THE TRIANGLE, GREAT BARTON

Flood Risk Assessment and Outline Surface Water Drainage Strategy

Prepared for: Montagu Evans LLP

DRAFT

PRELIMINARY REPORT - FOR INFORMATION PURPOSES ONLY

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BASIS OF REPORT

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1.0 Introduction

1.1 Context

SLR Consulting Limited (SLR) was commissioned by Montagu Evans LLP (the client), to undertake a Flood Risk Assessment (FRA) and Outline Surface Water Drainage Strategy (SWDS) for land known as The Triangle, Great Barton, Burys St Edmunds, IP31 2NP ("the site").

This FRA has been prepared by SLR Consulting Ltd (SLR), under the direction of a Principal Hydrologist of SLR who specialises in flood risk and associated planning matters. Reporting has been completed in accordance with guidance presented within the National Planning Policy Framework[1] (NPPF) and its associated Planning Practice Guidance[2] (PPG), taking due account of current best practice documents relating to assessment of flood risk published by the British Standards Institution BS8533[3].

1.2 Site Location

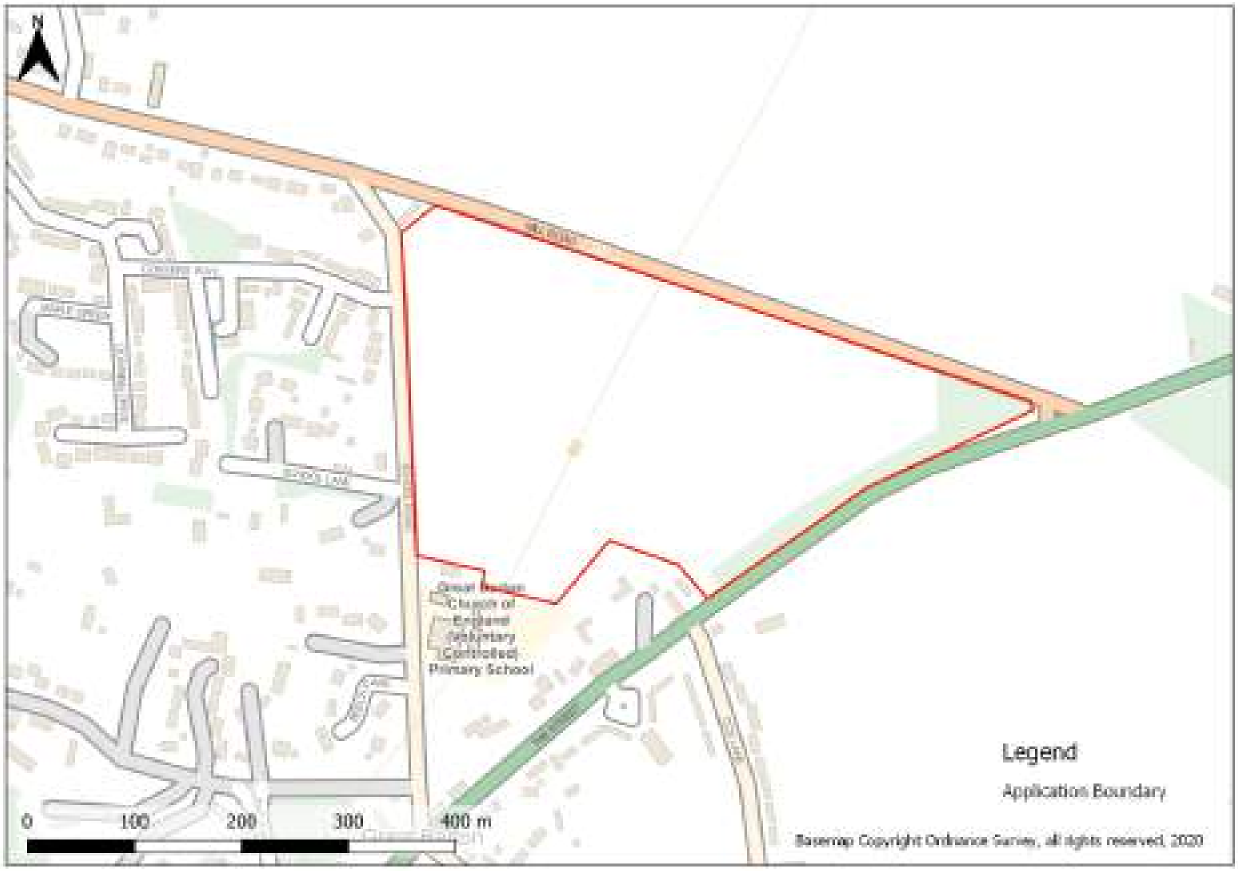
The site is situated in Great Barton to the northeast of Bury St Edmunds and is centred at National Grid Reference (NGR) 589360 267399. A site location plan showing the likely application boundary is provided in Figure 1-1. The site comprises farmland and covers an area of approximately 12.4ha.

1 National Planning Policy Framework: Communities and Local Government (Updated February 2019)

2 Planning Practice Guidance: Communities and Local Government (Updated October 2018)

3 BS8533:2017, Assessing and managing flood risk in development: Code of Practice (December 2017)

Figure 1-1
Site Location Plan



1.3 Administrative Context

The proposed development site is located within an area under the administration of West Suffolk District Council who act as the planning authority and will deal with any future planning applications for the site.

Suffolk County Council are the Lead Local Flood Authority (LLFA) who deal with issues relating to drainage and flood risk from localised sources.

1.4 Development Proposals

The site is currently owned by Suffolk County Council (SCC) and is used as farmland. It benefits from an existing allocation for residential and community use within the adopted local plan[4]. That allocation requires the capacity of the site to be determined through a Development Brief. The Development Plan will be submitted by the end of March 2021.

Thereafter separate planning applications will be submitted initially for a 1.9 ha plot on the western boundary and later on for the rest of the site (10.4 ha). Applications for planning permission will only be determined once the Development Brief has been adopted by the Local Authority.

4 Forest Heath and St Edmundsbury Local Plan, February 2015

While the final layout has not been confirmed the draft Great Barton Neighbourhood Plan includes general elements of residential housing with private gardens, public open space and children's play area, expansion of the primary school and community facilities.

This report is intended to cover issues relating to flood risk and storm water drainage across the entire site. Additional assessments will however subsequently be required in support of the future individual application.

2.0 Site Details

The site, shown in Figure 2-1, is currently undeveloped agricultural land comprised of fields.

The site is bounded to the north by Mill Road beyond which are arable fields. The eastern boundary of the site is a band of woodland and A413 road.

To the south the site is the Great Barton CEVC Primary School and residential housing, with a petrol filling station located approximately 60m south of the site boundary. The boundary of the site to the east is School Road with residential housing within the rest of Great Barton beyond.

Figure 2-1
Aerial Image of Site

2.1 Topography

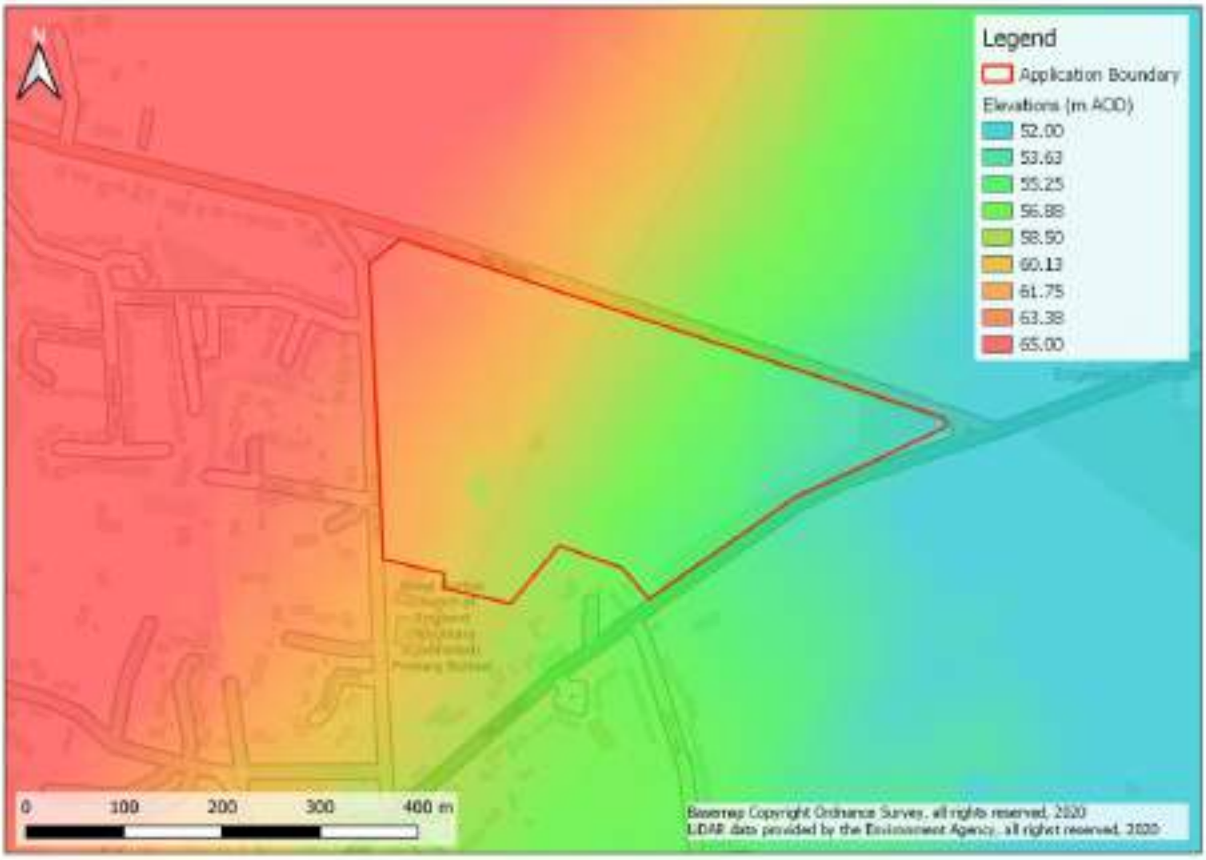
Topographic data for the site and immediate locale has been downloaded from the Environment Agency open data website[5] (refer to Figure 2-2). A topographic survey has also been undertaken for the site and is included as Appendix 01.

This data indicates a general fall to the east across the site. The western boundary of the site is at approximately 64m above Ordnance Datum (AOD) with the lowest point of the site at the eastern boundary is at approximately 52m (AOD).

In the context of the local topography the site lies c.500m to the east of a local high point at roughly 70m AOD.

5 Environment Agency open data website, http://environment.data.gov.uk

Figure 2-2
LiDAR Data for the Local Area



2.2 Geology and Hydrogeology

2.2.1 Geology

British Geology Survey (BGS) mapping[6] indicates the entire site is underlain by solid geology of the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Culver Chalk Formation (undifferentiated).

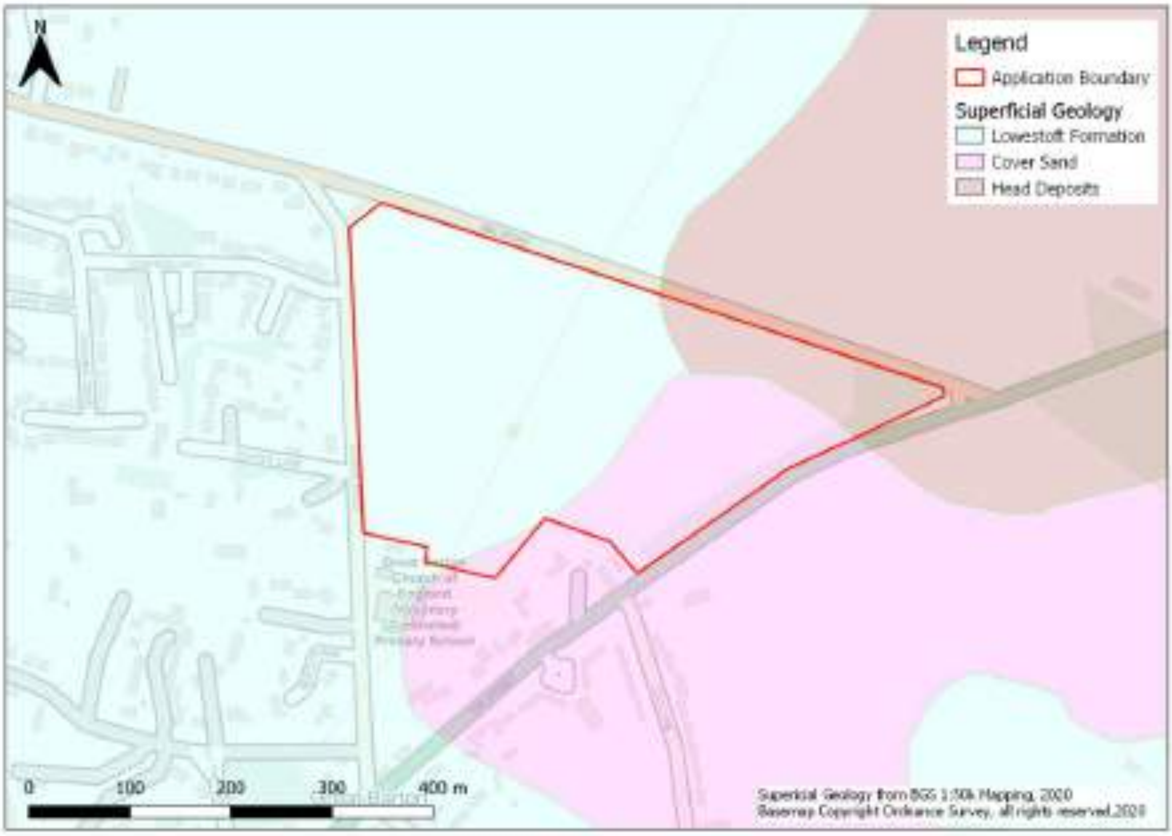
Superficial deposits on site are recorded over the surrounding areas as Lowestoft Formation (diamicton, i.e. unsorted deposits ranging from clay to boulders). Cover sand (wind blown deposits) are shown in the east of the site with head deposits (gravel, sand, silt and clay) present in the north eastern corner, as shown in Figure 2-3.

A historic BGS borehole record[7] located approximately 180m south (BGS Ref TL86NE74) describes the underlying geology as drift over chalk but provides no indication of drift thickness or composition. A second borehole log (BGS Ref TL86NE72) from a well c. 215m to the southwest also shows drift over chalk, again with no indication of drift thickness or composition.

6 BGS Geology of Britain Viewer, Surface Geology available at http://mapapps.bgs.ac.uk/geologyofbritain/home.html

7 BGS Geology of Britain Viewer, Borehole Scans available at http://mapapps.bgs.ac.uk/geologyofbritain/home.html

Figure 2-3
Superficial Geology



2.2.2 Hydrogeology

Superficial deposits, as described above, have variable (low to very high) permeability. The Lowestoft Formation (diamicton) is classified by the Environment Agency[8] as a secondary undifferentiated aquifer which is described as being *'assigned in cases where it has not been possible to attribute either category A or B to a rock type'.* The superficial deposits in the east of the site are a secondary A aquifer defined as *'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers'*. Soils are considered to be '*freely draining slightly acid but base-rich soils'*[9]*.*

The underlying chalk bedrock geology is classified as a principal aquifer, i.e. high permeability providing a high level of water storage and may support water supply / river base flow on a strategic scale. Groundwater flow within the chalk will predominantly be through well connected fractures.

