109 Memorial Road

SuDS Strategy

Job Number: 1417

Date	Version	Notes/Amendments
January 2024	1	Issued for Information
March 2024	2	Updated based on client team comments

Contents **Page**

Acronyms	
AOD	Above Ordnance Datum
CIRIA	Construction Industry Research and Information Association
EA	Environment Agency
NPPF	National Planning Policy Framework
PPG	Planning Practice Guidance
NSTS	DEFRA's Non-statutory technical standards for sustainable drainage systems

Introduction

Flume Consulting Engineers have been appointed to undertake a Sustainable Drainage Systems (SuDS) Strategy for the proposed development at Land Adjoining 109 Memorial Road, Hanham, South Gloucestershire BS15 3LA.

This report has been carried out in accordance with the National Planning Policy Framework (NPPF) and the Planning Practice Guidance 'Flood Risk and Coastal Change' (PPG). This report also incorporates advice and guidance from the Environment Agency (EA), the Strategic Flood Risk Assessment (SFRA) and *Developer Advice for Surface Water Drainage Strategies*, produced by South Gloucestershire Council and CIRIA documents.

The EA's indicative floodplain map shows that the site is located in Flood Zone 1, however, a SuDS Strategy and drainage design has been carried out to assess the available options for SuDS use for the proposed development and a viable surface water drainage strategy is proposed.

South Gloucestershire Council have granted planning approval for the development but provided the following pre-commencement conditions as it relates to drainage; Condition 8:

> *No development shall commence until surface water drainage details including SUDS (Sustainable Drainage Systems e.g. soakaways if ground conditions are satisfactory), for flood prevention; pollution control and environmental protection have been submitted and approved by the Local Planning Authority. A detailed development layout showing the location of surface water proposals is required along with results of percolation tests and infiltration calculations to demonstrate that the proposal is suitable for this site.*
>
> *The following will be required:*
>
> *- A clearly labelled drainage layout plan showing the exact location of any soakaways. - Evidence is required to confirm that the ground is suitable for soakaways. Percolation / Soakage test results in accordance with BRE Digest 365 and as described in Building Regs H - Drainage and Waste Disposal.*
>
> *- The submitted infiltration rate/s must be expressed in m/s (meters per second).*
>
> *- Evidence that the soakaway is appropriately sized in accordance with BRE Digest 365 Soakaway Design.*
>
> *- Soakaways must be located 5 Metres from any structure including the Public Highway*
>
> *- No surface water discharge will be permitted to an existing foul sewer without the expressed approval of the sewage undertaker.*
>
> *Please note that if on-site infiltration testing reveals that infiltration is unsuccessful on- site, then any alternative surface water disposal strategies must be in accordance and follow the SUDS hierarchy. Each option within the hierarchy must be fully explored and exhausted in order, before considering the next available option.*

This report and the appended information aims to satisfy this condition.

Site Description and Location

The site occupies an area of land to the north of the schools entrance road to the east and south east. The site contains an existing two storey detached dwelling which is accessed from Memorial Road to the west. The site includes a front and rear garden together with parking areas. There is also a large area of overgrown land with trees, scrub, and a large three bay garage block building.

The River Avon is located within 400m of the development to the west, although this does not impact the proposed development from a flood risk perspective which is located within Flood Zone 1 (less than 1 in 1000 annual probability of river or sea flooding (<0.1%)) according to the EA Flood Map for Planning. Developments in this flood zone have no restrictions other than ensuring surface water drainage proposals do not increase the flood risk on site and the surrounding areas.

The site postcode is BS15 3LA and the OS grid reference is ST 63855 71694.

FIGURE 1. SITE LOCATION

Development Proposal

The development proposals include the removal of the existing garage building and construction of three new residential dwellings with associated parking, bin storage and cycle storage. The plans also include the removal of two existing trees and existing overgrown scrub, and the planting of three new trees.

The existing dwelling will be retained and will be unaffected by the development.

FIGURE 2. PROPOSED SITE LAYOUT

Flood Risk

The EA's indicative floodplain map shows that the site is located in Flood Zone 1 and is not at risk of flooding (Figure 3). Developments in this flood zone do not have any restrictions, provided they do not increase the risk of flooding elsewhere.

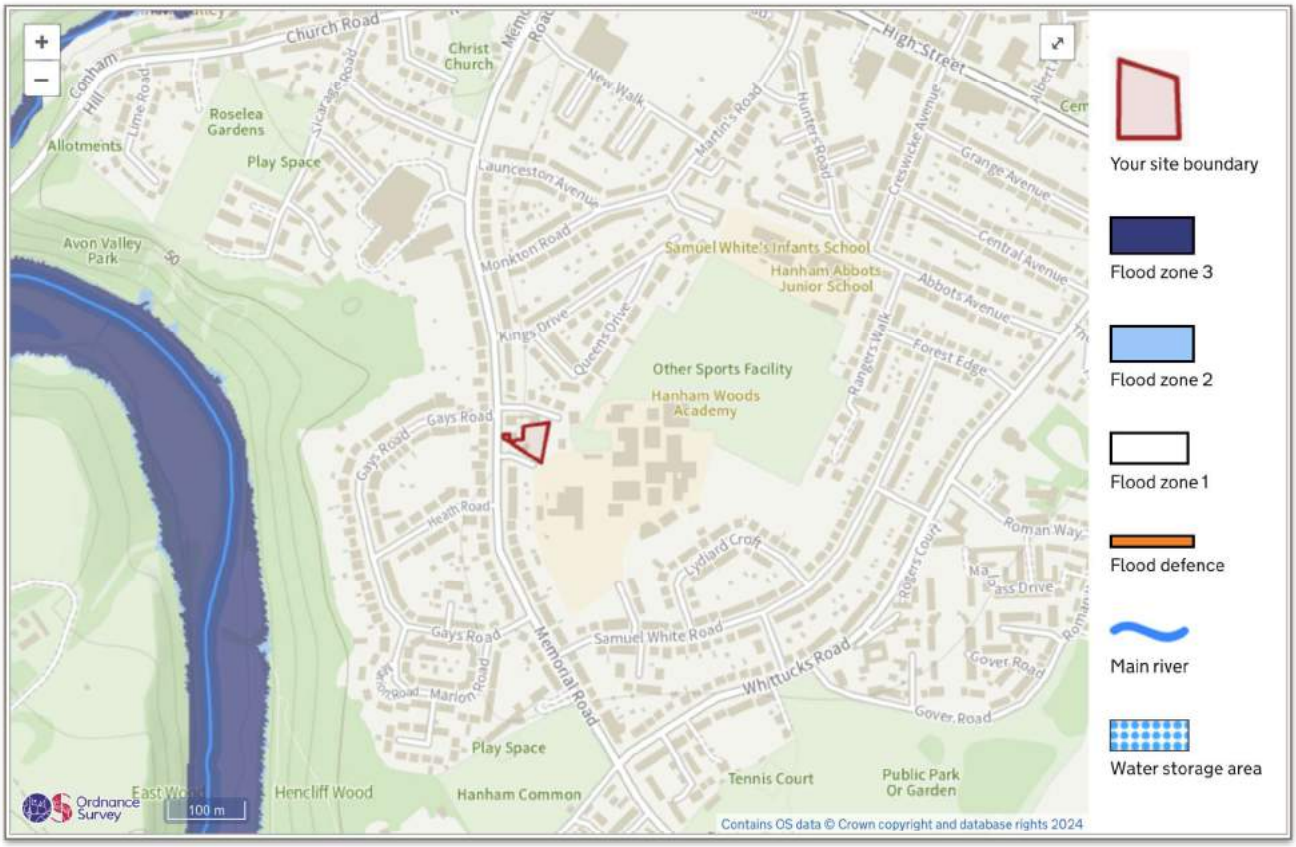


FIGURE 3. ENVIRONMENT AGENCY FLOOD RISK FROM RIVERS OR SEA MAP (GOV.UK, 2023)

Surface Water Run-off Assessment

Existing Run-off

Brownfield Run-off Rate

The total site area which includes the existing dwelling and soft landscaping, is approximately 2020m²/0.202ha, of which 550m² is impermeable hardstanding and roof areas.

The existing peak run-off rate for the design storm event (1 in 1, 1 in 30 and 1 in 100 year) was calculated using the Modified Rational Method | Wallingford Procedure as shown below:
as shown below:
Q = 2.78 x i x A

Where 'A' is the catchment area in ha and 'i' is the rainfall intensity in mm/hr as estimated using the relevant maps presented in the Flood Studies Report.

Q_{1ex} = 2.78 x 30 x 0.05= 4.20 l/s
Q_{30ex} = 2.78 x 73 x 0.05 = 10.10 l/s
Q_{100ex} = 2.78 x 95 x 0.05 = 13.20 l/s

Greenfield Run-off Rate

The existing Greenfield run-off rates for storm events of several different return periods were calculated using the Greenfield Run-off Estimator tool from uksuds.com as shown below. Supporting documentation is contained in Appendix A.

