TECHNICAL NOTE

Job Name: Pump Farm Lower Rainham

Job No: 44538

Note No: 44538/TN001

Date: January 2020

Prepared By: Iris Kalaci

Subject: **Surface Water Drainage Strategy Addendum**

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1. Introduction

This note has been produced by Stantec, on behalf of AC Goatham & Son and is issued in support of the Outline Planning application MC/19/1566 for approximately 1,250 residential units, a local centre, a village green, a two form entry primary school, a 60 bed extra care facility, an 80 bed care home and associated access (vehicular, pedestrian, cycle).

This note is an addendum to the surface water drainage strategy detailed in the approved PBA's Flood Risk Assessment (January 2019) included in **Appendix E**. The subsequent sections of this note detail only the changes made to the surface water drainage strategy.

2. Executive Summary of Changes

The surface water drainage strategy has been amended to address comments made by LLFA and Natural England (NE) during the planning consultation process (see **Appendix A**). Below is a list of the changes made:

- show ground infiltration as the surface water drainage solution for the proposed development;
- use Flood Estimation Handbook (FEH) rain profile data in the drainage modelling and design;
- provide drainage modelling results (Micro-Drainage) for storms with return 1 in 100 year plus 40% climate change;
- allow for Urban Creep, 10% increase in impermeable areas; and,
- include further information on SuDS train and water quality improvement.

The latest surface water drainage proposals and catchments are detailed in drawing 44538/2001/001 included in **Appendix B**. The latest Micro-Drainage surface water drainage modelling and calculations are included in **Appendix D**.

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3. Impermeable Areas

The Masterplan has been produced by PRC and is divided into sub-catchments (development plots), as shown in drawing 44538/2001/001 in **Appendix B**.

The existing extent of impermeable surfaces is assumed to be zero. **Table 3.1** presents a breakdown of the proposed impermeable areas of the development plots (sub-catchments) shown in the Masterplan. In line with the drainage strategy detailed in the FRA, 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%. In addition, in accordance with CIRIA Report C753 '*The SuDS Manual*' (2015) a 10% increase has been included in the drainage calculations to account for Urban Creep. The proposed open spaces are anticipated to retain the same greenfield drainage characteristics as existing.

Table 3.1 Proposed Impermeable Areas

Development Use	Gross Development Area (ha)	Impermeable Area %	Net Impermeable Area (ha)	Net Impermeable Area (ha) incl. 10% Urban Creep
A1	3.789	65	2.463	2.709
A2	1.150	65	0.748	0.822
B1(a)	1.252	65	0.813	0.894
B1(b)	0.535	65	0.348	0.382
B2	1.314	65	0.854	0.940
B3 (inc. care)	1.526	65	0.992	1.091
C(a)	8.037	65	5.224	5.746
C(b)	0.305	65	0.198	0.218
D(a)	1.938	65	1.260	1.385
D(b)	8.024	65	5.215	5.737
E1(a)	3.378	65	2.195	2.415
E1(b)	0.669	65	0.434	0.478
E2	2.117	65	1.376	1.514
SCHOOL	2.603	80	2.082	2.291
Total	**36.637**	**-**	**24.205**	**26.625**

4. Hierarchy of Surface Water Disposal

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:

- infiltration, or where that is not reasonably practicable;
- a watercourse, or where that is not practicable;
- a sewer.

In order to prove suitability of ground infiltration and determine the infiltration rates, borehole soakage testing was undertaken by Southern Testing Laboratories Ltd in October 2019, and the results are included in **Appendix C**. These test results indicate that the infiltration rate of the chalk layer is generally in excess of 1 x 10^{-5} m/s, which proves that infiltration is a suitable surface water drainage solution for the Site. *Kent Design Guide, Making it Happen, Sustainability Drainage Systems (February 2007)* notes that a minimum infiltration rate of 1 x 10^{-5} m/s is required for deep bore soakaway drainage solutions.

5. Ground Conditions and Groundwater

From the earliest available historical records, the Site which comprises both Pump Farm and Bloor Farm has been predominantly used as agricultural land since the mid nineteenth century.

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.

As detailed in the FRA a Phase 1 Ground Conditions Assessment has been prepared by PBA (2018), which provides an overview of the expected ground conditions at the Site. A summary of the ground conditions detailed in this assessment is shown in **Table 5.1**.

Table 5.1 Summary of Ground Conditions (PBA, 2018) Note:

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

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 the Site.
Seaford Chalk Formation	>16.70	Firm chalk with fragments of hard chalk and flint

Groundwater levels recorded in close proximity to the Lower Twydall Chalk Pit landfill are 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 (ground levels 24.00-22.00m AOD) 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 (ground levels 9.15m AOD) e.g. borehole BH3a, to the north of the landfill site closest to Lower Rainham Road.

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 groundwater at 12.8m below ground, therefore, there is an unsaturated chalk band of 10.3m.

Recently, Southern Testing Laboratories Ltd carried out borehole permeability testing to confirm the borehole soakage rates for the Site. **Table 5.2** shows a summary of the ground conditions encountered during these investigative works (see **Appendix C** for further details). As part of these works a groundwater monitoring well was installed. The groundwater monitoring results are not available at the time of writing this Technical Note and are to be considered at the next stage of the drainage design.

Table 5.3 shows a summary of the groundwater strikes encountered during the investigative works by Southern Testing Laboratories Ltd.

The ground conditions and groundwater level presented in the PBA's Phase 1 Ground Conditions Assessment (2018) are generally similar/in line with those established by Southern Testing Laboratories Ltd. Due to the size of the Site it is proposed that a detailed site investigation and ground water monitoring is carried out at the next stage of the development to confirm the infiltration rates and inform the surface water drainage detailed design for each development plot.

Table 5.2 Summary of Ground Conditions (Southern Testing Laboratories, 2019)

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

Strata	Base Level (m bgl)	Typical Description
Topsoil	0 – 0.5	Brown, silty CLAY with rootlets
Made Ground	0/0.5 – 0.6/1.5	Dark brown/brown & brownish white, CLAY with gravel of chalk, brick flint & sandstone
Seaford Chalk	1.5 – 5.90	CHALK recovered as silty very gravelly CLAY or very clayey gravelly SILT with occasional flint cobbles
Seaford Chalk	8.0-9.5	CHALK recovered as off-white, clayey very gravelly SILT with flint cobbles

Table 5.3 Summary of Groundwater Strikes (Southern Testing Laboratories, 2019)

Borehole Reference	Typical Description
BH01	Wet soil from approximately 8.6m. Water struck at 9.5m BGL and rose to 9.25m after 30min.
BH02	Wet soil from approximately 15.0m BGL. Water struck at 15.2m. Water 15.16m at completion of installation.

The groundwater is within the Seaford Chalk Formation, which has been identified as being a Principal Aquifer. The surface water drainage design detailed in the subsequent sections of this note is based on the Southern Testing Laboratories following design criteria:

- *Development Plot A1, A2, B1(b), B2, B3, C(b), D(b), E1(a), E1(b), E2 and School*: It is assumed that the groundwater level at the location of the proposed attenuation basins for these development plots is 9.0m BGL, which is reflective of that surveyed/recorded on borehole BH01 by Southern Testing Laboratories Ltd;
- *Development Plot B1(a), C(a), D(a) and D(b):* It is assumed that the groundwater level at the location of the proposed attenuation basins for these development plots is 15.0m BGL, which is reflective of that surveyed/recorded on borehole BH02 by Southern Testing Laboratories Ltd;

As detailed in **Figure 5.1**, there are no Groundwater Source Protection Zones within 500m of the Site. The ground water protection zones are described by the Environment Agency as follows:

- *Inner zone – SPZ1:* This zone is 50day travel time of pollutant to source with a 50 metres default minimum radius;
- *Outer zone – SPZ2*: This zone is 400day travel time of pollutant to source. This has a 250 or 500 metres minimum radius around the source depending on the amount of water taken;
- *Total catchment – SPZ3:* This is the area around a supply source within which all the groundwater ends up at the abstraction point. This is the point from where the water is taken. This could extend some distance from the source point;
- *Zone of special interest – SPZ4:* This zone is where local conditions require additional protection.

6. Groundwater Flooding

As detailed in the FRA, the PFRA provides a high-level view of the general areas that might be at risk from groundwater flooding. It shows 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.

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.

From a review of the available geotechnical information (see **Section 5**), the depth to the groundwater varies from ~ 15m at the higher southwestern end of the Site to ~ 9m at the lower north-eastern end.

From an overview of historic flooding in Medway, it was reported in the PFRA, there has been no groundwater flooding recorded on the Site. Therefore, as noted in the FRA it is assessed that there is a low risk of groundwater flooding on the Site.

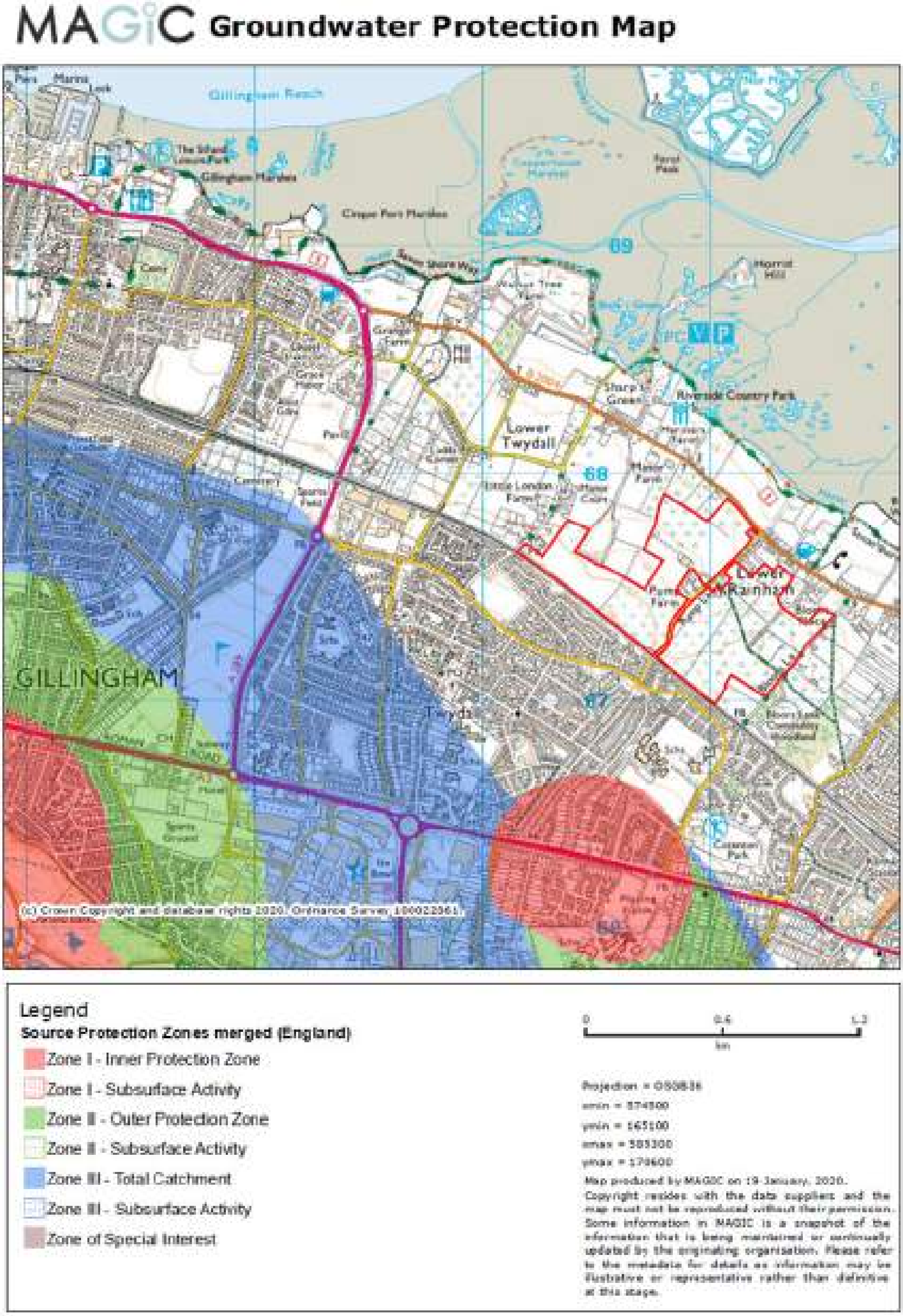

Figure 5.1 Groundwater Protection Zones Map (DEFRA)

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7. Existing and Proposed Discharge Rates

The Site is currently undeveloped agricultural land and therefore it is assumed that there are no below ground/sub-soil drainage pipes serving the Site. Due to the topography of the Site and the made ground/clay make-up of the topsoil layers, it is considered that the greenfield surface water runoff drains overland towards the existing lower ground areas (incl. Pump Lane and Lower Rainham Road) to the north of the Site as shown in Drawing No. 44538-2001-002 (see **Appendix B**). The topographic survey and the Southern Water asset records (see the FRA in **Appendix E**) indicate that there are existing road gullies and surface water sewers on Pump Lane and Lower Rainham Road. These gullies and sewers drain in a northerly direction towards Rainham Creek Marshes. In addition, based on DEFRA Maps (see **Figure 2.1**) it appears that the low ground areas immediately to the north of the Site fall in a northerly direction towards the Rainham Creek Marshes. Therefore, it can be concluded that the surface water runoff from the existing Site eventually drains into the Rainham Creek Marshes via ether overland flows or the surface water piped drainage networks in Pump Lane and Lower Rainham Road. It should be noted that Rainham Creek Marshes form part of Medway Estuary and Marshes Special Protection Area / Ramsar Site.

The existing greenfield surface water runoff rate (Qbar) has been established using the ICP SuDS Method of Micro-Drainage and is as summarised in **Table 7.1** and detailed in **Appendix D**.

Table 7.1 Greenfield Runoff Rates

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

As shown in Drawing No. **44538-2001-001** (see **Appendix B**), the proposed development is sub-divided into various development plots. The proposed surface water discharge rate from each development plot will be limited to the combined infiltration rate of the deep bore soakaways provided within that development plot as detailed in **Table 7.2** below.

The infiltration/discharge rate of the boreholes is estimated based on the guidance notes of *Kent County Council's The Soakaway Design Guide, July 2000*. The calculations and design assumptions are detailed in **Appendix D**. The infiltration rates shown in **Table 7.2** are considered to be conservative and it is recommended that additional deep borehole and pit soakage tests are undertaken at the locations of the proposed attenuation basins to confirm groundwater level, infiltration rates of deep boreholes and that of the basins. The borehole soakaways are proposed to extend 8.0m and 14.0m BGL providing a minimum of 1.0m clearance between the bottom liner of the soakaway and the recorded groundwater.

Table 7.2 Infiltration Rates per Catchment

Note (#): Refer to the drainage calculations in Appendix D for details of the estimated infiltration rates

Catchment	Proposed Number of Deep Bore Soakaways	Estimated Infiltration Rate per Soakaway (l/s) (#)	Total Infiltration Rate per Catchment (l/s)
A1	18	0.143	2.6
A2	7	0.143	1.0
B1(a)	6	1.018	6.1

B1(b)	4	0.143	0.6
B2	7	0.143	1.0
B3 (inc. care)	9	0.143	1.3
C(a)	24	1.018	24.4
C(b)	3	0.143	0.4
D(a)	9	1.018	9.2
D(b)	8 25	1.018 0.143	8.1 3.6
E1(a)	18	0.143	2.6
E1(b)	4	0.143	0.6
E2	7	0.143	1.0
SCHOOL	14	0.143	2.0

8. Attenuation Requirements

It is recognised that surface water attenuation will need to be provided within the surface water drainage system, to demonstrate that (in accordance with Building Regulations – Approved Document Part H, 2015) the drainage system accommodates the surface water runoff for all storm events up to and including the 1 in 100 (1%) Annual Probability event plus 40% climate change.

Surface water attenuation requirements have been estimated using the Flood Estimate Handbook (FEH) rainfall data and the ‘Quick Storage Estimate’ function of Micro-Drainage and are based on the estimated infiltration/discharge rates detailed in in **Table 7.2**.

The required volumes of surface water attenuation to serve the proposed development plots for all storms up to an including 1 in 100y plus 40% climate change are summarised in **Table 8.1** and copies of the Micro-Drainage outputs are included in **Appendix D**.

The volume of surface water attenuation proposed for each development plot is detailed in **Table 8.2**. It is proposed that the surface water attenuation will be provided by lined permeable paving, swales, attenuation basins, deep bored soakaways and piped drainage network. At this stage of the design, the volume of attenuation provided by the swales and piped drainage network has not been accounted for and is not reflected in **Table 8.2**.

The layout and extent of the proposed SuDS is shown in drawing 44538/2001/001 (see **Appendix B)** and is subject to detailed design and coordination with the existing and proposed utility services routes, surface finishes, soft landscaping, architectural layouts/sections, site logistics, phasing of works, building foundations etc, all of which will be confirmed at the detailed design stage.

Based on experience from other projects, the average volume of attenuation provided from lined permeable paving of 1ha residential development is 250m³. It is assumed that permeable paving will be provided on driveways, communal external hardstanding/landscape areas and communal parking areas of the development plots.

The volume of attenuation provided by a deep bore soakaway would consist of the volume of attenuation provided by the chamber and that by the deep bore soakaway. At this stage of the design, the deep bore soakaway chambers are considered to be 1.5m diameter and 1.5m deep (see **Figure 8.1** as an example of Deed Bore Soakaway). The deep bore soakaways are considered to have a 0.25m borehole diameter and either a depth of 8.0m or 14.0m this depending on the groundwater level.

Volume Soakaway Chamber = π x r^2 x depth = π x 0.75^2 x 1.5 = 2.65m^3

Volume of Deep Bore Soakaway (8m BGL) = π x r^2 x depth = π x 0.125^2 x (8.0-1.5)

Volume of Deep Bore Soakaway (8m BGL) = 0.32m^3

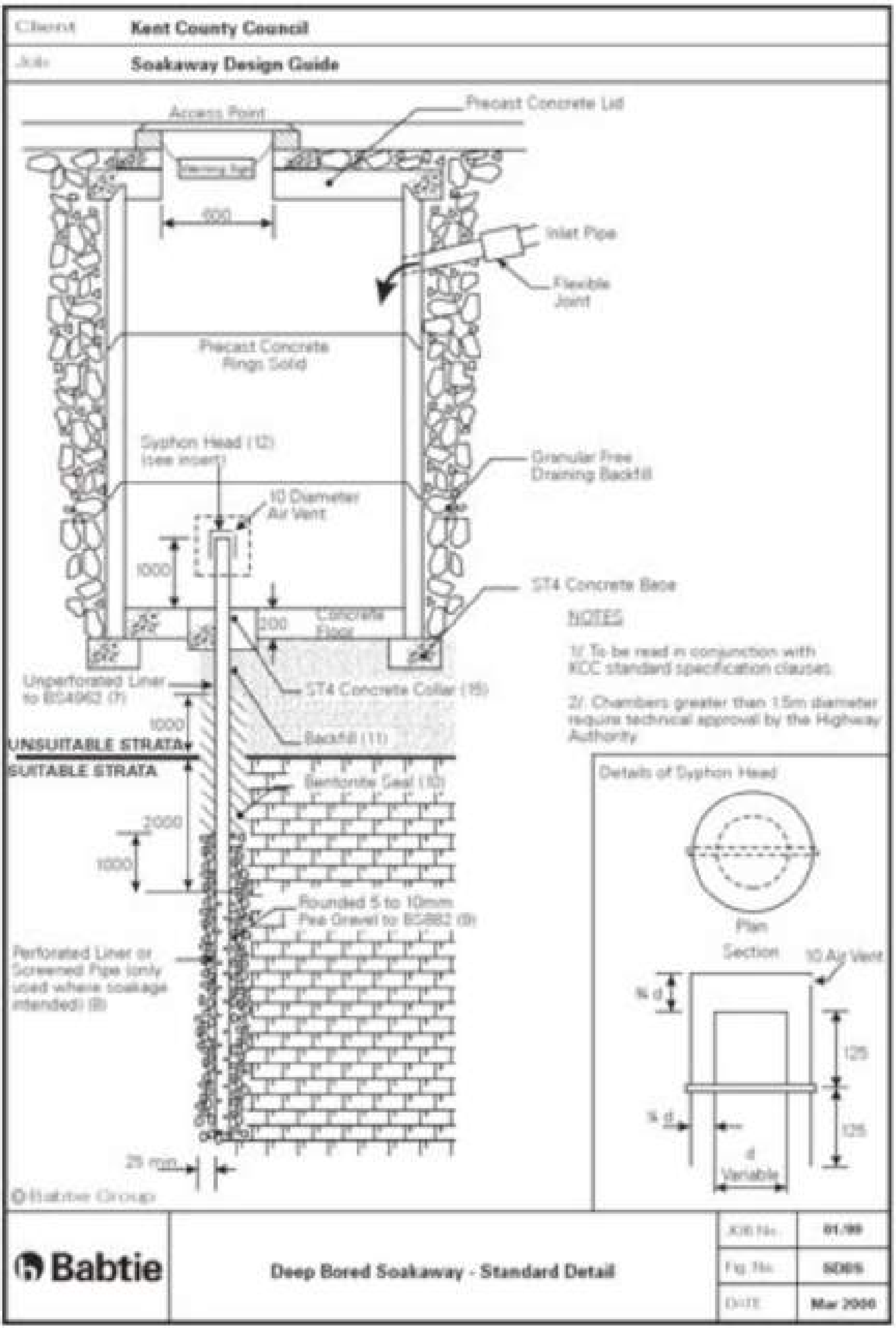
Volume of Deep Bore Soakaway (14m BGL) = π x r^2 x depth = π x 0.125^2 x (14.0-1.5)

Volume of Deep Bore Soakaway (14m BGL) = 0.61m^3

Total Volume of 1no Deep Bore Soakaway (8m BGL) = 2.65 + 0.32m^3 = 2.97m^3

Total Volume of 1no Deep Bore Soakaway (14m BGL) = 2.65 + 0.61m^3 = 3.26m^3

The volume of attenuation provided by the proposed basins is estimated based on a maximum 1.20-1.50m surface water depth (excluding freeboard). The overall depth of the basins would be 1.50-1.80m (to allow for 0.3m freeboard) with inner slopes ranging from 1 in 3 to 1 in 4 and maintenance access along the perimeter.



Client Kent County Council

Job Soakaway Design Guide

NOTES

1/ To be read in conjunction with KCC standard specification clauses.

2/ Chambers greater than 1.5m diameter require technical approval by the Highway Authority

Deep Bored Soakaway - Standard Detail

JOB No. 01/99

Fig. No. SD05

DATE Mar 2000

Figure 8.1 Deep Bore Soakaway Standard Details, KCC’s Soakaway Design Guide (2000)

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Table 8.1 Attenuation Volume Requirements for All Storms up to and Incl. 1 in 100y plus 40% CC

Catchment	Gross Development Area (ha)	Net Impermeable Area (65%) Plus 10% Urban Creep (ha)	Proposed Maximum Discharge (l/s)	Required Total Attenuation Volume (m^3)
A1	3.789	2.709	2.6	3960
A2	1.150	0.822	1.0	1162
B1(a)	1.252	0.894	6.1	851
B1(b)	0.535	0.382	0.6	517
B2	1.314	0.940	1.0	1353
B3 (inc. care)	1.526	1.091	1.3	1547
C(a)	8.037	5.746	24.4	6174
C(b)	0.305	0.218	0.4	286
D(a)	1.938	1.385	9.2	1329
D(b)	8.024	5.737	11.7	7355
E1(a)	3.378	2.415	2.6	3471
E1(b)	0.669	0.478	0.6	672
E2	2.117	1.510	1.0	2310
SCHOOL	2.603	2.291	2.0	3391
Total	**36.637**	**26.625**		**34,378**

Table 8.2 Attenuation Volume Provided on Site

Catchment	Proposed Attenuation Vol. Permeable Paving 250m^3 / ha (m^3)	Proposed Attenuation Vol. Deep Bore Soakaways (m^3)	Proposed Attenuation Vol. Basins (m^3)	Proposed Total Attenuation Volume (m^3)
A1	615 (2.463 x 250)	47 (16 x 2.97)	3466	4128
A2	187 (0.748 x 250)	20 (7 x 2.97)	1161	1368
B1(a)	203 (0.813 x 250)	19 (6 x 3.26)	725	947
B1(b)	87 (0.348 x 250)	12 (4 x 2.97)	671	770
B2	213 (0.854 x 250)	20 (7 x 2.97)	1260	1493
B3 (inc. care)	248 (0.992 x 250)	27 (9 x 2.97)	1300	1575
C(a)	1306 (5.224 x 250)	78 (24 x 3.26)	4820	6204
C(b)	49 (0.198 x 250)	8 (3 x 2.97)	1179	1601
D(a)	315 (1.260 x 250)	29 (9 x 3.26)	1060	1404
D(b)	1306 (5.224 x 250)	48 (8 x 3.26) 74 (25 x 2.97)	1224 4722	7374
E1(a)	548 (2.195 x 250)	53 (18 x 2.97)	3015	3616
E1(b)	108 (0.434 x 250)	12 (4 x 2.97)	636	756
E2	344 (1.376 x 250)	20 (7 x 2.97)	2000	2364
SCHOOL	520 (2.082 x 250)	42 (14 x 2.97)	2868	3430
Total	**6047**	**846**		**37,030**

9. Design Standards and Exceedance

Adoptable piped sewer systems will be designed in accordance with Sewers for Adoption with any private drainage systems designed in accordance with Building Regulations – Approved Document Part H (2015).