The south western half of the site lies within a Groundwater Source Protection Zone (SPZ)[10] 2 associated with groundwater abstractions located over 2.5km south west of the site. The remainder of the site is within a Source Protection Zone 3 (total catchment). These areas represent the catchment of a potable water supply with the Zone 2 relating to areas where the travel time for groundwater to the point of abstraction is less than 400 days.

The BGS borehole record to the south of the site (BGS Ref TL86NE74), records groundwater being encountered at a depth of around 28.0m below the ground level (bgl). This equates to around 30.0m AOD. The BGS borehole

8 Aquifer Designation Map, https://magic.defra.gov.uk/MagicMap.aspx

9 Soilscapes map, http://www.landis.org.uk/soilscapes/index.cfm

10 Source Protection Zones, https://magic.defra.gov.uk/MagicMap.aspx

to the southwest (BGS RefTL86NE72) encountered at a depth of around 34.0m below the ground level (bgl). This also equates to around 30.0m AOD.

2.3 Local Hydrology

Detailed Ordnance Survey mapping indicates there is a small pond in the central/southern area of the site. During a site walkover conducted on the 17th of November 2020 the pond was found to be dry. The pond area was lined with trees and contained tree growth in the middle with no indication it regularly or has recently contained water.

No other surface water features are present on or within 100m of the site. The nearest surface water feature is an unnamed minor stream roughly 740m to the west of the site. The ditch drains in a westerly and is not hydraulically linked to the site.

There is a series of drains and ponds downgradient and approximately 800m south of the site which discharge to the east then northeast to Pakenham Fen roughly 3km east of the site.

2.4 Existing Site Drainage

The site currently comprises agricultural fields and is situated on largely permeable geology. Rainfall falling on the site will therefore infiltrate into the ground from where it will either be evaporated or will contribute to groundwater recharge.

During extreme prolonged rainfall events it is possible that some water logging at the ground surface could occur particularly in any area where the variable diamicton drift has a lower permeability. Rainfall falling on such area could generate surface water runoff which will follow topographic gradient draining to the east.

As highlighted in Figure 2-4 a number of ditches were identified during a site walkover carried out by SLR on the 17th of November. A ditch was present on the western boundary of the site. This receives runoff from the adjacent School Road and drains to the south discharging to the road drainage network along the A143 (The Street). The ditch was dry during the visit.

There was also a ditch on the eastern boundary of the site which receives road runoff from the A143 (The Street) and drains to the northeast. The southern section of the ditch was dry; however, a small section to the northeast of the site contained standing water. The ditch enters a culvert at the connection of Mill Road and the A143 and continues to drain to the northeast via a ditch adjacent and to the north of the A143. This system, which would receive any surface runoff from the site itself, is believed to ultimately drain to Pakenham Fen.

Figure 2-4
Nearby Drainage Ditches

3.0 Policy Status for Proposed Development

3.1 Development Proposals

The development proposals are for a residential led scheme. At this stage further details are not available.

With reference to Table 2: Flood risk vulnerability classification at PPG Paragraph 066, 'buildings used for dwelling houses' are classified as a '*More Vulnerable*' use.

Under the development types defined within PPG[2] this development would be considered as a '*Residential'* which is classified as a 'more *vulnerable*' development type with respect to flood risk.

In line with PPG and best practice guidance (BS8533), in the absence of more specific information, a 100 year lifetime of development is assumed for residential schemes.

3.2 Planning Context

3.2.1 Planning Policy

National Planning Policy

This preliminary FRA report has been completed in accordance with the guidance presented in the NPPF[1] and with reference to the PPG[2].

Local Planning Policy

The St Edmundsbury Core Strategy[11] sets out the polices and guidance for development of the area. It includes policies to guide development in housing, retail, leisure, employment and community facilities, as well as protection of the natural and historic environment. Sections of Policy CS2 (sustainable development), relating directly to the FRA and Surface Water Drainage Strategy Report are presented below.

> ***Policy C2 Sustainable development***
>
> *F) protecting the quality and availability of water resources;*
>
> *J) incorporating the principles of sustainable design and construction in accordance with recognised appropriate national standards and codes of practice to cover the following themes:*
>
> - *Surface Water Run-off – incorporating flood prevention and risk management measures, such as sustainable urban drainage;*

3.3 Flood Zone Classification

The definition of Environment Agency Flood Zones is provided in PPG *Table 1: Flood Zones*: *Zone 1 - Low Probability* (Flood Zone 1) is defined as land which could be at risk of flooding from fluvial or tidal flood events with less than 0.1% annual probability of occurrence i.e. considered to be at 'low probability' of flooding.

- *Zone 2 - Medium Probability* (Flood Zone 2) is defined as land which could be at risk of flooding with an annual probability of occurrence between 1% and 0.1% from fluvial sources and between 0.5% and 0.1% from tidal sources i.e. considered to be at 'medium probability' of flooding.

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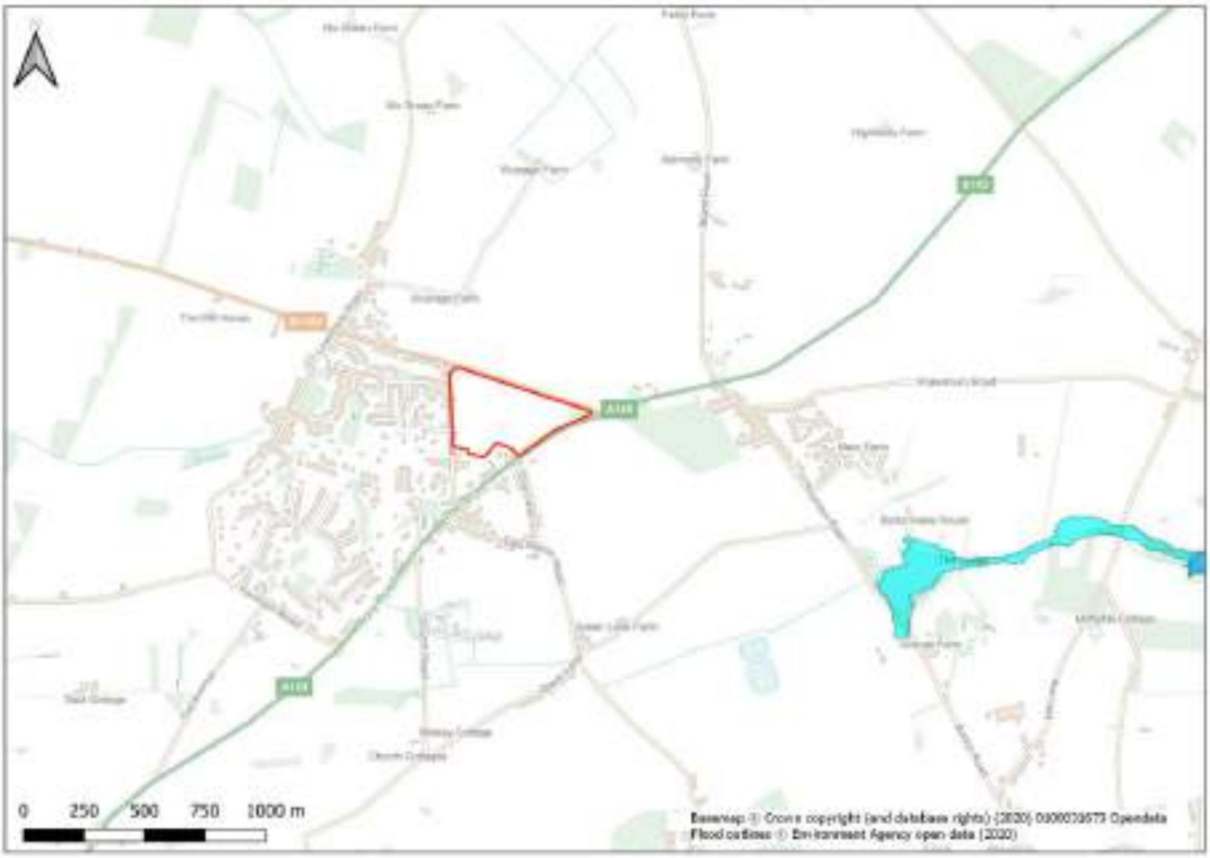
11 West Sussex Council, St Edmundsbury Core Strategy, Adopted December 2010

- *Zone 3a - High Probability* (Flood Zone 3a) is defined as land which could be at risk of flooding with an annual probability of occurrence greater than 1% from fluvial sources and greater than 0.5% from tidal sources i.e. considered to be at 'high probability' of flooding.
- *Zone 3b - the Functional Floodplain* (Flood Zone 3b) is defined as land where water has to flow or be stored in times of flood. Local Planning Authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain in agreement with the Environment Agency. In the absence of definitive information, it is often defined as land that would flood with an annual probability of occurrence of 5% or greater.

Based upon the Environment Agency Flood Map for Planning[12] (Figure 3-1) the entire site lies within Flood Zone 1.

Figure 3-1
Extract of the Environment Agency's Flood Map for Planning



3.4 Climate Change

Consideration of future climate change is included in this report and should be considered over the projected development lifetime.

12 Flood Map for Planning, https://flood-map-for-planning.service.gov.uk/, accessed 13/09/2017

3.4.1 Climate Change Allowances

In 2016 the Environment Agency issued updated guidance on the impacts of climate change on flood risk in the UK[13] to support NPPF. This guidance sets out that peak rainfall intensity, sea level, peak river flow; offshore wind speed and extreme wave heights are all expected to increase in the future as a result of climate change.

The guidance acknowledges that in relation to certain factors there is considerable uncertainty with respect to the absolute level of change that is likely to occur. As such, in these instances, the guidance provides estimates of possible changes that reflect a range of different emission scenarios.

Concerns relating to sea level, offshore wind speed and wave height are really only of relevance in contexts that are in direct proximity to the open coast or tidal river reaches. This is not the case for the site and therefore potential changes for these parameters are not considered further. Similarly allowances for peak river flows are only of relevance in area close to fluvial waterbodies. This is not the case for the site and therefore potential changes for this parameter is also not considered further.

3.4.2 Allowances for Extreme Rainfall

For peak rainfall intensity the guidance states that flood risk assessments should assess both the 'central' and 'upper end' allowances to understand the range of impact. As detailed in Table 3-1, these equate to uplifts of 20% and 40% respectively.

Table 3-1
Peak rainfall intensity allowance in small and urban catchments

River Basin District	Allowance Category	Total potential change anticipated for 2015 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Applies across all of England	Upper End	10%	20%	40%
	Central	5%	10%	20%

In line with Table 3-1, the surface water drainage plan has been developed to take into account increases in rainfall intensity of 40% over the 100 year lifetime of the proposed development.

13 Environment Agency, Flood Risk Assessments: Climate change allowances, 2016 (Updated July 2020)

4.0 Potential Sources of Flooding

4.1 Methodology & Best Practice

This FRA report has been prepared in accordance with the advice and requirements prescribed in current best practice documents relating to management of flood risk in development published by the Construction Industry Research and Information Association (CIRIA)[14], and British Standard BS8533[3].

A screening study has been completed to identify whether there are any potential sources of flooding at the site which may warrant further consideration. If required, any potential significant flooding issues identified in the screening study are then considered in subsequent sections of this assessment.

4.2 Screening Study

Potential sources of flooding include:

- Flooding from the sea or tidal flooding;
- Flooding from rivers or fluvial flooding;
- Flooding from surface water and overland flow;
- Flooding from groundwater;
- Flooding from sewers and mains water systems;
- Flooding from reservoirs, canals, and other artificial sources; and
- Flooding from infrastructure failure.

The flood risk from each of these potential sources is discussed below and summarised in Table 4-1.

4.2.1 Flooding from the Sea or Tidal Flooding

The site is remote from the coast and is elevated more than 50m above sea level.

The risk of flooding from the sea or tidal flooding is assessed to be very low and not considered further.

4.2.2 Flooding from Rivers or Fluvial Flooding

There are no rivers or significant streams at, or in the vicinity of the site, and Environment Agency flood maps indicate that the site lies wholly within Flood Zone 1 which indicates that there is a low probability (less than 0.1% annual chance) of fluvial flooding.

The risk of fluvial flooding is therefore assessed to be very low and is not considered further.

4.2.3 Flooding from Surface Water and Overland Flow

The site is currently fully permeable and the topography (See Figure 2-2) at the site slopes from west to east. Land to the west is raised relative to the site, but a ditch is present along the western site boundary. This ditch would intercept any flows from this upgradient area and convey them southwards and into road drainage system along the AS143 (The Street). The risk of flooding from surface water runoff would be expected to be low.

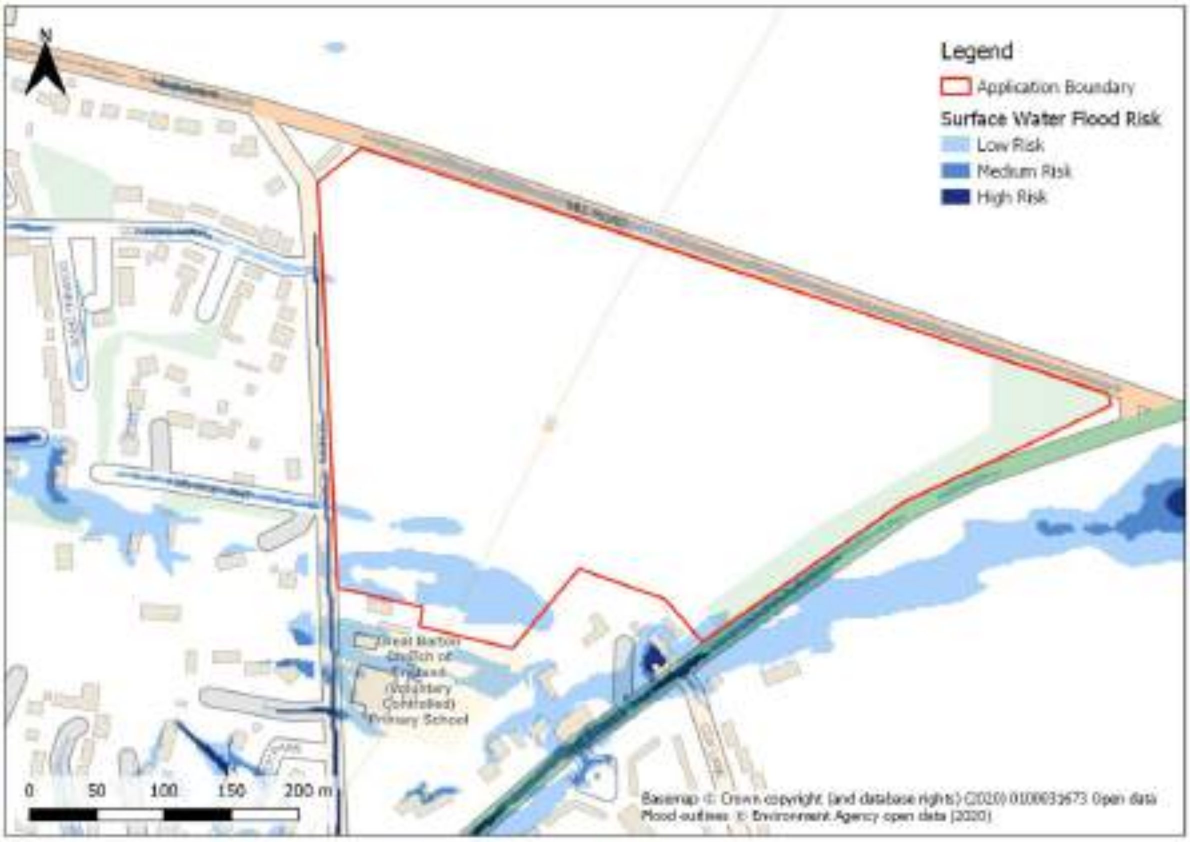
The Environment Agency have undertaken surface water flood mapping and an extract from the surface water flood mapping is reproduced in Figure 4-1. Within this they define the surface water flood risk categories as:

14 CIRIA Report C624, Development and flood risk: guidance for the construction industry

- Very Low: less than 1 in 1,000 chance of flooding in any given year;
- Low: less than 1 in 100 but greater than or equal to 1 in 1,000 chance of flooding in any given year;
- Medium: between 1 in 100 and 1 in 30 chance of flooding in any given year; and
- High: greater than 1 in 30 chance of flooding in any given year.