Q_{1exGR} = 0.9 l/s
Q_{30exGR} = 2.2 l/s
$Q_{100exGR}$ = 2.7 l/s

Proposed Run-off

According to Planning Practice Guidance (PPG), *"generally the aim should be discharge surface runoff as high up the following hierarchy of drainage options as reasonably practicable: 1. Into the ground (infiltration) 2. To a surface water body; 3. To a surface water sewer, highway drain or another drainage system; 4. To a combined sewer",* whilst ensuring that surface water run-off is managed as close to its source as possible.

Infiltration

In December 2023, Earth Environmental & Geotechnical (Southern) Ltd compiled a ground investigation report. This report reveals that the ground composition includes Made Ground and Weathered Mangotsfield Member, characterised by clay, sand, and gravel. An infiltration test following the BRE365 standard was conducted at 1.7 metres below ground level. However, determining an infiltration rate was unfeasible as the water level in the pit remained unchanged. Consequently, the report concludes that due to the observed ground conditions and the outcomes of the soakaway/permeability tests, soakaway drainage is impracticable at this site. As a result, infiltration is deemed an unsuitable approach for surface water disposal. Detailed results of the infiltration test can be found in Appendix B of the report.

To Surface Water Body

There are no rivers or watercourses in the immediate vicinity of the site. Therefore, it is not viable to dispose of surface water from the site to a surface water body.

To Surface Water Sewer

An excerpt from the Wessex Water sewer records is presented in Figure 4 below, with the full plan accessible in Appendix C. These records indicate the presence of a 375mm diameter surface water sewer situated to the south-east of the site. The plan further reveals that this sewer transitions into a Highway Drain at manhole number 8761, located within the school access road to the south of the site. It then flows from south to north along Memorial Road.

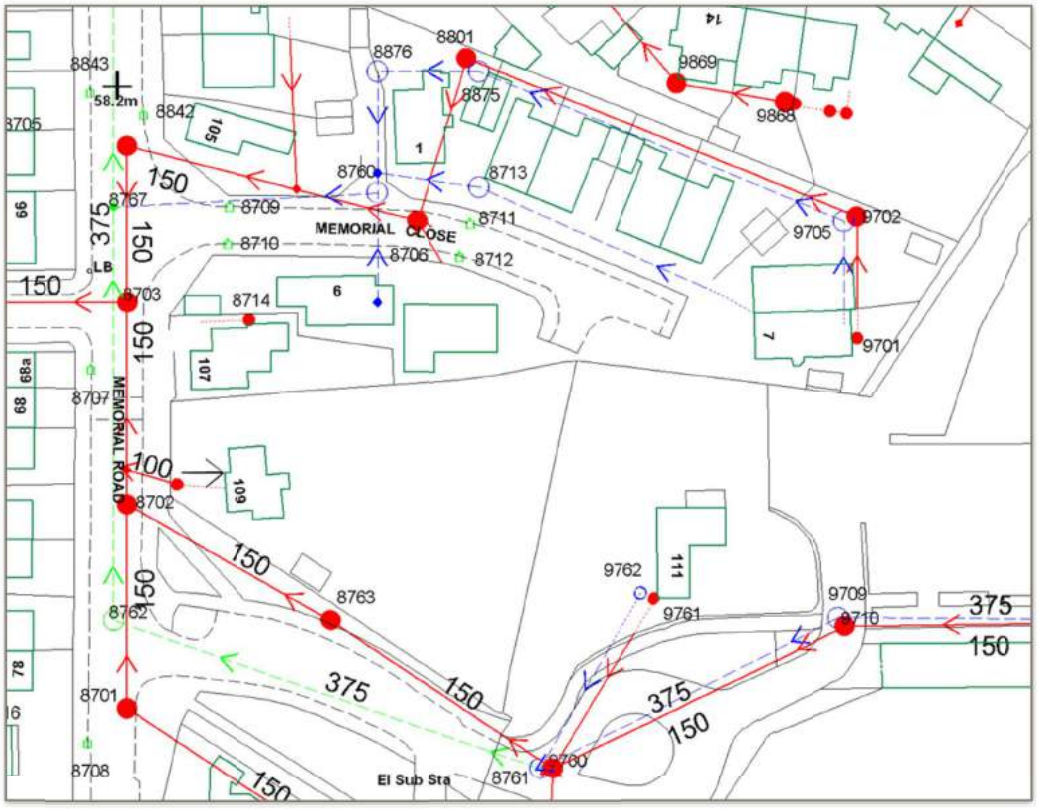


FIGURE 4. WESSEX WATER SEWER RECORDS

A CCTV drainage survey was carried out by Maintain A Drain in December 2023 and the survey plan is available within Figure 5 below. The survey shows that surface water from part of the existing building drains to suspected soakaways and partly to the private foul water network. The surface water drainage from the existing garages also connects to the private foul water system.

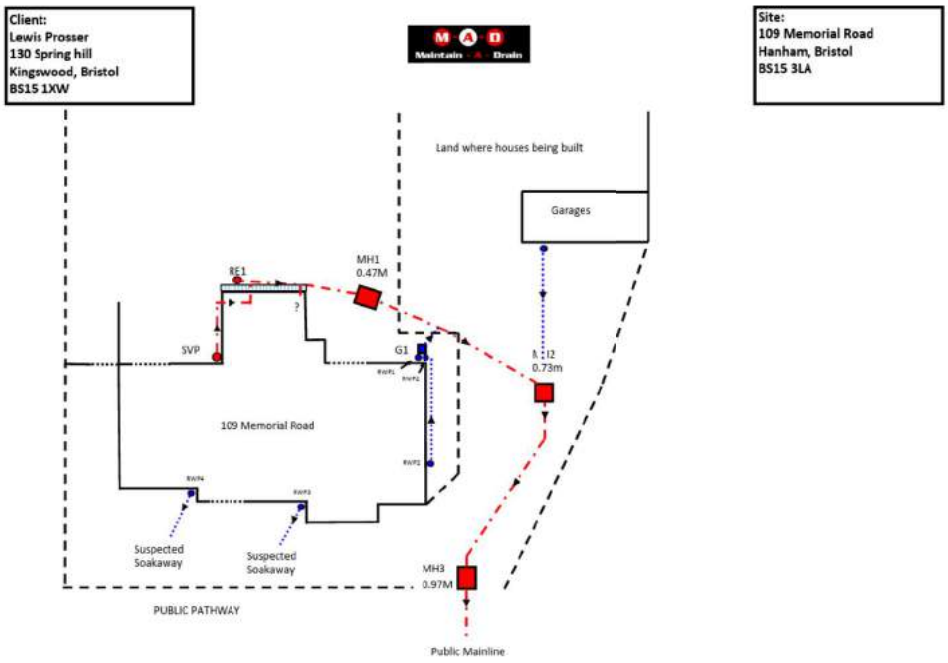


FIGURE 5. CCTV DRAINAGE SURVEY PLAN

It is proposed to connect the surface water drainage from the site to the 375mm diameter highway drain in the school access road to the south. The Highway Authority will be contacted to obtain consent for the new connection. This is the only *viable* connection which can be made to a surface water sewer, without reusing the existing combined outfall to the public sewer.

The surface water run-off rate will be restricted to 2.3 l/s for all storm events up to and including the 100 year plus 45% climate change event (design storm) which is the minimum practical rate of restriction as it allows a 75mm opening within the vortex flow control device. Flow controls with openings smaller than 75mm have an increased risk of blockage which would increase the risk of flooding on site. An allowance for a 34mm orifice plate has also been made, should it be preferred based on the incorporation of suitable mitigation measures to reduce the possibility of a blockage occurring in the below ground drainage system.

Attenuation storage will be provided by a below ground geocellular attenuation tank. The hydraulic calculations show that a storage volume of 13.20m^3 is suitable to prevent flooding for the design storm. The calculations are available in full in Appendix D. Permeable paving has also been incorporated into the design to intercept surface water and provide a form of treatment to the run-off. The proposed drainage layout is available in Appendix D.

The climate change allowances that should be applied to the rainfall intensity are set out by the EA and vary depending on the catchment. The Avon Bristol and North Somerset Streams Management Catchment peak rainfall allowances are set out in Figures 6 and 7 below:

Epoch	Central Allowance	Upper End Allowance
2050s	20%	35%
2070s	25%	40%

FIGURE 6. CLIMATE CHANGE ALLOWANCES FOR 3.3% ANNUAL EXCEEDANCE RAINFALL EVENT

Epoch	Central Allowance	Upper End Allowance
2050s	25%	40%
2070s	25%	45%

FIGURE 7. CLIMATE CHANGE ALLOWANCES FOR 1% ANNUAL EXCEEDANCE RAINFALL EVENT

Therefore, the hydraulic calculations include a climate change allowance of 40% for the 30 year storm event and 45% for the 100 year storm event.

SuDS Component	Site Suitability	Comments
Green Roofs & Rainwater Reuse	✗ /✓	No Green Roofs have been incorporated into the scheme. However, Watering Butts will be introduced to reduce both the surface water run-off for smaller storm events and reduce water demand.
Soakaways	✗	Soakaways are not viable due to poor infiltration rates.
Filter Strips	✗	Other SuDS features are preferred in this instance.
Infiltration Trenches	✗	Infiltration trenches are not viable due to poor infiltration rates.
Swales	✗	Not suitable due to site layout and size of the development.
Bioretention	✗	Not suitable due to site layout and size of the development.
Porous Pavements	✓	Permeable Paving will be introduced to the proposed hard landscaped areas. An overflow from the permeable paving will be provided to connect to the drainage network, as a fail-safe solution.
Infiltration basins	✗	Infiltration basins are not viable due to poor infiltration rates.
Detention basins	✗	Not suitable due to site layout and size of the development.
Ponds	✗	Not suitable due to site layout and size of the development.
Stormwater wetlands	✗	Not suitable due to site layout and size of the development.
Geocellular Attenuation Tank	✓	Proposed 13.20m^3 tank to be located beneath the parking bays.