The surface water attenuation for the proposed development plots has been sized to accommodate surface water runoff with no flooding for all storms up to and including the 1 in 100 (1%) Annual Probability plus 20% climate change event. The 20% Climate Change is based on the latest guidance from the EA (EA, 2016). The impact of a 40% Climate Change has also been considered and as detailed in **Table 8.1** and **8.2** the proposed attenuation can accommodate all storms with a return period up to and including 1 in 100 (1%) Annual Probability plus 40% climate change event.

During an exceedance event [i.e. drainage outfall from the development plot blocked, or storm events exceeding the 1 in 100 (1%) Annual Probability plus 20% climate change], the flood water will be directed towards the proposed basins, which are positioned at the lowest part of the Site. In order to not exacerbate the existing flood risk downstream of the Site, it is proposed that all basins include a 0.30m freeboard to accommodate flood exceedance.

As outlined in **Section 8** above, the development proposals have been designed on a precautionary basis to avoid direct discharge into Medway Estuary and Marshes Special Protection Area / Ramsar site, through the use of deep bore soakaways. Moreover, the proposals will accommodate surface water runoff with no flooding associated with storms up to the 1 in 100 (1%) annual probability plus 40% climate change event, such that there would be no discharge of flood water into the European designated site. However, in a worst-case scenario, where the freeboard of the proposed basins is surpassed, flood water would be directed by basin overflows and site wide exceedance routes towards Pump Lane and Lower Rainham Road and will drain towards the Rainham Creek Marshes. The likelihood of such an event is considered to be very low in light of the design; moreover, it is important to reiterate that the current situation involves discharge of surface water runoff to the Medway Estuary from the Site in any event.

10. Sustainable Urban Drainage Systems (SuDS)

It is a requirement of the NPPF that SuDS are used in all major development, if feasible. The LLFA also advocate the use of appropriate SuDS measures in new developments.

CIRIA Report C753 *'The SuDS Manual'* (2015) outlines the various types of SuDS, their benefits and limitations, and design considerations associated with each. Not all SuDS components/methods are feasible or appropriate for all developments, factors such as available space, ground conditions, and site gradient will influence the feasibility of different methods for a particular development.

The surface water management strategy has been developed to ensure that surface water runoff from the Site receives the appropriate level of water quality treatment in line with the guidelines and requirements of CIRIA Report C753 *'The SuDS Manual'* (2015) Table 26.2 and 26.3. Below is a summary of the SuDS considered appropriate for the proposed development.

Permeable Paving (Source Control): Permeable paving is proposed where practical on driveways, communal external hardstanding/landscape areas and communal parking areas of the development plots. Permeable paving will provide attenuation, water quality treatment and slow down the time of concentration into the drainage network.

Swales (Interception and Conveyance): Swales are proposed along the perimeter of the development plots and highways. These will intercept, collect and convey surface water runoff, whilst also providing water quality treatment. As noted in the CIRIA report C753 '*The SuDS Manual*' (2015) Chapter 17, there is usually no runoff from the majority of the small rain fall events.

Detention Basins (Interception, Downstream End): Detention basins are proposed at the lowest parts of the proposed development plots. These will offer attenuation, water quality treatment, amenity space and will house the proposed deep bore soakaways described below. It is proposed that the basins are 1.50-1.80m deep in order to provide 1.20-1.50m of surface water attenuation and 0.30m of freeboard. All basins shall include forebays to contain accumulating sediments and overflows to route exceedance flood water. Basins will provide attenuation and water quality treatment via gravitational settling of particulate pollutants. Vegetated detention basins can deliver some Interception because there tends to be no runoff from them for the majority of small rainfall events. The water soaks into the basin topsoil layer and is removed via evapotranspiration. At the next stage of the design, the infiltration capacity of the basins shall be considered as a design solution based on detailed Site Investigation data. The drainage design shown in this Technical Note does not account for basin infiltration. The inner basin side slopes would be between 1 in 3 to 1 in 4 and the outside tie-in slopes would be 1 in 3. A 3.0-3.5m track is to be provided around the basins for maintenance access.

Filter Drains (Conveyance): Filter drains can be used to drain surface water runoff from the proposed highways. Filter drains can help reduce pollutant levels in surface water runoff by filtering out fine sediments, metals, hydrocarbons and other pollutants. The use and extent of filter drains is to be detailed in the next stage of design through consultations with the Highway Authority.

Deep Bore Soakaways (Source Control): Deep bored soakaways have been proposed as the surface water drainage solution. These are to be located within the proposed detention basins and in other landscaped areas at least 10.0m away from housing, roads and infrastructure to avoid settlement and 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. Refer to the deep bore soakaway design in **Appendix D** for further details.

11. Pollution Control and Water Quality Management

Appropriate pollution control and water quality management measures will be included in the proposed surface water drainage system to minimise the risk of contamination or pollution entering the ground from surface water runoff from the development.

In particular it is essential to provide treatment within the SuDS components for the frequent rainfall events (i.e. 1 in 1-year storm events) and the first flush, where urban contaminants are being mobilised and washed off urban surfaces.

The proposed SuDS management treatment train detailed below and in drawing no. 44538/2001/001 will use drainage components/SuDS in series to achieve a robust surface water management system that does not pose an unacceptable risk of pollution to groundwater.

This is in line with the Environment Agency's approach to groundwater protection, guideline G13 - Sustainable Drainage Systems and CIRIA Report C753 '*The SuDS Manual*' (2015).

Furthermore, the proposed surface water sewer network will incorporate suitable pollution control measures such as trapped gullies and catchpit manholes to manage sediment control.

The final strategy of pollution control and water quality management will be confirmed as part of the detailed design.

Residential Roofs: Surface water runoff from roofs will undergo two stages of treatment, one via swales and another via the basins. As detailed in CIRIA Report C753 '*The SuDS Manual*' (2015) Table 26, the pollution hazard indices for roofs are detailed as follows:

- Total Suspended Solids = 0.2
- Metals = 0.2
- Hydrocarbons = 0.05

[First Stage of Treatment] In accordance with CIRIA Report C753 '*The SuDS Manual*' (2015) Table 26.3, the swales provide the following SuDS mitigation indices:

- Total Suspended Solids = 0.5
- Metals = 0.6
- Hydrocarbons = 0.6

[Second Stage of Treatment] In accordance with CIRIA Report C753 '*The SuDS Manual*' (2015) Table 26.3, the basins provide the following SuDS mitigation indices:

- Total Suspended Solids = 0.5
- Metals = 0.5
- Hydrocarbons = 0.6

The overall SuDS mitigation indices for residential roof runoff is derived in accordance with the CIRIA Report C753 '*The SuDS Manual*' (2015) recommendations as follows:

Total SuDS Mitigation Index = Mitigation Index 1 + 0.5 x (Mitigation Index 2…)

- Total Suspended Solids = 0.75 (0.5+0.5x0.5)
- Metals = 0.85 (0.6+0.5x0.5)
- Hydrocarbons = 0.9 (0.6+0.5x0.6)

On this basis, it can be concluded that the proposed swales and basins will provide adequate water quality treatment for the residential roof runoff.

Highways: Surface water runoff from the highways will undergo three stages of treatment via filter drains, swales and basins. As detailed in CIRIA Report C753 '*The SuDS Manual*' (2015) Table 26, the pollution hazard indices for highways are detailed below. These are based on the assumption that the Site will have more than 300 traffic movements a day.

- Total Suspended Solids = 0.7
- Metals = 0.6
- Hydrocarbons = 0.7

[First Stage of Treatment] In accordance with CIRIA Report C753 '*The SuDS Manual*' (2015) Table 26.3, the filter drains provide the following SuDS mitigation indices:

- Total Suspended Solids = 0.4

- Metals = 0.4
- Hydrocarbons = 0.4

[Second Stage of Treatment] In accordance with CIRIA Report C753 '*The SuDS Manual'* (2015) Table 26.3, the swales provide the following SuDS mitigation indices:

- Total Suspended Solids = 0.5
- Metals = 0.6
- Hydrocarbons = 0.6

[Third Stage of Treatment] In accordance with CIRIA Report C753 '*The SuDS Manual'* (2015) Table 26.3, the basins provide the following SuDS mitigation indices:

- Total Suspended Solids = 0.5
- Metals = 0.5
- Hydrocarbons = 0.6

The overall SuDS mitigation indices for highways runoff is derived in accordance with the CIRIA Report C753 *'The SuDS Manual'* (2015) recommendations as follows:

Total SuDS Mitigation Index = Mitigation Index 1 + 0.5 x (Mitigation Index 2…)

- Total Suspended Solids = 0.9 (0.4+0.5x0.5+0.5x0.5)
- Metals = 0.95 (0.4+0.6x0.5+0.5x0.5)
- Hydrocarbons = 1.0 (0.4+0.5x0.6+0.5x0.6))

On this basis, it can be concluded that the proposed filter drains, swales and basins will provide adequate water quality treatment for the highway's runoff.

Driveways and Car Parking Areas: Surface water runoff from the driveways and car parking areas will undergo three stages of treatment via lined permeable paving, swales and basins. As detailed in CIRIA Report C753 '*The SuDS Manual'* (2015) Table 26, the pollution hazard indices for the driveways and car parking areas highways are detailed below. These are based on the assumption that the Site will have more than 300 traffic movements a day.

- Total Suspended Solids = 0.7
- Metals = 0.6
- Hydrocarbons = 0.7

[First Stage of Treatment] In accordance with CIRIA Report C753 *'The SuDS Manual'* (2015) Table 26.3, the lined permeable paving provides the following SuDS mitigation indices:

- Total Suspended Solids = 0.7
- Metals = 0.6
- Hydrocarbons = 0.7

[Second Stage of Treatment] In accordance with CIRIA Report C753 '*The SuDS Manual'* (2015) Table 26.3, the swales provide the following SuDS mitigation indices:

- Total Suspended Solids = 0.5
- Metals = 0.6
- Hydrocarbons = 0.6

[Third Stage of Treatment] In accordance with CIRIA Report C753 *'The SuDS Manual'* (2015) Table 26.3, the basins provide the following SuDS mitigation indices:

- Total Suspended Solids = 0.5
- Metals = 0.5
- Hydrocarbons = 0.6

The overall SuDS mitigation indices for driveways and car parking areas runoff is derived in accordance with the CIRIA Report C753 *'The SuDS Manual'* (2015) recommendations as follows:

Total SuDS Mitigation Index = Mitigation Index 1 + 0.5 x (Mitigation Index 2…)

- Total Suspended Solids = 1.2 (0.7+0.5x0.5+0.5x0.5)
- Metals = 1.15 (0.6+0.6x0.5+0.5x0.5)
- Hydrocarbons = 1.3 (0.7+0.5x0.6+0.5x0.6))

On this basis, it can be concluded that the proposed lined permeable paving, swales and basins will provide adequate water quality treatment for the driveways and car parking areas runoff.

The final strategy for the surface water runoff pollution control will be confirmed as part of the detailed design, however at this stage of the assessment and considering the Site constraints an appropriate upstream SuDS treatment train has been incorporated into the design prior to infiltration.

12. Adoption and Maintenance

The proposed surface water sewer networks up to the outfall headwalls into the swales and basins will be offered for adoption to the Drainage Authority under a Section 104 Agreement of the Water Industry Act (1991).

It is unlikely that the proposed SuDS features would be adopted by the LLFA, Drainage Authority or Highways Authority. The ongoing management and maintenance of the proposed SuDS will be the responsibility of a management company.

The long-term management of surface water drainage assets, including any SuDS components, is essential to ensure they continue to function to their design standard. As such, a management and maintenance plan will be developed at detailed design stage in order to ensure the systems continue to work effectively.

13. Conclusion

Surface water runoff from the development is proposed to be disposed via infiltration into the existing ground. The surface water management strategy will incorporate Sustainable Drainage Systems (SuDS) measures such as deep bore soakaways, permeable paving, filter drains, swales and basins to provide water quality and surface water attenuation benefits.

Through the use of on-site infiltration via deep bore soakaways, in addition to the use of SuDS measures as detailed above to fully address potential pollutants, the surface water drainage strategy ensures that the development will not result in impacts to off-site habitats or species associated with the Medway Estuary. Noting that the final strategy for surface water runoff control at the Site will necessarily need to be confirmed at the detailed design stage, the additional information presented within this Addendum Note demonstrates that such measures can be implemented and provides certainty that the development will not lead to an adverse effect upon the integrity of Medway Estuaries and Marshes Special Protection Area / Ramsar site via hydrological pathways.

In conclusion, the future occupants and users of the proposed development will be at a low risk of flooding due to surface water runoff. It is demonstrated that the development proposals comply with the NPPF, PPG and the local planning policy with respect to management of surface water runoff.

Appendix A – Outline Planning Stakeholders Consultation

MC/19/1566 | Outline planning application with some matters reserved (appearance, landscaping, layout and scale) for redevelopment of land off Pump Lane to include residential development comprising of approximately 1,250 residential units, a local centre, a village green, a two form entry primary school, a 60 bed extra care facility, an 80 bed care home and associated access (vehicular, pedestrian, cycle). | Land Off Pump Lane Rainham Kent ME8 7TJ

<u>LLFA Decision: Condition recommended</u>

The LLFA have made the decision to recommend a condition, based on the submitted Flood Risk Assessment (42252/2013) and following further site investigations;

At this early stage, infiltration/soakage tests have been undertaken and have shown good results and therefore, our initial concerns that a workable scheme had not been produced have been overcome. Going forward, the LLFA is confident a suitable scheme can be produced.

The Flood Estimation Handbook (FEH) should be used for the design storms, opposed to FSR. For runoff, outputs from both FEH and ICP SuDS should be submitted with the more conservative of the two, being selected. MicroDrainage outputs (or other industry appropriate software) should be provided for the critical duration for a 2 year, 30 year and 1 in 100 year + 40% intensity climate change scenarios. Urban creep, whereby the permeable surfaces are converted to impermeable over time should be considered as part of the design calculations. In this instance, it is recommended that an additional 10% impermeability is included. This is required at this stage to give the most conservative scenario as it may result in storage requirements increasing, which in turn could largely change the proposed site layout.

Whilst we support the use of SuDS across the site and especially the choices of SuDS, the location and use of them from a landscape perspective could be revisited. Locating swales and soakaway basins to the edge of the development and around the edge of catchments, is seen as a very practical solution, but a lost opportunity for facilitating the creation of place. The design of SuDS provides the opportunity to maximise other benefits associated with the use of SuDs and fulfil other planning objectives such as, increased biodiversity, landscaping and enhanced amenity. We strongly recommend seeking advice from the Council's Landscape Architect/Urban Designer with respect to the design and integration of SuDS systems with the surrounding landscape/public open space.

The SuDs scheme should be designed in accordance with SuDs Management Train principles including the prevention of runoff by reducing impermeable areas and utilising source, site and regional controls where necessary. We would recommend looking into options of managing surface water at source such as permeable paving.

The Environment Agency's updated surface water Flood Risk mapping indicates that areas the of site are at high risk of surface water flooding meaning that the chance of flooding in any one year is equal to or greater than 3.33% (1 in 30). We would expect any development to be avoided in areas at high or medium risk of surface water flooding. For any development in areas at low risk of flooding, we would expect finished floor levels to be raised suitably and flood resilience measures such as solid floors to be installed.

We would also expect the use of infiltration to be used to its maximum extent to reduce the stress on the Southern Water surface water sewer network. If it is proposed to use an existing surface water sewer, evidence will need to be provided that there is suitable capacity.

It should be ensured that there is a maintenance schedule in place for the lifetime of the development to maintain any SuDs, which serve it. All SuDS should be located in publicly accessible areas, unless deemed inappropriate or not possible, to allow for suitable access for maintenance. We will need to see a plan of the frequency of maintenance for each SuDS feature on site based on guidance in the CIRIA SuDS Manual as well as details of who will carrying out the maintenance.

Cross sections for the ponds should be provided ensuring each pond has a minimum of a 1 in 3 side slope with a 300mm freeboard.

____

Condition 1: No development shall take place until a scheme showing details of the disposal of surface water, based on sustainable drainage principles, including details of the design, implementation, maintenance and management of the surface water drainage scheme have been submitted to and approved in writing by the Local Planning Authority in consultation with the Lead Local Flood Authority.

Those details shall include (if applicable):

i. a timetable for its implementation (including phased implementation where applicable).
ii. appropriate operational, maintenance and access requirements for each sustainable drainage component are adequately considered.
iii. proposed arrangements for future adoption by any public body, statutory undertaker or management company.

Reason: To manage surface water during and post construction and for the lifetime of the development as outlined at Paragraph 165 of NPPF.

Condition 2: Prior to occupation (or within an agreed implementation schedule) a signed verification report carried out by a qualified drainage engineer (or equivalent) must be submitted to and approved by the Local Planning Authority to confirm that the agreed surface water system has been constructed as per the agreed scheme and plans. The report shall include details and locations of critical drainage infrastructure (such as inlets, outlets and control structures) including as built drawings, and an operation and maintenance manual for the unadopted parts of the scheme as constructed.

Reason: This condition is sought in accordance with paragraph 165 of the NPPF to ensure that suitable surface water drainage scheme is designed and fully implemented so as to not increase flood risk onsite or elsewhere.

Date: 01 August 2019
Our ref: 287468
Your ref: MC/19/1566

Customer Services
Hornbeam House
Crewe Business Park
Electra Way
Crewe
Cheshire
CW1 6GJ

T 0300 060 3900

Hannah Gunner
Medway Council - Planning Service
Physical & Cultural Regeneration
Regeneration, Culture, Environment & Transformation
Civic Headquarters
Gun Wharf
Dock Road
Chatham ME4 4TR

By email only, no hard copy to follow

Dear Hannah Gunner

Proposal: Outline planning application with some matters reserved (appearance, landscaping, layout and scale) for redevelopment of land off Pump Lane to include residential development comprising of approximately 1,250 residential units, a local centre, a village green, a two form entry primary school, a 60 bed extra care facility, an 80 bed care home and associated access (vehicular, pedestrian, cycle).
Location: Land off Pump Lane, Rainham, Kent, ME8 7TJ

Thank you for your consultation on the above dated 28 June 2019 which was received by Natural England on the same day

Natural England is a non-departmental public body. Our statutory purpose is to ensure that the natural environment is conserved, enhanced, and managed for the benefit of present and future generations, thereby contributing to sustainable development.

Summary of Natural England's advice

Further information required to determine impacts to designated sites

As submitted, the application could have potential significant effects on the Medway Estuary and Marshes Site of Special Scientific Interest (SSSI), Special Protection Area (SPA) and Wetland of International Importance under the Ramsar Convention (Ramsar Site) and the Medway Estuary Marine Conservation Zone (MCZ).

Natural England requires further information in order to determine the significance of these impacts and the scope for mitigation and suggest that the following information is provided:

- Clarity on the additional measures (over and above the contribution to the Strategic Access Management and Monitoring Strategy) that will be provided to ensure impacts to the designated sites from recreational disturbance do not occur;
- Clarity on the surface water drainage measures that are to be implemented to ensure that the water entering the designated sites via the existing outfall does not result in impacts to habitats or species associated with them

Without this information, Natural England may need to object to the proposal. Please re-consult Natural England once this information has been obtained. Natural England's further advice on designated sites/landscapes and advice on other issues is set out below.

Additional Information required

Given the close proximity of the application site to the Medway Estuary and Marshes SPA and Ramsar Site and the number of dwellings that are proposed, Natural England's advice is that in addition to the appropriate financial contribution being made to the Strategic Access Management and Monitoring Strategy, additional measures will also be required. These could include the provision of significant areas of off-site greenspace and the provision of additional wardening at locations closest to the application site, for example.

The applicant acknowledges that further measures are required, as detailed within Section 5.73 of the 'Information for Habitats Regulations Assessment' document submitted in support of the application. This suggests that discussions will be held with Medway Council regarding the additional measures that will be implemented. Natural England advise that details of the further measures that will be implemented to manage recreational disturbance to the coastal designated sites in close proximity to the development should be provided at this stage to ensure that the proposal does not result in an adverse effect on the integrity of the SPA or Ramsar Site.

Section 5.47 of the 'Information for Habitats Regulations Assessment' report accompanying the planning application confirms that the surface water drainage will discharge into the River Medway via a connection to the existing surface water sewer (MH2754). The report details that measures to manage the flow of contaminated run-off leaving the site will be agreed following further technical studies. Given the scale of the development and the apparent direct discharge via the surface water sewer into the designated sites, we recommend that further information should be provided at this stage to demonstrate that measures can be implemented to ensure that contaminated surface water does not enter the River Medway. We acknowledge that the detailed design will follow at the reserved matters stage but sufficient information should be provided at the outline application stage to give certainty that measures can be implemented to prevent impacts to the designated sites.

Upon submission of the further information above, we will of course be pleased to provide our further advice. Please note that if your authority is minded to grant planning permission contrary to the advice in this letter, you are required under Section 28I (6) of the Wildlife and Countryside Act 1981 (as amended) to notify Natural England of the permission, the terms on which it is proposed to grant it and how, if at all, your authority has taken account of Natural England's advice. You must also allow a further period of 21 days before the operation can commence.

In addition, Natural England would advise on the following issues with further general advice on protected species and other natural environment issues is provided at Annex A appended to this letter.

Soils and Land Quality

Having considered the proposals as a consultation under the Development Management Procedure Order (as amended), and in the context of Government's policy for the protection of the 'best and most versatile' (BMV) agricultural land as set out in paragraph 170 and 171 of the National Planning Policy Framework, Natural England draws your Authority's attention to the following land quality and soil considerations.

Based on the information provided with the planning application, it appears that the proposed development will result in the direct loss of 51.5 hectares of land classified as 'best and most versatile' (Grades 1, 2 and 3a land in the Agricultural Land Classification (ALC) system).

Government policy is set out in Paragraph 170 and 171 of the National Planning Policy Framework which states that:

> *'Planning policies and decisions should contribute to and enhance the natural and local environment by:*

> *recognising the intrinsic character and beauty of the countryside, and the wider benefits from natural capital and ecosystem services – including the economic and other benefits of the best and most versatile agricultural land, and of trees and woodland.'*
>
> And
>
> *Plans should: distinguish between the hierarchy of international, national and locally designated sites; allocate land with the least environmental or amenity value, where consistent with other policies in this Framework*[1]*; take a strategic approach to maintaining and enhancing networks of habitats and green infrastructure; and plan for the enhancement of natural capital at a catchment or landscape scale across local authority boundaries.*

As this application site does not benefit from a development plan allocation, the Council needs to fully consider the impacts that will arise from the direct loss of best and most versatile agricultural land as a result of this proposal to ensure the decision is in accordance with Government policy.

We would be happy to comment further should the need arise but if in the meantime you have any queries please do not hesitate to contact us. For any queries relating to the specific advice in this letter only please contact Sean Hanna on 0208 0266 064 or by email to sean.hanna@naturalengland.org.uk. For any new consultations, or to provide further information on this consultation please send your correspondences to consultations@naturalengland.org.uk.

Yours sincerely

[redacted]

Senior Adviser
Sussex and Kent Team

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[1] Where significant development of agricultural land is demonstrated to be necessary, areas of poorer quality land should be preferred to those of a higher quality.

Annex A

Natural England offers the following additional advice:

Landscape

Paragraph 170 of the National Planning Policy Framework (NPPF) highlights the need to protect and enhance valued landscapes through the planning system. This application may present opportunities to protect and enhance locally valued landscapes, including any local landscape designations. You may want to consider whether any local landscape features or characteristics (such as ponds, woodland or dry stone walls) could be incorporated into the development in order to respect and enhance local landscape character and distinctiveness, in line with any local landscape character assessments. Where the impacts of development are likely to be significant, a Landscape & Visual Impact Assessment should be provided with the proposal to inform decision making. We refer you to the Landscape Institute Guidelines for Landscape and Visual Impact Assessment for further guidance.