The mapping, shown in (Figure 4-1) indicates that most of the site is at Very Low risk of flooding. There is a minor surface water flow pathway that traversers the southern section of the site that is predicted during extreme, low probability events. In reality this flow pathway would be intercepted by western boundary drainage ditch and conveyed southwards away from the site. If there were any issues with the receiving drainage network water would flow northeast along the A143 (The Street) and not through the site.

Figure 4-1
Environment Agency Surface Water Flood Map



The Environment Agency also have mapping indicating the depth of flooding from areas identified as being at risk of surface water flooding. The surface water flood depth for the southern area of the site is predicted as less than 0.15m, the lowest depth category considered.

Given the above reasons, the risk of surface water flooding is believed to be very low across the majority of the site. To the south the risk is low and care should be taken that finished floor levels for houses are set at least 150mm above adjacent ground levels / road deck levels. Provided that this is adhered to the risk of surface water flooding to all properties on the site will be very low.

4.2.4 Flooding from Groundwater

Groundwater flooding can be defined as flooding caused by the emergence of water originating from subsurface strata. Groundwater flooding can occur where sites are located on permeable ground. After a prolonged period of rainfall and groundwater recharge, a considerable rise in the water table can results in inundation for extended periods of time.

As identified in Section 2.2.1, the site is underlain by superficial deposits with variable permeability. The bedrock geology is chalk which typically has a high permeability and can be susceptible to groundwater flooding.

As mentioned in Section 2.2.2 BGS boreholes near the site (BGS Ref TL86NE74 and TL86NE72) recorded standing groundwater levels of 28m bgl and 34m bgl respectively.

Regional mapping showing areas of elevated groundwater flood risk is contained within the Suffolk Preliminary Flood Risk Assessment[15]. This coarse mapping does not suggest that the site lies within an area of elevated risk.

Local mapping within the Forest Heath District Council and St Edmundsbury Borough Council Strategic Flood Risk Assessment (SFRA)[16] indicates that there have been four incidents of groundwater flooding that have occurred near the site however none within a roughly 2.5km radius).

A review of the site indicates that there are no topographic or geological features on or adjacent to the site that are likely create a spring or seep.

Taking the above into consideration the risk of flooding from groundwater is assessed to be 'very low' at this site and is not considered further.

4.2.5 Flooding from Sewers and Mains Water Systems

The site is currently undeveloped and is not formally drained. Anglian Water sewer plans (Appendix 02) indicate there are no foul or surface water sewer pipes beneath the site.

There is a foul water sewer beneath School Road that borders the site to the west. The sewer conveys foul water south towards Great Barton Primary School. If this surcharged for any reason flood water would be conveyed along School Road to the south, any overtopping of School Road at the surface water flow pathway to the south of the site would be intercepted by the ditch and routed along the A143 (The Street). There is also a foul sewer beneath the A143 (The Street) to the south of the site. Any surcharged flows would follow topographic gradient and flow northeast along the A143 away from the site.

Taking the above into consideration the risk of flooding from sewers and mains water systems is assessed to be 'low' at this site and is not considered further.

4.2.6 Flooding from Reservoirs, Canals, and other Artificial Sources

Environment Agency mapping[17] indicates that the site does not lie within an area at risk of flooding from the failure (breach) of a reservoir. In addition, there are no canals or other artificial hydrological sources adjacent to or upgradient from the site.

For to the above reasons the risk of flooding from reservoirs, canals, and other artificial sources is not considered further.

4.2.7 Flooding from Infrastructure Failure

Environment Agency mapping indicates that the site does not benefit from flood defence infrastructure and there is no other known infrastructure that protects the site from flooding. Flooding from failure of infrastructure is not considered further.

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15 Suffolk County Council Preliminary Flood Risk Assessment Report, Aecom, 2011, http://www.suffolk.gov.uk/assets/suffolk.gov.uk/Emergency%20and%20Safety/Civil%20Emergencies/SUFFOLKPFRAREPORTFINAL.pdf

16 Forest Heath District Council and St Edmundsbury Borough Council, Level 1 SFRA and Outline Water Cycle Study, June 2009

17 Environment Agency Long Term Flood Risk Map https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

4.3 Summary of Flood Screening

Table 4-1 summarises the flood screening assessment.

Table 4-1
Potential Risk Posed by Flooding Sources

Potential Source	Potential Significant Flood Risk at site?
Sea or Tidal Flooding	No
Rivers or Fluvial Flooding	No
Surface Water and Overland Flow	No
Groundwater	No
Sewers and Water Mains	No
Reservoirs, Canals and other Artificial Sources	No
Infrastructure Failure	No

5.0 Surface Water Drainage Statement

This chapter details the opportunities and constraints for discharging surface water at the site, offering a conceptual recommendation for the future development.

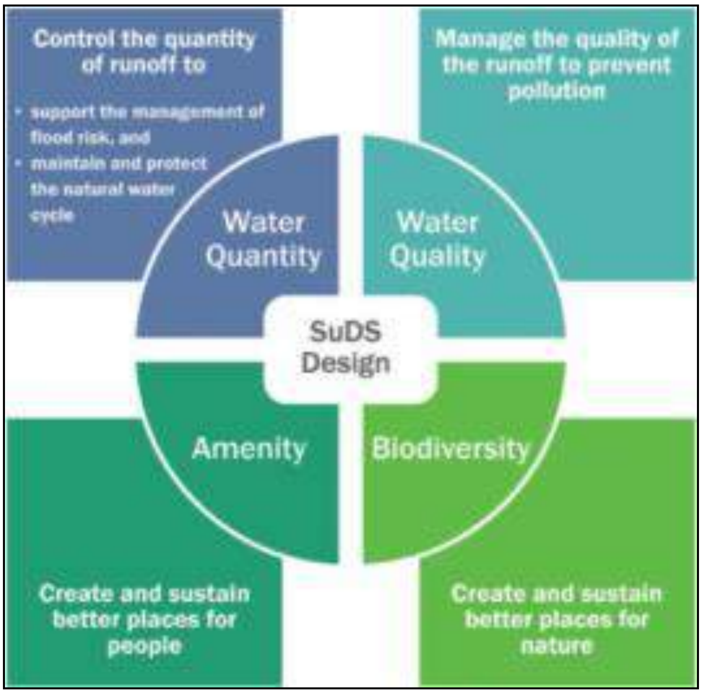
More detailed drainage design will then be undertaken at the planning stage in line with the basic concepts outlined within this chapter. Finally, at the post planning stage, full drainage infrastructure designs will be prepared and submitted to the Suffolk County Council, in their role as Lead Local Flood Authority (LLFA), for approval.

5.1 Key Principles of Surface Water Management

5.1.1 Overview

Current best practice guidance document; The Sustainable Drainage System (SuDS) Manual (CIRIA Report C753)[18], promotes sustainable water management through the use of SuDS. There are four main categories of SuDS which are referred to as the 'four pillars of SuDS design' as depicted in Figure 5-1.

Figure 5-1
Four Pillars of SuDS (extract from CIRIA Report C753)



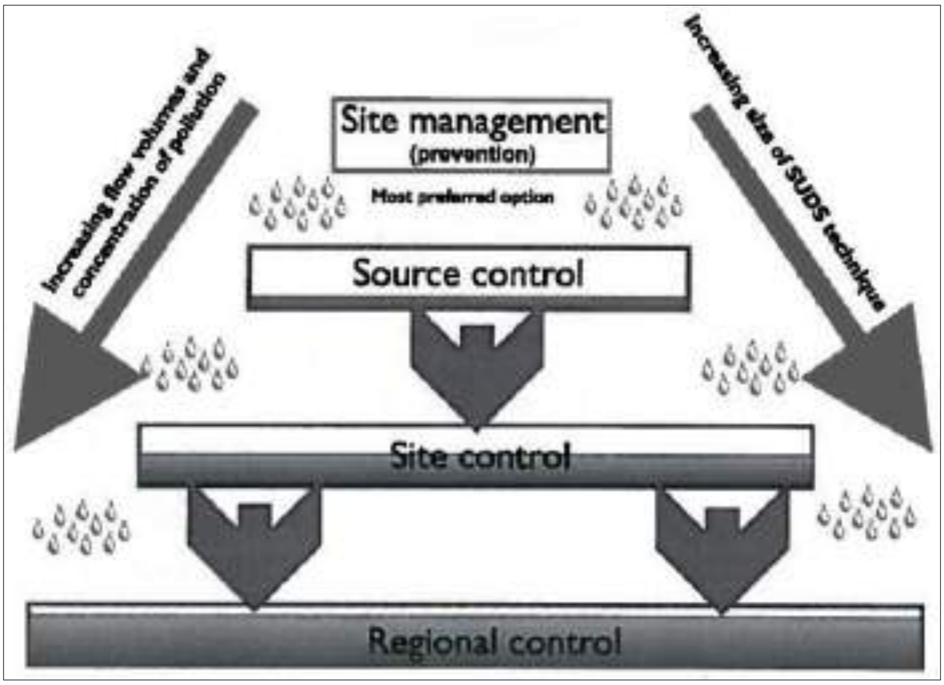
The SuDS Manual identifies a hierarchy of SuDS for managing runoff, which is commonly referred to as a 'management train'. The hierarchy of techniques is identified as:

- **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing).
- **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting).

18 Report C753, The SuDS Manual; CIRIA (2015). Report C753, November 2015.

- **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site).
- **Regional Control** – management of runoff from several sites, typically in a retention pond or wetland.

Figure 5-2
SuDS Management Train



It is generally accepted that the implementation of SuDS, as opposed to conventional drainage systems, provides a number of benefits by:

- Reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- Reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;
- Improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- Reducing potable water demand through rainwater harvesting;
- Improving amenity through the provision of public open spaces and wildlife habitat; and replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

5.1.2 National Policy Context

Current national planning policy guidance and best practice, namely NPPF and PPG, require development proposals in all flood zones to seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of SuDS.

5.1.3 Local Policy Context

Suffolk County Council in their role as LLFA has published guidance relating to surface water drainage[19]. Some of the key principles stated in this document are;

> *"Since April 2016, planning applications for all major development should be accompanied by a site-specific drainage strategy that demonstrates that the proposed drainage scheme is compliant with the National Planning Policy Framework, Planning Practice Guidance and DEFRA Technical Standards."*

The document also specifies that;

> *"The guiding principles for SuDS in Suffolk will be:*
>
> *a) Early consideration of sustainable flood and coastal risk management in production of Local Plans and master planning– promoting and protecting 'blue and green corridors';*
>
> *b) Wherever possible, the use of multifunctional, above ground SuDS that deliver drainage, enhancement of biodiversity, improvements in water quality and amenity benefits;*
>
> *c) Ensuring that land owners realise both the importance of reducing flood risk and how properly designed sustainable drainage systems can be an asset to their development;*
>
> *d) Ensuring no increase in flood risk from new development wherever possible and contributing to reducing existing risk if feasible; and*
>
> *e) Ensuring water flows around properties when the design capacity of drainage systems is exceeded by extreme rainfall.*

5.2 Existing Surface Water Regime

The site is completely undeveloped and rain falling on it currently is either evaporated or contributes to groundwater recharge. Due to the high permeability of the ground conditions it is expected that runoff will be minimal. Only exceptionally, during a major storm when the ground is already saturated, could water ever drain to the east via shallow subsurface flow pathways or over land flow. A drainage ditch on the eastern boundary of the site would collect and convey any runoff that does occur from the site to the northeast. This ditch is however primarily for road runoff.

5.2.1 Influences of Site Drainage

Geology

As discussed in Section 2.2, the site is underlain by solid chalk geology which typically is suitable for discharging surface water to; albeit the depth to the chalk is unknown.

The chalk is overlain by the Lowestoft Formation (diamicton, i.e. unsorted deposits ranging from clay to boulders). Cover sand (wind blown deposits) are shown in the east of the site with head deposits (gravel, sand, silt and clay) present in the north eastern corner. The Cover sand is likely to have a suitable permeability to support infiltration whereas the Lowestoft Formation and the Head deposits are likely to have a variable permeability. The depths of the deposits at the site are currently not known.

Sewer plans (Appendix 02) indicate there are no surface water sewers near the site which suggests infiltration techniques are used locally.

For these reasons, infiltration techniques are likely to be suitable at this site.

19 Surrey County Council Sustainable Drainage Systems (SuDS) Local Design Guide, Appendix A to Suffolk Flood Risk Management Strategy, May 2018

Watercourses

There are no watercourses at or within the vicinity of the site to which a connection could be made. There is a drainage ditches at the eastern boundary of the site and during the site walkover (winter after a wet period) these were found to be dry.

Topography

As discussed in Section 2.1 the site slopes to the east to where Mill Road joins the A143. Where infiltration is the final discharge then SuDS features should be located to the east of potential runoff areas. If discharge to the ditch is required, then below ground attenuation features should be kept at a suitable depth to ensure gravity drainage.

Sewers

There are no surface water sewers near the site. There is a combined sewer to the west of the site beneath School Road which continues to the south of the site beneath the A143 as far as the petrol station. A connection to the combined sewer could be feasible however a large section in the east of the site would be at a lower elevation than the sewer and gravity drainage may not be possible (invert levels not included in sewer plans).

5.2.2 Discharge Receptor

With reference to the SuDS Manual, the hierarchy of preferred disposal options for surface water runoff from development sites in decreasing order of sustainability is:

- Infiltration to Ground;
- Discharge to Surface Waters; or
- Discharge to Sewer.

Table 5-1 summarises the suitability of disposal methods in the context of the site and the proposed development.