FIGURE 8. SUDS SITE SUITABILITY

SuDS Run-off Summary

Return Period	Greenfield (l/s) (interpolated - minimum site area calculation = 0.1ha)	Existing (l/s)	Proposed (l/s)
1 in 1 Year	0.9	4.1	2.0
1 in 30 Year	2.2	10.2	2.3
1 in 100 Year	2.7	13.1	2.3
1 in 100 Year + 45%cc	-	-	2.3

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential Roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads and non-residential car parking with infrequent change	Low	0.5	0.5	0.4

In conclusion, the proposed surface water discharge rate will be reduced significantly compared to the existing development and will reduce the rate below the 100 year greenfield rate. A below ground geocellular attenuation tank will provide the attenuation storage required to accommodate the 100 year plus 45% climate change event. Furthermore, a form of Rainwater Harvesting (Watering Butts) will be utilised primarily to reduce water demand.

Type of SuDS Component	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Permeable Pavement	0.7	0.6	0.7

	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Total Pollution Hazard Indices	0.7	0.6	0.45
Total Pollution Mitigation Indices	0.7	0.6	0.7
Sufficiency of Pollution Mitigation Measures	Sufficient	Sufficient	Sufficient

Water Quality

CIRIA C753 The SuDS Manual, Chapter 26 sets out the 'simple index approach' to water quality risk management.

Step 1 of the simple index approach is to identify the pollution hazard indices for the proposed land use. The proposed residential development is considered to have a 'Low' pollution hazard level and Figure 9 below shows the associated pollution hazard indices that are taken from Table 26.2 of The SuDS Manual:

FIGURE 9: POLLUTION HAZARD INDICES

Step 2 of the simple index approach is to select SuDS with a total pollution mitigation index that equals or exceeds the pollution hazard index.

As the destination of the run-off is to a highway drain and there is no infiltration from the SuDS to groundwater, the surface water pollution mitigation indices should be used as shown in Figure 10 below:

FIGURE 10: SURFACE WATER POLLUTION MITIGATION INDICES, TAKEN FROM TABLE 26.3 OF THE SUDS MANUAL

Provided that the mitigation indices of the treatment techniques are greater than or equal to the hazard indices for the proposed development then there should be no reduction in the overall water quality within the receiving system. Therefore, the incorporation of permeable paving will provide suitable treatment of surface water. Figure 11 indicates that sufficient mitigation has been achieved for the hazard pollution indices associated with the development.

FIGURE 11: EVALUATION OF POLLUTION INDICES

Surface Water Maintenance Strategy

The drainage design will be designed to be fully maintainable in accordance with building regulations and the recommendations of CIRIA C753 – SuDS Manual, outlined below.

In relation to ownership, it is intended that the future plot owners will be responsible for maintenance. The completed development will be sold to third parties and the responsibility for drainage maintenance will be included as a covenant in the Title Deeds (along with details of the maintenance responsibility of the shared driveway more generally). The covenant will form part of any potential purchaser's Solicitor's report on Title, hence they will certainly be aware of their future obligations prior to the completion of the purchase. The applicant will also ensure that a copy of this document is passed to the purchaser's Solicitor.

Attenuation Tank

Maintenance Schedule	Required Action	Typical Frequency
Monitoring / Inspections	Inspect all inlets, outlets, vents, overflows and control structures to ensure they are working as they should	Annually or after severe storms
Regular Maintenance	Inspect and identify any elements that are not operating correctly.	Monthly for three months, then Half yearly or as required.
	Remove sediments / debris from catch pits / gullies and control structures	Annually, after severe storms or as required
Remedial Actions	Repair inlets, outlets, vents, overflows and control structures.	As required

Below-Ground Drainage Pipework

Monthly Checks:

- Inspection: Survey for signs of obstruction, sediment accumulation, and structural integrity issues. Inspect grilles and covers for any damage or misplacement.
- Clearance: Remove debris from grilles, inlets, and inspection chambers.

Annual Review:

- Thorough Inspection: Examine the entire drainage system, including pipes, manholes, and gullies, for wear, damage, or blockages.
- Jetting: Utilise high-pressure water jetting to eliminate sediment and debris build-up in pipes.

Flow Control Devices

Quarterly Routine:

- Inspections: Ensure flow control devices are unobstructed and functioning as intended. Look for wear or damage.
- Operational Testing: Confirm that mechanical components and flow regulation mechanisms are in proper working order.

Annual Maintenance:

- Servicing: Lubricate moving parts, replace components showing wear, and conduct necessary repairs.
- Calibration: Verify and adjust settings to ensure devices are operating at designed flow rates.

General Maintenance Advice

- Record Maintenance: Keep detailed logs of all inspections, maintenance activities, and repairs. These records are vital for tracking the system's performance over time and planning future upkeep tasks.
- Safety Measures: Ensure all maintenance activities are conducted with appropriate safety precautions, particularly when working within confined spaces or with heavy equipment.

Conclusions

- The site resides in Flood Zone 1 where there is less than 1 in 1000 annual probability of river or sea flooding (<0.1%). Developments in this flood zone have no restrictions other than ensuring surface water drainage proposals do not increase the flood risk on site and the surrounding areas.

- It is not considered to be viable to discharge surface water to the ground via infiltration or to a surface water body. Therefore, it is proposed to connect the surface water drainage from the site to the 375mm diameter highway drain in Memorial Road to the south.

- The surface water run-off rate will be restricted to 2.3 l/s for all storm events up to and including the 100 year plus 45% climate change event. A below ground geocellular attenuation tank will provide the 13.20m^3 of storage required to accommodate the 100 year plus 45% climate change event.

- The design incorporates permeable paving to capture surface water and treat the runoff. Despite low infiltration rates, a Type B Permeable Paving system will be implemented to maximise opportunities to discharge the surface water into the underlying soils, with an overflow mechanism connected to the private surface water drainage system. Additionally, Rainwater Harvesting techniques, such as Watering Butts, will be employed to primarily reduce water demand.

- A SuDS Maintenance Plan will also be in place to ensure efficient operation and prevent failure of the system.

Note:

This report has been prepared for the purposes of reviewing the possibility of incorporating SuDS into the proposed development and uses the most up-to-date information available to us at the time. It should not be relied upon by anyone else or used for any other purpose. This report is confidential to our Client; it should only be shown to others with their permission. We retain copyright of this report which should only be reproduced with our permission.

	Prepared By	Checked By	Approved for issue
Name	Tom Spawton MEng	Tom Quigg BSc MSc CEng MICE	Tom Quigg BSc MSc CEng MICE
Signature	TS	TQ	TQ
Date	4 March 2024	4 March 2024	4 March 2024

Appendix A – Greenfield Run-off Rates

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Tom Spawton
Site name:	Memorial Road
Site location:	Bristol

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	51.44358° N
Longitude:	2.52147° W
Reference:	2924425277
Date:	Dec 31 2023 15:58

Runoff estimation approach

IH124

Site characteristics

Total site area (ha): .202

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	785	785
Hydrological region:	8	8
Growth curve factor 1 year:	0.78	0.78
Growth curve factor 30 years:	1.95	1.95
Growth curve factor 100 years:	2.43	2.43
Growth curve factor 200 years:	2.78	2.78

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	1.12	1.12
1 in 1 year (l/s):	0.87	0.87
1 in 30 years (l/s):	2.17	2.17
1 in 100 year (l/s):	2.71	2.71
1 in 200 years (l/s):	3.1	3.1

Appendix B – Infiltration Testing

A summary of exploratory holes undertaken in presented in Table 1 below.

Table 1 – Summary of Exploratory Holes Undertaken

Hole	Type*	Depth (m)	Date Started	Date Finished	Location		Backfill Details**
					Easting (m)	Northing (m)	
WS01	WS	2.00	16/11/2023	16/11/2023	363892	171723	A
DPWS01	DP	2.50	16/11/2023	16/11/2023	363892	171723	A
WS02	WS	2.00	16/11/2023	16/11/2023	363868	171735	A
DPWS02	DP	2.70	16/11/2023	16/11/2023	363868	171735	A
WS03	WS	1.50	16/11/2023	16/11/2023	363887	171747	A
DPWS03	DP	1.80	16/11/2023	16/11/2023	363887	171747	A
WS04	WS	2.00	16/11/2023	16/11/2023	363889	171738	A
DPWS04	DP	2.30	16/11/2023	16/11/2023	363889	171738	A
TP01	TP	1.70	16/11/2023	16/11/2023	363889	171732	A

The fieldwork was carried out generally in accordance with BS 5930:2015 Code of Practice for Site Investigations, Eurocode 7, unless otherwise stated. The exploratory hole locations are shown approximately on the Exploratory Hole Location Plan below:

Figure 4 - Exploratory Hole Location Plan

3.2 Laboratory Testing Programme

A programme of laboratory testing was carried out on samples taken from the various strata to assist in classification and determine the engineering properties of the materials underlying the site. The testing was scheduled by EEGSL and carried out by GSTL Ltd. The test procedures used were generally in accordance with the methods described in BS1377:1990 Details of the specific tests used in each case are given in Table 2 overleaf.

