60
120 min Winter	29.354	0.0	11709.9	118
180 min Winter	21.556	0.0	12903.3	176
240 min Winter	17.210	0.0	13735.7	234
360 min Winter	12.501	0.0	14960.4	360
480 min Winter	9.962	0.0	15884.5	368

Cascade Summary of Results for Final Pond with Area A2.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
600 min Winter	7.564	0.664	183.9	169.3	O K
720 min Winter	7.498	0.598	183.2	148.2	O K
960 min Winter	7.435	0.535	181.3	129.3	O K
1440 min Winter	7.377	0.477	178.2	112.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
600 min Winter	8.347	0.0	16621.0	428
720 min Winter	7.221	0.0	17231.9	492
960 min Winter	5.740	0.0	18201.3	534
1440 min Winter	4.148	0.0	19473.9	792

Cascade Rainfall Details for Final Pond with Area A2.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	0.400	Longest Storm (mins)	1440
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.748

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.748

Cascade Model Details for Final Pond with Area A2.srcx

Storage is Online Cover Level (m) 7.900

Tank or Pond Structure

Invert Level (m) 6.900

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	189.6	1.000	410.4

Hydro-Brake® Optimum Outflow Control

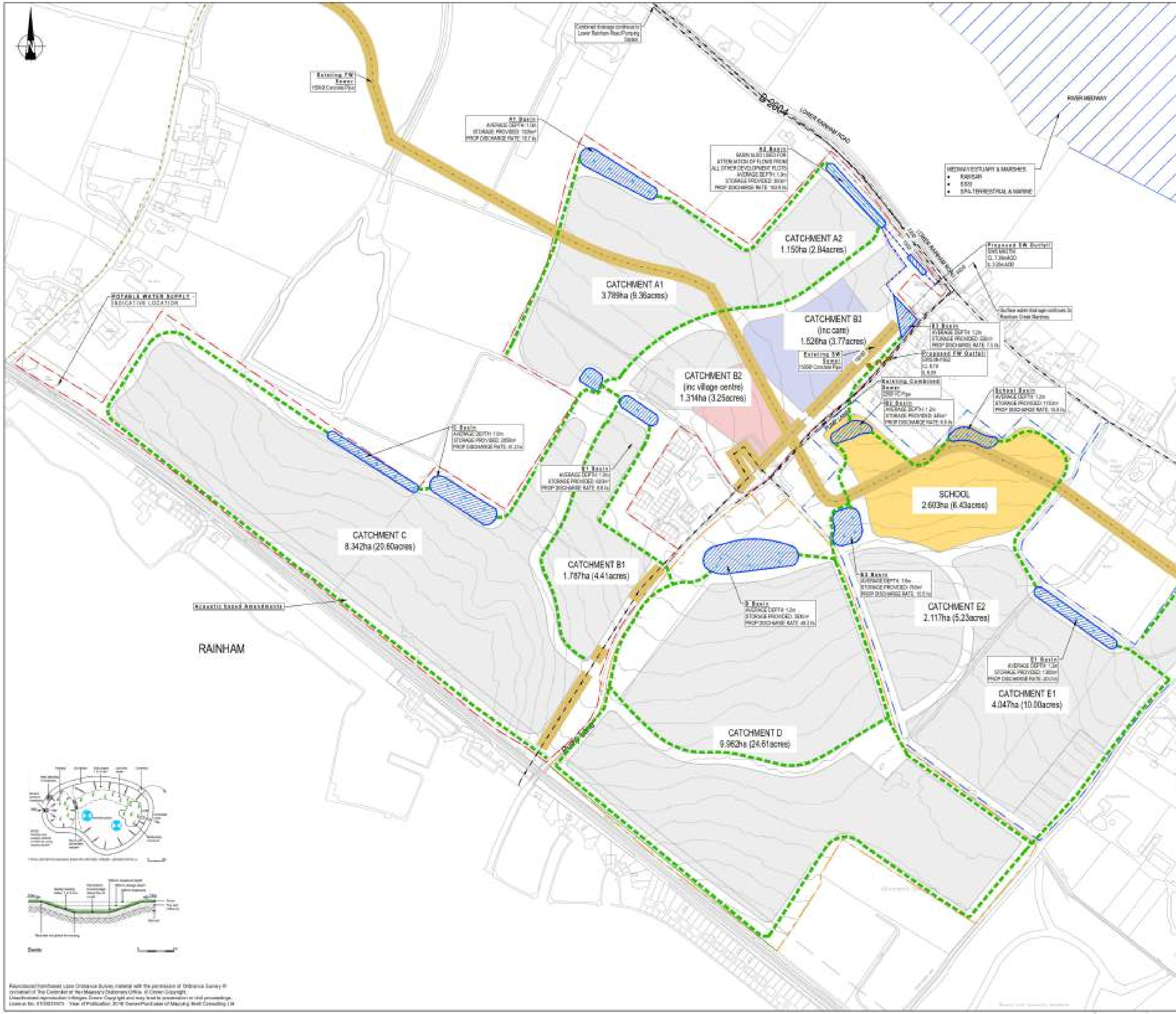
Unit Reference	MD-SHE-0511-1839-1000-1839
Design Head (m)	1.000
Design Flow (l/s)	183.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	511
Invert Level (m)	6.900
Minimum Outlet Pipe Diameter (mm)	Site Specific Design (Contact Hydro International)
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)	1.000	183.9	Kick-Flo®	0.912	175.8
Flush-Flo™	0.665	183.9	Mean Flow over Head Range	-	130.4