Table 5-1
Suitability of Surface Water Disposal Methods

Disposal Method (in Order of Preference)	Suitability Description	Method Suitable? (Y / N)
Infiltration to Ground	With reference to Section 2.2.2 the site is underlain by permeable chalk bedrock geology which is likely to have a suitable permeability for infiltration of surface water. Superficial deposits across the site are likely to have a variable permeability however Cover sand to the east should be suitable for infiltration. In addition, the absence of surface water sewers indicates infiltration may be a preferential discharge method locally.	Y
Discharge to Surface Waters	There are no watercourses within 100m of the site; however, there is a ditch on the eastern boundary of the site (Figure 2-4) to which a connection could be made.	Y
Discharge to Sewer	A combined sewer is located to the west and south of the site to which a connection could be made. The eastern part of the site is at significantly lower elevations than the sewer and a gravity discharge may not be possible.	N

Based on the information in Table 5-1 the drainage hierarchy set out in guidance would require storm water runoff to be discharged to the ground. Intrusive investigations including infiltration testing will however be required to confirm that this is feasible.

If ultimately discharge to the ground were found to not be possible discharge to the ditch on the eastern site boundary at a low attenuated rate would be necessary.

5.3 Proposed Surface Water Disposal

It is proposed that the surface water run-off from the site will be managed within the confines of the site for up to and including the 1% AEP (1in 100) storm event with an uplift of 40% for climate change. In advance of the outcome of infiltration results, two different surface water management schemes are proposed.

5.4 Preferred Solution

It is proposed that all surface water runoff from the site is infiltrated via a suitable storage structure such as geo-cellular storage crates or a series of soakaways, depending on preferential infiltration depths. Where possible infiltration features will be located downgradient from development ensuring that any possible exceedance routes do not pose a threat to dwellings.

5.4.1 Infiltration Rates

Based on the underlying geology of the site infiltration is the preferred surface water disposal method. Currently at the outline drainage design stage infiltration testing has not been carried out. To help develop a conceptual surface water management plan for the site, infiltration rates have been acquired from a desk-based study.

The West Suffolk Planning portal[20] was used to find planning applications from a nearby development that included infiltration testing results within similar geology to the site. While there were no infiltration results identified within close proximity of the site, testing was undertaken for an application (DC/19/1599/FUL) for the development of Hopkins Homes Headquarters[21], Suffolk Business Park, Bury St Edmunds approximately 3km from the site.

A summary of the infiltration testing results from the desk-based study are included in Table 5-2. The geology at the test location is recorded as Lowestoft Formation underlain by chalk which is the same as the majority of the Great Barton site. Similarly to the site, the Hopkins Homes proposed development area is located where Lowestoft drift deposits meet Cover sand.

Three trial pits were dug at different depths with testing occurring in different strata. The minimum infiltration rate was from testing conducted in the predominantly Diamicton deposits of 2.2×10^{-6}.

Table 5-2
Desk Based Study on Infiltration Rates

Test Location	Strata	Depth (m bgl)	Infiltration Rate (m/sec)
TP01	Sand and Gravel	2.0 – 3.0	1.4×10^{-4}
TP04	Diamicton + Sand and Gravel	2.3 – 3.5	1.3×10^{-4}
TP08A	Diamicton	0.1 – 1.5	2.2×10^{-6}

20 West Suffolk Planning Portal, https://planning.westsuffolk.gov.uk/online-applications/simpleSearchResults.do?action=firstPage, Accessed 23/11/2020

21 Rossi Long, Flood Risk Assessment and Flood Risk and Drainage Strategy on Hopkins Homes Headquarters, Suffolk Business Park, Bury St Edmunds, July 2019

5.4.2 SuDS Attenuation Requirements

Based on a conservative infiltration rate of 2.2 x10^{-6} high level calculations using Microdrainage Quick Storage Estimate, included as Appendix 03, indicate that the maximum storage volume would be in the region of 5,540m^3 to hold excess flows. The Quick Storage Estimate consider one large feature and accounts for infiltration occurring from both the sides and base of the structure and. A series of smaller features would likely be used at the site which would result in a greater surface area and an increase in infiltration potential. With typical infiltration features of 1.5m deep this would result in a maximum area of 3,693m^2 which is roughly 3% of the total site area. Such features could however be flexibly sited around the site and as such would have minimal impact on the overall site layout.

This is based on an assumed total impermeable development area on the site of 4.19ha (40% of total site area) and is assessed for the 1 in 100 annual probability storm with a 40% uplift to account for climate change over the development lifetime (design storm).

5.4.3 Pollution control

As mentioned is Section 2.2.2 the site is located within groundwater source protection Zone II – Outer Protection Zone and the chalk is a Principal Aquifer which and is described as *"a major aquifer with 'Medium to High' groundwater vulnerability"*.

Guidance from the SuDS manual[22] on precaution of infiltration to vulnerable groundwater states that

> *"In England and Wales, where the discharge is to protected surface waters or groundwater, an additional treatment component (i.e. over and above the required standard for discharges), or other equivalent protection, is required that provides environmental protection in the event of an unexpected pollution event or poor system performance. Protected groundwater resources are defined as Source Protection Zone 1."*

The site is not located in Source Protection Zone 1. However, as a precautionary approach runoff from new areas of carparking will be passed via a filter drain or permeable paving prior to discharging to the ground via soakaways or geo-cellular crates. This will reduce the risk of contamination of groundwater. Filter drains and permeable paving will also be utilised if the fallback drainage option of discharging to the ditch is progressed.

SuDS provide a number of water quality benefits and the arrangements for a new development should typically provide some treatment and for an area where runoff could be polluted (i.e. road and car park) at least two stages of the SuDS 'management train' (in line with SuDS Manual guidance). This will be achieved for this scheme as described below:

- Soakaways – A subterranean structure with associated void storage that allows surface water to infiltrate into the underlying sub-base layers before discharging from the base.
- Filter Drain – Sits above the geo-cellular crate and separates oil from polluted the stormwater as it drains through the device. Acts to prevents the oil from polluting the groundwater.

The simple index method as outlined within the SuDS Manual provides a way of quantifying the benefit to water quality of the SuDS Management Train. The pollution hazard from the land use and the mitigation from the SUDS component are each assigned an index. The total mitigation index must be greater than the pollution hazard index for adequate treatment to be delivered.

Total SuDS mitigation index ≥ pollution hazard index

(for each contaminant type) (for each containment type)

22 CIRIA SuDS Manual 2015 (Accessed February 2019)

The total SuDS mitigation is the summation of the first components mitigation index and half the mitigation index of any subsequent component.

With reference to the SuDS Manual, post-development surface water runoff generated from residential roofs and low traffic roads is considered to have a 'very low' and 'low' *Pollution Hazard Level* respectively as presented in Table 5-3.

Table 5-3
Pollution Hazard Potential for Proposed Development

Land Use	Pollution Hazard Level	Pollution Hazard Indices		
		Total Suspended Solids (TSS)	*Metals*	*Hydro-Carbons*
Residential Roofs	Very Low	0.2	0.2	0.05
Low Traffic Roads	Low	0.5	0.4	0.4

The mitigation indices are shown in Table 5-4.

Table 5-4
Pollution Mitigation Indices for Proposed Development

Type of SuDS Component	Mitigation Indices		
	Total Suspended Solids (TSS)	*Metals*	*Hydro-Carbons*
Filter drain above / upgradient of soakaway[1]	0.7	0.6	0.7
Soakaway[2]	0.4	0.4	0.4

1 Modelled as "Pervious pavement underlain by 300 mm minimum depth of soils with good contamination attenuation potential"

2 Modelled as "Infiltration trench with suitable depth of filtration material underlain by 300 mm minimum depth of soils with good contamination attenuation potential "

Table 5-5 compares the *SuDS Mitigation Indices*, against the *Pollution Hazard Indices* for the preferred and fallback solution respectively. In line with guidance the *SuDS Mitigation Indices* for the tiered system is calculated based on the value for the first tier plus 50% of any subsequent tiers.

Table 5-5
SuDS Performance: Water Quality Indices Assessment

Land Use	Pollution Hazard Level	*Pollution Hazard and SuDS Mitigation Indices Comparison*					
		Total Suspended Solids (TSS)		*Metals*		*Hydro-Carbons*	
		Pollution Index	SuDS Mitigation Index	Pollution Index	SuDS Mitigation Index	Pollution Index	SuDS Mitigation Index
Residential Roofs	Very Low	0.2	0.4[1]	0.2	0.4[1]	0.05	0.4[1]
Low Traffic Roads	Low	0.5	0.9[2]	0.2	0.8[2]	0.05	0.9[2]

Notes: 1 Soakaway only
2 Permeable paving then soakaway

As the *SuDS Mitigation Index* provided by the proposed SuDS measures are ≥ *Pollution Hazard Index* the water quality assessment criteria are satisfied. If the fallback method is chosen permeable paving and filter drains would provide sufficient mitigation to satisfy the water quality assessment criteria for discharging to surface waters.

5.5 Fallback Solution

If following testing, infiltration rates are found to be too low for the preferred strategy to function, then a backup solution will be implemented. This will involve the provision of a series of ponds and wetland features to receive and control storm flows from the site. These attenuation features would be located to the east (i.e. downgradient) of areas of development and would drain to the existing eastern boundary ditch at a low controlled rate. Features would also be unlined to allow some infiltration losses; however, this would not be relied upon.

5.5.1 SuDS Attenuation Requirements

Based on ReFH 2 the median (QBAR – 1 in 2 annual probability) greenfield runoff rate for the site is estimated to be 4.3l/s (0.34l/s/ha). This is relatively low and reflects the permeable geology and soil cover at the site. Results from the greenfield runoff calculations are included as Appendix 04.

If discharge from the site were restricted to this rate, a high level Quick Storage Estimate (Appendix 03) indicates that the maximum storage volume required would be in the region of 6,618m^3.

This is based on an assumed total impermeable development area on the site of 4.19ha (40% of total site area) and is assessed for the 1 in 100 annual probability storm with a 40% uplift to account for climate change over the development lifetime.

For a scheme of this size attenuation would have to be provided within above ground attenuation features such as ponds. Typically, a pond or wetland would be designed to contain a rise in water level of no more than 1.5m from storm water which would require an area of 4,412m^2; however smaller water level and a larger plan area will allow for greater ecological and amenity benefit at and around the features.

If there is a limit on available open space for above ground features a proportion of the storage could be facilitated by features such as permeable paving and below ground geo-cellular storage crates. Further work will clearly be required to further define these and ensure that sufficient storage is available in each area of the site.

The ditch on the eastern boundary of the site is large and would have sufficient capacity to convey attenuated flows from the site which would be lower than peak runoff rates from the current site. If the fallback method is progressed a survey and calculations would be carried out to confirm this.

5.5.2 Pollution control

The simple index method is used to quantify the benefit to water quality of the SuDS Management Train. With reference to the SuDS Manual, post-development surface water runoff generated from residential roofs and low traffic roads is considered to have a 'very low' and 'low' *Pollution Hazard Level* respectively as presented in Table 5-3.

Table 5-6
Pollution Hazard Potential for Proposed Development

Land Use	Pollution Hazard Level	Pollution Hazard Indices		
		Total Suspended Solids (TSS)	*Metals*	*Hydro-Carbons*
Residential Roofs	Very Low	0.2	0.2	0.05
Low Traffic Roads	Low	0.5	0.4	0.4

The mitigation indices are shown in Table 5-4.

Table 5-7
Pollution Mitigation Indices for Proposed Development

Type of SuDS Component	Mitigation Indices		
	Total Suspended Solids (TSS)	*Metals*	*Hydro-Carbons*
Pond	0.7	0.7	0.5

Table 5-5 compares the *SuDS Mitigation Indices*, against the *Pollution Hazard Indices* for the preferred and fallback solution respectively. In line with guidance the *SuDS Mitigation Indices* for the tiered system is calculated based on the value for the first tier plus 50% of any subsequent tiers.

Table 5-8
SuDS Performance: Water Quality Indices Assessment

Land Use	Pollution Hazard Level	*Pollution Hazard and SuDS Mitigation Indices Comparison*					
		Total Suspended Solids (TSS)		*Metals*		*Hydro-Carbons*	
		Pollution Index	SuDS Mitigation Index	Pollution Index	SuDS Mitigation Index	Pollution Index	SuDS Mitigation Index
Residential Roofs	Very Low	0.2	0.7[1]	0.2	0.7[1]	0.05	0.5[1]
Low Traffic Roads	Low	0.5	0.7[2]	0.2	0.7[2]	0.05	0.5[2]

Notes: 1 Pond

As the *SuDS Mitigation Index* provided by the proposed SuDS measures are ≥ *Pollution Hazard Index* the water quality assessment criteria are satisfied. If the fallback method is chosen permeable paving and filter drains would provide sufficient mitigation to satisfy the water quality assessment criteria for discharging to surface waters.

5.6 Design Exceedance Arrangement

In the low probability event of a blockage or exceedance of the capacity of the site drainage systems, water will be routed via the road network along topographic gradient to the eastern boundary of the site to the existing drain. Any exceedance of the capacity of the attenuation features would flow northeast via the drain away from the site without posing a risk to the development or other built development locally.

This will be detailed in a drawing after the development proposals have been confirmed.

5.7 Maintenance

Responsibility for management and maintenance of the infiltration features and all other parts of the site drainage network will fall to a site management company who will manage and maintain the long-term integrity and function of the proposed SuDS facilities. This can be secured by way of an appropriately worded planning condition, if required by the Local Planning Authority.

6.0 Conclusions

SLR Consulting Limited (SLR) has been appointed to complete a Flood Risk Assessment (FRA) and an outline Surface Water Drainage Statement (SWDS) for the land to the north of Great Barton.