Earth Environmental & Geotechnical Ltd

Tel / Fax: 01225 858823
Web: www.earthenvironmental.co.uk
Email: southwest@earthenvironmental.co.uk

SOAKAWAY TEST

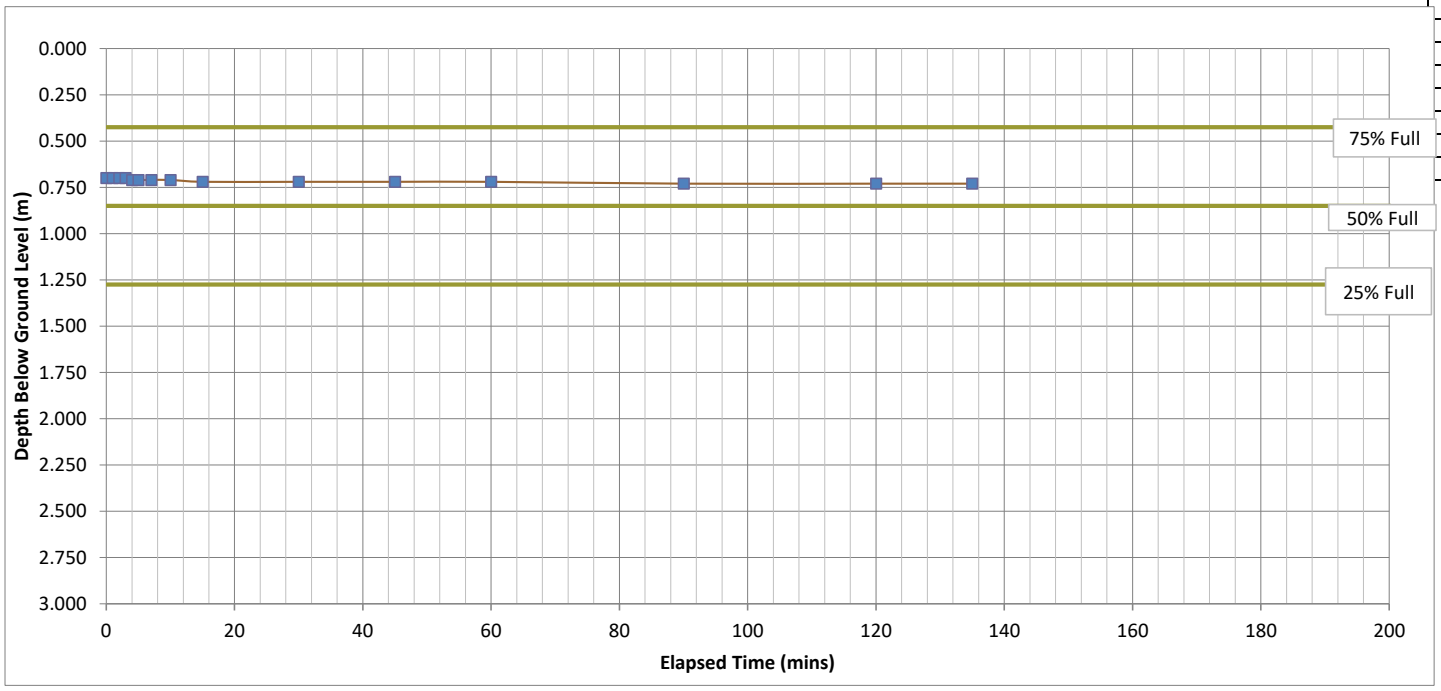
(To: BRE 365 2016)

Job No:	B3327
Site:	Memorial Road Hanham
Client:	Grandle Developments

Location Reference:	**TP01**	**Test 1**
Date	16/11/2023	
Geology in test section	slightly gravelly, slightly silty, sandy CLAY	
Depth to Base of Hole	1.70	m
Effective Depth	1.70	m
Hole Width	0.25	m
Hole Length	1.80	m
Depth to water at start of test below ground level	0.70	m
Depth to water at end of test below ground level	0.73	m
Effective storage depth to 75% full	1.28	m
(Depth below GL)	0.43	m
Effective storage depth to 50% full	0.85	m
(Depth below GL)	0.85	m
Effective storage depth to 25% full	0.43	m
(Depth below GL)	1.28	m
Height to 50% depth	0.50	m3
Effective Storage Volume V*p75-25*	0.77	m3
Time tp25 at which water is 75% of effective depth (minutes)		mins
Time tp25 at which water is 25% of effective depth (minutes)		mins
Time for water level to fall between Vp75 -25	0.0	mins
Time for water level to fall between Vp75 -25	0.0	secs
Internal surface area of hole up to 50% depth including base	3.94	m2
Soil Infiltration Rate, f		m/s

Measured Data

Time Elapsed (mins:sec)	**Depth of Water below GL** (m)
0.00	0.700
1.00	0.700
2.00	0.700
3.00	0.700
4.00	0.710
5.00	0.710
7.00	0.710
10.00	0.710
15.00	0.720
30.00	0.720
45.00	0.720
60.00	0.720
90.00	0.730
120.00	0.730
135.00	0.730



Appendix C – Wessex Water Sewer Records

Wessex Water
YTL GROUP

109 Memorial Road

Hanham, Bristol

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WATER MAINS Public Private
Public
Raw Water
Abandoned
Valve Hydrant PRV Meter M

SEWERS Public - Section 104 - Private
Foul
Combined
Surface
Abandoned sewers

OTHER WESSEX PIPES
Rising Mains
Effluent Disposal Main
Overflow

NON-WESSEX PIPES
Private Rising Mains
Culverted Water Course
Highway Drain

Information in this plan is provided for identification purposes only. No warranty as to accuracy is given or implied. The precise route of pipe work may not exactly match that shown. Wessex Water does not accept liability for inaccuracies. Sewers and lateral drains adopted by Wessex Water under the Water Industry (Schemes for Adoption of Private Sewers) Regulations 2011 are to be plotted over time and may not yet be shown.

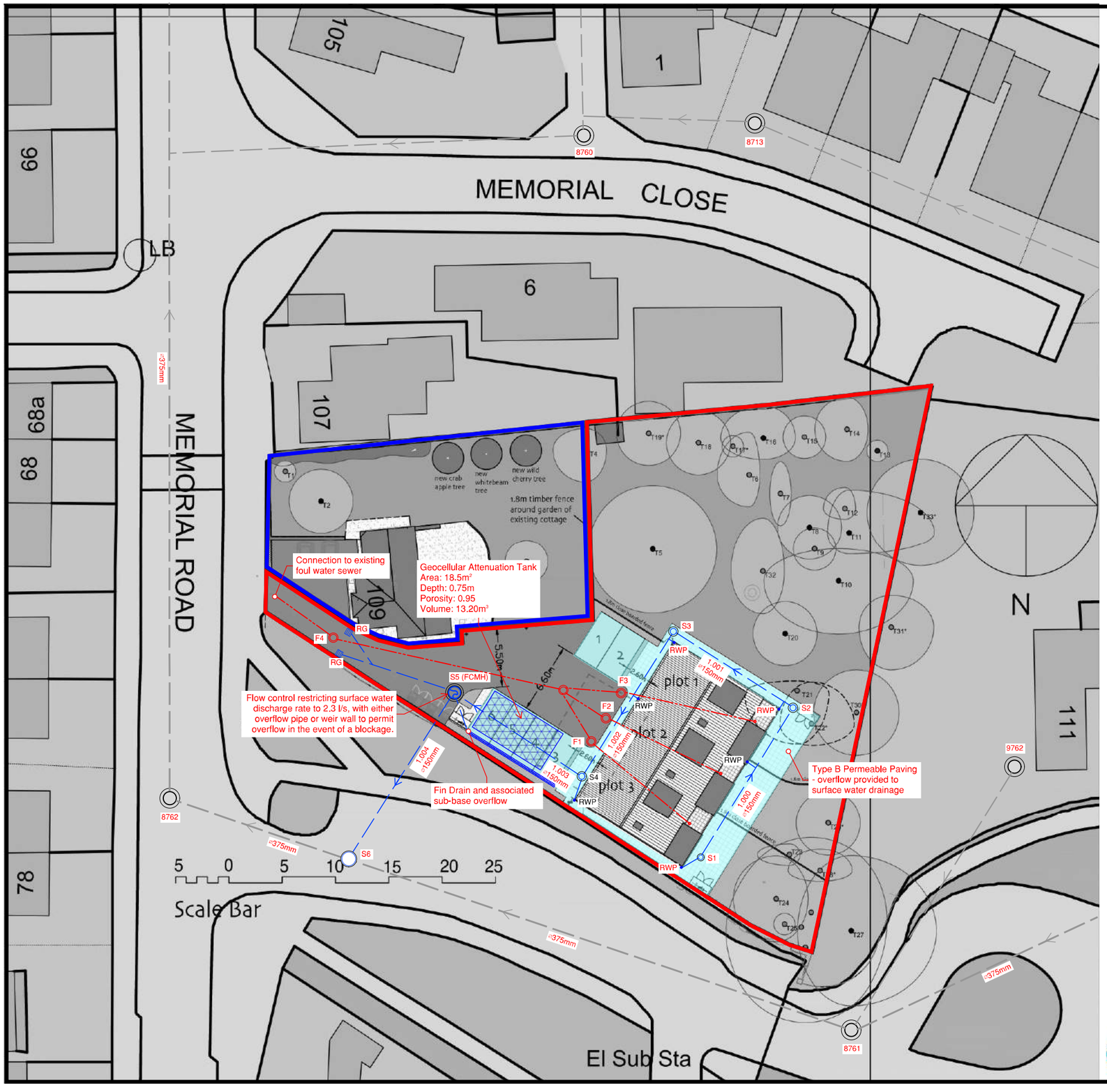
In carrying out any works, you accept liability for the cost of any repairs to Wessex Water apparatus damaged as a result of your works. You are advised to commence excavations using hand tools only. Mechanical digging equipment should not be used until pipe work has been precisely located.