Best and most versatile agricultural land and soils

Local planning authorities are responsible for ensuring that they have sufficient detailed agricultural land classification (ALC) information to apply NPPF policies (Paragraphs 170 and 171). This is the case regardless of whether the proposed development is sufficiently large to consult Natural England. Further information is contained in GOV.UK guidance.

Agricultural Land Classification information is available on the Magic website on the Data.Gov.uk website. If you consider the proposal has significant implications for further loss of 'best and most versatile' agricultural land, we would be pleased to discuss the matter further.

Guidance on soil protection is available in the Defra *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, and we recommend its use in the design and construction of development, including any planning conditions. Should the development proceed, we advise that the developer uses an appropriately experienced soil specialist to advise on, and supervise soil handling, including identifying when soils are dry enough to be handled and how to make the best use of soils on site.*

Protected Species

Natural England has produced standing advice[2] to help planning authorities understand the impact of particular developments on protected species. We advise you to refer to this advice. Natural England will only provide bespoke advice on protected species where they form part of a SSSI or in exceptional circumstances.

Local sites and priority habitats and species

You should consider the impacts of the proposed development on any local wildlife or geodiversity sites, in line with paragraphs 171 and174 of the NPPF and any relevant development plan policy. There may also be opportunities to enhance local sites and improve their connectivity. Natural England does not hold locally specific information on local sites and recommends further information is obtained from appropriate bodies such as the local records centre, wildlife trust, geoconservation groups or recording societies.

Priority habitats and Species are of particular importance for nature conservation and included in the England Biodiversity List published under section 41 of the Natural Environment and Rural Communities Act 2006. Most priority habitats will be mapped either as Sites of Special Scientific Interest, on the Magic website or as Local Wildlife Sites. List of priority habitats and species can be found here[3]. Natural England does not routinely hold species data, such data should be collected when impacts on priority habitats or species are considered likely. Consideration should also be given to the potential environmental value of brownfield sites, often found in urban areas and former industrial land, further information including links to the open mosaic habitats inventory can be found here.

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[2] https://www.gov.uk/protected-species-and-sites-how-to-review-planning-proposals

[3] http://webarchive.nationalarchives.gov.uk/20140711133551/http:/www.naturalengland.org.uk/ourwork/conservation/biodiversity/protectandmanage/habsandspeciesimportance.aspx

Ancient woodland, ancient and veteran trees
You should consider any impacts on ancient woodland and ancient and veteran trees in line with paragraph 175 of the NPPF. Natural England maintains the Ancient Woodland Inventory which can help identify ancient woodland. Natural England and the Forestry Commission have produced standing advice for planning authorities in relation to ancient woodland and ancient and veteran trees. It should be taken into account by planning authorities when determining relevant planning applications. Natural England will only provide bespoke advice on ancient woodland, ancient and veteran trees where they form part of a SSSI or in exceptional circumstances.

Environmental enhancement
Development provides opportunities to secure net gains for biodiversity and wider environmental gains, as outlined in the NPPF (paragraphs 8, 72, 102, 118, 170, 171, 174 and 175). We advise you to follow the mitigation hierarchy as set out in paragraph 175 of the NPPF and firstly consider what existing environmental features on and around the site can be retained or enhanced or what new features could be incorporated into the development proposal. Where onsite measures are not possible, you should consider off site measures, including sites for biodiversity offsetting. Opportunities for enhancement might include:

- Providing a new footpath through the new development to link into existing rights of way.
- Restoring a neglected hedgerow.
- Creating a new pond as an attractive feature on the site.
- Planting trees characteristic to the local area to make a positive contribution to the local landscape.
- Using native plants in landscaping schemes for better nectar and seed sources for bees and birds.
- Incorporating swift boxes or bat boxes into the design of new buildings.
- Designing lighting to encourage wildlife.
- Adding a green roof to new buildings.

You could also consider how the proposed development can contribute to the wider environment and help implement elements of any Landscape, Green Infrastructure or Biodiversity Strategy in place in your area. For example:

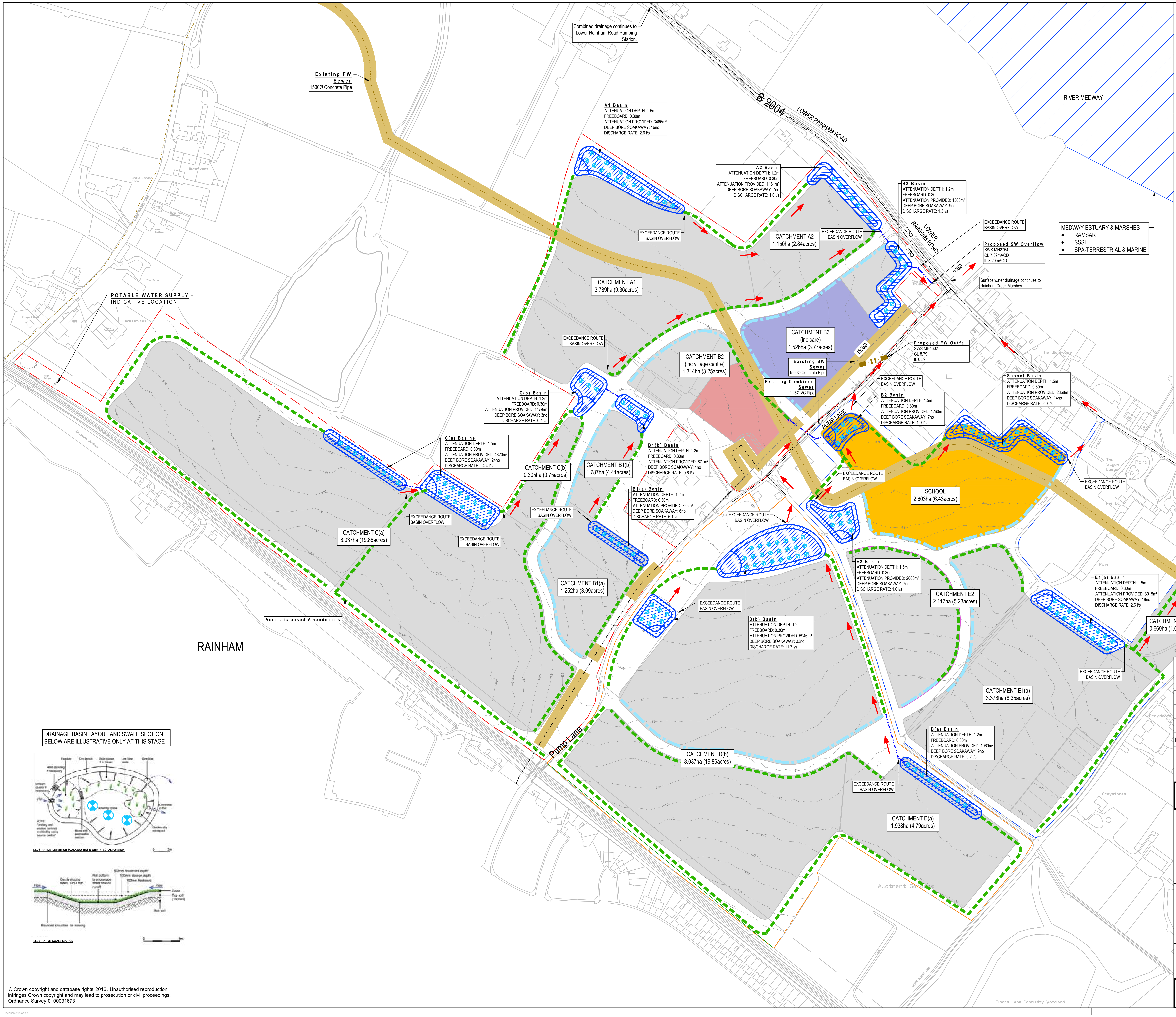
- Links to existing greenspace and/or opportunities to enhance and improve access.
- Identifying opportunities for new greenspace and managing existing (and new) public spaces to be more wildlife friendly (e.g. by sowing wild flower strips)
- Planting additional street trees.
- Identifying any improvements to the existing public right of way network or using the opportunity of new development to extend the network to create missing links.
- Restoring neglected environmental features (e.g. coppicing a prominent hedge that is in poor condition or clearing away an eyesore).

Access and Recreation
Natural England encourages any proposal to incorporate measures to help improve people's access to the natural environment. Measures such as reinstating existing footpaths together with the creation of new footpaths and bridleways should be considered. Links to other green networks and, where appropriate, urban fringe areas should also be explored to help promote the creation of wider green infrastructure. Relevant aspects of local authority green infrastructure strategies should be delivered where appropriate.

Rights of Way, Access land, Coastal access and National Trails
Paragraphs 98 and 170 of the NPPF highlights the important of public rights of way and access. Development should consider potential impacts on access land, common land, rights of way and coastal access routes in the vicinity of the development. Consideration should also be given to the potential impacts on the any nearby National Trails. The National Trails website www.nationaltrail.co.uk provides information including contact details for the National Trail Officer. Appropriate mitigation measures should be incorporated for any adverse impacts.

Biodiversity duty
Your authority has a duty to have regard to conserving biodiversity as part of your decision making. Conserving biodiversity can also include restoration or enhancement to a population or habitat. Further information is available here.

Appendix B – Drainage Strategy Drawings



DRAINAGE BASIN LAYOUT AND SWALE SECTION BELOW ARE ILLUSTRATIVE ONLY AT THIS STAGE

ILLUSTRATIVE DETENTION SOAKAWAY BASIN WITH INTEGRAL FOREBAY

ILLUSTRATIVE SWALE SECTION

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 18/00/188, DATED SEPTEMBER 2018.

LEGEND:

▨	SURFACE WATER SOAKAWAY BASIN
— · · —	PROPOSED SURFACE WATER SEWER
▬ ▮ ▮ ▬	PROPOSED FOUL WATER SEWER
⊗	SOAKAWAY BORE HOLE
▨	STRATEGIC LANDSCAPING AREA
▬	EASEMENT 13.5m
- - - -	PROPOSED SWALE
— - —	PROPOSED FILTER DRAIN
— - - —	EXISTING SURFACE WATER SEWER
— · - · —	EXISTING FOUL WATER SEWER
— · - · —	EXISTING FOUL WATER SEWER
→	FLOOD EXCEEDANCE ROUTE
—	DEVELOPMENT A
—	DEVELOPMENT B
—	DEVELOPMENT C
—	DEVELOPMENT D
—	DEVELOPMENT E

DEVELOPMENT AREAS

— — —	DEVELOPMENT AREA 25.1 Ha
— · —	DEVELOPMENT AREA 14.0 Ha
—··—··—	DEVELOPMENT AREA 11.1Ha

Mark	Revision	Date	Drawn	Chkd	Appd
D	SURFACE WATER DRAINAGE SOLUTION CHANGED TO INFILTRATION. SIZE OF BASINS AND NUMBER OF DEEP BORE SOAKAWAYS AMENDED. FILTER DRAINS AND EXCEEDANCE ROUTES ADDED.	27.01.20	IK	IK	ET
C	UPDATED MASTERPLAN	05.12.18	AH	CD	CD
B	SURFACE WATER AREAS UPDATED	12.11.18	AP	CD	CD
A	CONTOUR INFORMATION SHOWN	08.11.18	AP	CD	CD

SCALING NOTE: Do not scale this drawing - any errors or omissions shall be reported to Stantec without delay.

UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

Drawing Issue Status

CONCEPT

PUMP FARM, LOWER RAINHAM
DRAINAGE STRATEGY

Client

A.C. GOATHAM & SON

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

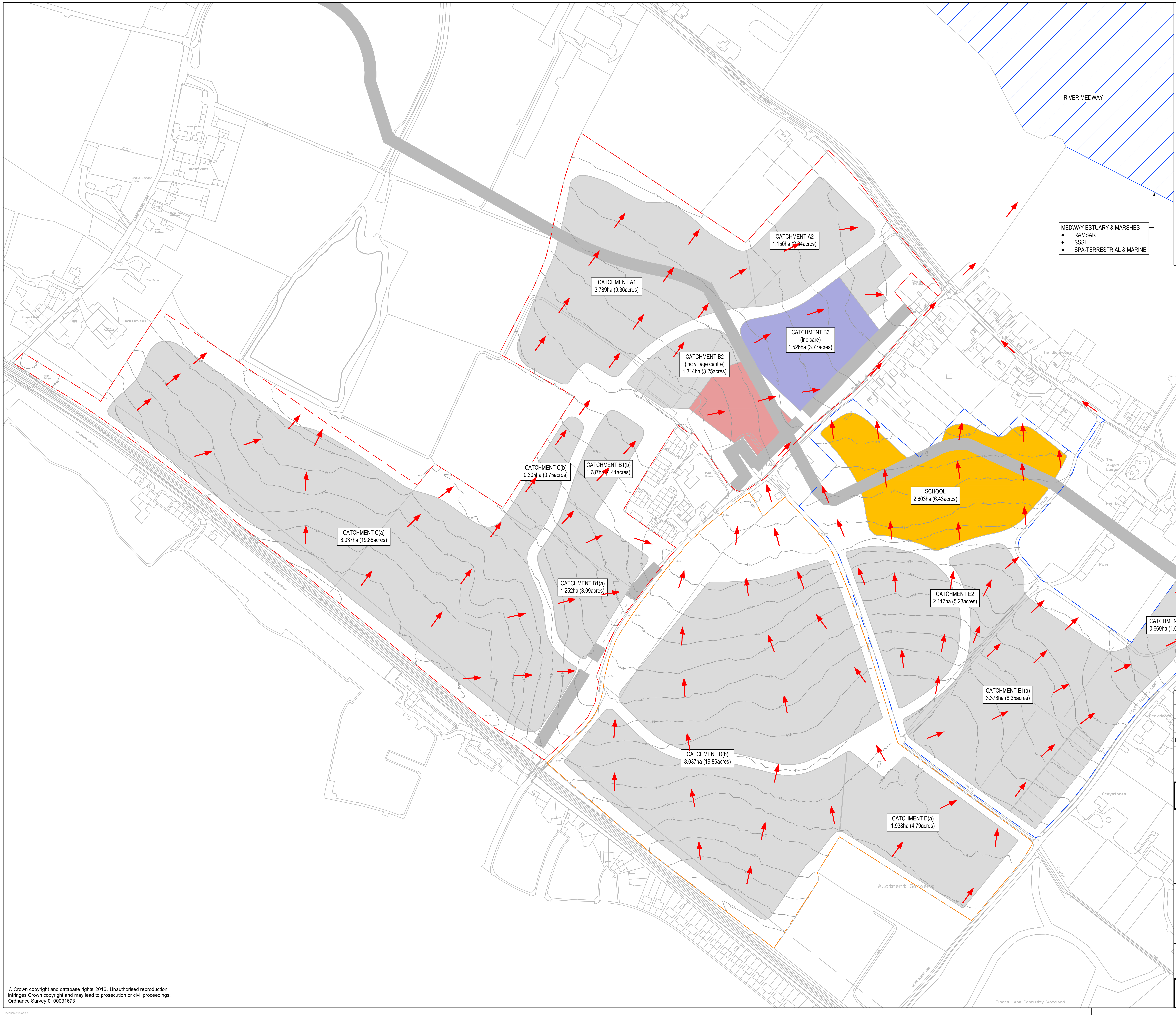
Drawing Number	Revision
44538/2001/001	D

Stantec

stantec.com/uk

LONDON
Tel: 020 3824 6600

File Location: z:\stantec\44538 pump farm lower rainham\5. drawings & models\cad\civils\44538-2001-001.dwg



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 18/00/188, DATED SEPTEMBER 2018.

LEGEND:

→	EXISTING SURFACE WATER DRAINAGE RUNOFF ROUTES
—	DEVELOPMENT A
—	DEVELOPMENT B
—	DEVELOPMENT C
—	DEVELOPMENT D
—	DEVELOPMENT E

DEVELOPMENT AREAS

– – –	DEVELOPMENT AREA 25.1 Ha
– · –	DEVELOPMENT AREA 14.0 Ha
–··–	DEVELOPMENT AREA 11.1Ha

Mark	Revision	Date	Drawn	Chkd	Appd
A	PRELIMINARY ISSUE	27.01.20	IK	IK	ET

SCALING NOTE: Do not scale this drawing - any errors or omissions shall be reported to Stantec without delay.

UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

Drawing Issue Status
CONCEPT

PUMP FARM, LOWER RAINHAM
EXISTING DRAINAGE RUNOFF ROUTES

Client
A.C. GOATHAM & SON

Date of 1st Issue 27.01.2020	Designed IK	Drawn IK
A1 Scale 1:2000	Checked IK	Approved ET

Drawing Number: 44538/2001/002
Revision: A

Stantec

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LONDON
Tel: 020 3824 6600

File Location: z:\stantec\44538 pump farm lower rainham\5. drawings & models\cad\civils\44538-2001-002_.dwg

Appendix C – Infiltration Test Results

Southern Testing
Environmental & Geotechnical

Southern Testing Laboratories Ltd
Keeble House, Stuart Way
East Grinstead, West Sussex RH19 4QA

t 01342 333100 f 01342 410321
e info@southerntesting.co.uk w southerntesting.co.uk

Directors M W Stevenson BSc MBA CEng CEnv MICE CGeol FGS MconsE (Chairman)
Dr L D Mockett BSc PhD PGDip FGS (Joint Managing Director)
Dr J Kelly BSc PhD DIC (Joint Managing Director)
S F Pratt BSc MSc CGeol FGS DIC
P J Sugden BSc MSc FGS
D Vooght BSc (Civ Eng) MSc (Non Executive)
A J Timms CEng MICE (Non Executive)
Co. Secretary J N Joseph
Consultant Dr D Petley BSc PhD DIC MHIT FGS
D Illingworth BSc FGS

Our Ref: J14206

4 November 2019

A C Goatham & Son
Flanders Farm
Ratcliffe Highways
Rochester
Kent
ME3 8QE

For the attention of Andy Hughes.

Dear Sirs,

Re: Borehole Permeability Testing at: Pump & Bloors Farm Development, Rainham, ME8 7AT
National Grid Reference: TQ 80899 67494
Geology: Head over Possible Thanet Formation over Seaford Chalk

1 Authority

Our authority for carrying out this work is contained in a signed Project Order Form from Helena Sullivan on behalf of A C Goatham & Son.

2 Background and Objectives

The object of the investigation was to drill 2 No. 200mm diameter boreholes, in the locations as determined by the Clients engineer, which extend approximately 10m into the underlying chalk and carry out borehole soakage testing at a range of depths within each of the boreholes. One of the borehole was to be installed with a 50mm groundwater monitoring well.

3 Scope

This letter report presents our exploratory hole logs and test results only. As with any site there may be differences in soil conditions between exploratory hole positions.

This report is not an engineering design and the figures and calculations contained in the report should be used by the Engineer, taking note that variations will apply, according to variations in design loading, in techniques used, and in site conditions. Our figures therefore should not supersede the Engineer's design.

Contamination issues are not considered in this report.

The findings and opinions conveyed via this Site Investigation Report are based on information obtained from a variety of sources as detailed within this report, and which Southern Testing Laboratories Limited believes are reliable. Nevertheless, Southern Testing Laboratories Limited cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

The site investigation was conducted and this report has been prepared for the sole internal use and reliance of A C Goatham & Son and their appointed Engineers. This report shall not be relied upon or transferred to any other parties without the express written authorization of Southern Testing Laboratories Limited. If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

4 Geology

The British Geological Survey Map No. 272 indicates that the site geology consists of Head over possible Thanet Formation over Seaford Chalk.

Head

Head is a superficial deposit predominantly formed by solifluction processes during cold, periglacial periods in the Ice Ages. Shallow soils were frequently waterlogged during these periods and together with freeze/thaw cycles caused a gradual downward migration of shallow soils. Although the climate has since changed, poorly designed engineering works, or periods of adversely high rainfall may still reactivate the relic slip surfaces.

Head soils characteristically comprise sandy silty clay containing randomly oriented fragments of angular materials of local derivation. Stratification, if present, is generally poor and the upper and lower surfaces of the deposits are rarely horizontal.

Thanet Formation

The Thanet Formation is a Palaeocene deposit consisting of fine-grained pale yellow and grey mottled silty to very silty sand that can be clayey or glauconitic.

The boundary between the Thanet Formation and the underlying Chalk is very irregular and is marked by a bed of green-coated flints and glauconitic sand and clay (Bullhead Beds).

It is not uncommon to find sinkholes in the vicinity of the outcrop of the Thanet Formation particularly where there was a layer of overlying clay. In some areas, there are many old shafts that were dug in order to mine the underlying Chalk.

Seaford Chalk Formation

The Seaford Chalk Formation comprises a fairly homogeneous white chalk with regular and conspicuous flint bands. These flints are commonly laterally very continuous and traceable over large distances. Some of the flints can be very large. A few marl seams are present within the lower parts of the formation.

The White Chalk outcrop in particular is frequently highly fractured and highly permeable, and usually has good infiltration characteristics. On the other hand, Chalk Head, highly weathered Chalk and Chalk under a low permeability superficial cover may have very poor infiltration characteristics.

Chalk is slightly soluble in water and, while it has excellent bearing properties when unweathered, this solubility can lead to deep weathering and softening, and the upper layers of chalk often have an irregular boundary with overlying strata

The Chalk may be softened by solution to a depth of 5-15 metres and bearing capacities and engineering properties improve with depth. Where there is an outcrop of impermeable soil overlying the chalk there may be a dramatically increased solution effect due to concentrated surface water flow to the Chalk close to the outcrop boundary.

Solution features are common in the Chalk, and these can present significant difficulties to development on affected sites.

Man has also worked the chalk for flints, and for other purposes, for thousands of years and any signs of old workings should be carefully investigated.

5 General Site Description

The site was located to the north west of Pump Lane in Rainham, Gillingham. The site location is shown in Figure 1 attached.

The site area extended approximately 25ha and at the time of the investigation consisted apple orchards associated with Pump Farm.

6 Fieldwork

The site work was carried out on 28th October 2019, at which time the weather was dry with sunny spells. However, in the time leading up to the sitework there had been heavy rainfall.

The sitework comprised drilling 2 No. boreholes using a cable percussive rig. The boreholes were drilled in the locations as set out by the Clients engineer, to a depth of approximately 10m into the underlying chalk. The borehole locations are shown in Figure 2 attached.

Soakage testing was carried out in the chalk at a range of depths within each of the borehole. Each soakage test consisted a constant head test followed by a falling head test.

On completion of the boreholes, BH02 was installed with a 50mm diameter groundwater monitoring well comprising slotted pipe over the lowest 14m of the borehole, followed by plain pipe up to ground level. The perforated pipe was surrounded with pea shingle and the plain pipe surrounded with a bentonite seal. The installation was completed with a flush cover. BH01 was backfilled with arisings.

Details of the ground conditions encountered and the installation details are presented in the attached logs

7 Soils as Found

The soils encountered are described in detail in the attached exploratory hole logs, but in general comprised a covering of Topsoil/Made Ground over Chalk. A summary is given below.

Depth	Thickness	Soil Type	Description
GL to 0.5 (BH01 only)	0.5m	Topsoil	Brown, silty CLAY with rootlets
GL/0.5m to 0.6m/1.5m	0.6m to 1.0m	Made Ground	Dark brown/brown & brownish white, CLAY with gravel of chalk, brick, flint & sandstone.
0.6m/1.5m to 3.0m/6.5m	1.5m to 5.90m	Seaford Chalk	CHALK recovered as silty very gravelly CLAY or very clayey gravelly SILT with occasional flint cobbles.
3.0/6.5m to 11.0m/16.0m	8.0m+ to 9.50m+	Seaford Chalk	CHALK recovered as off-white, clayey very gravelly SILT with flint cobbles.

Please note cable percussive techniques destroy most of the structure of the chalk. Therefore, it is not usually possible to classify the chalk or log in any particular detail with this technique.

8 Groundwater Strikes

Water was struck in the exploratory holes as follows:

BH	Water Strikes
BH01	Wet soil from approximately 8.6m. Water struck at 9.5mbgl, rose to 9.25m after 30mins.
BH02	Wet soil from approximately 15mbgl. Water struck at 15.2m. Water at 15.16m on completion of installation.

Groundwater levels can vary considerably from season to season and year to year, often rising in wet or winter weather, and falling in periods of drought. As such, a high groundwater table may affect the storage capacity of soakaways. In addition, it should be noted that an unsaturated zone may be required between the base of soakaways and the groundwater table, by the Environment Agency.

A groundwater monitoring well was installed within BH02, as requested by the Clients engineer on the day of the investigation.

Subsequent groundwater monitoring visits are proposed to be carried out at the site.