Following the completion of this assessment the following conclusions are made:

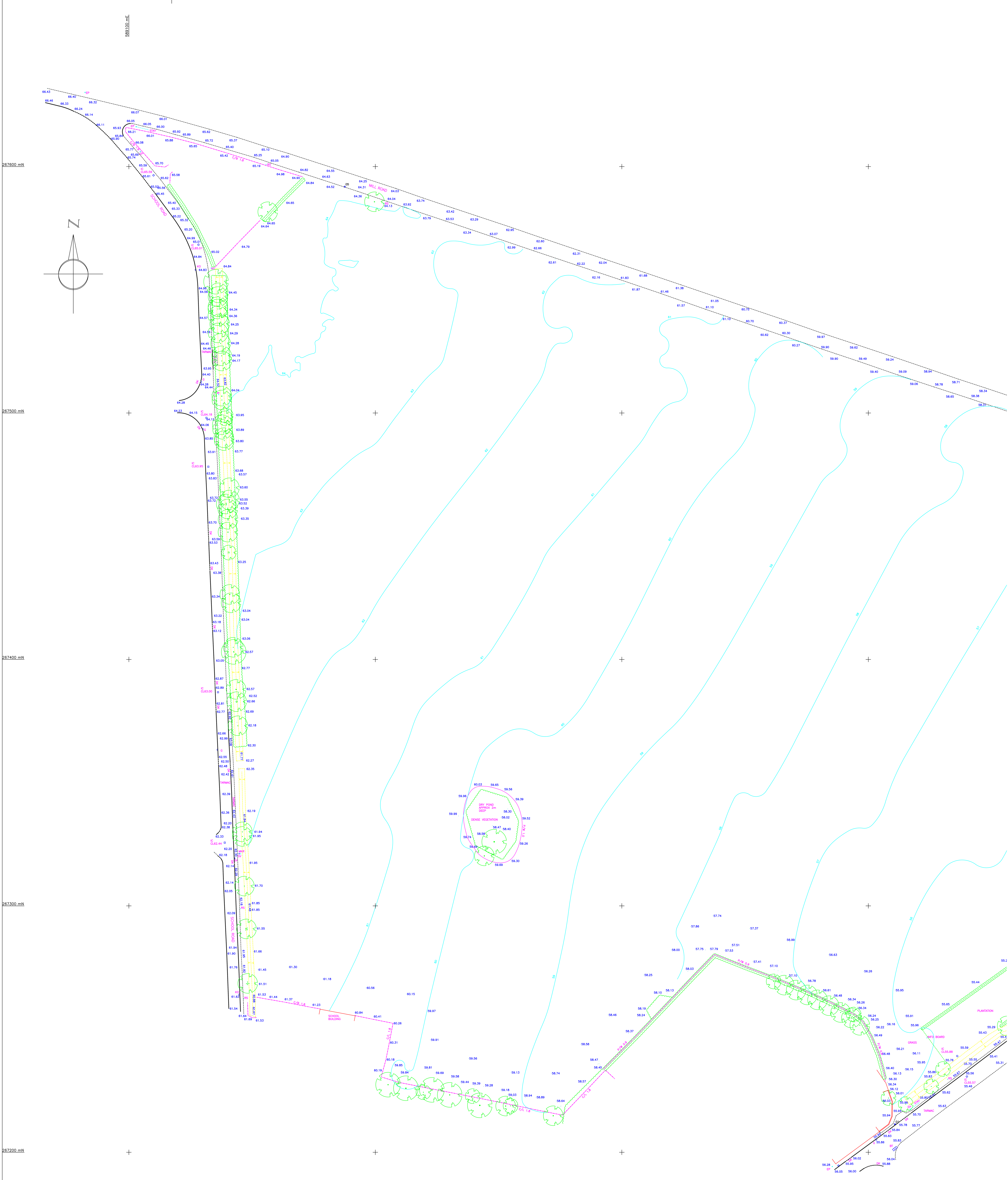
1. The site is located completely within Flood Zone 1, as defined by the Planning Practice Guide. However, as the Site extends to some 12.4ha, a formal Site-specific flood risk assessment has been prepared as required under the National Planning Policy Framework.
2. Following a review of a broad range of potential sources, it is concluded that the proposed development would not be at significant risk of flooding. Finished floor levels to the south of the site should however be set at least 150mm above adjacent ground / road levels to provide some additional protection from surface water flooding during extreme low probability events.
3. Changes in flood risk as a result of climate change have been considered in line with national guidance for the lifetime of the development. Climate change is not anticipated to significantly alter the risk of flooding at this site. An increase in the intensity of rainfall as a result of climate change has been included in surface water drainage design.
4. Surface water runoff will be managed within the Site for up to and including the 1 in 100 annual probability event including a 40% climate change uplift.
5. Based on the underlying geology, the absence of surface water sewers in the area, and data for other nearby application with similar geology, traditional infiltration techniques are deemed to be viable. It is therefore proposed that surface water runoff from the site will be infiltrated to ground via soakaways or geo-cellular storage crates.
6. Infiltration testing should be conducted for the site but in the absence of this information rates have been obtained from testing carried out in the local area within similar mapped geology to the site.
7. High level surface water drainage calculations demonstrate that, with a conservative infiltration rate of 2.2×10^{-6}m /s, an infiltration storage volume of 5,540m^3 would be required to allow surface water to drain to the ground without flooding. This would be sufficient for all proposed impermeable areas of the site for up to and including the 1% AEP (1 in 100 year) event including a 40% climate change uplift.
8. If infiltration is not deemed possible then surface water discharge should be made to the existing drainage ditch on the eastern boundary of the site at the QBAR greenfield runoff rate (4.3l/s). It is estimated that approximately 6,618m^3 of storage would be required to attenuate runoff from the development which would need to be provided within a series of surface water features located preferentially to the east of the site

APPENDIX 01

Topographic Survey

REVISIONS				
ZONE	REV	DESCRIPTION	Date	APPROVED

589200 mE 589300 mE 589400 mE



STATION SCHEDULE

01	589410.815	267211.392	55.875	NAIL
02	589533.670	267302.298	54.205	NAIL
03	589767.122	267402.576	52.067	NAIL
04	589613.865	267346.157	53.368	NAIL
05	589187.618	267591.815	64.417	NAIL
06	589464.050	267251.183	55.249	TEMP

LEGEND

SP Sign Post
TP Telegraph Pole
EP Electricity Pole
LP Lamp Post
RS Road Sign
GV Gas Valve
BT Telecom
G Gully
FH Fire Hydrant
SV Stop Valve
IC Inspection Chamber

589100 mE

Sterling Surveys
Brookfield Place
Low Street
Glemsford
Suffolk
CO10 7QF
Phone: 01787 280325
Mobile: 07989 581290
Fax: 07050 650887
E-mail: pw@sterling-surveys.com
www.sterling-surveys.com

Peter Whitney
Land Surveying
Site Engineering

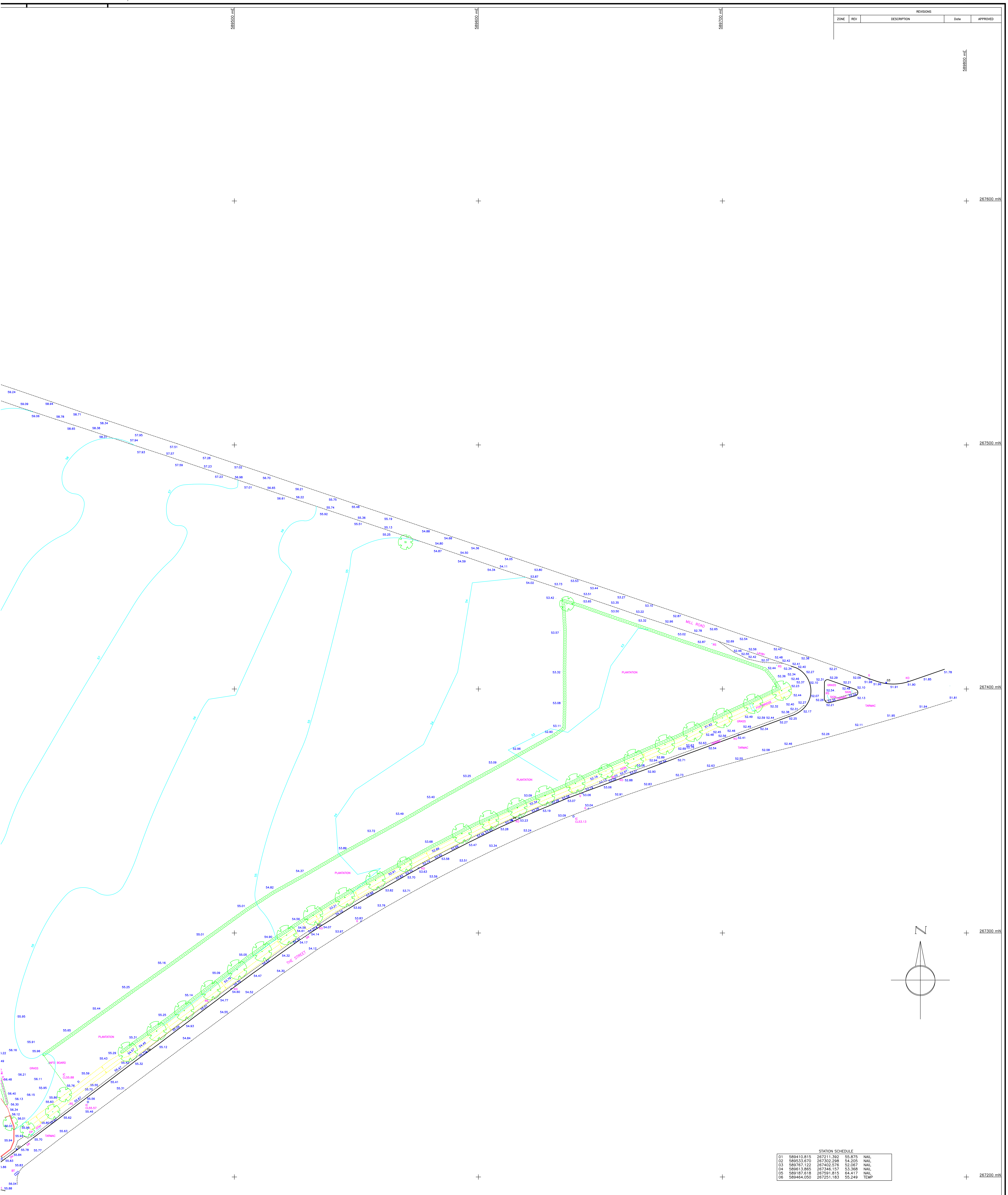
DAP Architecture

TOPOGRAPHIC SURVEY AT THE STREET/MILL ROAD, GT BARTON
SURVEY RELATED TO OS NATIONAL GRID (OSTN15)

SIZE	Date	DWG NO.	REV
A0	OCT 2020	1979−1	

Scale 1:500@A0 | Drawn by PW | Sheet

589200 mE 589300 mE 589400 mE



STATION SCHEDULE

01	589410.815	267211.392	55.875	NAIL
02	589533.670	267302.298	54.205	NAIL
03	589767.122	267402.576	52.067	NAIL
04	589613.865	267346.157	53.368	NAIL
05	589187.618	267591.815	64.417	NAIL
06	589464.050	267251.183	55.249	TEMP

LEGEND

SP	Sign Post
TP	Telegraph Pole
EP	Electricity Pole
LP	Lamp Post
RS	Road Sign
GV	Gas Valve
BT	Telecom
G	Gully
FH	Fire Hydrant
SV	Stop Valve
IC	Inspection Chamber

Sterling Surveys
Brookfield Place
Low Street
Glemsford
Suffolk
CO10 7QF
Phone: 01787 280325
Mobile: 07989 581290
Fax: 07050 650887
E-mail: pw@sterling-surveys.com
www.sterling-surveys.com

Peter Whitney
Land Surveying
Site Engineering

DAP Architecture

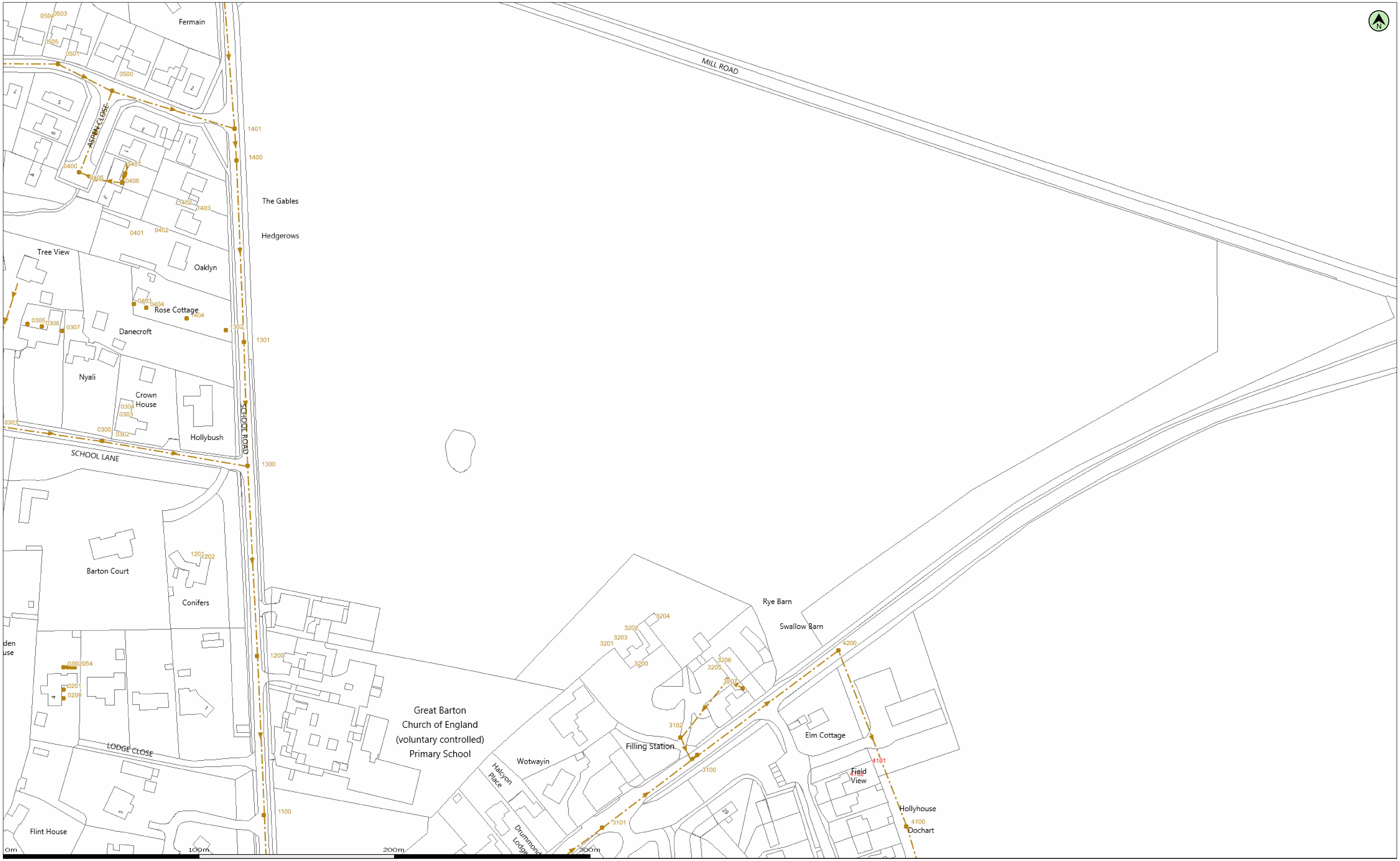
TOPOGRAPHIC SURVEY AT THE STREET/MILL ROAD, GT BARTON
SURVEY RELATED TO OS NATIONAL GRID (OSTN15)

SIZE	Date	DWG NO.	REV
A0	OCT 2020	1979–2	

Scale	Drawn by	Sheet
1:500@A0	PW	

APPENDIX 02

Anglian Water Sewer Plans



(c) Crown copyright and database rights 2020 Ordnance Survey 100022432 | Date: 03/11/20 | Scale: 1:1250 | Map Centre: 589371,267343 | Data updated: 30/09/20 | Our Ref: 454608 - 1 | Wastewater Plan A2

This plan is provided by Anglian Water pursuant its obligations under the Water Industry Act 1991 sections 198 or 199. It must be used in conjunction with any search results attached. The information on this plan is based on data currently recorded but position must be regarded as approximate. Service pipes, private sewers and drains are generally not shown. Users of this map are strongly advised to commission their own survey of the area shown on the plan before carrying out any works. The actual position of all apparatus MUST be established by trial holes. No liability whatsoever, including liability for negligence, is accepted by Anglian Water for any error or inaccuracy or omission, including the failure to accurately record, or record at all, the location of any water main, discharge pipe, sewer or disposal main or any item of apparatus. This information is valid for the date printed. This plan is produced by Anglian Water Services Limited (c) Crown copyright and database rights 2020 Ordnance Survey 100022432.This map is to be used for the purposes of viewing the location of Anglian Water plant only. Any other uses of the map data or further copies is not permitted. This notice is not intended to exclude or restrict liability for death or personal injury resulting from negligence.