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)	Depth (m)	Flow (l/s)
0.100	12.7	0.800	181.4	2.000	258.1	4.000	362.6	7.000	477.6
0.200	47.0	1.000	183.9	2.200	270.4	4.500	384.3	7.500	494.2
0.300	95.7	1.200	201.0	2.400	282.2	5.000	404.7	8.000	510.1
0.400	149.4	1.400	216.7	2.600	293.5	5.500	424.1	8.500	525.6
0.500	179.5	1.600	231.4	3.000	314.8	6.000	442.7	9.000	540.6
0.600	183.3	1.800	245.1	3.500	339.6	6.500	460.5	9.500	555.3

Appendix E Drainage Strategy Plan



GENERAL NOTES:

1. DO NOT SCALE FROM THIS DRAWING.
2. PROPOSED DRAINAGE LAYOUT SUBJECT TO MASTERPLAN AND DETAILED DRAINAGE DESIGN.
3. TOPOGRAPHICAL SURVEY INFORMATION BY JC WHITE, DRAWING REFERENCE 15/89/18B, DATED SEPTEMBER 2018.

LEGEND:

- SURFACE WATER SOAKAWAY BASIN
- PROPOSED SURFACE WATER SEWER
- PROPOSED FOUL WATER SEWER
- SOAKAWAY BORE HOLE
- STRATEGIC LANDSCAPING AREA
- EASEMENT 13.8m
- PROPOSED SWALE
- EXISTING SURFACE WATER SEWER
- EXISTING FOUL WATER SEWER
- EXISTING FOUL WATER SEWER
- DEVELOPMENT A
- DEVELOPMENT B
- DEVELOPMENT C
- DEVELOPMENT D
- DEVELOPMENT E

DEVELOPMENT AREAS

- DEVELOPMENT AREA 25.1 Ha
- DEVELOPMENT AREA 14.0 Ha
- DEVELOPMENT AREA 11.1 Ha

Mark	Revision	Date	Drawn	Chk'd	App'd
C	UPDATED MASTERPLAN AND STORAGE VOLUMES	06.12.18	AH	CD	
B	SURFACE WATER AREAS UPDATED	12.11.18	AP	CD	
A	CONTOUR INFORMATION SHOWN	08.11.18	AP	CD	

SCALING NOTE: Do not scale from this drawing. If in doubt, ask.

Drawing Issue Status:

CONCEPT

PUMP FARM, LOWER RAINHAM DRAINAGE STATEGY

Client

A.C. GOATHAM & SON

Date of 1st Issue	Designed	Drawn
31.10.2018	-	AP
A1 Scale	Checked	Approved
1:2000	CD	CD

Drawing Number: 44538/2001/001

Revision: C

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