9 Borehole Soakage Test Results

2 No. boreholes were drilled into the underlying chalk with 2-3 No. constant head soakage tests, followed by a falling head soakage test carried out within each borehole.

A summary of the results from the tests are shown in the tables below. The results of the falling head tests are appended.

Constant Head Soakage Results				
Position Number	Test Number	Depth of Borehole (mbgl)	Approximate soakage rate (l/min)	Comment
BH01	1	5.0	40	Head maintained at 2.0mbgl
	2	8.6	300	Head maintained at 2.0mbgl Soil becoming wet from 8.6m.
BH02	1	5	10	Head maintained at 2.0mbgl
	2	10	400	Head maintained at 2.0mbgl
	3	13	350	Head maintained at 2.0mbgl

Falling Head Soakage Results					
Position Number	Test Number	Depth of Borehole (mbgl)	Commencing test depth (mbgl)	Approximate soakage rate (l/m^2/min)	Approximate soakage rate BRE Units (m/sec)
BH01	1	5.0	2.75	5.62	9.37×10^{-5}
	2	8.6	4.70	2.80	4.67×10^{-5}
BH02	1	5	2.69	0.496	8.27×10^{-6}
	2	10	4.40	25.91	4.23×10^{-4}
	3	15	5.10	14.19	2.36×10^{-4}

It should be noted that the soakage rates are likely to decrease over time.

The results should be inspected by a drainage engineer to design a suitable drainage system with appropriate storage capacity.

Any soakaway scheme will require the approval of the Environment Agency, Building Control and, where applicable, the adopting Highways Authority.

If you have any queries or we can be of further assistance, please do not hesitate to contact us

Yours faithfully,

Vicky Francis BSc MSc FGS
For and on behalf of
Southern Testing Laboratories Limited
DDI: 01342 333 145
Email: vfrancis@southerntesting.co.uk

Encs

NB: Contains Ordnance Survey Data © Crown Copyright and Database Right 2017

Site: Pump & Bloors Farm Development, Rainham, ME8 7AT

STL: J14206

Fig No: 1

Date: 29 October 2019

Site Location Plan
(not to scale)

Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

ST Consult

NB: Positions of Boreholes are only indicative unless dimensioned. Base plan provided by Client.

Site: Pump & Bloors Farm Development, Rainham, ME8 7AT

STL: J14206

Fig No: 2

Date: 29 October 2019

Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

ST Consult

Site Investigation Plan
(Not to Scale)

www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020

Start - End Date	Project ID:	Hole Type:	BH01
28/10/2019	J14206	CP	Sheet 1 of 2

Project Name:	Pump & Bloors Farm Development	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					VF
Location:	Rainham, ME8 7AT				
Client:	A C Goatham & Son				

Wet soil from 8.6m. Water struck at approximately 9.5m, rose to 9.25m after 30mins.
Borehole collapsing on completion.

Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
		Depth (m bgl)	Type	Results					
						(0.50)		0.50	Grass over brown, silty CLAY with rootlets. TOPSOIL
						(1.00)		1.50	Brown & brownish white slightly gravelly CLAY. Gravel consists of chalk, flint and rare fine brick. MADE GROUND / REWORKED SOIL
						(1.50)		3.00	CHALK recovered as pale brownish white, silty sandy very gravelly CLAY with rare flint cobbles. Gravel is fine to coarse, subangular, weak, off-white with black speckles.
						(8.00)			CHALK recovered as off-white, clayey very gravelly SILT with occasional flint cobbles. Gravel is fine to coarse, angular to subangular, weak, white with black speckles.
									5.0m... constant head followed by falling head soakage test carried out.
									8.6m... soil becoming wet. constant head followed by falling head soakage test carried out.

Hole Details		Casing Details		Waterstrike (m bgl)						Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks
11.00	200			28-10-2019	9.50	1.50		9.25	30				

Southern Testing ST Consult

www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020

	Start - End Date	**Project ID:**	**Hole Type:**	**BH01**
	28/10/2019	J14206	CP	Sheet 2 of 2

Project Name:	Pump & Bloors Farm Development	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					VF
Location:	Rainham, ME8 7AT	Wet soil from 8.6m. Water struck at approximately 9.5m, rose to 9.25m after 30mins. Borehole collapsing on completion.			
Client:	A C Goatham & Son				

Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
		Depth (m bgl)	Type	Results					
								11.00	CHALK recovered as off-white, clayey very gravelly SILT with occasional flint cobbles. Gravel is fine to coarse, angular to subangular, weak, white with black speckles.
									End of Borehole at 11.00m

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Hole Details		**Casing Details**		**Waterstrike (m bgl)**						**Standing/Chiselling (m bgl)**			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks
11.00	200			28-10-2019	9.50	1.50		9.25	30				

Start - End Date	Project ID:	Hole Type:	BH02
28/10/2019	J14206	CP	Sheet 1 of 2

Project Name:	Pump & Bloors Farm Development	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					VF
Location:	Rainham, ME8 7AT	Wet soil from 15.0m. Water struck at 15.2m. At 15.16m on completion of installation.			
Client:	A C Goatham & Son				

Well	Water Strikes	Samples and Insitu Testing: Depth (m bgl)	Type	Results	Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
						(0.60)		0.60	Dark brown, silty sandy CLAY with rootlets and gravel of fine to coarse brick, sandstone & chalk. Sand is fine. MADE GROUND
						(5.90)		6.50	CHALK recovered as pale brownish white, very clayey gravelly SILT with flint cobbles. Gravel is fine to coarse, angular to subangular, off-white with black speckles. *5.0m... constant head followed by falling head soakage test carried out.*
									CHALK recovered as off-white, clayey very gravelly SILT with flint cobbles. Gravel is fine to coarse, angular to subangular, weak, white with black speckles.

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Hole Details		Casing Details		Waterstrike (m bgl)						Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks
16.00	200			28-11-2019	15.20	1.50		15.16	30				

Southern Testing ST Consult

www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020

Start - End Date	Project ID:	Hole Type:	BH02
28/10/2019	J14206	CP	Sheet 2 of 2

Project Name: Pump & Bloors Farm Development

Location: Rainham, ME8 7AT

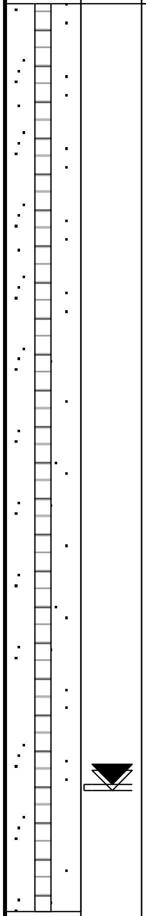
Client: A C Goatham & Son

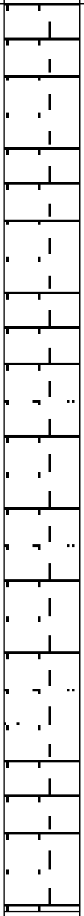
Remarks:

Co-ordinates:	Level:	Logger:
		VF

Wet soil from 15.0m. Water struck at 15.2m. At 15.16m on completion of installation.

Well	Water Strikes	Samples and Insitu Testing Depth (m bgl)	Type	Results	Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
						(9.50)		16.00	CHALK recovered as off-white, clayey very gravelly SILT with flint cobbles. Gravel is fine to coarse, angular to subangular, weak, white with black speckles. *10.0m... constant head followed by falling head soakage test carried out.* *13.0m... constant head followed by falling head soakage test carried out.* *15.0m... soil becoming wet.*
									End of Borehole at 16.00m





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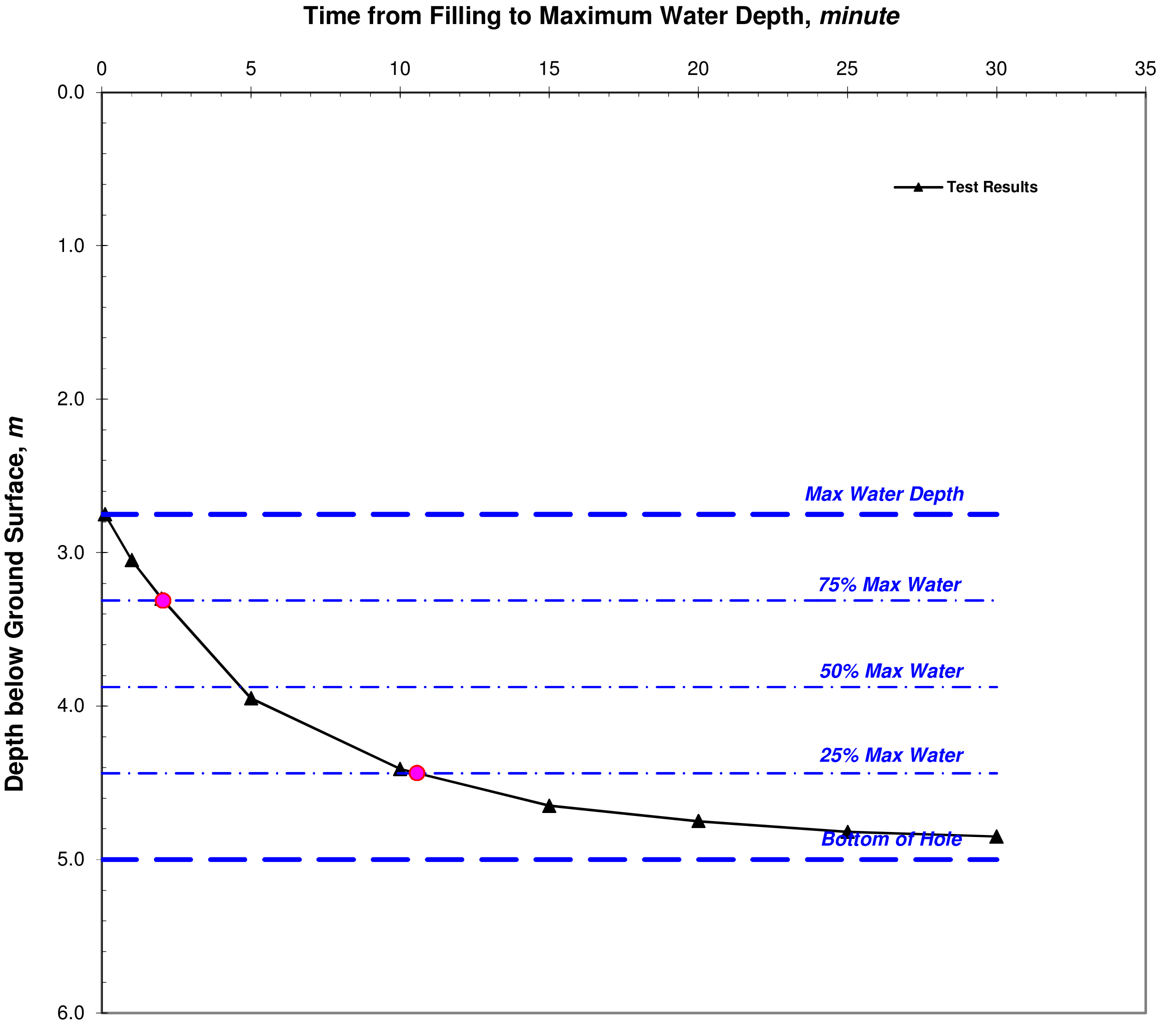
Hole Details		Casing Details		Waterstrike (m bgl)						Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks
16.00	200			28-11-2019	15.20	1.50		15.16	30				

Falling-Head Soakage Test

Test Hole No: BH01-1
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.200	Depth to Water at Start of Test, *m*	2.750
Depth to End of Borehole Casing, m	1.500	Max Water Dropdown during Test, *m*	2.100
Depth to Borehole Base, m	5.000	Total Soakage Test Time, *min*	30.0
Depth to Top of Permeable Soils, *m*		Mean Internal Discharge Area, m^2	0.738
Depth to Groundwater Surface, *m*		Discharge Rate, *litre/min*	4.151
Depth to Top of Granular Fill, *m*		Soakage Rate, *litre/*m^2*/min*	**5.62**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, *m/sec*	**9.37E-05**

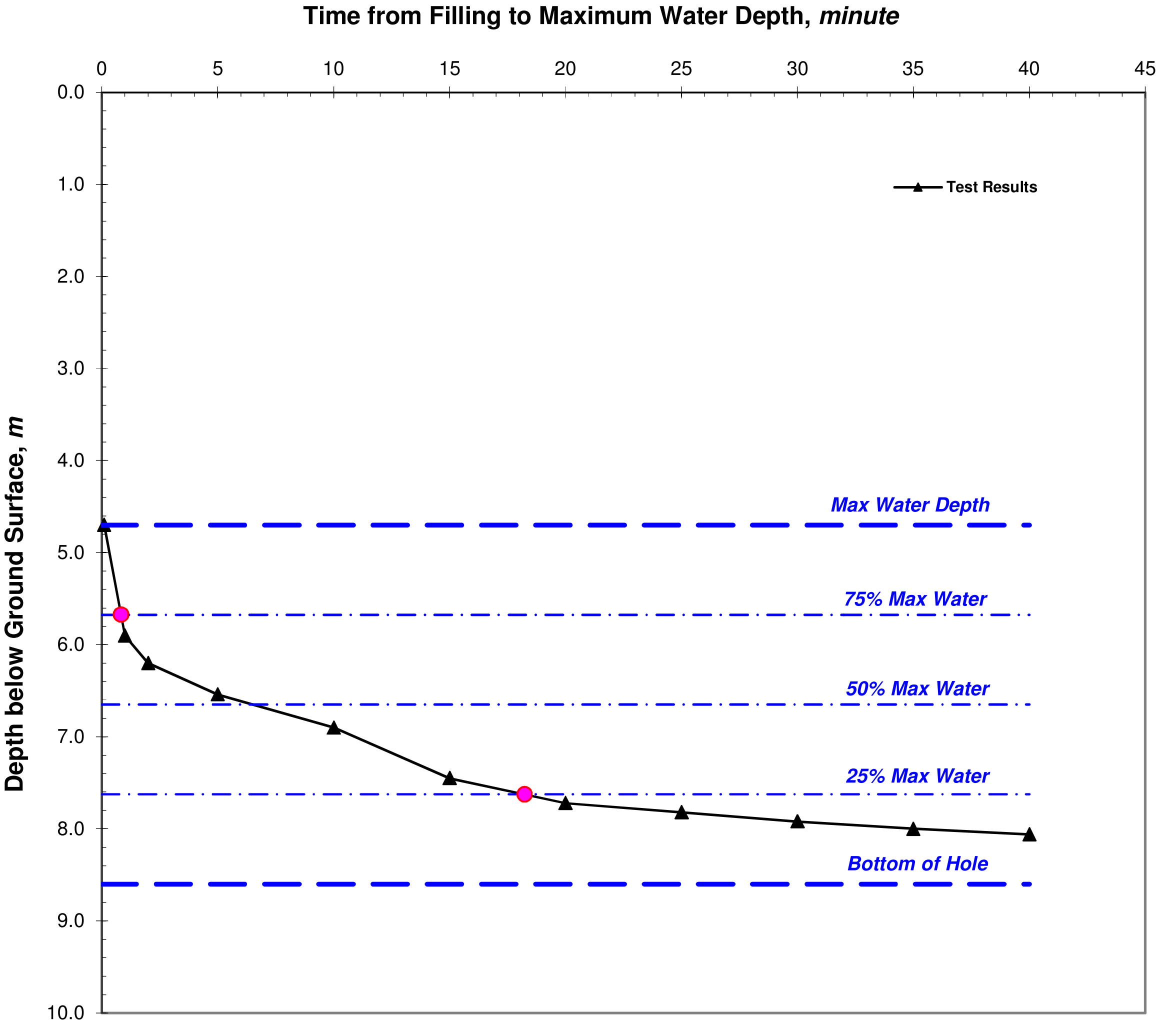
Comments:

Pit was nearly emptied at finish of test.

Client: AC Goatham & Son	**Job No:**	J14206	**Test Date:**	28/Oct/2019		
Site: Pump & Bloors Farm Development	**Tested By:**	AA/OS	**Engineer:**	VF	**Fig. S1**	

Falling-Head Soakage Test

Test Hole No: BH01-2
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.200	Depth to Water at Start of Test, *m*	4.700
Depth to End of Borehole Casing, m	1.500	Max Water Dropdown during Test, *m*	3.360
Depth to Borehole Base, m	8.600	Total Soakage Test Time, *min*	40.0
Depth to Top of Permeable Soils, *m*		Mean Internal Discharge Area, m^2	1.257
Depth to Groundwater Surface, *m*		Discharge Rate, *litre/min*	3.519
Depth to Top of Granular Fill, *m*		Soakage Rate, *litre/m^2/min*	**2.80**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, *m/sec*	**4.67E-05**

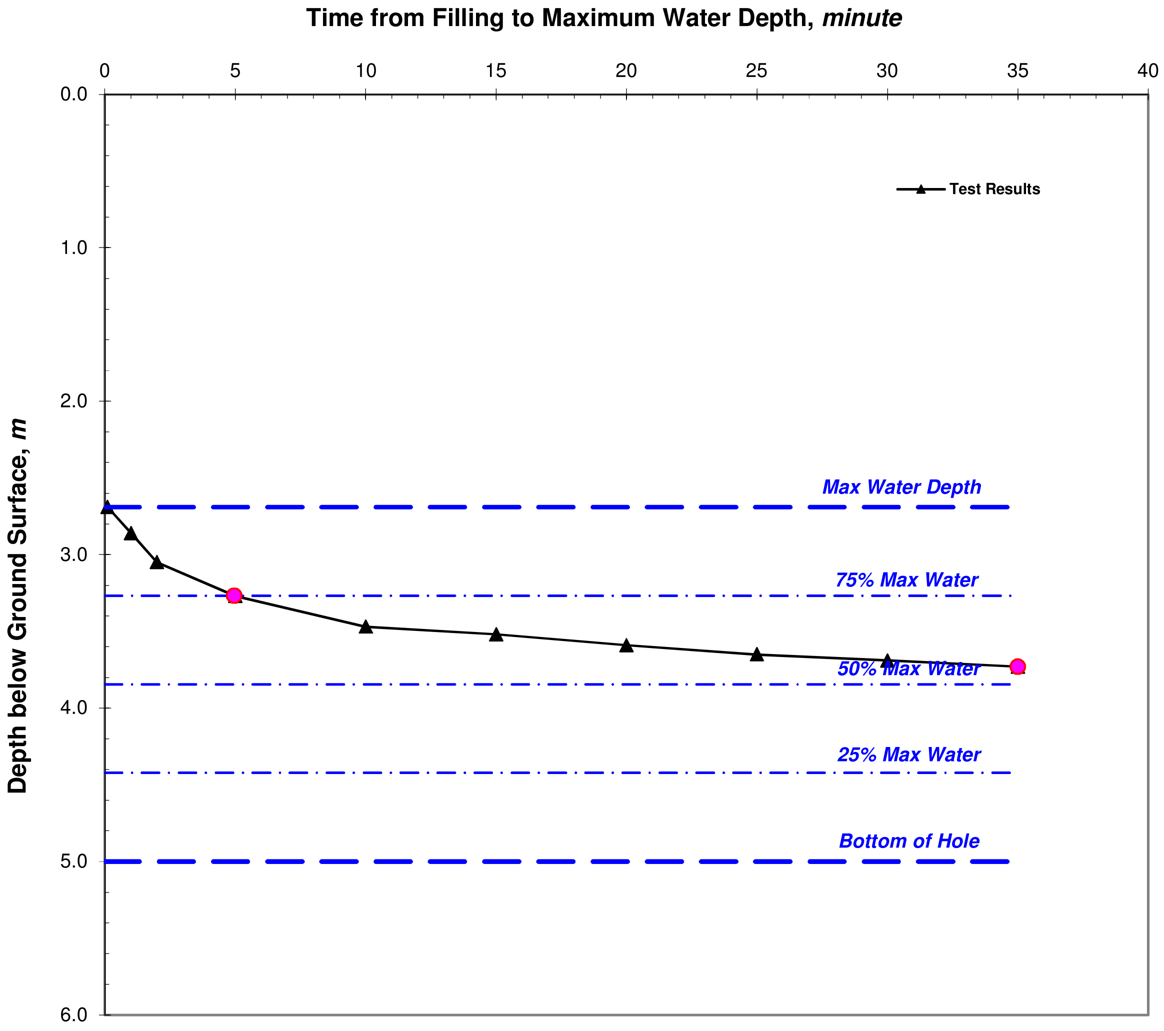
Comments:

Pit was nearly emptied at finish of test.

Client: AC Goatham & Son		**Job No:** J14206		**Test Date:** 28/Oct/2019	
Site: Pump & Bloors Farm Development		**Tested By:** AA/OS		**Engineer:** VF	**Fig. S2**

Falling-Head Soakage Test

Test Hole No: BH02-1
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.200	Depth to Water at Start of Test, *m*	2.690
Depth to End of Borehole Casing, m	1.500	Max Water Dropdown during Test, *m*	1.040
Depth to Borehole Base, m	5.000	Total Soakage Test Time, *min*	35.0
Depth to Top of Permeable Soils, *m*		Mean Internal Discharge Area, m^2	0.975
Depth to Groundwater Surface, *m*		Discharge Rate, *litre/min*	0.484
Depth to Top of Granular Fill, *m*		Soakage Rate, $litre/m^2/min$	**0.496**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, *m/sec*	**8.27E-06**

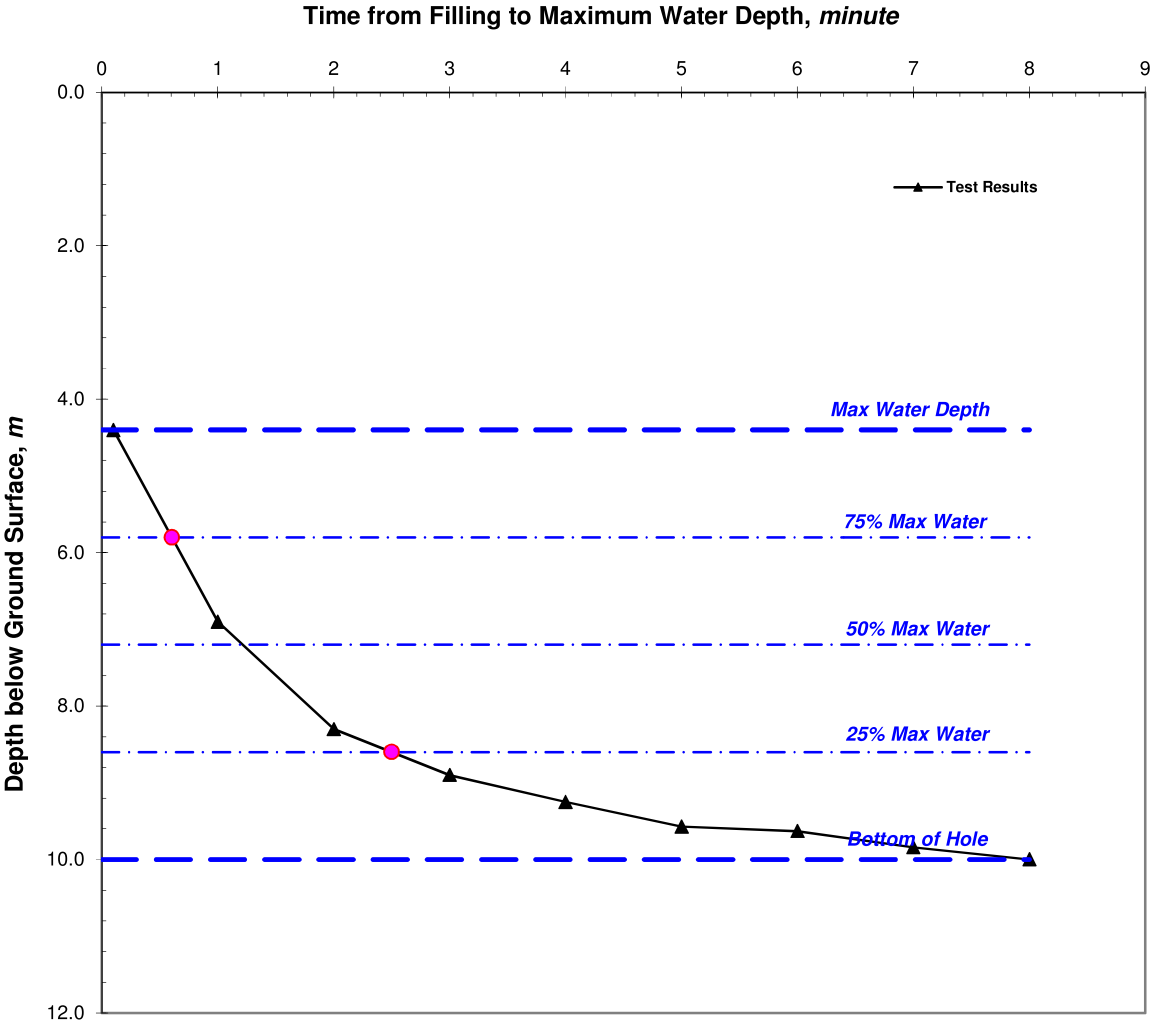
Comments:

Water level fell to 75% -- 50% max water depth, calculations were based on actual fall of water level achieved.
Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: AC Goatham & Son	**Job No:** J14206	**Test Date:** 28/Oct/2019	
Site: Pump & Bloors Farm Development	**Tested By:** AA/OS	**Engineer:** VF	**Fig. S3**

Falling-Head Soakage Test

Test Hole No: BH02-2
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.200	Depth to Water at Start of Test, *m*	4.400
Depth to End of Borehole Casing, m	1.500	Max Water Dropdown during Test, *m*	5.600
Depth to Borehole Base, m	10.000	Total Soakage Test Time, *min*	8.0
Depth to Top of Permeable Soils, *m*		Mean Internal Discharge Area, *m*^{2}	1.791
Depth to Groundwater Surface, *m*		Discharge Rate, *litre/min*	46.395
Depth to Top of Granular Fill, *m*		Soakage Rate, *litre/m*^{2}*/min*	**25.91**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, *m/sec*	**4.32E-04**

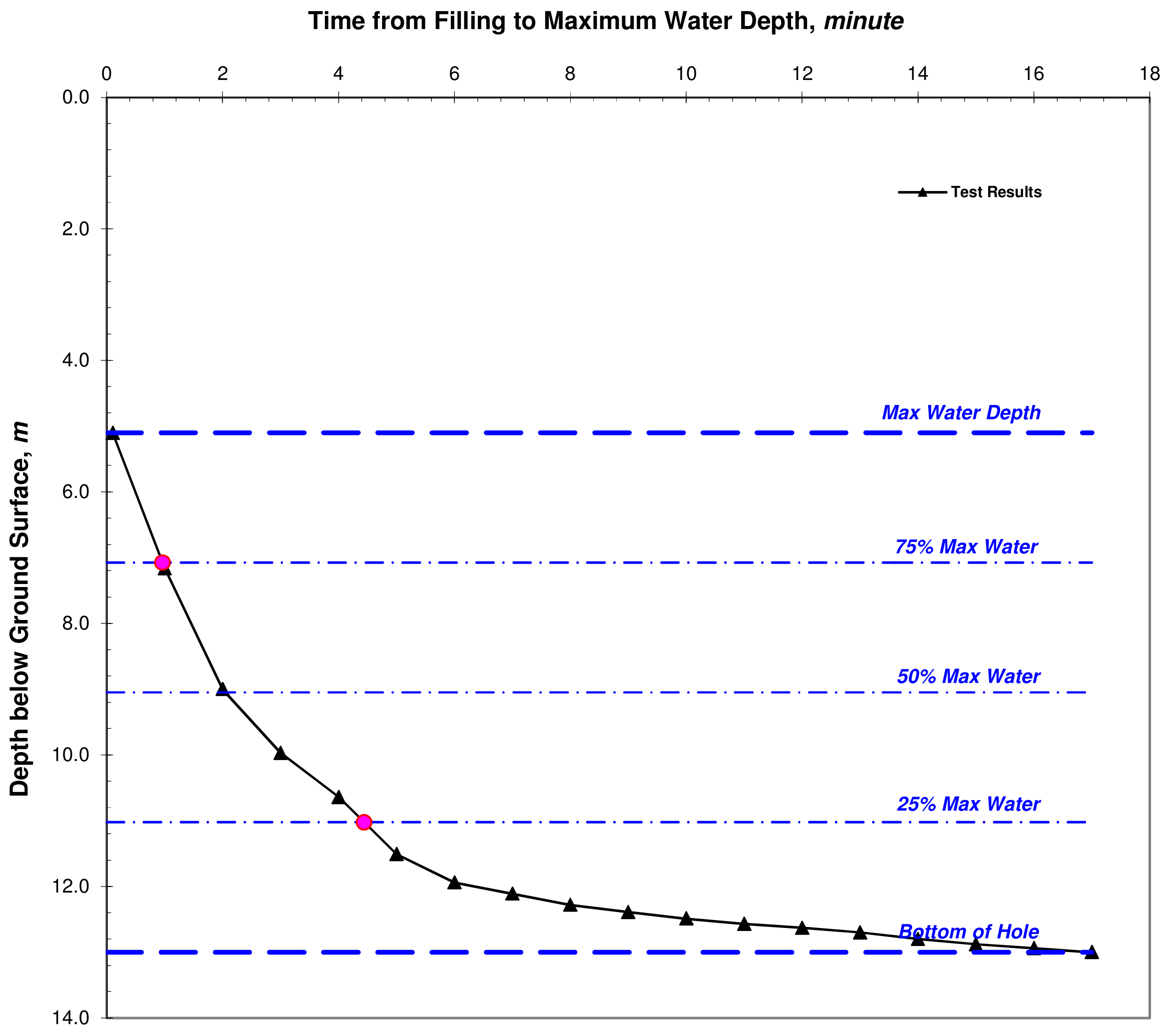
Comments:

Pit was emptied at finish of test.

Client: AC Goatham & Son	**Job No:** J14206	**Test Date:** 28/Oct/2019	
Site: Pump & Bloors Farm Development	**Tested By:** AA/OS	**Engineer:** VF	**Fig. S4**

Falling-Head Soakage Test

Test Hole No: BH02-3
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.200	Depth to Water at Start of Test, *m*	5.100
Depth to End of Borehole Casing, m	1.500	Max Water Dropdown during Test, *m*	7.900
Depth to Borehole Base, m	13.000	Total Soakage Test Time, *min*	17.0
Depth to Top of Permeable Soils, *m*		Mean Internal Discharge Area, m^2	2.513
Depth to Groundwater Surface, *m*		Discharge Rate, *litre/min*	35.662
Depth to Top of Granular Fill, *m*		Soakage Rate, *litre/m^2/min*	**14.19**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, *m/sec*	**2.36E-04**

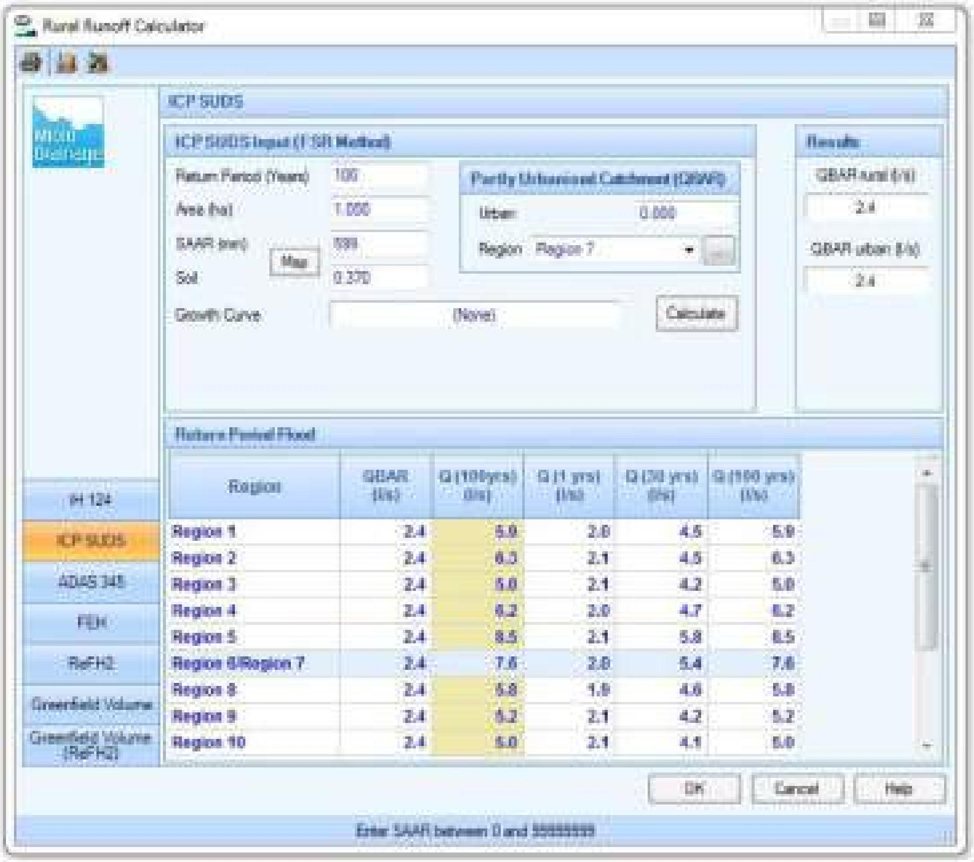
Comments:

Pit was emptied at finish of test.

Client: AC Goatham & Son	**Job No:** J14206	**Test Date:** 28/Oct/2019	
Site: Pump & Bloors Farm Development	**Tested By:** AA/OS	**Engineer:** VF	**Fig. S5**

Appendix D – Drainage Calculations

PUMP AND BLOORS FARM
GREENFIELD RUNOFF RATE



ICP SUDS Input (FSR Method)

Return Period (Years) 100

Area (ha) 1.000

SAAR (mm) 599

Soil 0.370

Growth Curve (None)

Partly Urbanised Catchment (QBAR)

Urban 0.000

Region Region 7

Results

QBAR rural (l/s) 2.4

QBAR urban (l/s) 2.4

Return Period Flood

Region	QBAR (l/s)	Q (100yrs) (l/s)	Q (1 yrs) (l/s)	Q (30 yrs) (l/s)	Q (100 yrs) (l/s)
Region 1	2.4	5.9	2.0	4.5	5.9
Region 2	2.4	6.3	2.1	4.5	6.3
Region 3	2.4	5.0	2.1	4.2	5.0
Region 4	2.4	6.2	2.0	4.7	6.2
Region 5	2.4	8.5	2.1	5.8	8.5
Region 6/Region 7	2.4	7.6	2.0	5.4	7.6
Region 8	2.4	5.8	1.9	4.6	5.8
Region 9	2.4	5.2	2.1	4.2	5.2
Region 10	2.4	5.0	2.1	4.1	5.0

Enter SAAR between 0 and 99999999

CALCULATIONS

Soakaway Drainage Calculations

The soakaway drainage calculations have been carried out based on the infiltration rates estimated by Southern Testing Laboratories Ltd (see **Appendix C**) and in accordance with the guidance set out in the KCC's Soakaway Design Guide (2000). These test results indicate that the infiltration rate of the chalk layer is generally in excess of 1 x 10^{-5} m/s, which proves that infiltration is a suitable surface water drainage solution for the Site.

<table>
<tr><td colspan="9">ESTIMATED INFILTRATION RATE OF 8.0m DEEP BORE SOAKAWAY BASED ON FIELD RESULTS OF BOREHOLE BH01</td></tr>
<tr><td>Depth to Base of Liner (mBGL)</td><td>Increment of Discharge (mBGL)</td><td>Maximum Driving Head (m) (v)</td><td>Area of Exposed Chalk (m^2) (iv)</td><td>Unit Field Soakage Rate (l/m^2/min) (v)</td><td>Unit Design Soakage Rate (l/m^2/min) (vi)</td><td>Increments of Available Discharge (l/min)</td><td>Total available discharge (l/min)</td><td>Total available discharge (l/sec)</td></tr>
<tr><td>5</td><td>3.5 to 5</td><td>4.25</td><td>1.18</td><td>5.62</td><td>2.81</td><td>3.316</td><td>3.316</td><td>0.055</td></tr>
<tr><td rowspan="2">8</td><td>3.5 to 5</td><td>4.25</td><td>1.18</td><td>5.62</td><td>2.81</td><td>3.316</td><td rowspan="2">8.561</td><td rowspan="2">0.143</td></tr>
<tr><td>5 to 8</td><td>6.50</td><td>2.36</td><td>4.45</td><td>2.22</td><td>5.245</td></tr>
<tr><td>Notes</td><td colspan="8">(i) It is assumed that Soakaway MHs will be 1.5m deep and that the non-perforated liner of the deep soakaway will penetrate 2.0m into the soakage medium</td></tr>
<tr><td></td><td colspan="8">(ii) It is proposed that the deep bore soakaways are 0.25m in diameter (0.125m radius) and bottom of liner is 8.0m BGL (length within chalk layer limited to 6.5m)</td></tr>
<tr><td></td><td colspan="8">(iii) It is proposed that the clearance between the bottom of the deep bore soakaway liner and the recorded ground water is 1.0m</td></tr>
<tr><td></td><td colspan="8">(iv) This relatest to the borehole diameter and not liner diameter (1.18m^2 = 2 x π x 0.125m x 1.5m increment) OR (2.36m^2 = 2 x π x 0.125m x 3m increment)</td></tr>
<tr><td></td><td colspan="8">(v) The unit field soakage rates have been interpolated between two field increments to get the unit field soakage rate at the driving head</td></tr>
<tr><td></td><td colspan="8">(vi) A safety factor of 2 has been considered to estimate the unit design soakage rate (Unit Design Soakage Rate = Unit Field Soakage Rate / 2)</td></tr>
<tr><td></td><td colspan="8">(vii) It is assumed that the cover of the deep bore soakaway manholes will be open grating at allow ingress of surface water runoff into the manhole</td></tr>
</table>

CALCULATIONS

ESTIMATED INFILTRATION RATE OF 14.0m DEEP BORE SOAKAWAY BASED ON FIELD RESULTS OF BOREHOLE BH02								
Depth to Base of Liner (mBGL)	Increment of Discharge (mBGL)	Maximum Driving Head (m) (v)	Area of Exposed Chalk (m²) (iv)	Unit Field Soakage Rate (l/m²/min) (v)	Unit Design Soakage Rate (l/m²/min) (vi)	Increments of Available Discharge (l/min)	Total available discharge (l/min)	Total available discharge (l/sec)
5	3.5 to 5	4.25	1.18	0.49	0.25	0.289	0.289	0.005
8	3.5 to 5	4.25	1.18	0.49	0.25	0.289	9.871	0.165
	5 to 8	6.50	2.36	8.12	4.06	9.582		
11	3.5 to 5	4.25	1.18	0.49	0.25	0.289	37.446	0.624
	5 to 8	6.50	2.36	8.12	4.06	9.582		
	8 to 11	9.50	2.36	23.37	11.68	27.575		
14	3.5 to 5	4.25	1.18	0.49	0.25	0.289	61.105	1.018
	5 to 8	6.50	2.36	8.12	4.06	9.582		
	8 to 11	9.50	2.36	23.37	11.68	27.575		
	11 to 14	12.50	2.36	20.05	10.03	23.659		
Notes	(i) It is assumed that Soakaway MHs will be 1.5m deep and that the non-perforated liner of the deep soakaway will penetrate 2.0m into the soakage medium							
	(ii) It is proposed that the deep bore soakaways are 0.25m in diameter (0.125m radius) and bottom of liner is 14.0m BGL (length within chalk layer limited to 6.5m)							
	(iii) It is proposed that the clearance between the bottom of the deep bore soakaway liner and the recorded ground water is 1.0m							
	(iv) This relatest to the borehole diameter and not liner diameter (1.18m² = 2 x π x 0.125m x 1.5m increment) OR (2.36m² = 2 x π x 0.125m x 3m increment)							
	(v) The unit field soakage rates have been interpolated between two field increments to get the unit field soakage rate at the driving head							
	(vi) A safety factor of 2 has been considered to estimate the unit design soakage rate (Unit Design Soakage Rate = Unit Field Soakage Rate / 2)							
	(vii) It is assumed that the cover of the deep bore soakaway manholes will be open grating at allow ingress of surface water runoff into the manhole							

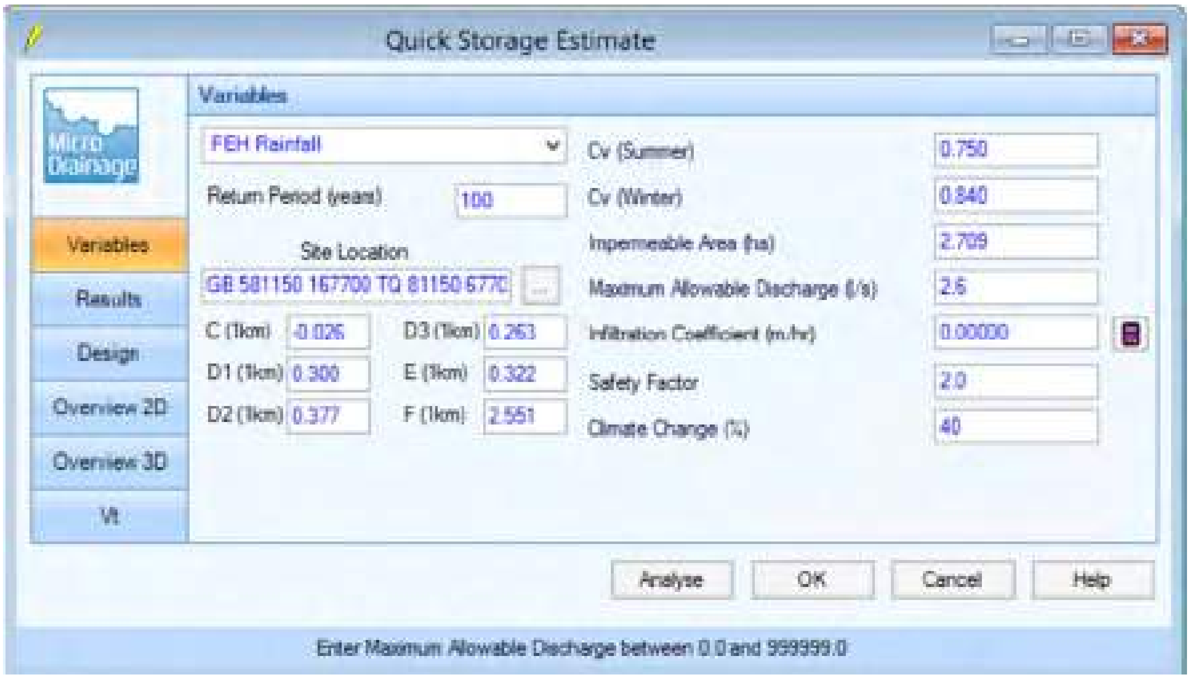
CALCULATIONS

Surface Water Attenuation Requirements

1 in 100 (1%) Annual Probability event plus 40% Climate Change Event

Catchment A1

Average Volume of Attenuation = 3588 + 4331 = 3960m³



Variables

FEH Rainfall

Return Period (years) 100

Site Location GB 581150 167700 TQ 81150 6770

C (1km) -0.026

D1 (1km) 0.300

D2 (1km) 0.377

D3 (1km) 0.263

E (1km) 0.322

F (1km) 2.551

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 2.709

Maximum Allowable Discharge (l/s) 2.6

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 40

Enter Maximum Allowable Discharge between 0.0 and 999999.0

Results

Global Variables require approximate storage of between 3588 m³ and 4331 m³.

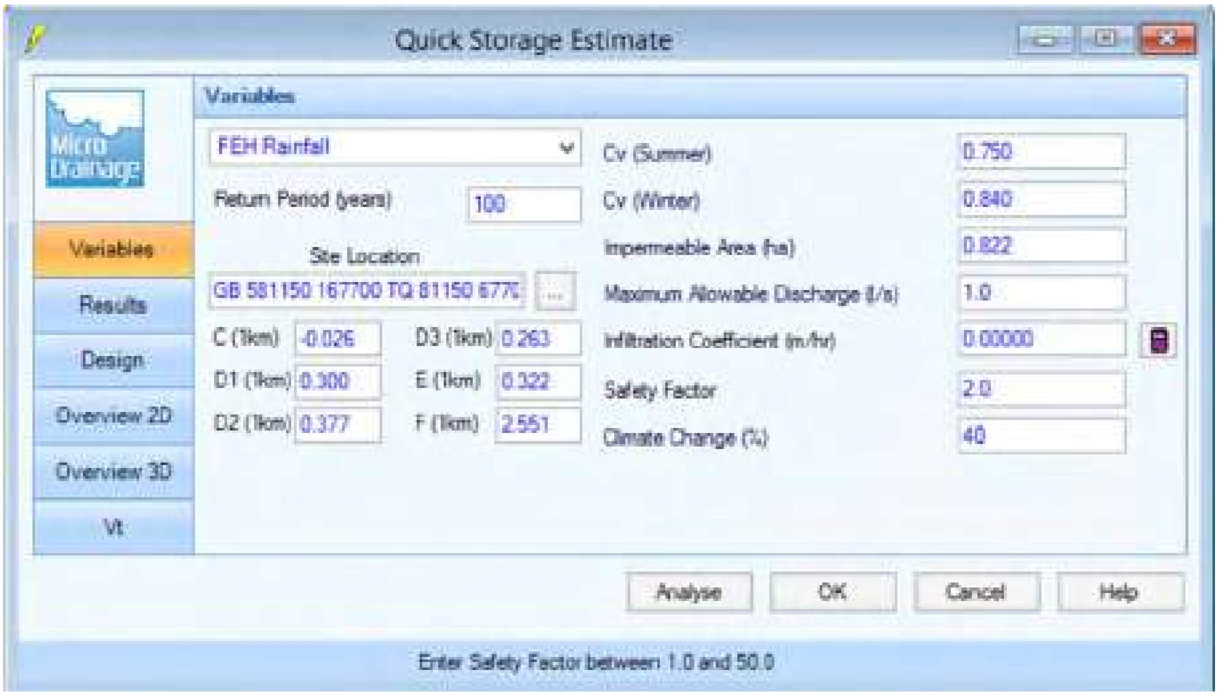
These values are estimates only and should not be used for design purposes.