If you are considering any form of building works and pipe work is shown within the boundary of your property or a property to be purchased (or very close by) a surveyor should plot its exact position prior to commencing works or purchase. If you are proposing to build over or near Wessex Water's apparatus you should contact the Developer Services Team, tel: 01225 526333 or e-mail: developer.enquiries@wessexwater.co.uk to discuss your proposals to discuss your proposals.

Centre:363856.77 , 171745.44

Scale = 1:800
Metres 10 20 30 40

Appendix D - SuDS Strategy and associated Hydraulic Calculations



NOTES:

1. COVER LEVELS TO ABOVE ORDNANCE DATUM (AOD) OBTAINED FROM THE LATEST LIDAR INFORMATION. COVER LEVELS OF ALL EXISTING MANHOLES TO BE CONFIRMED ON SITE TO ENSURE THE BELOW GROUND DRAINAGE HAS ADEQUATE FALLS TO ACHIEVE SELF-CLEANSING FLOWS.

2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.

3. DO NOT SCALE THIS DRAWING. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.

4. ONLY CONSTRUCTION STATUS DOCUMENTATION IS TO BE CONSTRUCTED FROM. PLEASE CONTACT FLUME CONSULTING ENGINEERS LTD (FLUME) TO OBTAIN THE NECESSARY CONSTRUCTION LEVEL INFORMATION. FLUME ACCEPTS NO LIABILITY FOR ANY ISSUES THAT MIGHT OCCUR IN THE EVENT THAT ANY WORKS PROGRESS OR ARE COMPLETED WITHOUT THE NECESSARY CONSTRUCTION INFORMATION. THIS DOCUMENT IS STRICTLY CONFIDENTIAL TO OUR CLIENT, OR THEIR OTHER PROFESSIONAL ADVISORS TO THE SPECIFIC PURPOSE TO WHICH IT REFERS. NO RESPONSIBILITY WHATSOEVER IS ACCEPTED TO ANY THIRD PARTIES FOR THE WHOLE OR PART OF ITS CONTENTS. THIS DOCUMENT AND ITS CONTENTS ARE COPYRIGHT BY FLUME - NO PART OF THIS DOCUMENT MAY BE REPRODUCED, STORED OR TRANSMITTED IN ANY FORM WITHOUT PRIOR WRITTEN PERMISSION.

5. GENERAL HIGH-PRESSURE JETTING REQUIRED TO REMOVE DEBRIS AND BLOCKAGES FROM EXISTING DRAINAGE SYSTEM IN LINE WITH THE RECOMMENDATIONS OUTLINED IN THE CCTV SURVEY.

6. REFER TO DRG 6100 FOR FURTHER DRAINAGE NOTES.

DRAINAGE LEGEND

New SW Drain

New FW Drain

Existing SW Sewer / Highway Drain

DRAINAGE KEY

RWP	Rainwater Down Pipe
RG	Road Gully
S1 F1	Surface Water and Foul Water Inspection Chambers
FCMH1	Flow Control Chamber (SW only)
	Storage or Attenuation Cells
	Permeable paving

HEALTH & SAFETY

List of site specific or unusual hazards relevant to the drawing: (Must be read in conjunction with the CDM risk register.)

Excavations	Excavation for manholes Contractor to ensure adequate edge protection to excavations for workers and plant and to ensure sides of excavations are sufficiently stable or shored up. Contractor to restrict access into areas where excavations are being carried out.
Sewer Connections	Working with live sewers Extra care must be taken when dealing with live sewers to ensure there is no adverse effect to the existing drainage.
Existing Services	Working alongside/near existing services. Extra care must be taken when working/digging near existing services. A survey should be carried out prior to works commencing to determine the exact location of existing services.

flume Consulting Engineers

Job No. 1417 Page 6000 Rev 2

Date 04/03/2024 Eng TS Chd TQ

Job 109 Memorial Road - Drainage Layout Drawing

flume

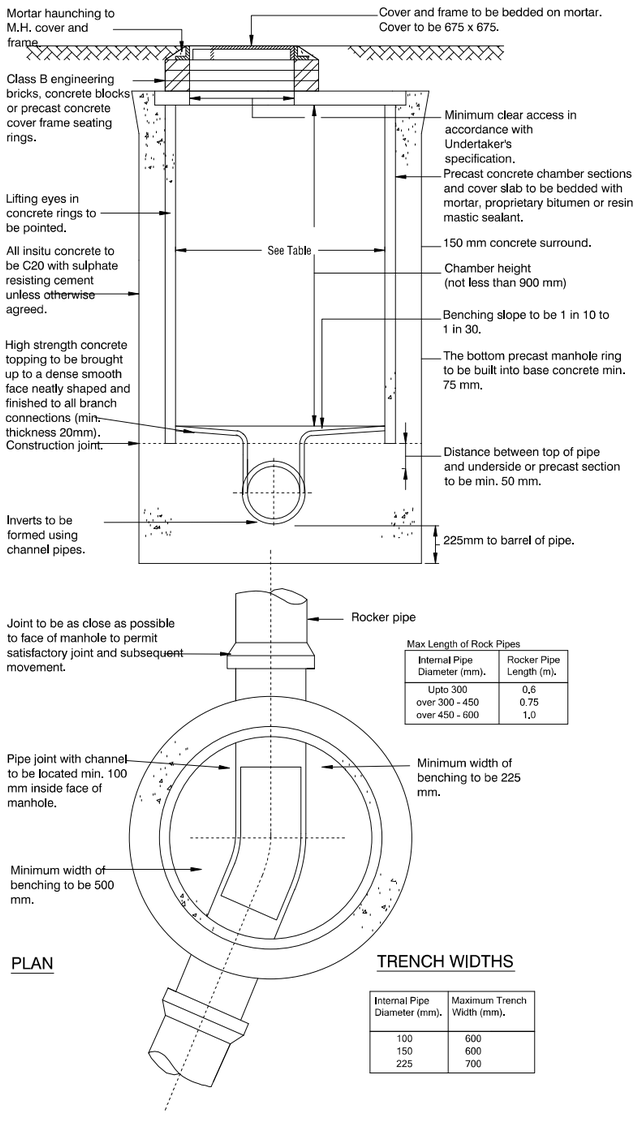
Job No. 1417 Page 6100 Rev 1

Date 04/03/2024 Eng TQ Chd

Job 109 Memorial Road - Drainage Details

TYPICAL MANHOLE DETAIL - TYPE B

Max depth from cover level to soffit of pipe 3.0 m



PLAN

Max Length of Rock Pipes

Internal Pipe Diameter (mm).	Rocker Pipe Length (m).
Upto 300	0,6
over 300 - 450	0.75
over 450 - 600	1,0

TRENCH WIDTHS

Internal Pipe Diameter (mm).	Maximum Trench Width (mm).
100	600
150	600
225	700

Minimum dimension for manholes

Type	Size of largest pipe (DN)	Min internal dimensions (1) Rectangular length and width	Circular diameter	Min clear opening size (1) Rectangular length and width	Circular diameter
Manhole < 1.5 deep to soffit	150 225 300 >300	750 x 675 (7) 1200 x 675 1200 x 750 1800 x (DN+450)	1050 (7) 1200 1200 The larger of 1800 OR (DN + 450)	750 x 675 (2) 1200 x 675 (2)	na (3)
> 1.5 deep to soffit	225 300 375 - 450 >450	1200 x 1000 1200 x 1075 1305 x 1225 1800 x (DN + 775)	1200 1200 1200 The larger of 1800 OR (DN + 775)	600 x 600	600
Manhole >3.0m deep to soffit of pipe	Steps (5) Ladder (5) Winch (6)	1050 x 800 1200 x 800 900 x 800	1050 1200 900	600 x 600 600 x 600	600 600

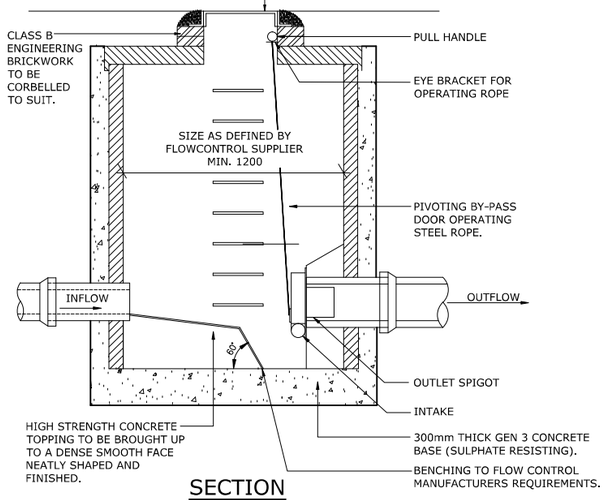
Notes

1. Large sizes may be required for manholes on bends or where there are junctions.
2. May be reduced to 600 where required by highway loadind considerations, subject to safe system of work being specified.
3. Not applicable due to working space needed.
4. Minimum height of chamber in shafted manhole 2m from benching to under side of reducing slab.
5. Min clear space between ladder or steps and the opposite face of the shaft should be approximately 900mm.
6. Winch only - no steps or ladders, permanent or removable.
7. The minimum size of any manhole serving a sewer (i.e any drain serving more than one property) should be 1200mm x 675mm rectangular or 1200mm diameter.