Foul Sewer
Surface Sewer
Combined Sewer
Final Effluent
Rising Main*
Private Sewer*
Decommissioned Sewer*

Outfall*
Inlet*
Manhole*

Sewage Treatment Works
Public Pumping Station
Decommissioned Pumping Station
*(Colour denotes effluent type)

fhamblybarton@slrconsulting.com
Great Barton

love every drop
anglianwater

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
0200	F	-	-	-
0201	F	-	-	-
0202	F	-	-	-
0203	F	-	-	-
0204	F	-	-	-
0205	F	-	-	-
0300	F	-	-	-
0305	F	-	-	-
0306	F	-	-	-
0307	F	-	-	-
0400	F	-	-	-
0403	F	-	-	-
0404	F	-	-	-
0405	F	-	-	-
0406	F	-	-	-
0407	F	-	-	-
0500	F	-	-	-
0501	F	-	-	-
1100	F	-	-	-
1200	F	-	-	-
1300	F	-	-	-
1301	F	-	-	-
1302	F	-	-	-
1400	F	-	-	-
1401	F	-	-	-
1404	F	-	-	-
3100	F	-	-	-
3101	F	-	-	-
3102	F	-	-	-
3205	F	-	-	-
3207	F	-	-	-
4100	F	-	-	-
4200	F	-	-	-

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

APPENDIX 03

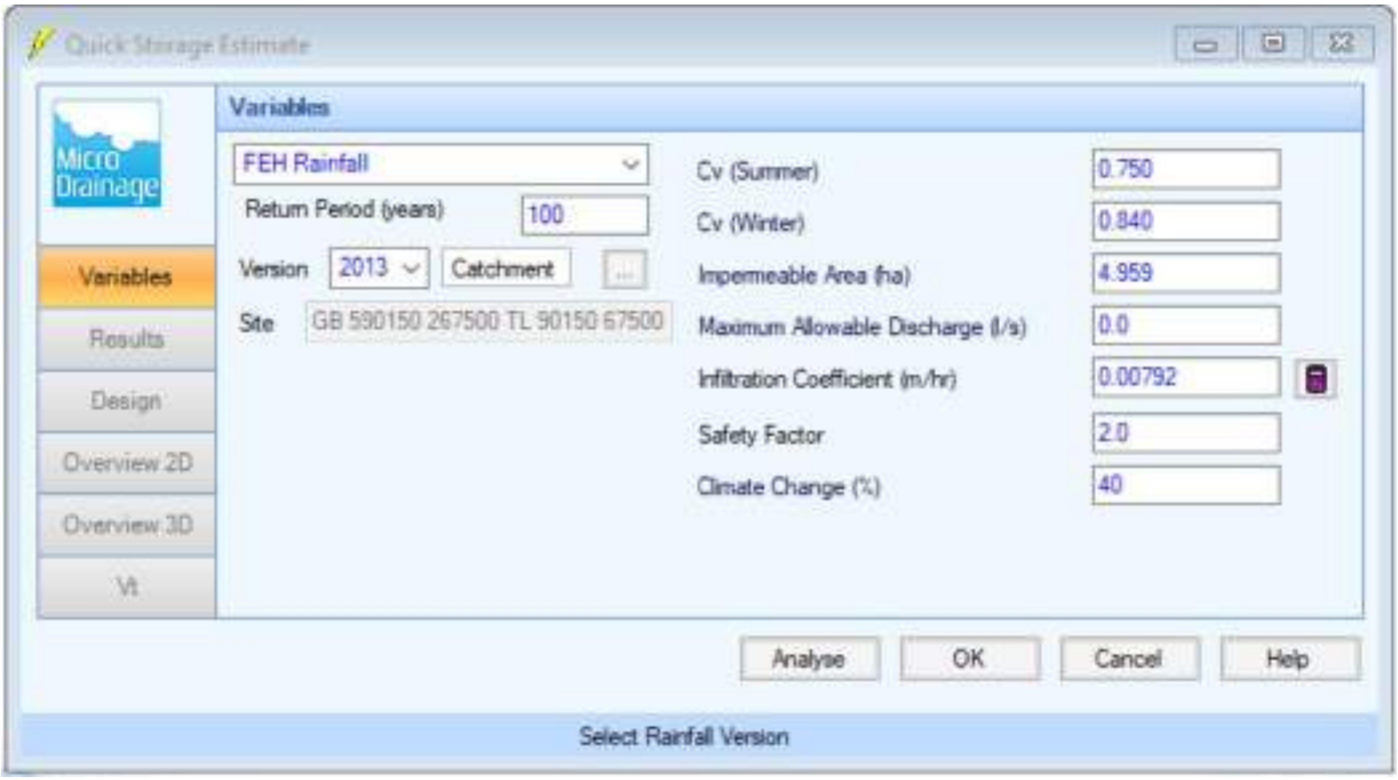
Quick Storage Estimates

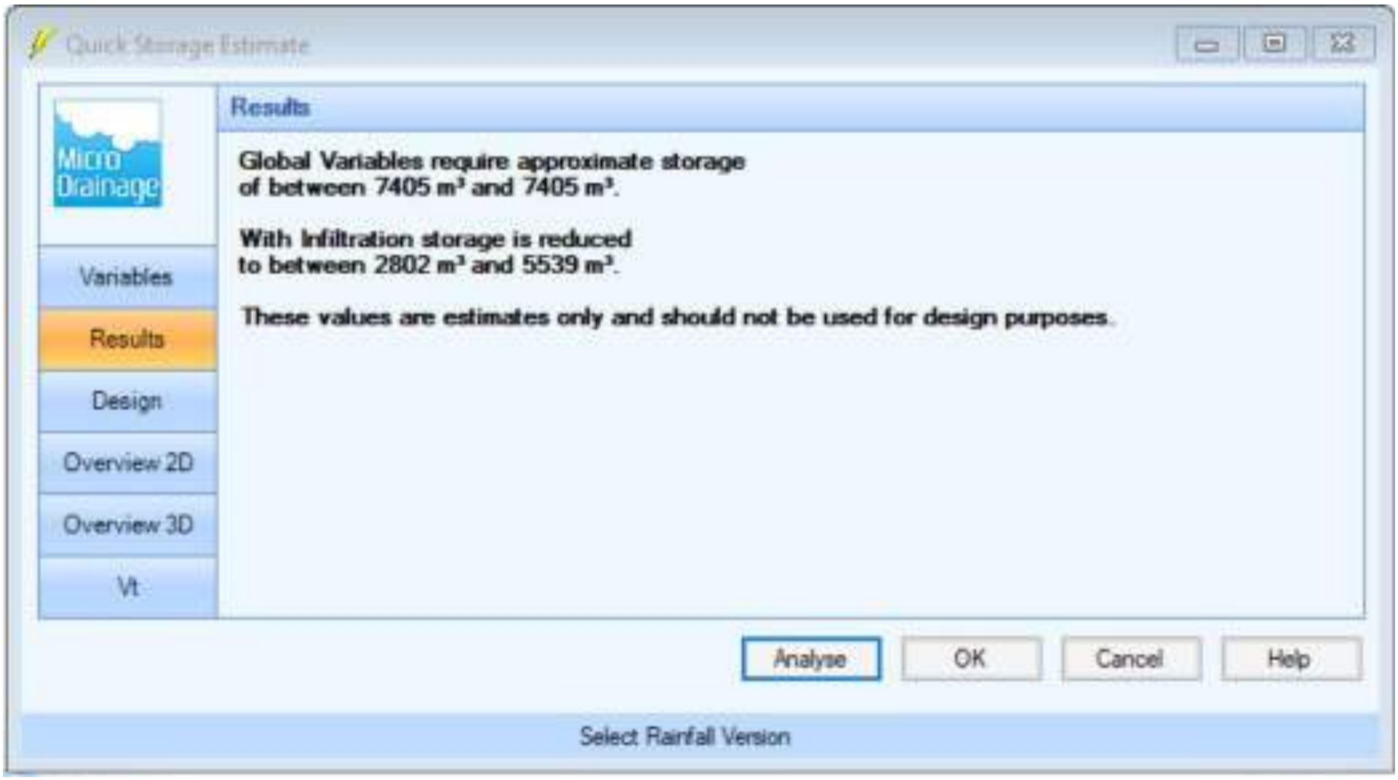
The Triangle, Great Barton: Flood Risk Assessment and Surface Water Drainage Strategy

MicroDrainage Source Control: Quick Storage Estimates

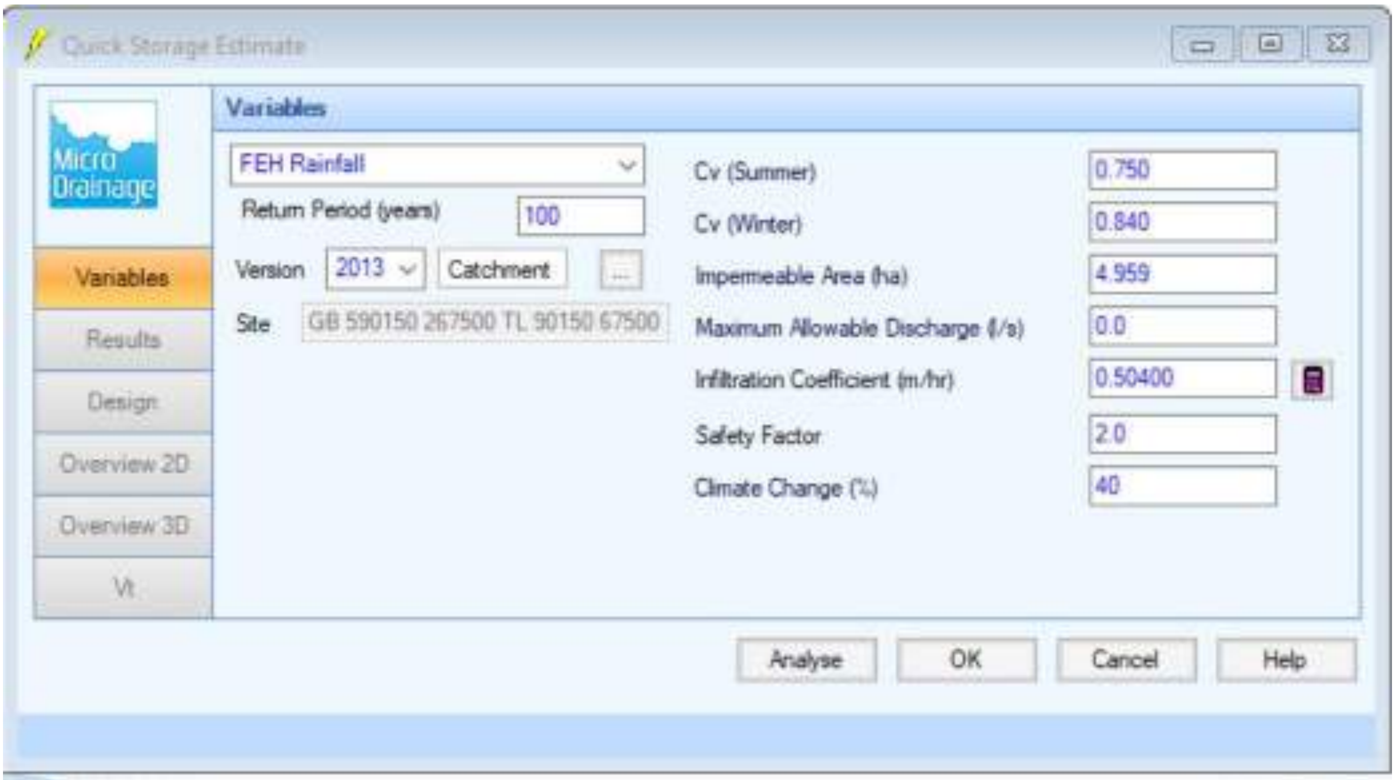
Infiltration results from application (DC/19/1599/FUL) for the development of Hopkins Homes Headquarters, Suffolk Business Park, Bury St Edmunds.

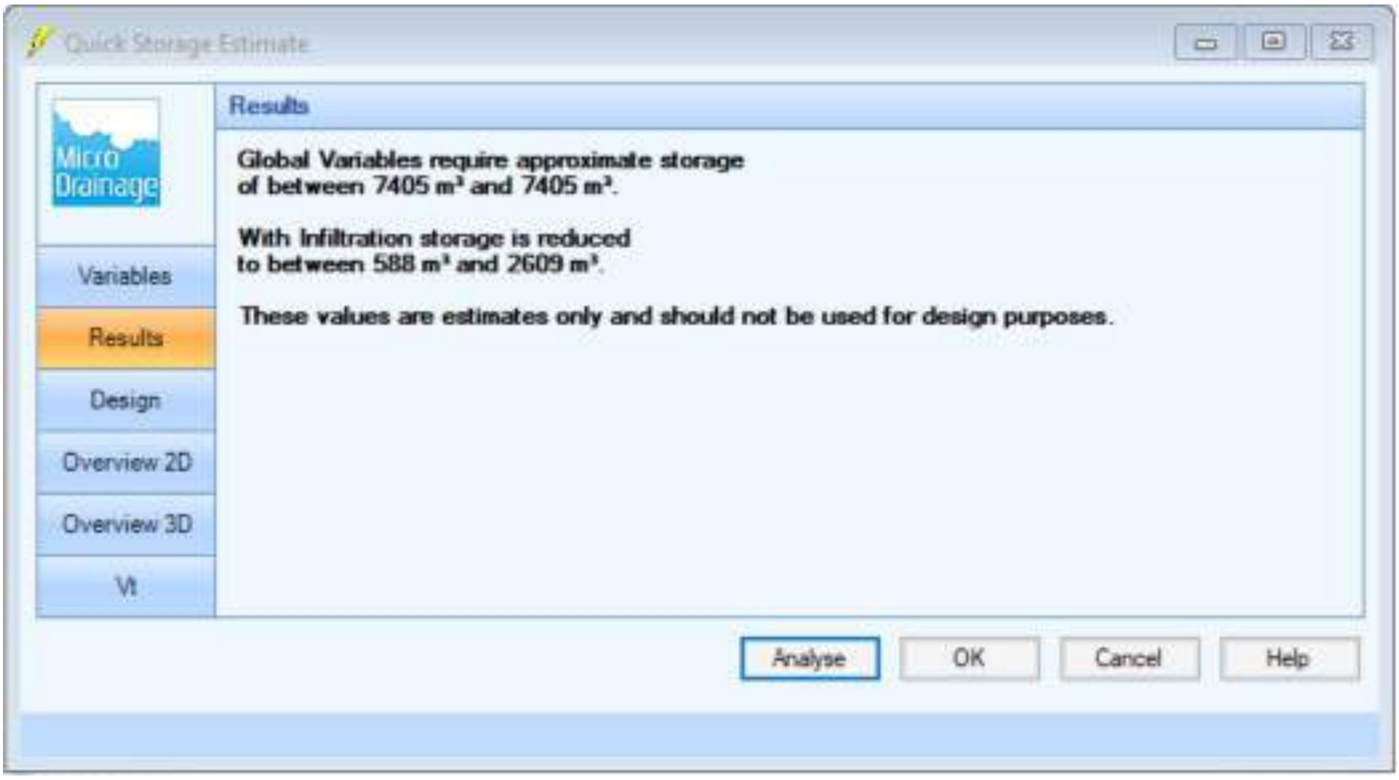
Quick Storage Estimate – Preferred Approach – Infiltration into Diamicton