Enter Maximum Allowable Discharge between 0.0 and 999999.0

CALCULATIONS

Catchment A2

Average Volume of Attenuation = 1047 + 1277 = 1162m³



Variables

FEH Rainfall

Return Period (years) 100

Site Location GB 581150 167700 TQ 81150 677

C (1km) -0.026

D1 (1km) 0.300

D2 (1km) 0.377

D3 (1km) 0.263

E (1km) 0.322

F (1km) 2.551

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 0.822

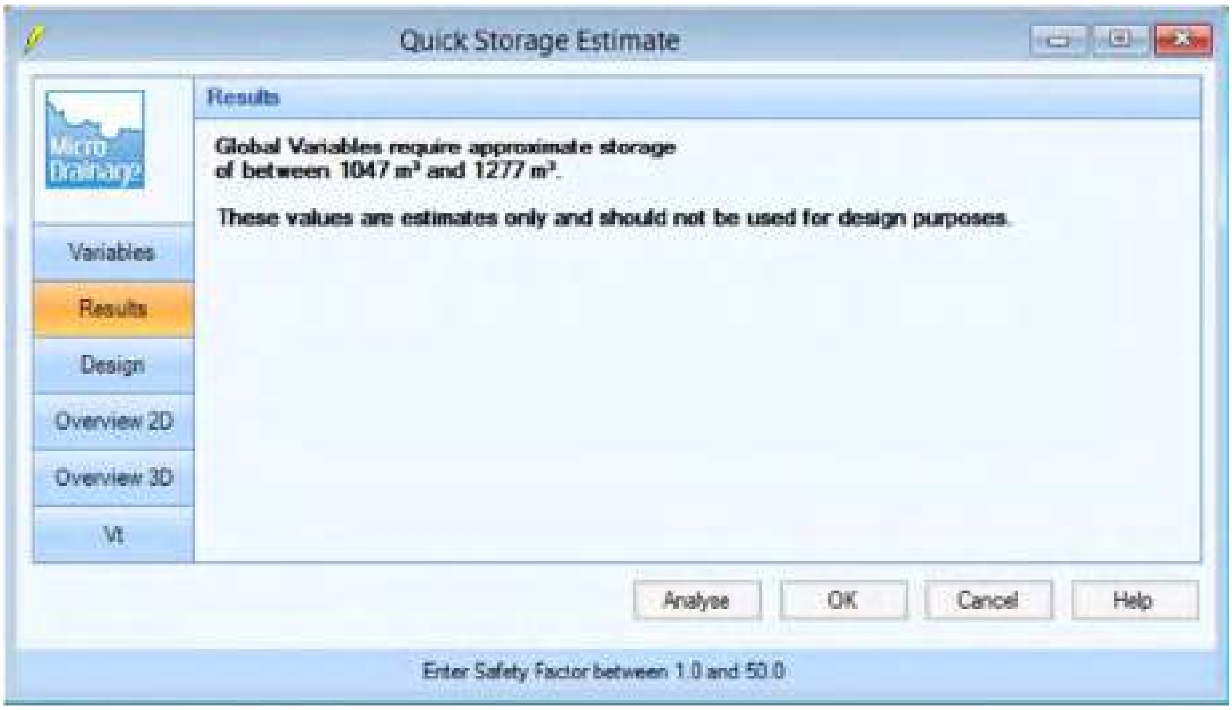
Maximum Allowable Discharge (l/s) 1.0

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 40

Enter Safety Factor between 1.0 and 50.0



Results

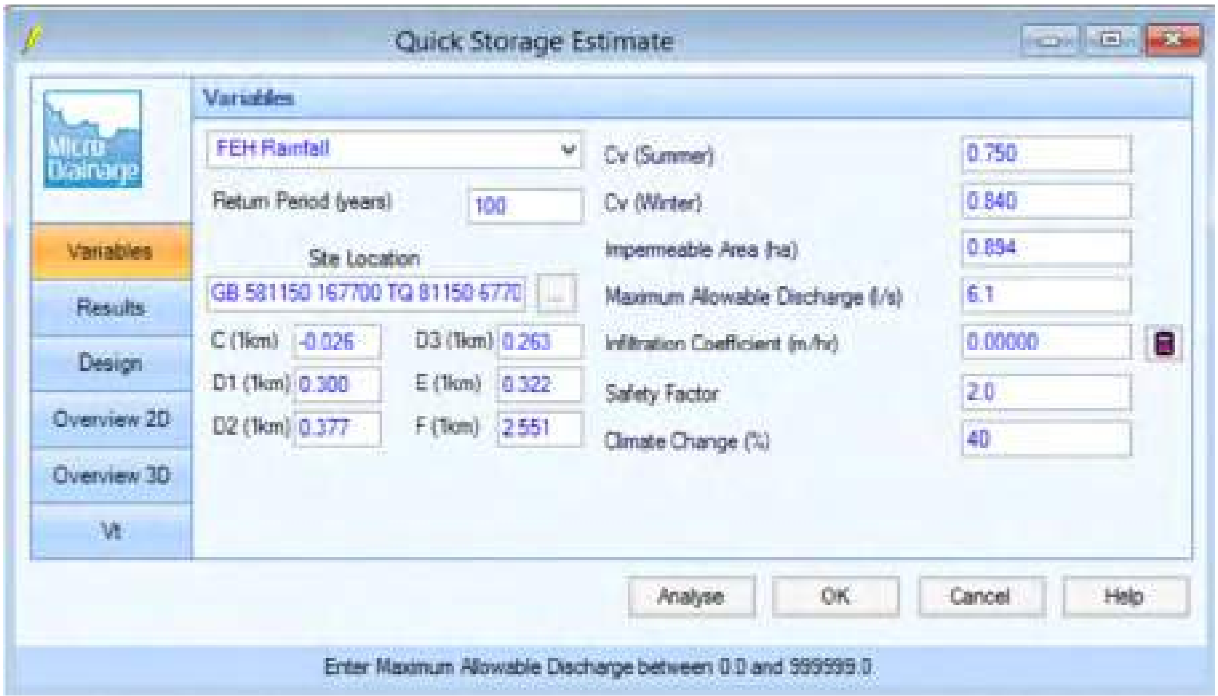
Global Variables require approximate storage of between 1047 m³ and 1277 m³.

These values are estimates only and should not be used for design purposes.

Enter Safety Factor between 1.0 and 50.0

Catchment B1(a)

Average Volume of Attenuation = 689 + 1014 = 851m³



Variables

FEH Rainfall

Return Period (years): 100

Site Location: GB 581150 167700 TQ 81150 6770

C (1km): -0.026

D1 (1km): 0.300

D2 (1km): 0.377

D3 (1km): 0.263

E (1km): 0.322

F (1km): 2.551

Cv (Summer): 0.750

Cv (Winter): 0.840

Impermeable Area (ha): 0.894

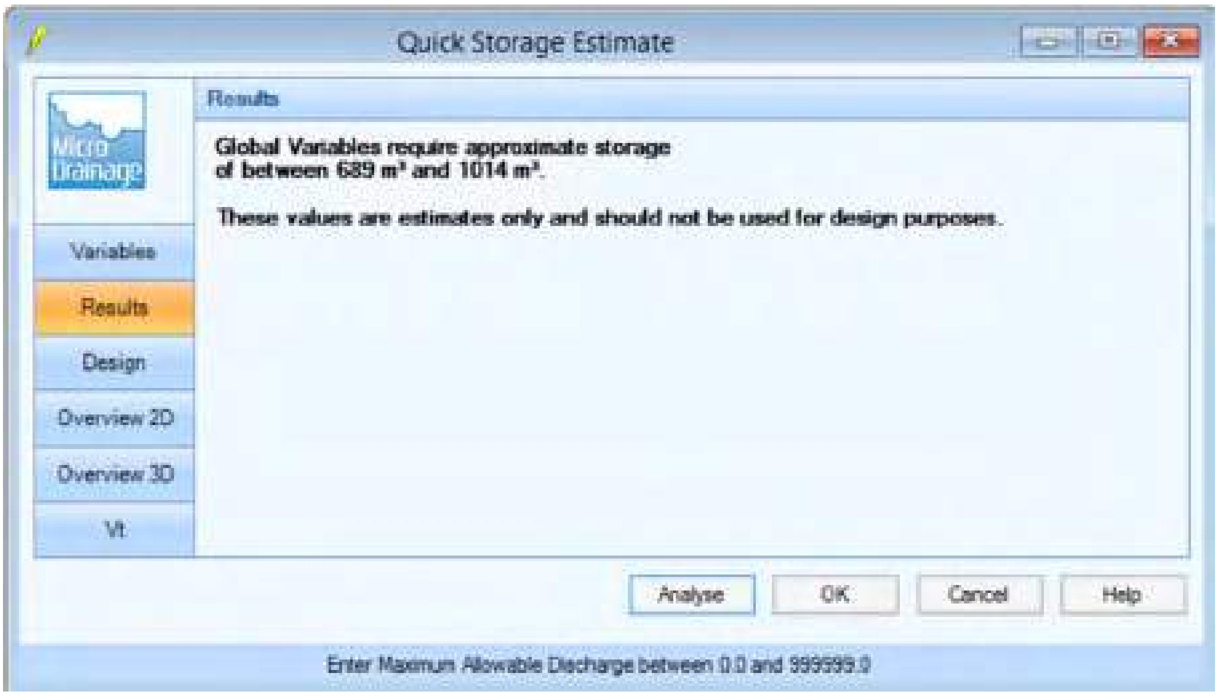
Maximum Allowable Discharge (l/s): 6.1

Infiltration Coefficient (m/hr): 0.00000

Safety Factor: 2.0

Climate Change (%): 40

Enter Maximum Allowable Discharge between 0.0 and 999999.0



Results

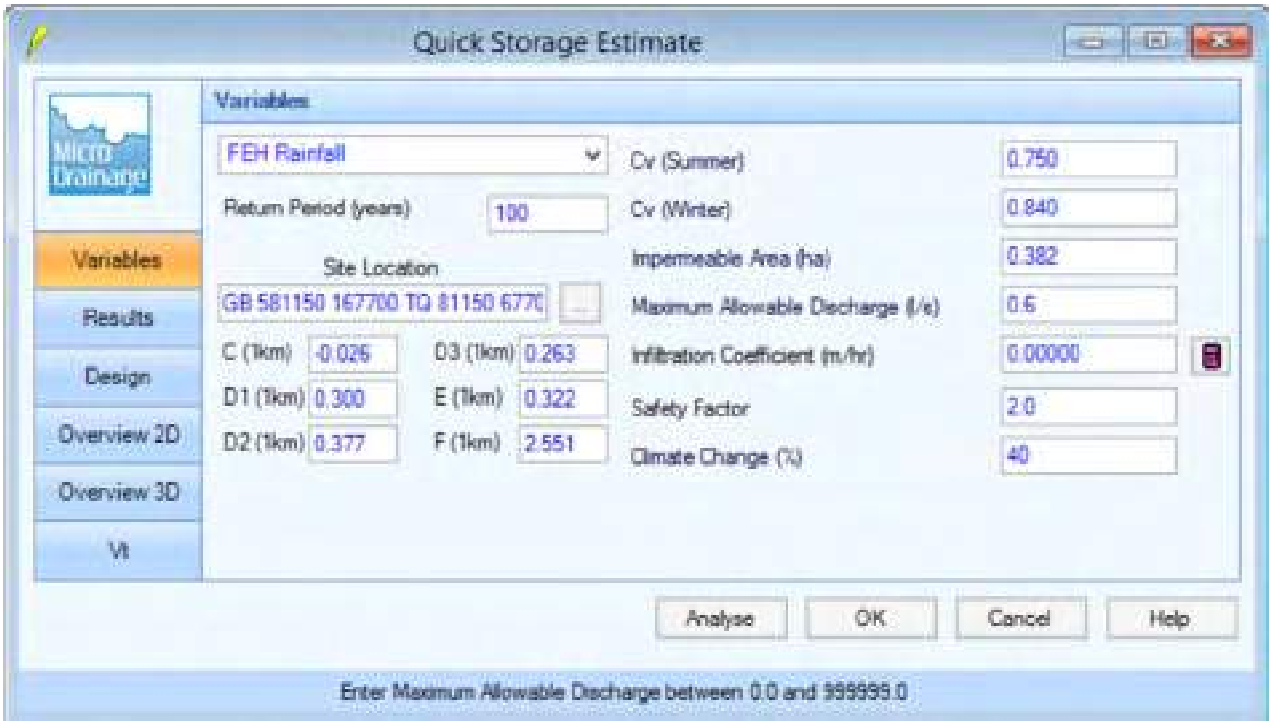
Global Variables require approximate storage of between 689 m³ and 1014 m³.

These values are estimates only and should not be used for design purposes.

Enter Maximum Allowable Discharge between 0.0 and 999999.0

Catchment B1(b)

Average Volume of Attenuation = 464 + 570 = 517m³



Variables

FEH Rainfall

Return Period (years) 100

Site Location GB 581150 167700 TQ 81150 677(

C (1km) -0.026

D1 (1km) 0.300

D2 (1km) 0.377

D3 (1km) 0.263

E (1km) 0.322

F (1km) 2.551

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 0.382

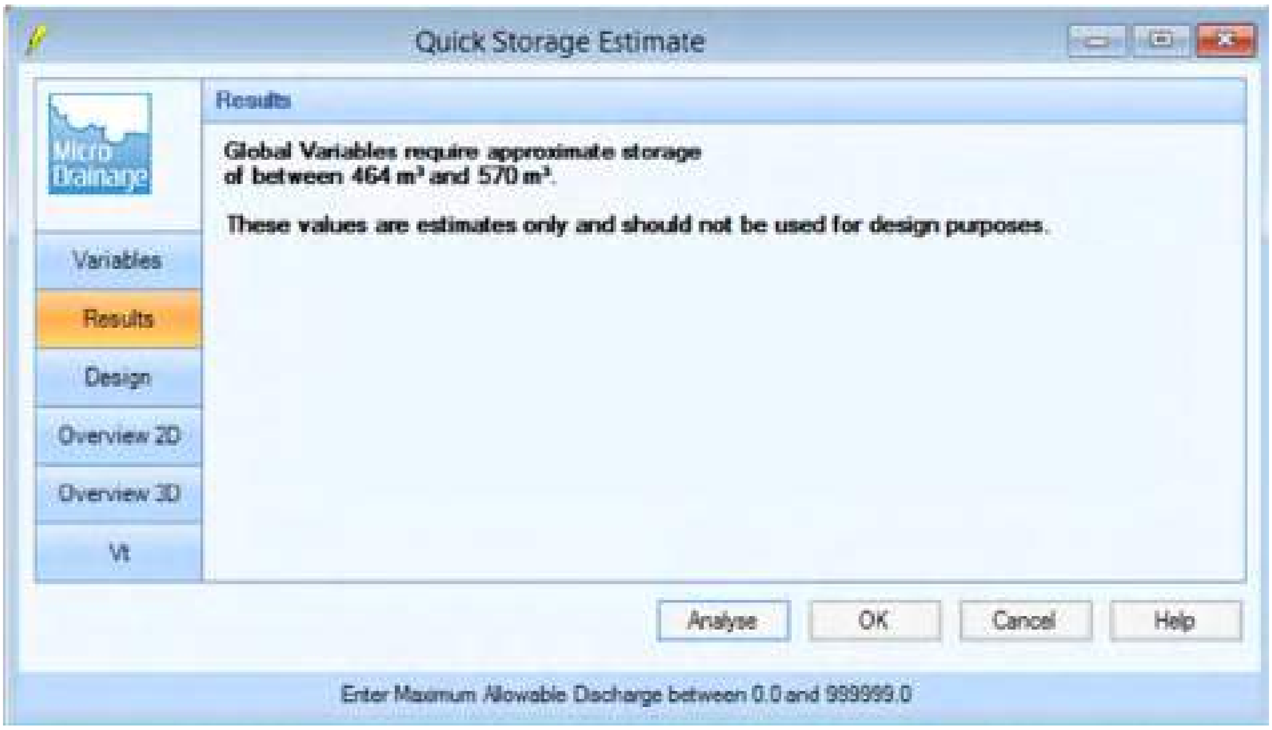
Maximum Allowable Discharge (l/s) 0.6

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 40

Enter Maximum Allowable Discharge between 0.0 and 999999.0



Results

Global Variables require approximate storage of between 464 m³ and 570 m³.

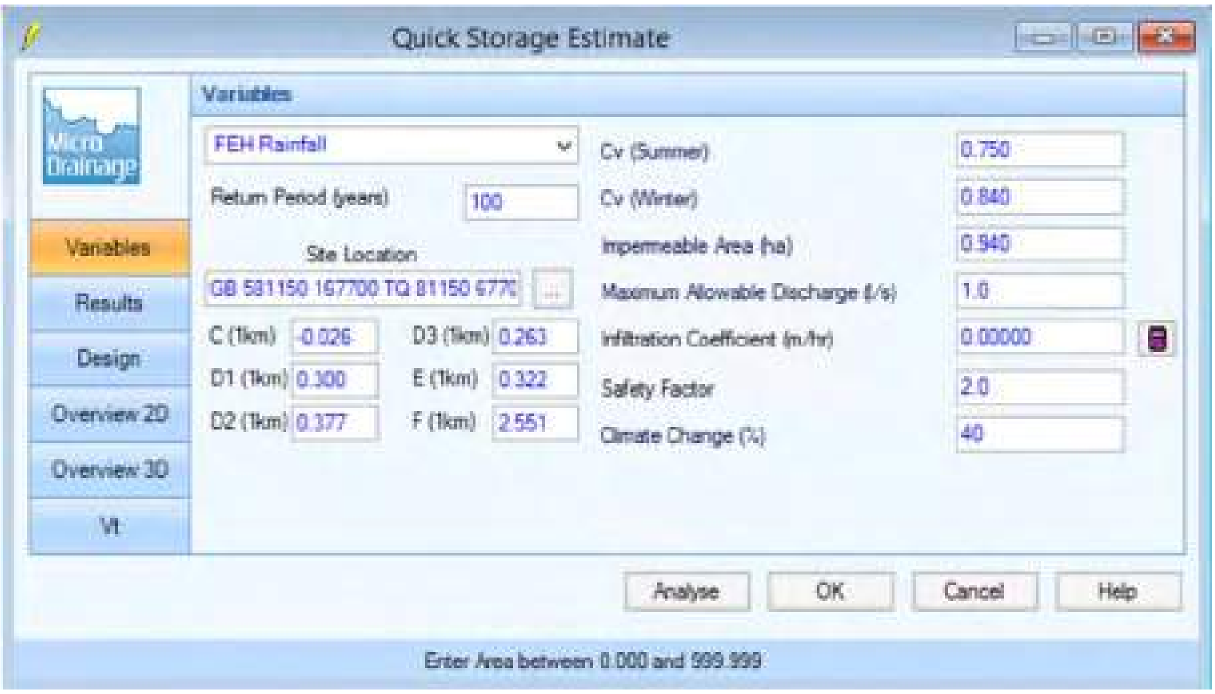
These values are estimates only and should not be used for design purposes.

Enter Maximum Allowable Discharge between 0.0 and 999999.0

CALCULATIONS

Catchment B2

Average Volume of Attenuation = 1221 + 1486 = 1353m³



Variables

FEH Rainfall

Return Period (years) 100

Site Location GB 581150 167700 TQ 81150 677

C (1km) -0.026

D1 (1km) 0.300

D2 (1km) 0.377

D3 (1km) 0.263

E (1km) 0.322

F (1km) 2.551

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 0.940

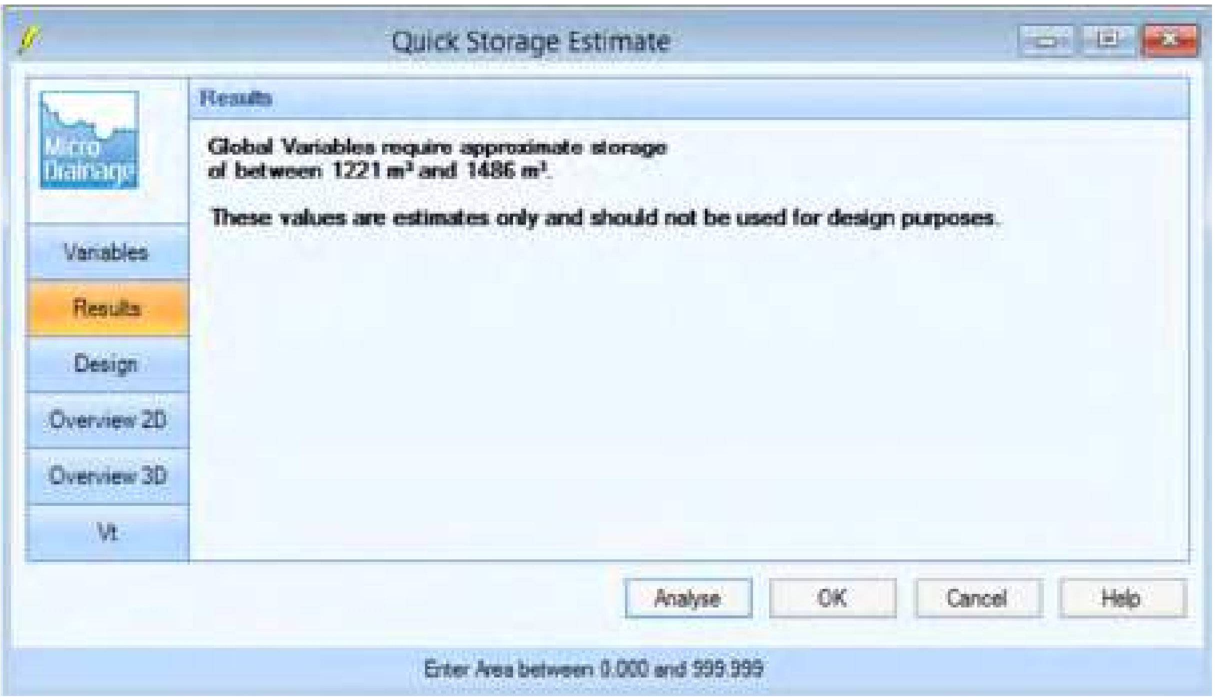
Maximum Allowable Discharge (l/s) 1.0

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 40

Enter Area between 0.000 and 999.999



Results

Global Variables require approximate storage of between 1221 m³ and 1486 m³.

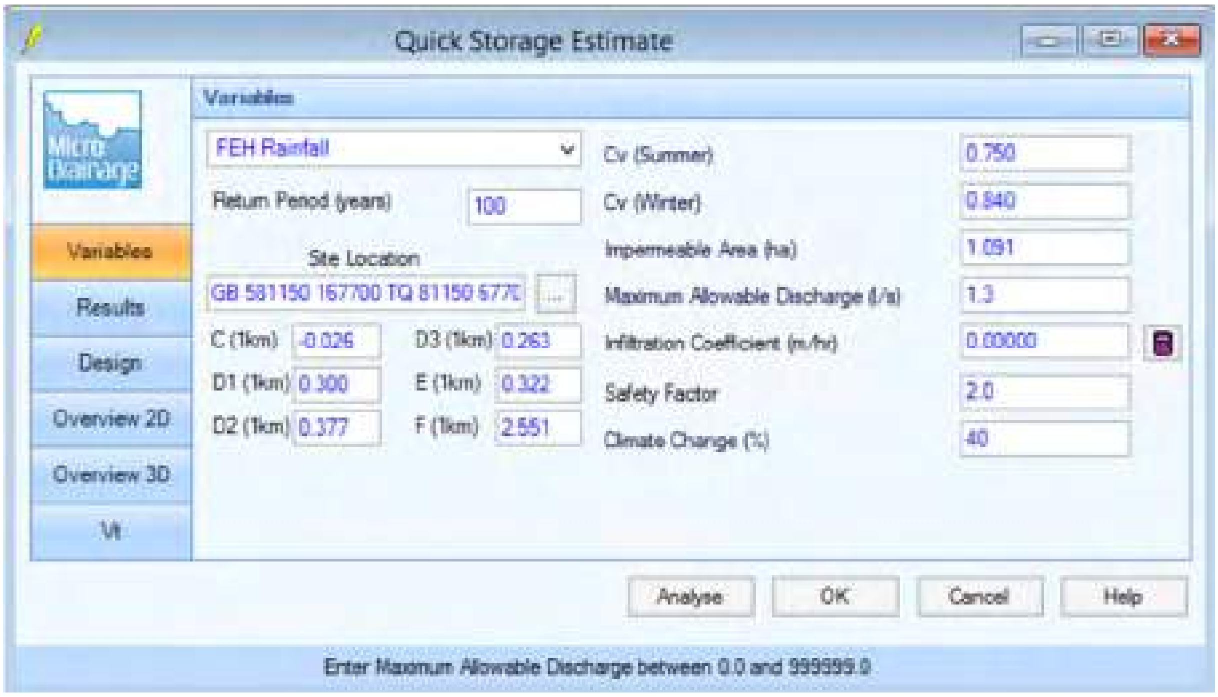
These values are estimates only and should not be used for design purposes.

Enter Area between 0.000 and 999.999

CALCULATIONS

Catchment B3 (incl. Care)

Average Volume of Attenuation = 1394 + 1700 = 1547m³



Variables

FEH Rainfall

Return Period (years) 100

Site Location GB 581150 167700 TQ 81150 677

C (1km) -0.026

D1 (1km) 0.300

D2 (1km) 0.377

D3 (1km) 0.263

E (1km) 0.322

F (1km) 2.551

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 1.091

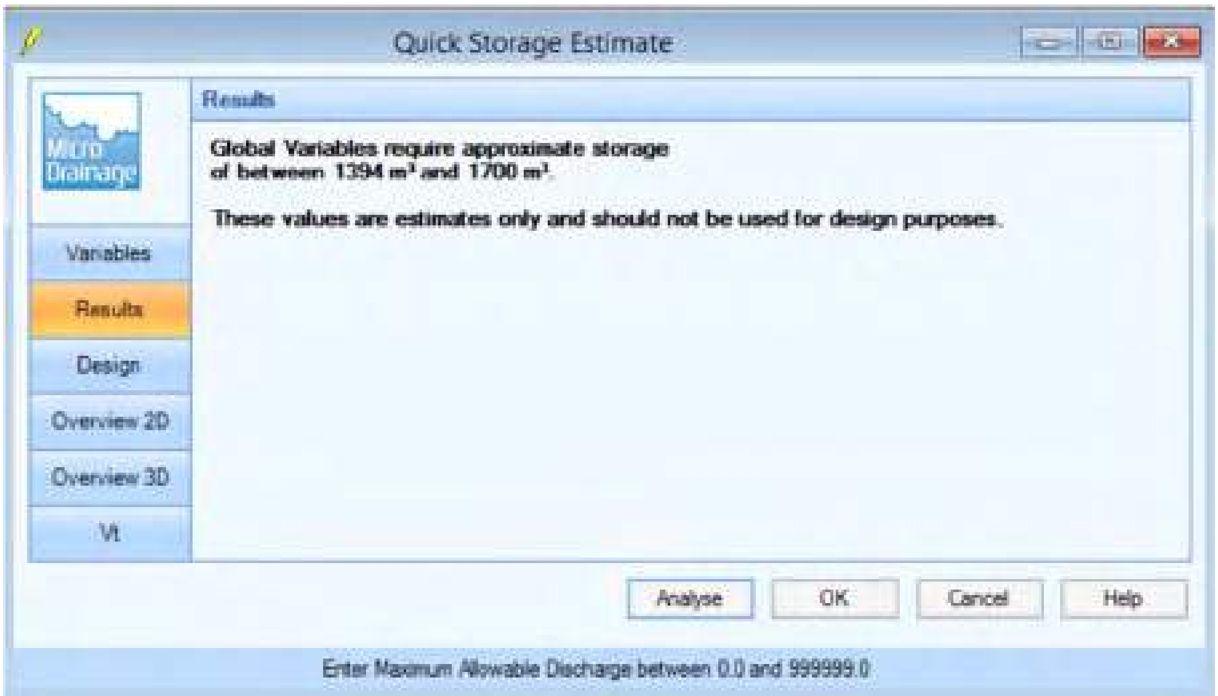
Maximum Allowable Discharge (l/s) 1.3

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 40

Enter Maximum Allowable Discharge between 0.0 and 999999.0



Results

Global Variables require approximate storage of between 1394 m³ and 1700 m³.