RECESSED DUCTILE IRON COVER & FRAME TO BS EN:124 C125, (1220X685 MIN CLEAR OPENING) BEDDED ON CLASS M1, M2 OR EPOXY MORTAR. APPROVED PACKING MATERIAL MAY BE USED IF REQUIRED.

HYDROBRAKE FLOW CONTROL UNIT BY HYDROK UK

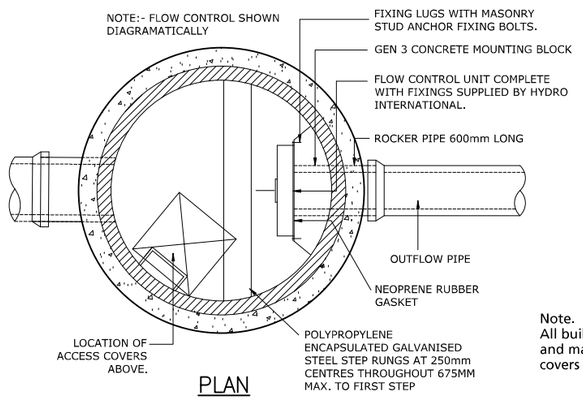
DESIGN FLOW	: 2.30 l/s
HYDROBRAKE UNIT REFERENCE	: CTL-SHE-0075-2300-0825-2300
MINIMUM OUTLET	: 150mmØ



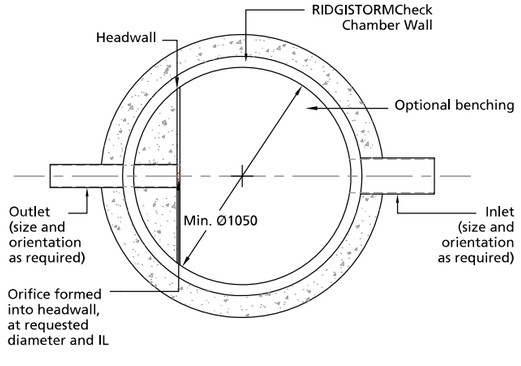
SECTION

TYPICAL FLOW CONTROL CHAMBER

NOT TO SCALE



PLAN



NOTES:

① COVER LEVELS TO ABOVE ORDNANCE DATUM (AOD) OBTAINED FROM THE LATEST LIDAR INFORMATION. COVER LEVELS OF ALL EXISTING MANHOLES TO BE CONFIRMED ON SITE TO ENSURE THE BELOW GROUND DRAINAGE HAS ADEQUATE FALLS TO ACHIEVE SELF-CLEANSING FLOWS.

② THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.

③ DO NOT SCALE THIS DRAWING. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.

④ ONLY CONSTRUCTION STATUS DOCUMENTATION IS TO BE CONSTRUCTED FROM. PLEASE CONTACT FLUME CONSULTING ENGINEERS LTD (FLUME) TO OBTAIN THE NECESSARY CONSTRUCTION LEVEL INFORMATION. FLUME ACCEPTS NO LIABILITY FOR ANY ISSUES THAT MIGHT OCCUR IN THE EVENT THAT ANY WORKS PROGRESS OR ARE COMPLETED WITHOUT THE NECESSARY CONSTRUCTION INFORMATION. THIS DOCUMENT IS STRICTLY CONFIDENTIAL TO OUR CLIENT, OR THEIR OTHER PROFESSIONAL ADVISORS TO THE SPECIFIC PURPOSE TO WHICH IT REFERS. NO RESPONSIBILITY WHATSOEVER IS ACCEPTED TO ANY THIRD PARTIES FOR THE WHOLE OR PART OF ITS CONTENTS. THIS DOCUMENT AND ITS CONTENTS ARE COPYRIGHT BY FLUME - NO PART OF THIS DOCUMENT MAY BE REPRODUCED, STORED OR TRANSMITTED IN ANY FORM WITHOUT PRIOR WRITTEN PERMISSION.

⑤ GENERAL HIGH-PRESSURE JETTING REQUIRED TO REMOVE DEBRIS AND BLOCKAGES FROM EXISTING DRAINAGE SYSTEM IN LINE WITH THE RECOMMENDATIONS OUTLINED IN THE CCTV SURVEY.

⑥ ALL PRIVATE SEWER MATERIALS AND WORKMANSHIP MUST COMPLY WITH PART H OF THE BUILDING REGULATIONS AND BS EN752 STANDARDS.

⑦ ADOPTABLE SEWER MATERIALS AND WORKMANSHIP MUST ADHERE TO THE SEWERS FOR ADOPTION 7TH EDITION BY THE WATER SERVICES ASSOCIATION AND ANY SUBSEQUENT REVISIONS BY THE WATER AUTHORITY - CONSTRUCTION DESIGN GUIDANCE ETC.

⑧ GULLEY AND CHANNEL GRATING SHOULD BE MADE FROM DUCTILE IRON TO BS EN124, LOAD CLASS D400, AND KITE MARKED.

⑨ MANHOLE COVERS AND FRAMES TO BE DUCTILE IRON TO BS EN124 CLASS D400 IN CARRIAGEWAYS AND CLASS B125 IN VERGES UNLESS OTHERWISE SPECIFIED; COVERS SHOULD BE MARKED "SW" OR "FW" UNLESS OTHERWISE INSTRUCTED BY THE WATER AUTHORITY. BRICK/BRICK INFILLED MANHOLE COVERS ARE NOT TO BE USED ON ADOPTABLE MANHOLES.

⑩ ALL CLAYWARE PIPES MUST BE VITRIFIED CLAY TO BS EN 295 OR BS 65, ENSURING MINIMUM STRENGTH CLASS 120 OR EXTRA STRENGTH.

⑪ ALL PLASTIC PIPES SHOULD CONFORM TO BS EN 1401.

⑫ ALL UNDERFLOOR HUNG DRAINAGE TO BE MADE FROM DUCTILE IRON IN ACCORDANCE WITH BS EN 545: 1994 AND BS EN 598: 1994 UNLESS THE DRAWING STATES OTHERWISE.

⑬ CARRIER DRAINS UNDER CARRIAGEWAYS SHOULD BE CONSTRUCTED WITH EITHER BEDDING TYPES S OR Z, WITH THE CHOICE DEPENDING ON DEPTH OF COVER AS SHOWN ON TYPICAL DRAINAGE DETAILS DRAWING.

⑭ FLEXIBLE JOINTS IN PIPES NEAR MANHOLES SHOULD BE 600MM FROM THE INSIDE FACE OF THE MANHOLE, CONNECTING TO ROCKER PIPES. FOR PIPES WITH DIAMETERS BETWEEN 150-450MM, THE ROCKER PIPE LENGTH SHOULD BE 750MM-1000MM.

⑮ PIPES MUST BE LAID ACCURATELY TO THEIR DESIGN LINE AND LEVEL, EITHER BY LASER OR BONING, FROM BOTH ENDS AND THE MIDDLE.

⑯ SOFT SPOTS WITHIN PIPE TRENCHES MUST BE EXCAVATED AND FILLED.

⑰ WATER ACCUMULATION IN PIPE TRENCHES DURING CONSTRUCTION IS NOT PERMITTED.

⑱ ALL FILL MATERIAL IN TRENCHES SHOULD BE CONSOLIDATED IN LAYERS, WITH EACH NOT EXCEEDING 150MM.

⑲ P.C. (PRECAST CONCRETE) LINTELS ARE REQUIRED OVER PIPES AND DUCTS PASSING THROUGH WALLS, DESIGNED BY A STRUCTURAL ENGINEER.

⑳ IN-SITU CONCRETE USED IN PIPE PROTECTION MUST BE AT LEAST GRADE ST2, UNLESS OTHERWISE SPECIFIED.

㉑ COMPRESSIBLE FILLER FOR INTERRUPTING CONCRETE PIPE PROTECTION SHOULD BE BITUMEN IMPREGNATED INSULATING BOARD TO BS 1142 AT EACH PIPE JOINT.