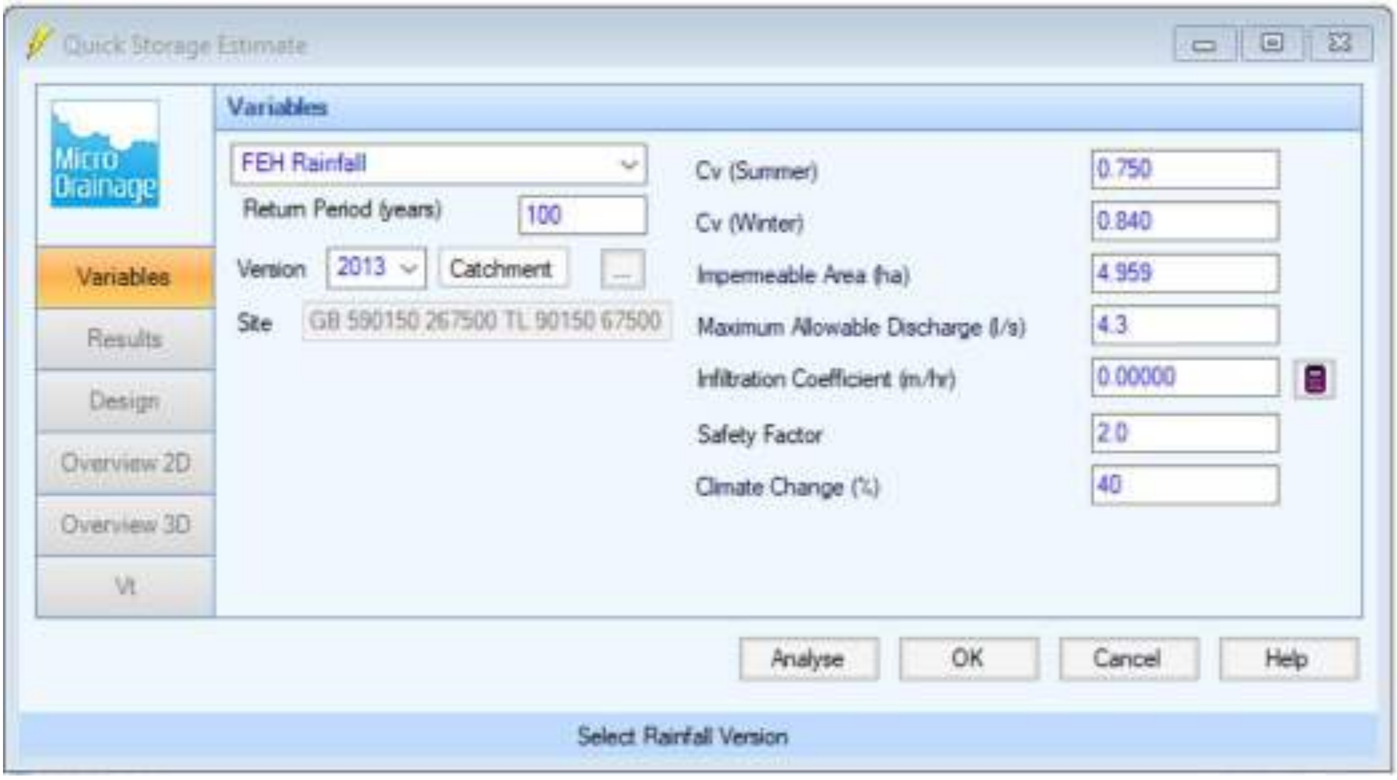


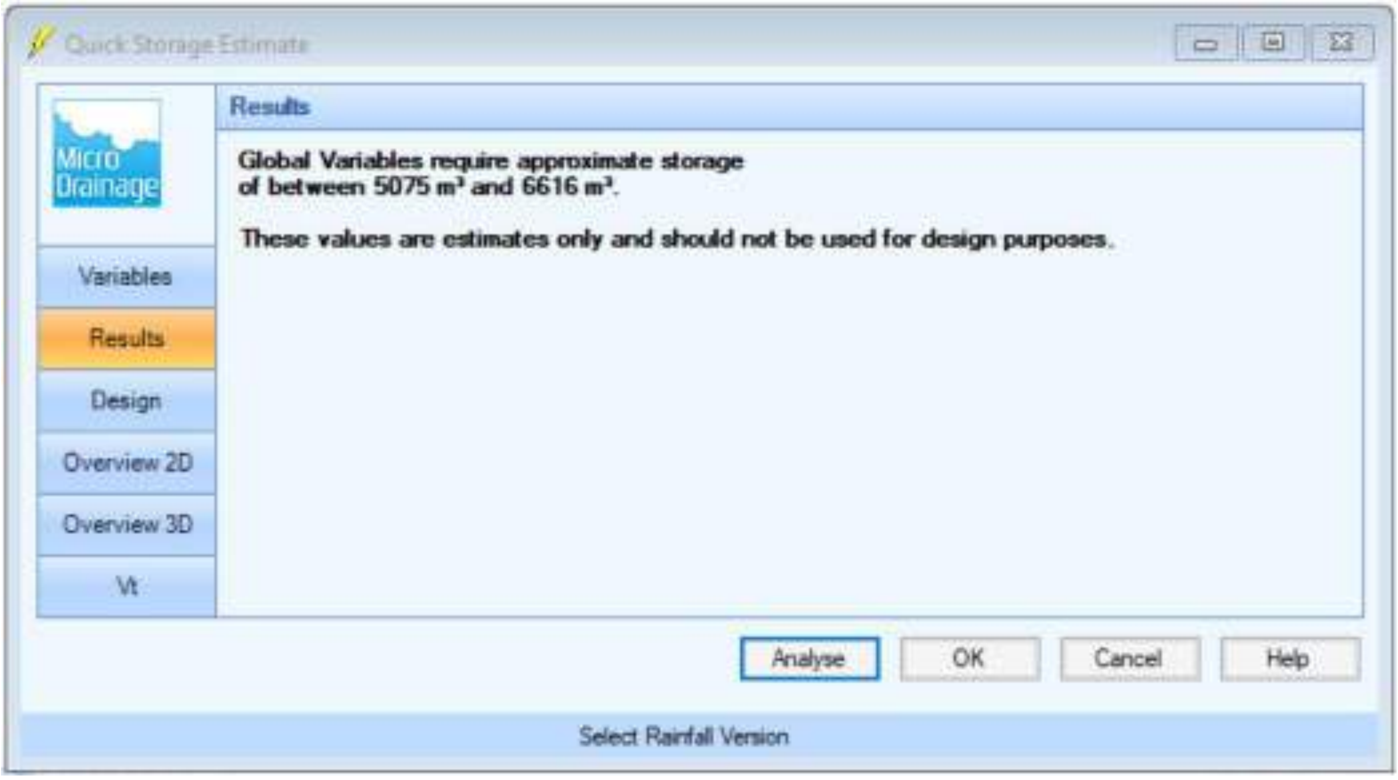
Quick Storage Estimate – Preferred Approach – Infiltration into Cover sand





Quick Storage Estimate – Preferred Approach – Infiltration into Cover sand





APPENDIX 04

ReFH2 Greenfield Runoff Calculations

UK Design Flood Estimation

Generated on 30 November 2020 15:46:18 by fhamblybarton
Printed from the ReFH Flood Modelling software package, version 2.2.7059.19021

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: DCAB-9E01

Site name: FEH_Catchment_Descriptors_590150_267500

Easting: 590150

Northing: 267500

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.12 [0.53]*

Using plot scale calculations: No

Site description: None

Model run: 2 year

Summary of results

Rainfall - FEH 2013 (mm):	24.18	Total runoff (ML):	0.09
Total Rainfall (mm):	15.66	Total flow (ML):	0.28
Peak Rainfall (mm):	3.56	Peak flow (m^3/s):	0.00

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	05:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.65	No
ARF (Areal reduction factor)	0.99	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	54.3	No
Cmax (mm)	1351.91	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	3.34	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	51.73	No
BR	2.38	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0 [0.01]	Yes
Urbext 2000	0 [0.05]	Yes
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.344	0.000	0.014	0.000	0.000	0.000
00:30:00	0.576	0.000	0.023	0.000	0.000	0.000
01:00:00	0.960	0.000	0.040	0.000	0.000	0.000
01:30:00	1.588	0.000	0.067	0.000	0.000	0.000
02:00:00	2.584	0.000	0.113	0.000	0.000	0.000
02:30:00	3.559	0.000	0.164	0.000	0.000	0.000
03:00:00	2.584	0.000	0.125	0.001	0.000	0.001
03:30:00	1.588	0.000	0.079	0.001	0.000	0.001
04:00:00	0.960	0.000	0.049	0.002	0.000	0.002
04:30:00	0.576	0.000	0.030	0.002	0.000	0.003
05:00:00	0.344	0.000	0.018	0.003	0.000	0.003
05:30:00	0.000	0.000	0.000	0.003	0.000	0.004
06:00:00	0.000	0.000	0.000	0.004	0.000	0.004
06:30:00	0.000	0.000	0.000	0.004	0.000	0.004
07:00:00	0.000	0.000	0.000	0.004	0.001	0.004
07:30:00	0.000	0.000	0.000	0.004	0.001	0.004
08:00:00	0.000	0.000	0.000	0.003	0.001	0.004
08:30:00	0.000	0.000	0.000	0.003	0.001	0.004
09:00:00	0.000	0.000	0.000	0.003	0.001	0.003
09:30:00	0.000	0.000	0.000	0.002	0.001	0.003
10:00:00	0.000	0.000	0.000	0.002	0.001	0.003
10:30:00	0.000	0.000	0.000	0.002	0.001	0.003
11:00:00	0.000	0.000	0.000	0.001	0.001	0.002
11:30:00	0.000	0.000	0.000	0.001	0.001	0.002
12:00:00	0.000	0.000	0.000	0.001	0.001	0.002
12:30:00	0.000	0.000	0.000	0.001	0.001	0.002
13:00:00	0.000	0.000	0.000	0.001	0.001	0.002
13:30:00	0.000	0.000	0.000	0.001	0.001	0.002
14:00:00	0.000	0.000	0.000	0.000	0.001	0.001
14:30:00	0.000	0.000	0.000	0.000	0.001	0.001
15:00:00	0.000	0.000	0.000	0.000	0.001	0.001
15:30:00	0.000	0.000	0.000	0.000	0.001	0.001
16:00:00	0.000	0.000	0.000	0.000	0.001	0.001
16:30:00	0.000	0.000	0.000	0.000	0.001	0.001
17:00:00	0.000	0.000	0.000	0.000	0.001	0.001

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:30:00	0.000	0.000	0.000	0.000	0.001	0.001
18:00:00	0.000	0.000	0.000	0.000	0.001	0.001
18:30:00	0.000	0.000	0.000	0.000	0.001	0.001
19:00:00	0.000	0.000	0.000	0.000	0.001	0.001
19:30:00	0.000	0.000	0.000	0.000	0.001	0.001
20:00:00	0.000	0.000	0.000	0.000	0.001	0.001
20:30:00	0.000	0.000	0.000	0.000	0.001	0.001
21:00:00	0.000	0.000	0.000	0.000	0.001	0.001
21:30:00	0.000	0.000	0.000	0.000	0.001	0.001
22:00:00	0.000	0.000	0.000	0.000	0.001	0.001
22:30:00	0.000	0.000	0.000	0.000	0.001	0.001
23:00:00	0.000	0.000	0.000	0.000	0.001	0.001
23:30:00	0.000	0.000	0.000	0.000	0.001	0.001
24:00:00	0.000	0.000	0.000	0.000	0.001	0.001
24:30:00	0.000	0.000	0.000	0.000	0.001	0.001
25:00:00	0.000	0.000	0.000	0.000	0.001	0.001
25:30:00	0.000	0.000	0.000	0.000	0.001	0.001
26:00:00	0.000	0.000	0.000	0.000	0.001	0.001
26:30:00	0.000	0.000	0.000	0.000	0.001	0.001
27:00:00	0.000	0.000	0.000	0.000	0.001	0.001
27:30:00	0.000	0.000	0.000	0.000	0.001	0.001
28:00:00	0.000	0.000	0.000	0.000	0.001	0.001
28:30:00	0.000	0.000	0.000	0.000	0.001	0.001
29:00:00	0.000	0.000	0.000	0.000	0.001	0.001
29:30:00	0.000	0.000	0.000	0.000	0.001	0.001
30:00:00	0.000	0.000	0.000	0.000	0.001	0.001
30:30:00	0.000	0.000	0.000	0.000	0.001	0.001
31:00:00	0.000	0.000	0.000	0.000	0.001	0.001
31:30:00	0.000	0.000	0.000	0.000	0.001	0.001
32:00:00	0.000	0.000	0.000	0.000	0.001	0.001
32:30:00	0.000	0.000	0.000	0.000	0.001	0.001
33:00:00	0.000	0.000	0.000	0.000	0.001	0.001
33:30:00	0.000	0.000	0.000	0.000	0.001	0.001
34:00:00	0.000	0.000	0.000	0.000	0.001	0.001
34:30:00	0.000	0.000	0.000	0.000	0.001	0.001
35:00:00	0.000	0.000	0.000	0.000	0.001	0.001