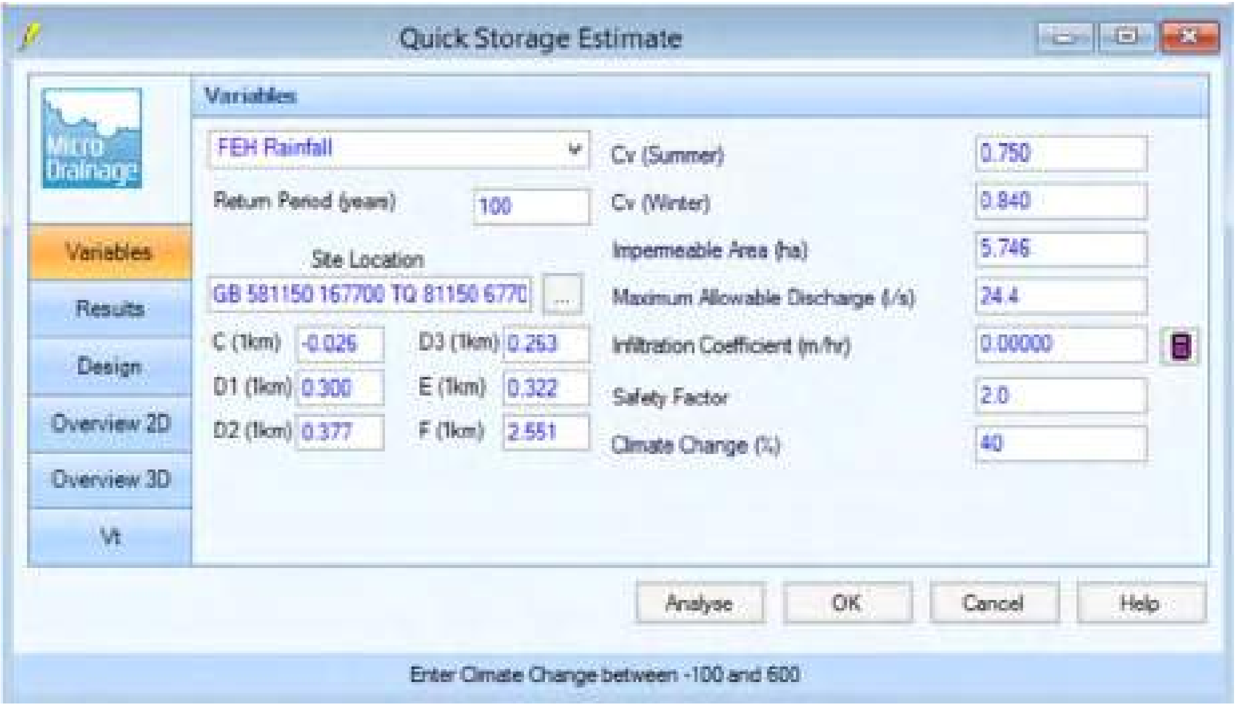
These values are estimates only and should not be used for design purposes.

Enter Maximum Allowable Discharge between 0.0 and 999999.0

CALCULATIONS

Catchment C (a)

Average Volume of Attenuation = 5087 + 7261 = 6174m³



FEH Rainfall

Return Period (years) 100

Site Location GB 581150 167700 TQ 81150 6770

C (1km) -0.026

D1 (1km) 0.300

D2 (1km) 0.377

D3 (1km) 0.263

E (1km) 0.322

F (1km) 2.551

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 5.746

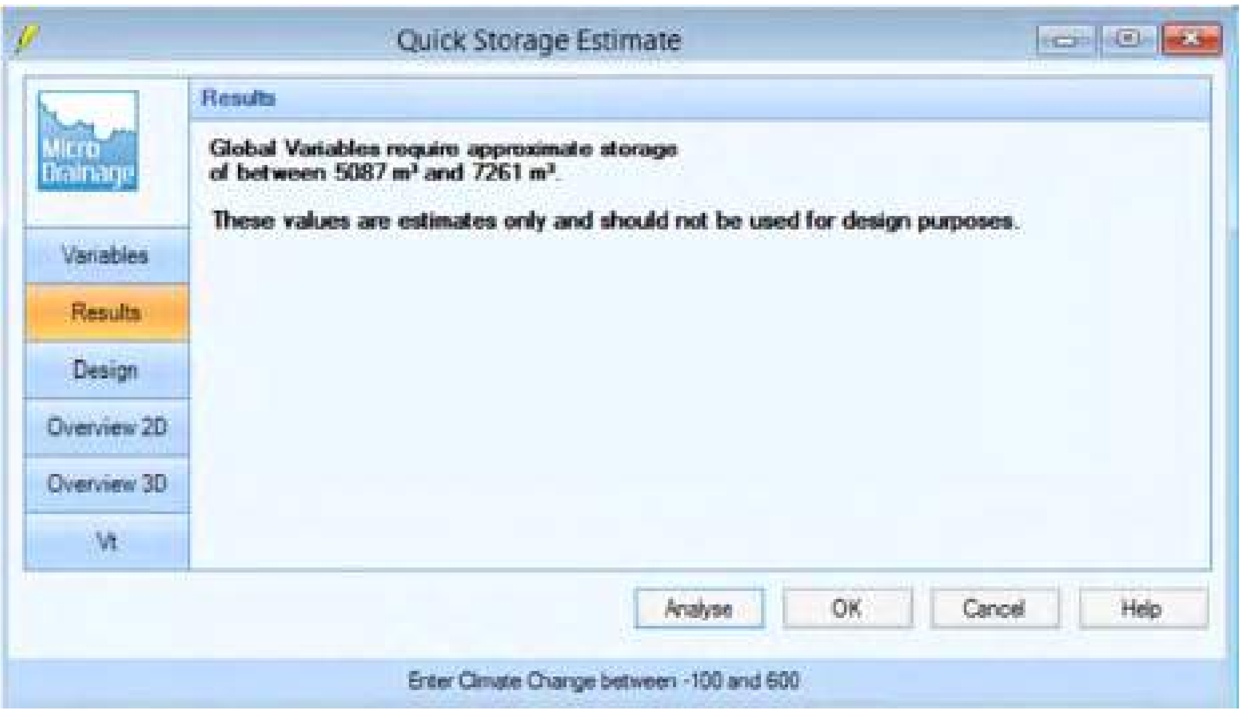
Maximum Allowable Discharge (l/s) 24.4

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 40

Enter Climate Change between -100 and 600



Global Variables require approximate storage of between 5087 m³ and 7261 m³.

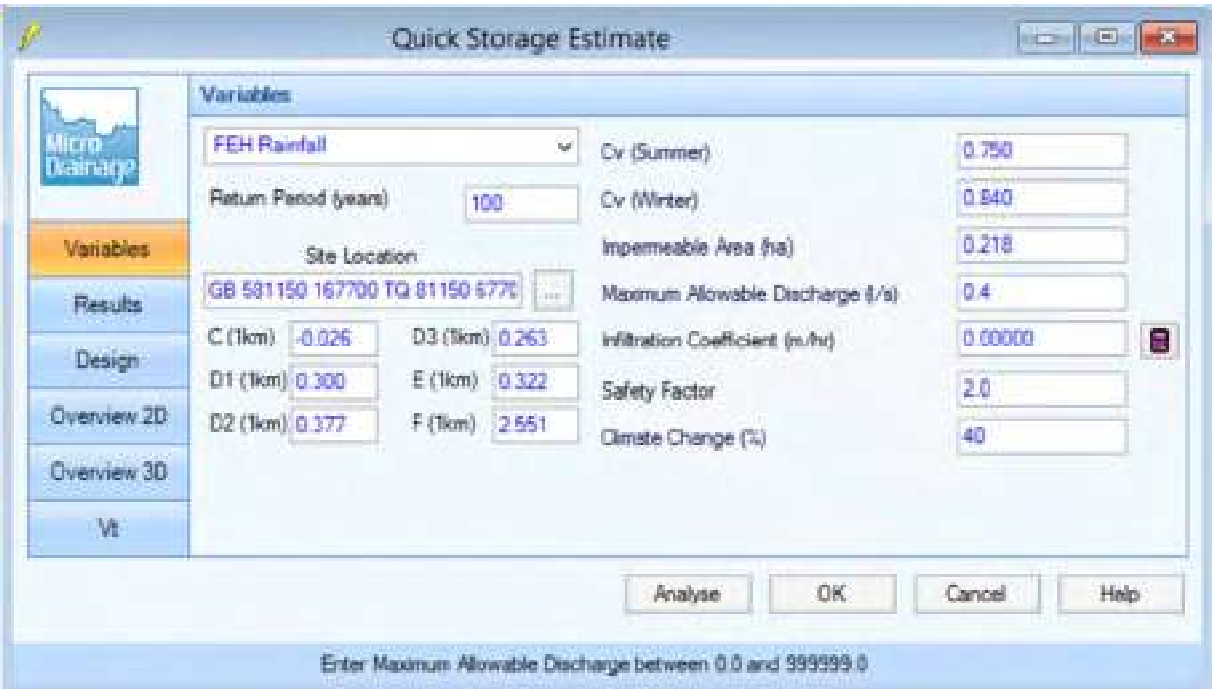
These values are estimates only and should not be used for design purposes.

Enter Climate Change between -100 and 600

CALCULATIONS

Catchment C (b)

Average Volume of Attenuation = 255 + 317 = 286m³



Variables

FEH Rainfall

Return Period (years): 100

Site Location: GB 581150 167700 TQ 81150 677

C (1km): -0.026

D1 (1km): 0.300

D2 (1km): 0.377

D3 (1km): 0.263

E (1km): 0.322

F (1km): 2.551

Cv (Summer): 0.750

Cv (Winter): 0.840

Impermeable Area (ha): 0.218

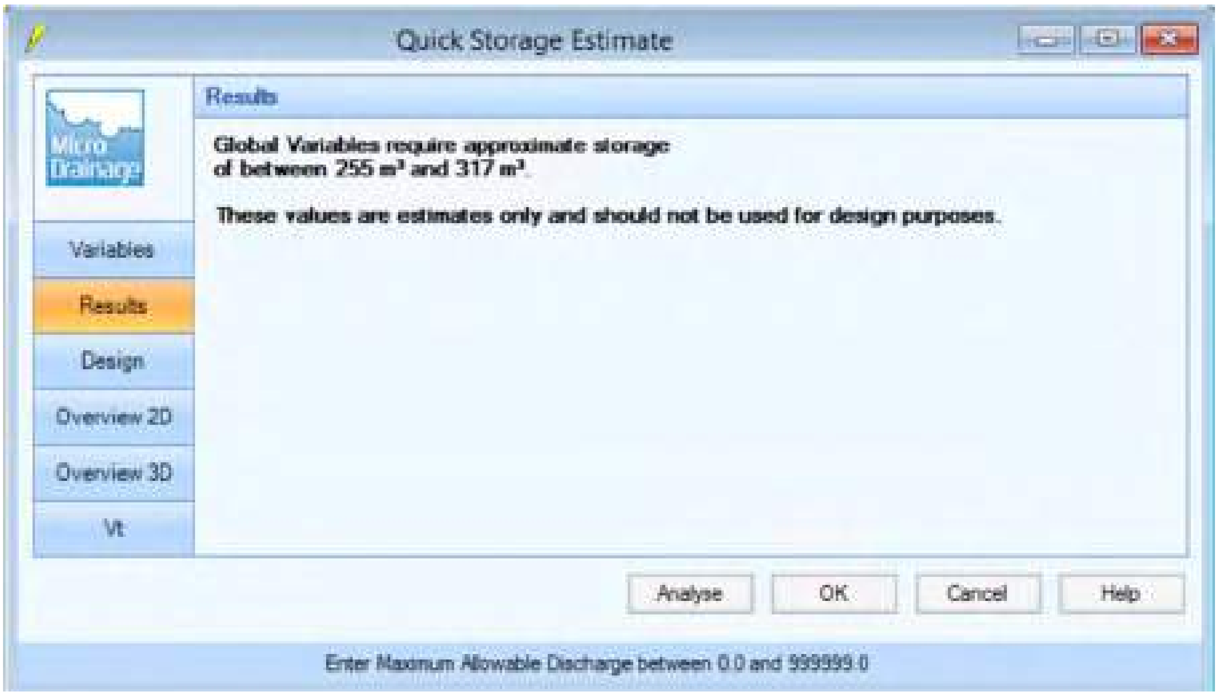
Maximum Allowable Discharge (l/s): 0.4

Infiltration Coefficient (m/hr): 0.00000

Safety Factor: 2.0

Climate Change (%): 40

Enter Maximum Allowable Discharge between 0.0 and 999999.0



Results

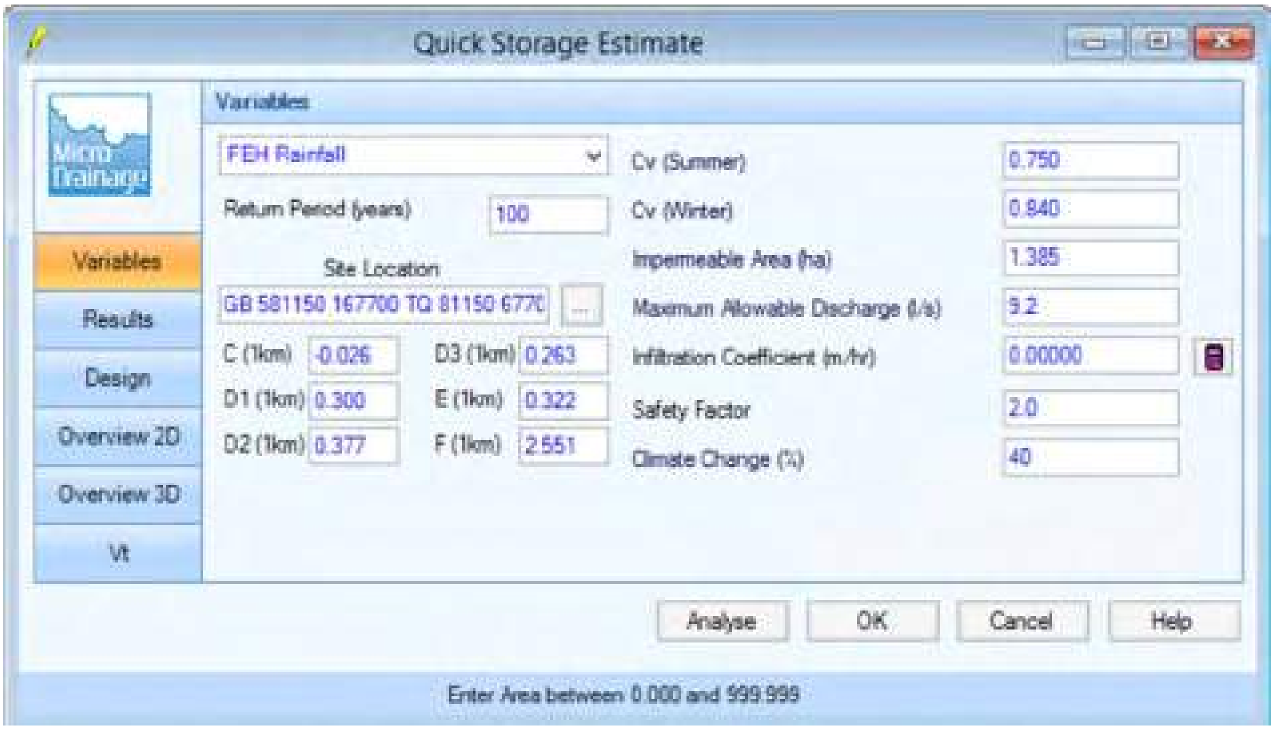
Global Variables require approximate storage of between 255 m³ and 317 m³.

These values are estimates only and should not be used for design purposes.

Enter Maximum Allowable Discharge between 0.0 and 999999.0

Catchment D (a)

Average Volume of Attenuation = 1074 + 1584 = 1329m³



Variables

FEH Rainfall

Return Period (years) 100

Site Location GB 581150 167700 TQ 81150 6770

C (1km) -0.026

D1 (1km) 0.300

D2 (1km) 0.377

D3 (1km) 0.263

E (1km) 0.322

F (1km) 2.551

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 1.385

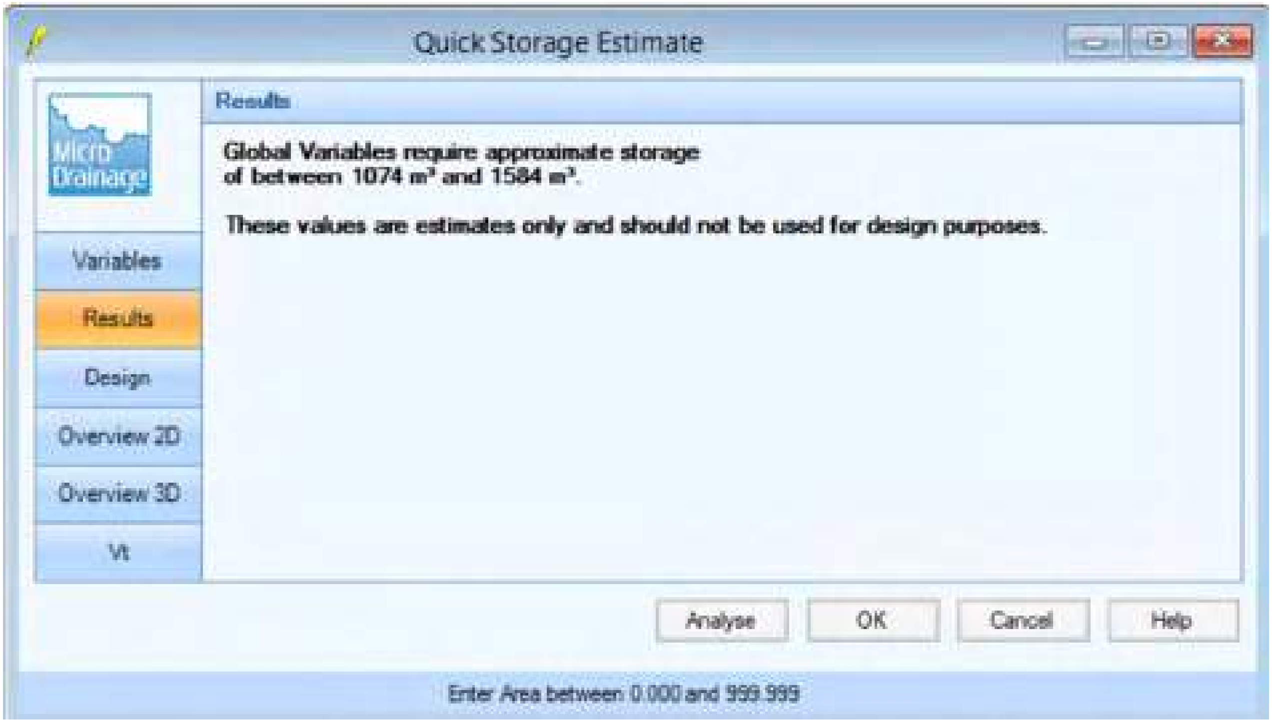
Maximum Allowable Discharge (l/s) 9.2

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 40

Enter Area between 0.000 and 999.999



Results

Global Variables require approximate storage
of between 1074 m³ and 1584 m³.

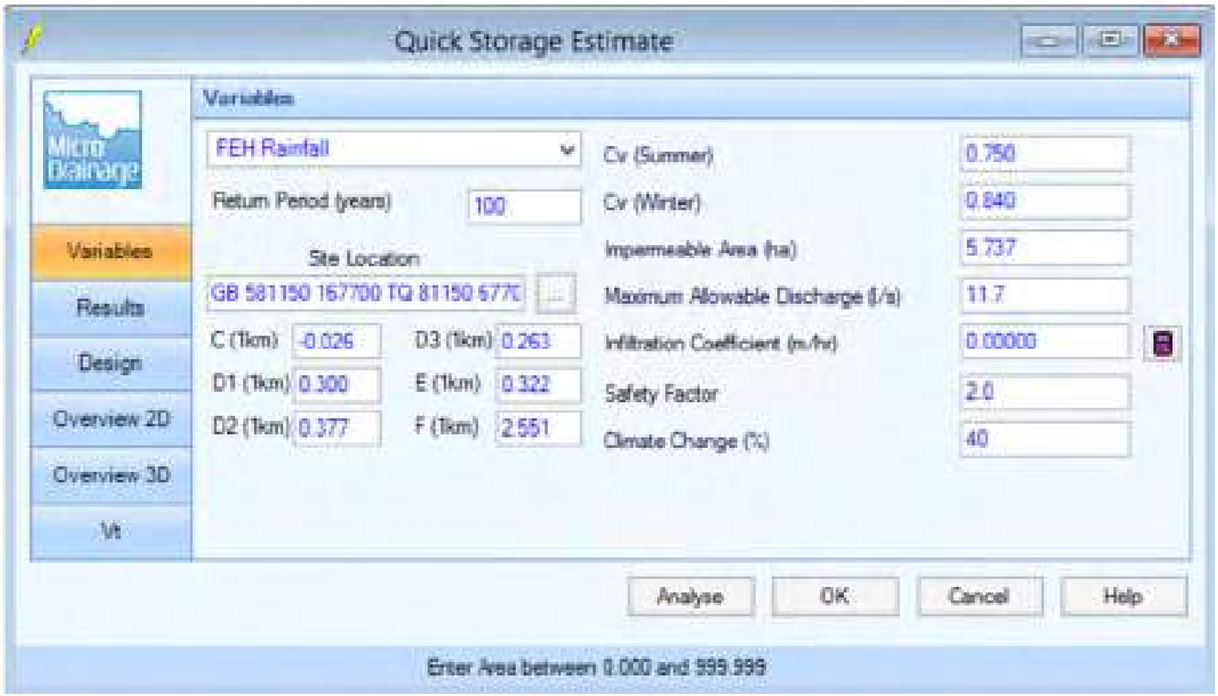
These values are estimates only and should not be used for design purposes.

Enter Area between 0.000 and 999.999

CALCULATIONS

Catchment D (b)

Average Volume of Attenuation = 6516 + 8194 = 7355m³



Variables

FEH Rainfall

Return Period (years): 100

Site Location: GB 581150 167700 TQ 81150 677

C (1km): -0.026

D1 (1km): 0.300

D2 (1km): 0.377

D3 (1km): 0.263

E (1km): 0.322

F (1km): 2.551

Cv (Summer): 0.750

Cv (Winter): 0.840

Impermeable Area (ha): 5.737

Maximum Allowable Discharge (l/s): 11.7

Infiltration Coefficient (m/hr): 0.00000

Safety Factor: 2.0

Climate Change (%): 40

Enter Area between 0.000 and 999.999

Results

Global Variables require approximate storage of between 6516 m³ and 8194 m³.