㉒ ALL REDUNDANT DRAINS MUST BE SEALED WITH CONCRETE.

㉓ FLEXIBLE JOINTS ARE MANDATORY FOR ALL PIPE RUNS.

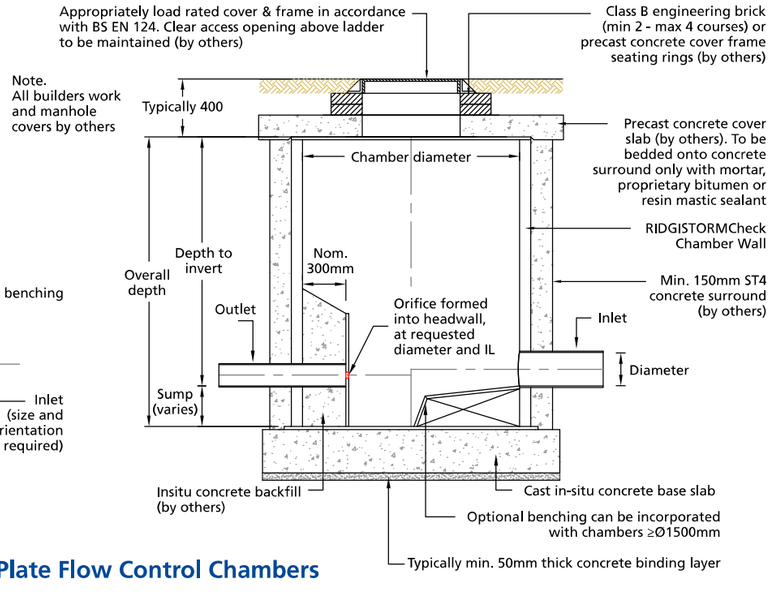
㉔ ALL PIPE CONNECTIONS TO SOFFITS MUST BE CRAFTED WITH CARE.

㉕ ANY PIPEWORK WITH LESS THAN 1.2CM OF COVER IN ROADS OR PARKING AREAS MUST BE PROTECTED WITH CONCRETE AND SURROUNDED.

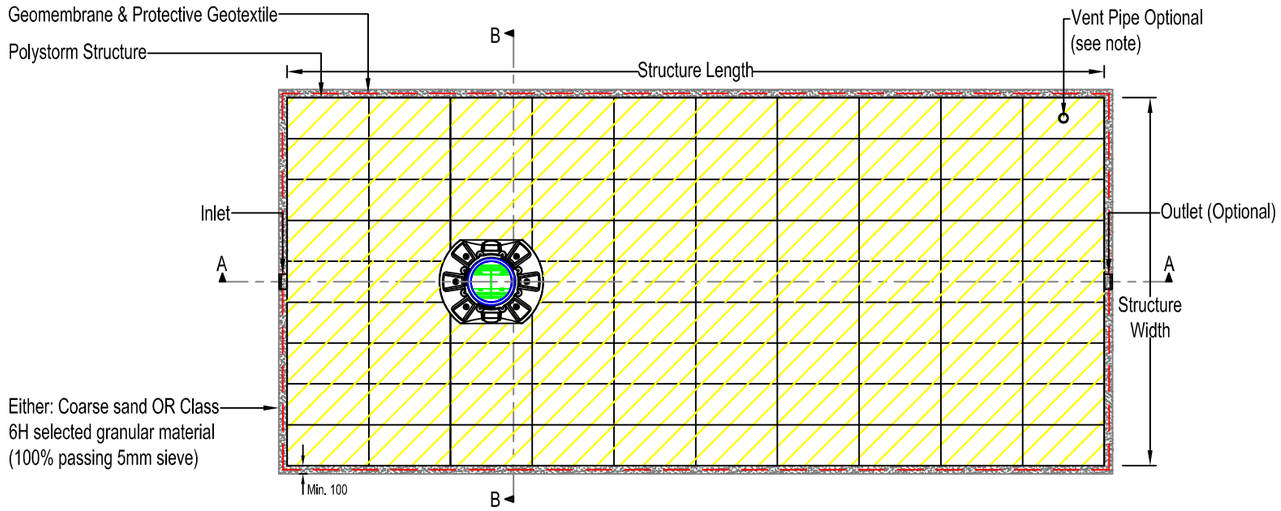
㉖ IF DISCREPANCIES ARE FOUND IN THE PROVIDED INFORMATION, THE CONTRACTOR MUST INFORM THE ENGINEER IMMEDIATELY BEFORE ORDERING MATERIALS OR COMMENCING WORK.

㉗ ALL UNDER SLAB DRAINAGE SHOULD FOLLOW A MINIMUM 1 IN 40 FALL.

㉘ PATIOS AND EXTERNAL SURFACES MUST SLOPE AWAY FROM BUILDING THRESHOLDS TO PREVENT WATER ACCUMULATION.



RIDGISTORMCheck Orifice Plate Flow Control Chambers

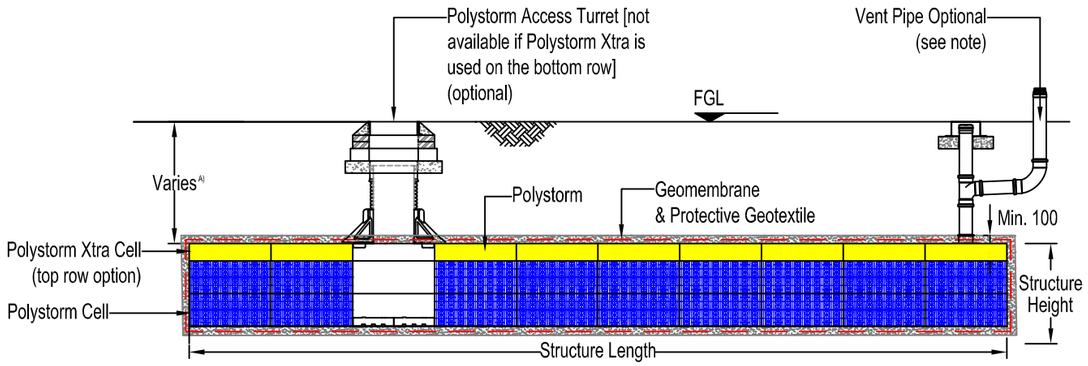


TYPICAL HYBRID TANK PLAN

(Scale 1:75)

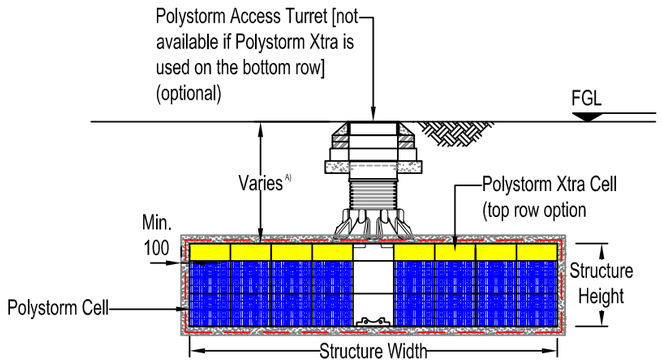
KEY:

- POLYSTORM (PSM1, 1A & 2 CELL)
- POLYSTORM (PSM3 CELL)



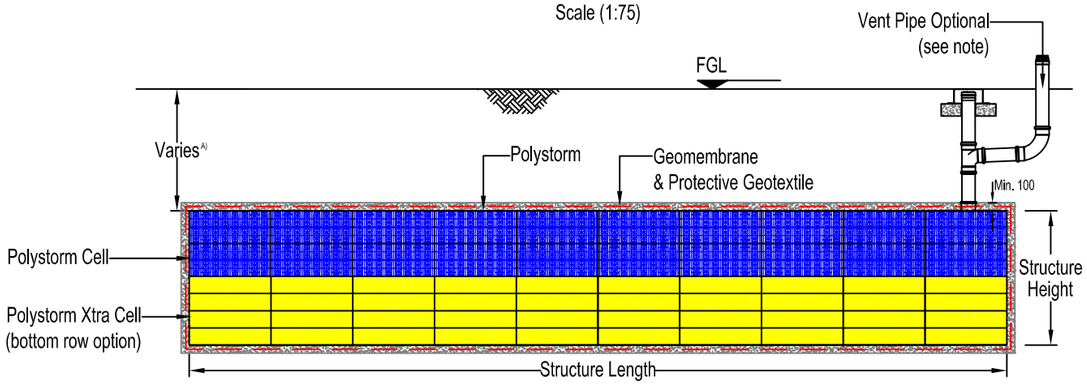
SECTION A-A

Scale (1:75)



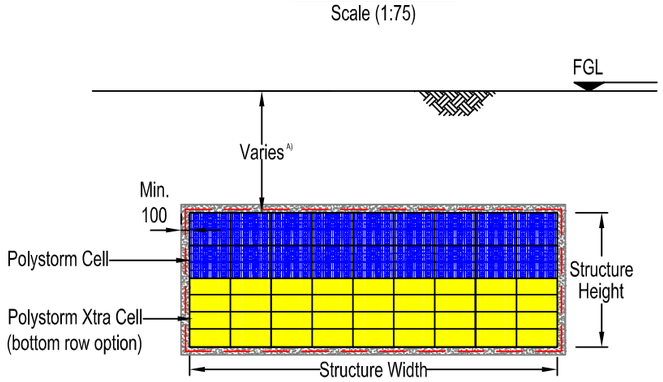
SECTION B-B

Scale (1:75)



SECTION A-A

Scale (1:75)



SECTION B-B

Scale (1:75)

VENTILATION NOTE

For information on Ventilation Options please refer to drawing ref: PSM_SD_PSM_002

NOTE A

For information on tank cover depths please contact the Technical Team:- 01509 61500

NOTES

1. All dimensions in millimetres, unless otherwise stated.
2. All dimensions are nominal and may vary within manufacturing or construction tolerances.
3. All site temporary and enabling works by others.
4. Polypipe products to be installed in accordance with Polypipe civils recommendations (refer to Polypipe technical guidance for further information), giving due consideration to the requirements of the organisation who will be taking ultimate owner ship of the installation.
5. This drawing is intended for guidance only. Confirmation of the information contained within this document should be sought from the consulting engineers before final design or construction activities commence.