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:30:00	0.000	0.000	0.000	0.000	0.001	0.001
36:00:00	0.000	0.000	0.000	0.000	0.001	0.001
36:30:00	0.000	0.000	0.000	0.000	0.001	0.001
37:00:00	0.000	0.000	0.000	0.000	0.001	0.001
37:30:00	0.000	0.000	0.000	0.000	0.001	0.001
38:00:00	0.000	0.000	0.000	0.000	0.001	0.001
38:30:00	0.000	0.000	0.000	0.000	0.001	0.001
39:00:00	0.000	0.000	0.000	0.000	0.001	0.001
39:30:00	0.000	0.000	0.000	0.000	0.001	0.001
40:00:00	0.000	0.000	0.000	0.000	0.001	0.001
40:30:00	0.000	0.000	0.000	0.000	0.001	0.001
41:00:00	0.000	0.000	0.000	0.000	0.001	0.001
41:30:00	0.000	0.000	0.000	0.000	0.001	0.001
42:00:00	0.000	0.000	0.000	0.000	0.001	0.001
42:30:00	0.000	0.000	0.000	0.000	0.001	0.001
43:00:00	0.000	0.000	0.000	0.000	0.001	0.001
43:30:00	0.000	0.000	0.000	0.000	0.001	0.001
44:00:00	0.000	0.000	0.000	0.000	0.001	0.001
44:30:00	0.000	0.000	0.000	0.000	0.001	0.001
45:00:00	0.000	0.000	0.000	0.000	0.001	0.001
45:30:00	0.000	0.000	0.000	0.000	0.001	0.001
46:00:00	0.000	0.000	0.000	0.000	0.001	0.001
46:30:00	0.000	0.000	0.000	0.000	0.001	0.001
47:00:00	0.000	0.000	0.000	0.000	0.001	0.001
47:30:00	0.000	0.000	0.000	0.000	0.001	0.001
48:00:00	0.000	0.000	0.000	0.000	0.001	0.001
48:30:00	0.000	0.000	0.000	0.000	0.001	0.001
49:00:00	0.000	0.000	0.000	0.000	0.001	0.001
49:30:00	0.000	0.000	0.000	0.000	0.001	0.001
50:00:00	0.000	0.000	0.000	0.000	0.001	0.001
50:30:00	0.000	0.000	0.000	0.000	0.000	0.000
51:00:00	0.000	0.000	0.000	0.000	0.000	0.000
51:30:00	0.000	0.000	0.000	0.000	0.000	0.000
52:00:00	0.000	0.000	0.000	0.000	0.000	0.000
52:30:00	0.000	0.000	0.000	0.000	0.000	0.000
53:00:00	0.000	0.000	0.000	0.000	0.000	0.000

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
53:30:00	0.000	0.000	0.000	0.000	0.000	0.000
54:00:00	0.000	0.000	0.000	0.000	0.000	0.000
54:30:00	0.000	0.000	0.000	0.000	0.000	0.000
55:00:00	0.000	0.000	0.000	0.000	0.000	0.000
55:30:00	0.000	0.000	0.000	0.000	0.000	0.000
56:00:00	0.000	0.000	0.000	0.000	0.000	0.000
56:30:00	0.000	0.000	0.000	0.000	0.000	0.000
57:00:00	0.000	0.000	0.000	0.000	0.000	0.000
57:30:00	0.000	0.000	0.000	0.000	0.000	0.000
58:00:00	0.000	0.000	0.000	0.000	0.000	0.000
58:30:00	0.000	0.000	0.000	0.000	0.000	0.000
59:00:00	0.000	0.000	0.000	0.000	0.000	0.000
59:30:00	0.000	0.000	0.000	0.000	0.000	0.000
60:00:00	0.000	0.000	0.000	0.000	0.000	0.000
60:30:00	0.000	0.000	0.000	0.000	0.000	0.000
61:00:00	0.000	0.000	0.000	0.000	0.000	0.000
61:30:00	0.000	0.000	0.000	0.000	0.000	0.000
62:00:00	0.000	0.000	0.000	0.000	0.000	0.000
62:30:00	0.000	0.000	0.000	0.000	0.000	0.000
63:00:00	0.000	0.000	0.000	0.000	0.000	0.000
63:30:00	0.000	0.000	0.000	0.000	0.000	0.000
64:00:00	0.000	0.000	0.000	0.000	0.000	0.000
64:30:00	0.000	0.000	0.000	0.000	0.000	0.000
65:00:00	0.000	0.000	0.000	0.000	0.000	0.000
65:30:00	0.000	0.000	0.000	0.000	0.000	0.000
66:00:00	0.000	0.000	0.000	0.000	0.000	0.000
66:30:00	0.000	0.000	0.000	0.000	0.000	0.000
67:00:00	0.000	0.000	0.000	0.000	0.000	0.000
67:30:00	0.000	0.000	0.000	0.000	0.000	0.000
68:00:00	0.000	0.000	0.000	0.000	0.000	0.000
68:30:00	0.000	0.000	0.000	0.000	0.000	0.000
69:00:00	0.000	0.000	0.000	0.000	0.000	0.000
69:30:00	0.000	0.000	0.000	0.000	0.000	0.000
70:00:00	0.000	0.000	0.000	0.000	0.000	0.000
70:30:00	0.000	0.000	0.000	0.000	0.000	0.000
71:00:00	0.000	0.000	0.000	0.000	0.000	0.000

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
71:30:00	0.000	0.000	0.000	0.000	0.000	0.000
72:00:00	0.000	0.000	0.000	0.000	0.000	0.000
72:30:00	0.000	0.000	0.000	0.000	0.000	0.000
73:00:00	0.000	0.000	0.000	0.000	0.000	0.000
73:30:00	0.000	0.000	0.000	0.000	0.000	0.000
74:00:00	0.000	0.000	0.000	0.000	0.000	0.000
74:30:00	0.000	0.000	0.000	0.000	0.000	0.000
75:00:00	0.000	0.000	0.000	0.000	0.000	0.000
75:30:00	0.000	0.000	0.000	0.000	0.000	0.000
76:00:00	0.000	0.000	0.000	0.000	0.000	0.000
76:30:00	0.000	0.000	0.000	0.000	0.000	0.000
77:00:00	0.000	0.000	0.000	0.000	0.000	0.000
77:30:00	0.000	0.000	0.000	0.000	0.000	0.000
78:00:00	0.000	0.000	0.000	0.000	0.000	0.000
78:30:00	0.000	0.000	0.000	0.000	0.000	0.000
79:00:00	0.000	0.000	0.000	0.000	0.000	0.000
79:30:00	0.000	0.000	0.000	0.000	0.000	0.000
80:00:00	0.000	0.000	0.000	0.000	0.000	0.000
80:30:00	0.000	0.000	0.000	0.000	0.000	0.000
81:00:00	0.000	0.000	0.000	0.000	0.000	0.000
81:30:00	0.000	0.000	0.000	0.000	0.000	0.000
82:00:00	0.000	0.000	0.000	0.000	0.000	0.000
82:30:00	0.000	0.000	0.000	0.000	0.000	0.000
83:00:00	0.000	0.000	0.000	0.000	0.000	0.000
83:30:00	0.000	0.000	0.000	0.000	0.000	0.000
84:00:00	0.000	0.000	0.000	0.000	0.000	0.000
84:30:00	0.000	0.000	0.000	0.000	0.000	0.000
85:00:00	0.000	0.000	0.000	0.000	0.000	0.000
85:30:00	0.000	0.000	0.000	0.000	0.000	0.000
86:00:00	0.000	0.000	0.000	0.000	0.000	0.000
86:30:00	0.000	0.000	0.000	0.000	0.000	0.000
87:00:00	0.000	0.000	0.000	0.000	0.000	0.000
87:30:00	0.000	0.000	0.000	0.000	0.000	0.000
88:00:00	0.000	0.000	0.000	0.000	0.000	0.000
88:30:00	0.000	0.000	0.000	0.000	0.000	0.000
89:00:00	0.000	0.000	0.000	0.000	0.000	0.000

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
89:30:00	0.000	0.000	0.000	0.000	0.000	0.000
90:00:00	0.000	0.000	0.000	0.000	0.000	0.000
90:30:00	0.000	0.000	0.000	0.000	0.000	0.000
91:00:00	0.000	0.000	0.000	0.000	0.000	0.000
91:30:00	0.000	0.000	0.000	0.000	0.000	0.000
92:00:00	0.000	0.000	0.000	0.000	0.000	0.000
92:30:00	0.000	0.000	0.000	0.000	0.000	0.000
93:00:00	0.000	0.000	0.000	0.000	0.000	0.000
93:30:00	0.000	0.000	0.000	0.000	0.000	0.000
94:00:00	0.000	0.000	0.000	0.000	0.000	0.000
94:30:00	0.000	0.000	0.000	0.000	0.000	0.000
95:00:00	0.000	0.000	0.000	0.000	0.000	0.000
95:30:00	0.000	0.000	0.000	0.000	0.000	0.000
96:00:00	0.000	0.000	0.000	0.000	0.000	0.000
96:30:00	0.000	0.000	0.000	0.000	0.000	0.000
97:00:00	0.000	0.000	0.000	0.000	0.000	0.000
97:30:00	0.000	0.000	0.000	0.000	0.000	0.000
98:00:00	0.000	0.000	0.000	0.000	0.000	0.000
98:30:00	0.000	0.000	0.000	0.000	0.000	0.000
99:00:00	0.000	0.000	0.000	0.000	0.000	0.000
99:30:00	0.000	0.000	0.000	0.000	0.000	0.000
100:00:00	0.000	0.000	0.000	0.000	0.000	0.000
100:30:00	0.000	0.000	0.000	0.000	0.000	0.000
101:00:00	0.000	0.000	0.000	0.000	0.000	0.000
101:30:00	0.000	0.000	0.000	0.000	0.000	0.000
102:00:00	0.000	0.000	0.000	0.000	0.000	0.000
102:30:00	0.000	0.000	0.000	0.000	0.000	0.000
103:00:00	0.000	0.000	0.000	0.000	0.000	0.000
103:30:00	0.000	0.000	0.000	0.000	0.000	0.000
104:00:00	0.000	0.000	0.000	0.000	0.000	0.000
104:30:00	0.000	0.000	0.000	0.000	0.000	0.000
105:00:00	0.000	0.000	0.000	0.000	0.000	0.000
105:30:00	0.000	0.000	0.000	0.000	0.000	0.000
106:00:00	0.000	0.000	0.000	0.000	0.000	0.000
106:30:00	0.000	0.000	0.000	0.000	0.000	0.000
107:00:00	0.000	0.000	0.000	0.000	0.000	0.000

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
107:30:00	0.000	0.000	0.000	0.000	0.000	0.000
108:00:00	0.000	0.000	0.000	0.000	0.000	0.000
108:30:00	0.000	0.000	0.000	0.000	0.000	0.000
109:00:00	0.000	0.000	0.000	0.000	0.000	0.000
109:30:00	0.000	0.000	0.000	0.000	0.000	0.000
110:00:00	0.000	0.000	0.000	0.000	0.000	0.000
110:30:00	0.000	0.000	0.000	0.000	0.000	0.000
111:00:00	0.000	0.000	0.000	0.000	0.000	0.000
111:30:00	0.000	0.000	0.000	0.000	0.000	0.000
112:00:00	0.000	0.000	0.000	0.000	0.000	0.000
112:30:00	0.000	0.000	0.000	0.000	0.000	0.000
113:00:00	0.000	0.000	0.000	0.000	0.000	0.000
113:30:00	0.000	0.000	0.000	0.000	0.000	0.000
114:00:00	0.000	0.000	0.000	0.000	0.000	0.000
114:30:00	0.000	0.000	0.000	0.000	0.000	0.000
115:00:00	0.000	0.000	0.000	0.000	0.000	0.000
115:30:00	0.000	0.000	0.000	0.000	0.000	0.000
116:00:00	0.000	0.000	0.000	0.000	0.000	0.000
116:30:00	0.000	0.000	0.000	0.000	0.000	0.000
117:00:00	0.000	0.000	0.000	0.000	0.000	0.000
117:30:00	0.000	0.000	0.000	0.000	0.000	0.000
118:00:00	0.000	0.000	0.000	0.000	0.000	0.000
118:30:00	0.000	0.000	0.000	0.000	0.000	0.000
119:00:00	0.000	0.000	0.000	0.000	0.000	0.000
119:30:00	0.000	0.000	0.000	0.000	0.000	0.000
120:00:00	0.000	0.000	0.000	0.000	0.000	0.000
120:30:00	0.000	0.000	0.000	0.000	0.000	0.000
121:00:00	0.000	0.000	0.000	0.000	0.000	0.000
121:30:00	0.000	0.000	0.000	0.000	0.000	0.000
122:00:00	0.000	0.000	0.000	0.000	0.000	0.000
122:30:00	0.000	0.000	0.000	0.000	0.000	0.000
123:00:00	0.000	0.000	0.000	0.000	0.000	0.000
123:30:00	0.000	0.000	0.000	0.000	0.000	0.000
124:00:00	0.000	0.000	0.000	0.000	0.000	0.000
124:30:00	0.000	0.000	0.000	0.000	0.000	0.000
125:00:00	0.000	0.000	0.000	0.000	0.000	0.000

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
125:30:00	0.000	0.000	0.000	0.000	0.000	0.000
126:00:00	0.000	0.000	0.000	0.000	0.000	0.000
126:30:00	0.000	0.000	0.000	0.000	0.000	0.000
127:00:00	0.000	0.000	0.000	0.000	0.000	0.000
127:30:00	0.000	0.000	0.000	0.000	0.000	0.000
128:00:00	0.000	0.000	0.000	0.000	0.000	0.000
128:30:00	0.000	0.000	0.000	0.000	0.000	0.000
129:00:00	0.000	0.000	0.000	0.000	0.000	0.000
129:30:00	0.000	0.000	0.000	0.000	0.000	0.000
130:00:00	0.000	0.000	0.000	0.000	0.000	0.000
130:30:00	0.000	0.000	0.000	0.000	0.000	0.000
131:00:00	0.000	0.000	0.000	0.000	0.000	0.000
131:30:00	0.000	0.000	0.000	0.000	0.000	0.000
132:00:00	0.000	0.000	0.000	0.000	0.000	0.000
132:30:00	0.000	0.000	0.000	0.000	0.000	0.000
133:00:00	0.000	0.000	0.000	0.000	0.000	0.000
133:30:00	0.000	0.000	0.000	0.000	0.000	0.000
134:00:00	0.000	0.000	0.000	0.000	0.000	0.000
134:30:00	0.000	0.000	0.000	0.000	0.000	0.000
135:00:00	0.000	0.000	0.000	0.000	0.000	0.000
135:30:00	0.000	0.000	0.000	0.000	0.000	0.000
136:00:00	0.000	0.000	0.000	0.000	0.000	0.000
136:30:00	0.000	0.000	0.000	0.000	0.000	0.000
137:00:00	0.000	0.000	0.000	0.000	0.000	0.000
137:30:00	0.000	0.000	0.000	0.000	0.000	0.000

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
Area (km^2)	0.12 [0.53]	**Yes**
ALTBAR	58	No
ASPBAR	97	No
ASPVAR	0.76	No
BFIHOST	0.95	No
DPLBAR (km)	0.85	No
DPSBAR (mkm^{-1})	12.5	No
FARL	1	No
LDP	1.73	No
PROPWET (mm)	0.28	No
RMED1H	10.8	No
RMED1D	29.1	No
RMED2D	36.3	No
SAAR (mm)	595	No
SAAR4170 (mm)	611	No
SPRHOST	8.52	No
Urbext2000	0 [0.05]	**Yes**
Urbext1990	0.03	No
URBCONC	0.94	No
URBLOC	1.8	No
Urban Area (km^2)	0 [0.01]	**Yes**
DDF parameter C	-0.02	No
DDF parameter D1	0.3	No
DDF parameter D2	0.29	No
DDF parameter D3	0.22	No
DDF parameter E	0.32	No
DDF parameter F	2.48	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.3	No
DDF parameter D2 (1km grid value)	0.27	No
DDF parameter D3 (1km grid value)	0.22	No
DDF parameter E (1km grid value)	0.32	No
DDF parameter F (1km grid value)	2.48	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

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