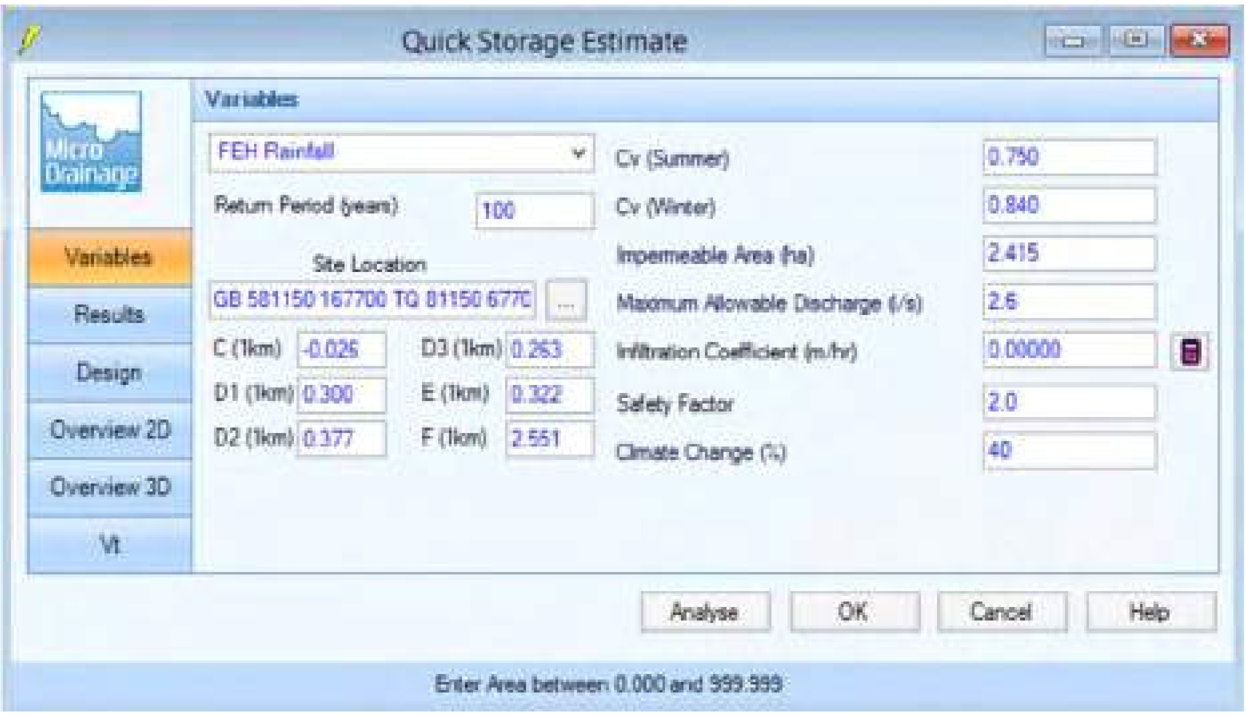
These values are estimates only and should not be used for design purposes.

Enter Area between 0.000 and 999.999

CALCULATIONS

Catchment E1 (a)

Average Volume of Attenuation = 3131 + 3811 = 3471m³



Variables

FEH Rainfall

Return Period (years) 100

Site Location GB 581150 167700 TQ 81150 6770

C (1km) -0.026

D1 (1km) 0.300

D2 (1km) 0.377

D3 (1km) 0.263

E (1km) 0.322

F (1km) 2.551

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 2.415

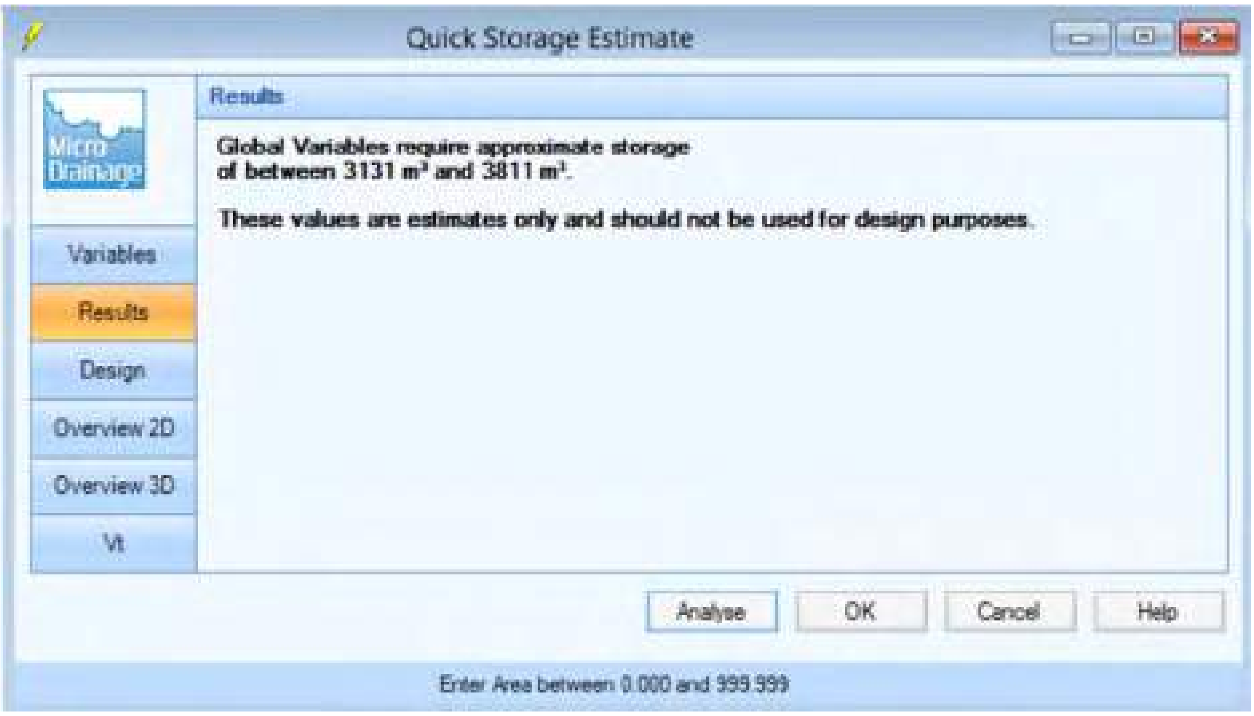
Maximum Allowable Discharge (l/s) 2.6

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 40

Enter Area between 0.000 and 999.999



Results

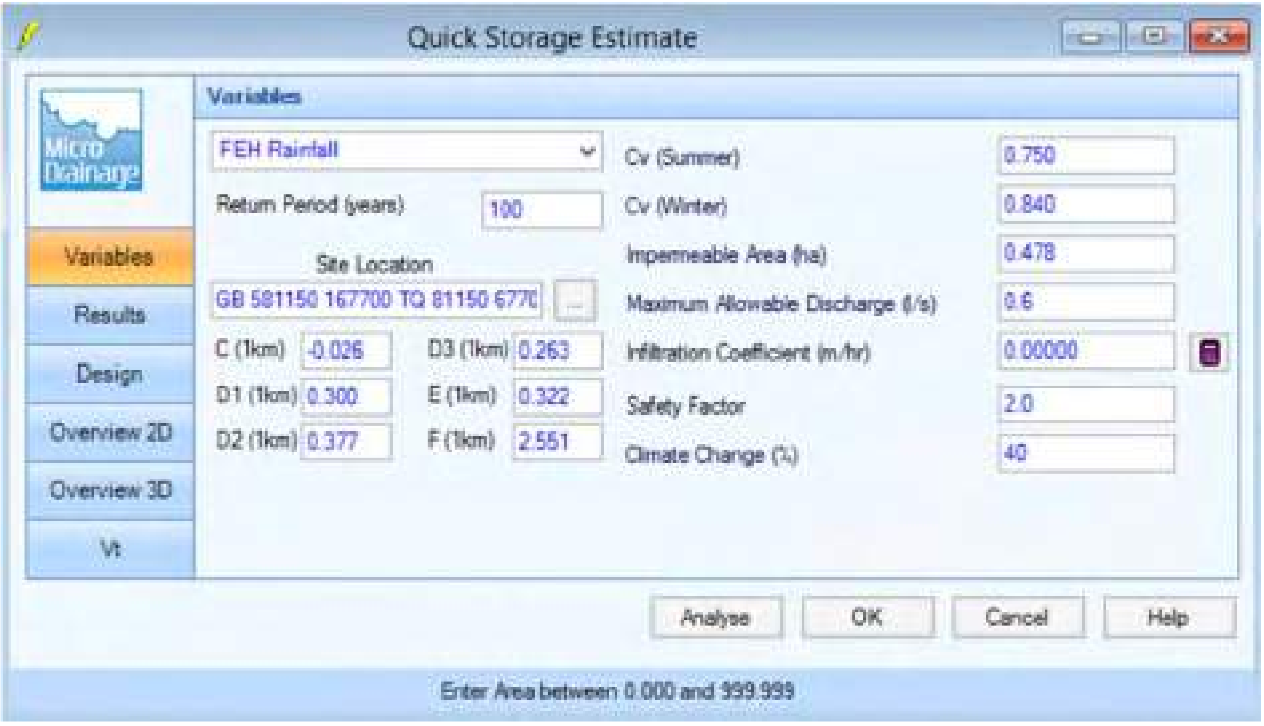
Global Variables require approximate storage of between 3131 m³ and 3811 m³.

These values are estimates only and should not be used for design purposes.

Enter Area between 0.000 and 999.999

Catchment E1 (b)

Average Volume of Attenuation = 606 + 739 = 672m³



Variables

FEH Rainfall

Return Period (years) 100

Site Location GB 581150 167700 TQ 81150 6770

C (1km) -0.026

D1 (1km) 0.300

D2 (1km) 0.377

D3 (1km) 0.263

E (1km) 0.322

F (1km) 2.551

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 0.478

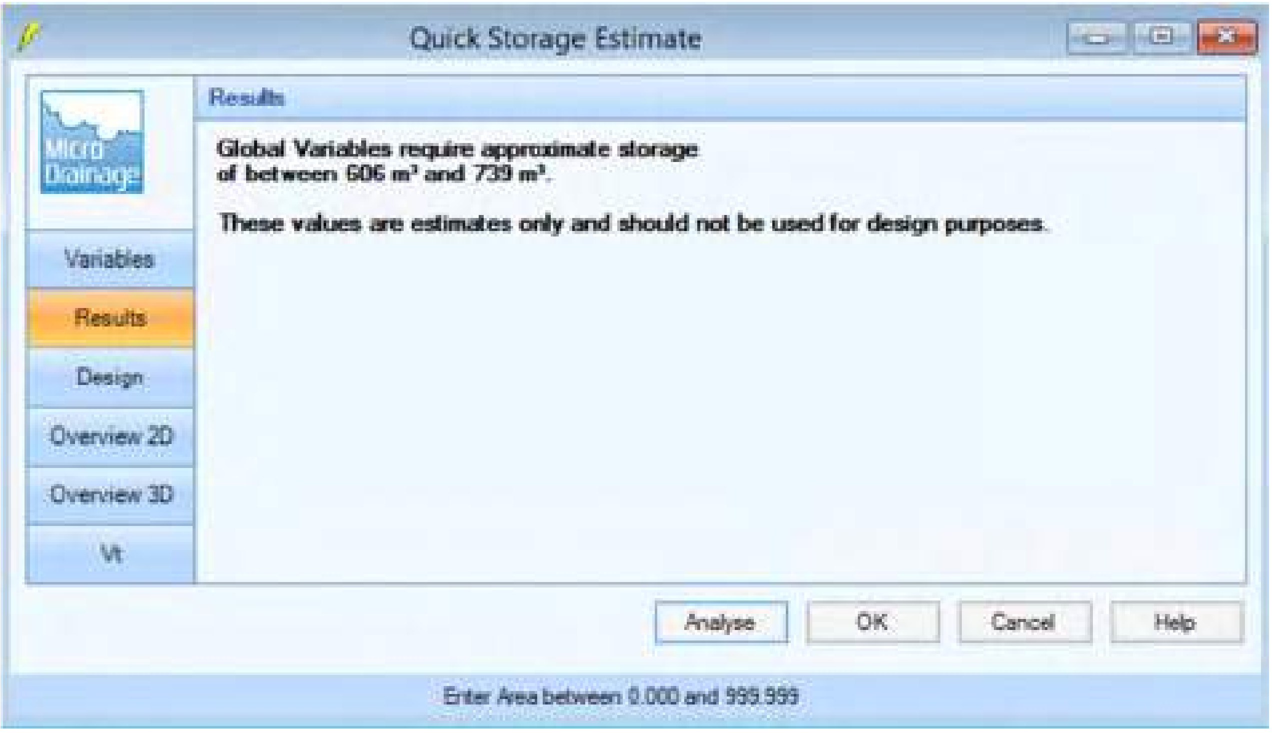
Maximum Allowable Discharge (l/s) 0.6

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 40

Enter Area between 0.000 and 999.999



Results

Global Variables require approximate storage
of between 606 m³ and 739 m³.

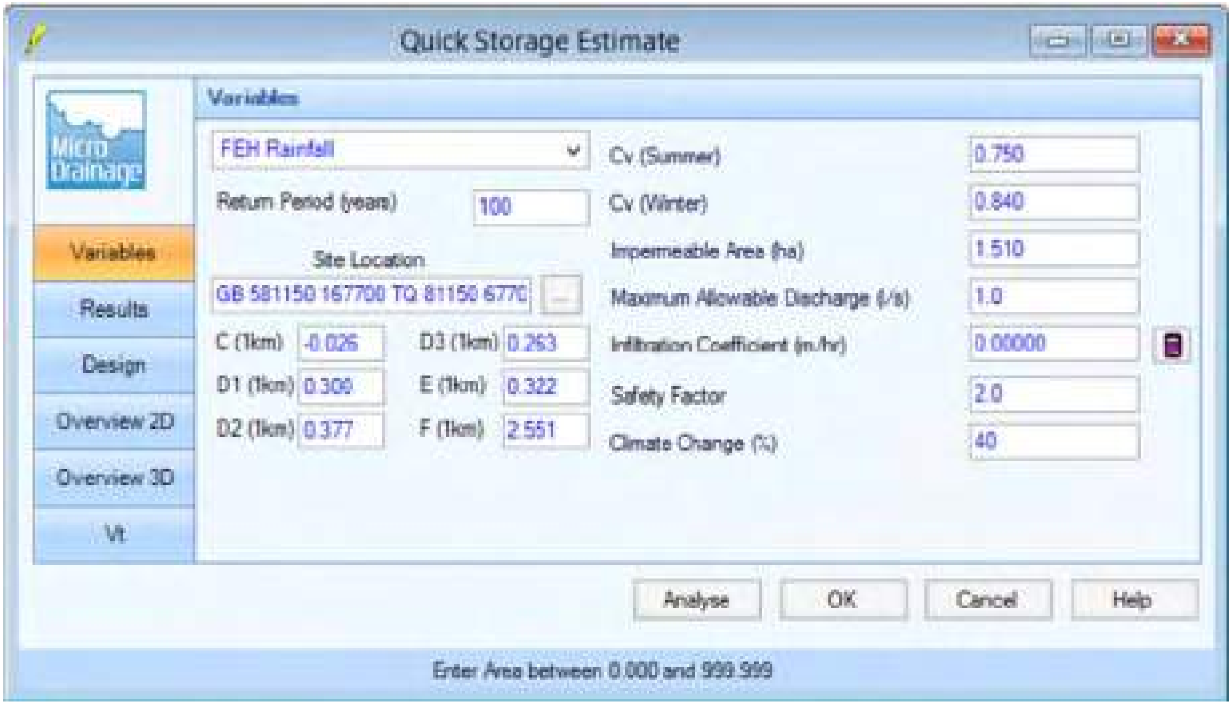
These values are estimates only and should not be used for design purposes.

Enter Area between 0.000 and 999.999

CALCULATIONS

Catchment E2

Average Volume of Attenuation = 2128 + 2493 = 2310m^3



Variables

FEH Rainfall

Return Period (years) 100

Site Location

GB 581150 167700 TQ 81150 6770

C (1km) -0.026

D1 (1km) 0.309

D2 (1km) 0.377

D3 (1km) 0.263

E (1km) 0.322

F (1km) 2.551

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 1.510

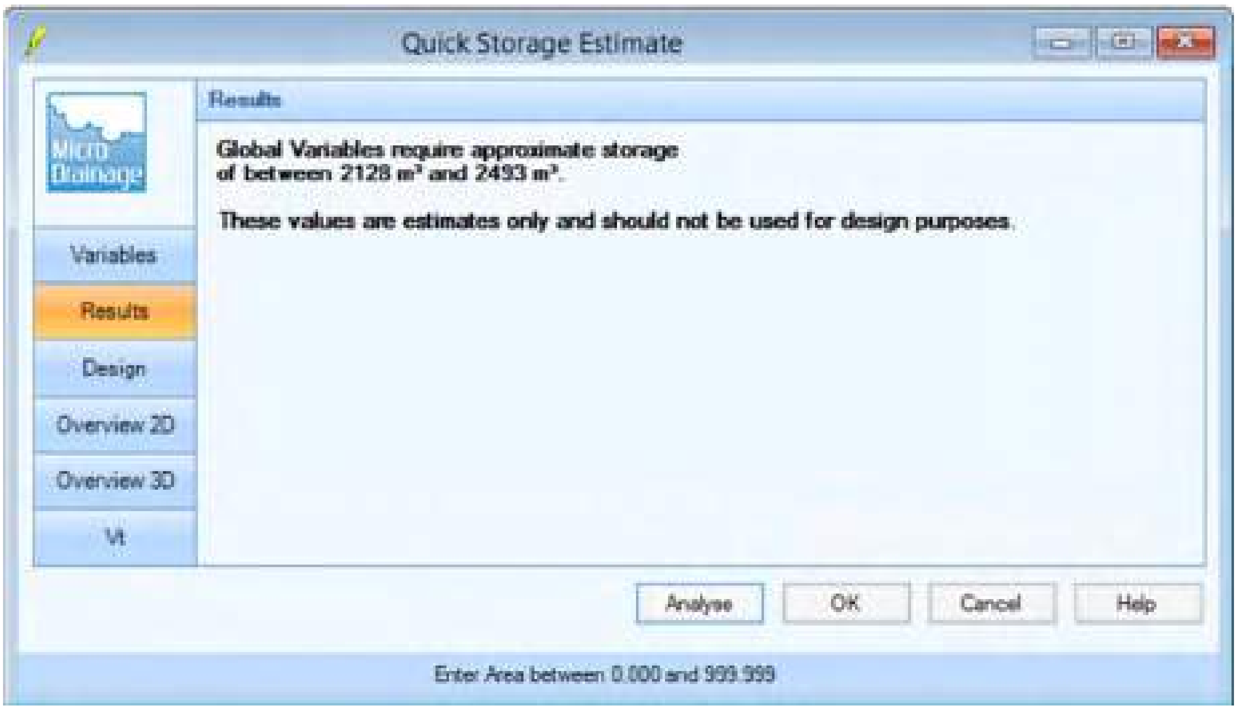
Maximum Allowable Discharge (l/s) 1.0

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 40

Enter Area between 0.000 and 999.999



Results

Global Variables require approximate storage
of between 2128 m^3 and 2493 m^3.

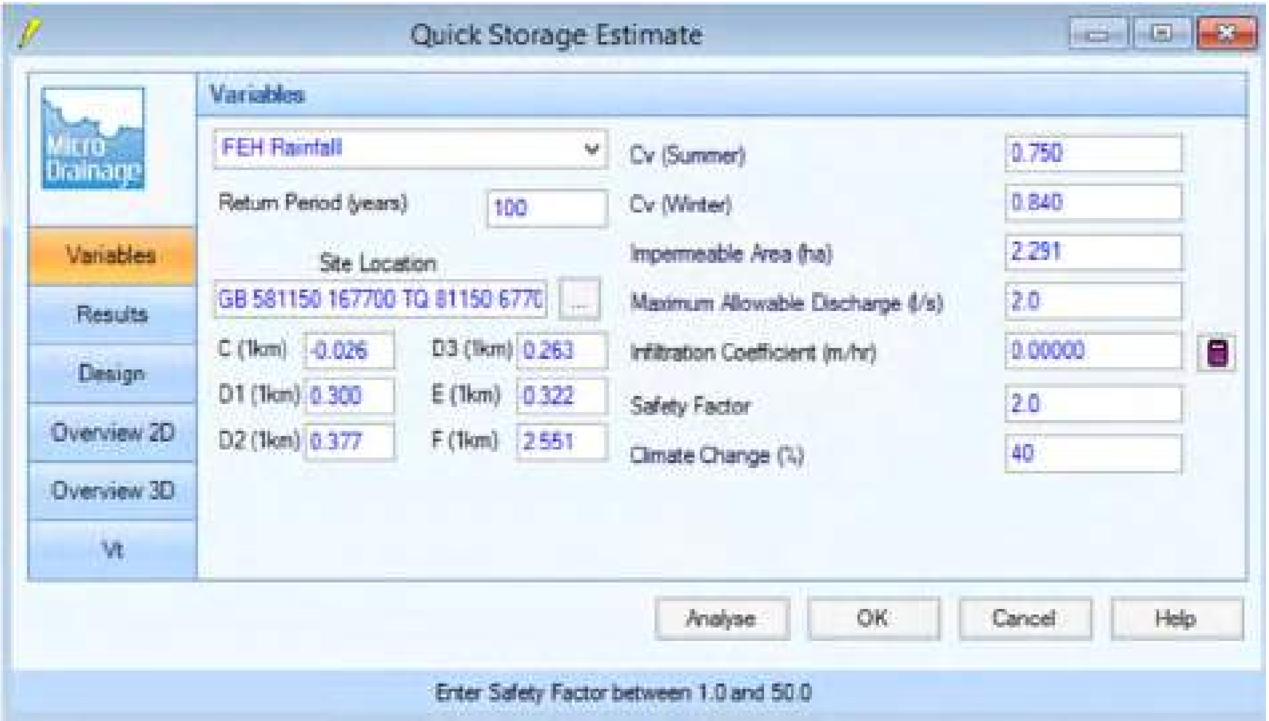
These values are estimates only and should not be used for design purposes.

Enter Area between 0.000 and 999.999

CALCULATIONS

Catchment School

Average Volume of Attenuation = 3084+ 3698 = 3391m³



Variables

FEH Rainfall

Return Period (years) 100

Site Location GB 581150 167700 TQ 81150 6770

C (1km) -0.026

D1 (1km) 0.300

D2 (1km) 0.377

D3 (1km) 0.263

E (1km) 0.322

F (1km) 2.551

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 2.291

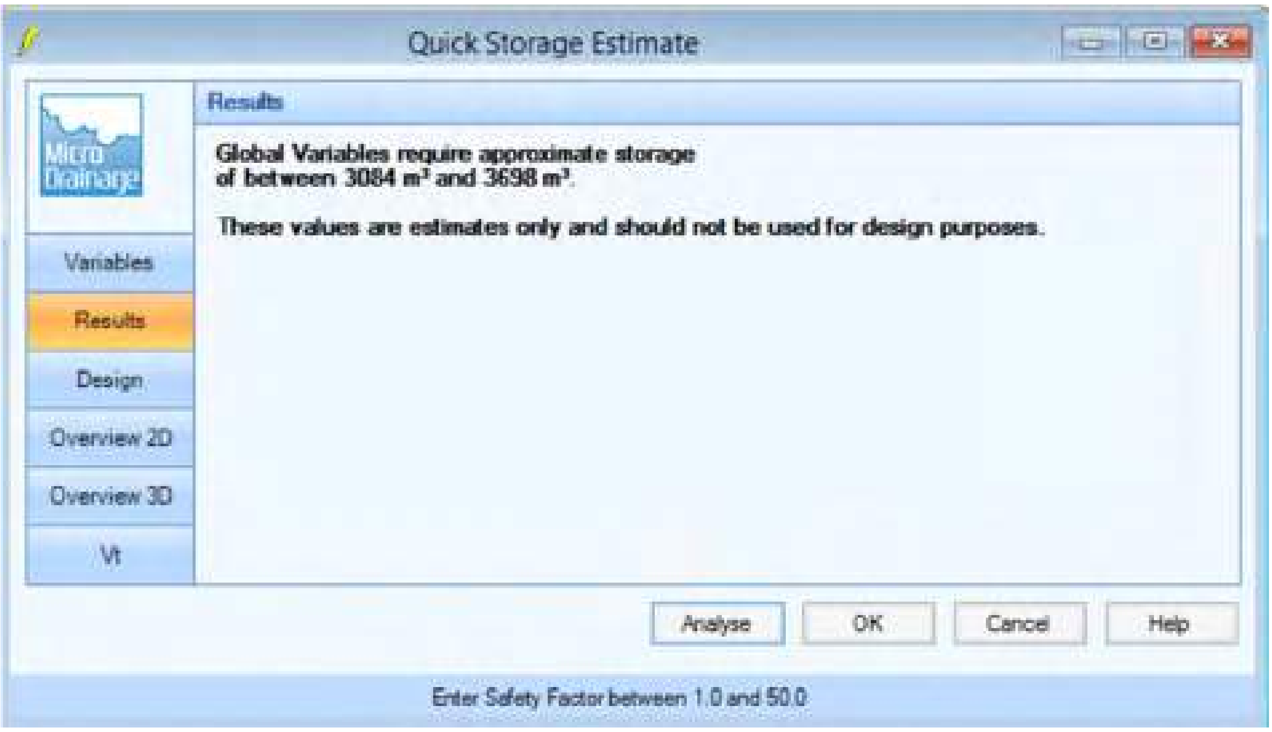
Maximum Allowable Discharge (l/s) 2.0

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 40

Enter Safety Factor between 1.0 and 50.0



Results

Global Variables require approximate storage of between 3084 m³ and 3698 m³.

These values are estimates only and should not be used for design purposes.

Enter Safety Factor between 1.0 and 50.0

Appendix E – Flood Risk Assessment