Polypipe Civils
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Leicestershire. LE11 1LE
Tel: 01509 615100
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www.polypipe.com/civils
www.polypipe.com/wms

PROJECT	POLYSTORM STANDARD DETAILS
TITLE	POLYSTORM HYBRID TANK
STATUS	FOR INFORMATION
DATE	17/03/16
DRAWN BY	JL
ORIGINAL SIZE	A3
SCALE	AS SHOWN
DRAWING No.	PSM_SD_EG_005
REV.	

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	150.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
S1	0.014	5.00	61.000	450	53.622	22.448	0.800
S2	0.005	5.00	61.000	600	62.231	36.258	1.003
S3	0.008	5.00	61.000	600	51.191	43.258	1.241
S4	0.008	5.00	61.000	600	42.785	29.811	1.439
S5 (FCMH)	0.009	5.00	61.000	1200	30.883	37.553	1.616
S6			61.000	1350	21.254	22.272	1.842

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	S1	S2	16.274	0.600	60.200	59.997	0.203	80.0	150	5.24	150.0
1.001	S2	S3	13.072	0.600	59.997	59.834	0.163	80.0	150	5.43	150.0
1.002	S3	S4	15.858	0.600	59.759	59.561	0.198	80.0	225	5.62	150.0
1.003	S4	S5 (FCMH)	14.198	0.600	59.561	59.384	0.177	80.0	225	5.78	150.0
1.004	S5 (FCMH)	S6	18.062	0.600	59.384	59.158	0.226	80.0	225	5.98	150.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.125	19.9	5.8	0.650	0.853	0.014	0.0	55	0.977
1.001	1.125	19.9	8.0	0.853	1.016	0.020	0.0	66	1.063
1.002	1.463	58.2	11.1	1.016	1.214	0.027	0.0	66	1.133
1.003	1.463	58.2	14.3	1.214	1.391	0.035	0.0	76	1.217
1.004	1.463	58.2	18.0	1.391	1.617	0.044	0.0	86	1.293

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	16.274	80.0	150	Circular	61.000	60.200	0.650	61.000	59.997	0.853
1.001	13.072	80.0	150	Circular	61.000	59.997	0.853	61.000	59.834	1.016
1.002	15.858	80.0	225	Circular	61.000	59.759	1.016	61.000	59.561	1.214
1.003	14.198	80.0	225	Circular	61.000	59.561	1.214	61.000	59.384	1.391
1.004	18.062	80.0	225	Circular	61.000	59.384	1.391	61.000	59.158	1.617

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	S1	450	Manhole	Adoptable	S2	600	Manhole	Adoptable
1.001	S2	600	Manhole	Adoptable	S3	600	Manhole	Adoptable
1.002	S3	600	Manhole	Adoptable	S4	600	Manhole	Adoptable
1.003	S4	600	Manhole	Adoptable	S5 (FCMH)	1200	Manhole	Adoptable
1.004	S5 (FCMH)	1200	Manhole	Adoptable	S6	1350	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S1	53.622	22.448	61.000	0.800	450				
						0	1.000	60.200	150
S2	62.231	36.258	61.000	1.003	600		1.000	59.997	150
						0	1.001	59.997	150
S3	51.191	43.258	61.000	1.241	600		1.001	59.834	150
						0	1.002	59.759	225
S4	42.785	29.811	61.000	1.439	600		1.002	59.561	225
						0	1.003	59.561	225
S5 (FCMH)	30.883	37.553	61.000	1.616	1200		1.003	59.384	225
						0	1.004	59.384	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S6	21.254	22.272	61.000	1.842	1350	1	1.004	59.158	225

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Detailed	Additional Storage (m³/ha)	20.0
Summer CV	0.750	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	0.840	Drain Down Time (mins)	240	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0	30	40	0	0
5	0	0	0	100	0	0	0
30	0	0	0	100	45	0	0

Node S5 (FCMH) Online Orifice Control

Flap Valve	x	Invert Level (m)	59.384	Design Flow (l/s)	2.1	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Design Depth (m)	0.750	Diameter (m)	0.034		

Node S5 (FCMH) Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	59.384
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	124

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	18.5	18.5	0.750	18.5	18.5	0.751	0.0	18.5

FOUL WATER MANHOLE SCHEDULE

MANHOLE SCHEDULE

MH No.	MANHOLE DIAMETER (mm)	MANHOLE TYPE	COVER LEVEL (m)	INVERT LEVEL (m)	COVER CLEAR OPENING AND COVER GRADE	NOTES (TO BUILDING REULATIONS PART H)
F1	450	PPIC	61.00	60.10	450x450 / BS EN 124 CLASS B125	
F2	450	PPIC	61.00	60.10	450x450 / BS EN 124 CLASS B125	
F3	450	PPIC	61.00	60.10	450x450 / BS EN 124 CLASS B125	
F4	450	PPIC	61.00	59.30	450x450 / BS EN 124 CLASS B125	

Results for 2 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	10	60.230	0.030	1.8	0.0157	0.0000	OK
15 minute winter	S2	11	60.033	0.036	2.5	0.0139	0.0000	OK
15 minute winter	S3	11	59.795	0.036	3.3	0.0148	0.0000	OK
15 minute summer	S4	10	59.603	0.042	4.1	0.0164	0.0000	OK
180 minute winter	S5 (FCMH)	124	59.541	0.157	1.8	2.9613	0.0000	OK
15 minute summer	S6	1	59.158	0.000	0.7	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S1	1.000	S2	1.8	0.617	0.089	0.0468	
15 minute winter	S2	1.001	S3	2.4	0.750	0.120	0.0416	
15 minute winter	S3	1.002	S4	3.3	0.728	0.057	0.0728	
15 minute summer	S4	1.003	S5 (FCMH)	4.1	0.916	0.071	0.1228	
180 minute winter	S5 (FCMH)	Orifice	S6	0.9				7.6

Results for 5 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	10	60.239	0.039	3.0	0.0202	0.0000	OK
15 minute winter	S2	10	60.044	0.047	4.1	0.0181	0.0000	OK
15 minute winter	S3	11	59.806	0.047	5.5	0.0191	0.0000	OK
120 minute winter	S4	86	59.628	0.067	2.6	0.0265	0.0000	OK
120 minute winter	S5 (FCMH)	88	59.628	0.244	3.3	4.5930	0.0000	SURCHARGED
15 minute summer	S6	1	59.158	0.000	0.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S1	1.000	S2	3.0	0.711	0.149	0.0677	
15 minute winter	S2	1.001	S3	3.9	0.862	0.198	0.0598	
15 minute winter	S3	1.002	S4	5.5	0.839	0.094	0.1040	
120 minute winter	S4	1.003	S5 (FCMH)	2.6	0.646	0.045	0.3530	
120 minute winter	S5 (FCMH)	Orifice	S6	1.2				9.2

Results for 30 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	10	60.252	0.052	5.1	0.0269	0.0000	OK
15 minute winter	S2	10	60.060	0.063	6.9	0.0245	0.0000	OK
15 minute winter	S3	10	59.822	0.063	9.4	0.0254	0.0000	OK
120 minute winter	S4	92	59.797	0.236	4.1	0.0930	0.0000	SURCHARGED
120 minute winter	S5 (FCMH)	92	59.797	0.413	4.9	7.7735	0.0000	SURCHARGED
15 minute summer	S6	1	59.158	0.000	1.2	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S1	1.000	S2	5.0	0.810	0.254	0.1014	
15 minute winter	S2	1.001	S3	6.7	0.992	0.339	0.0892	
15 minute winter	S3	1.002	S4	9.4	0.972	0.162	0.1919	
120 minute winter	S4	1.003	S5 (FCMH)	3.9	0.659	0.067	0.5647	
120 minute winter	S5 (FCMH)	Orifice	S6	1.5				14.9

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	10	60.263	0.063	7.1	0.0325	0.0000	OK
15 minute winter	S2	10	60.074	0.077	9.6	0.0298	0.0000	OK
120 minute winter	S3	94	59.979	0.220	4.3	0.0893	0.0000	OK
120 minute winter	S4	94	59.979	0.418	5.6	0.1647	0.0000	SURCHARGED
120 minute winter	S5 (FCMH)	94	59.979	0.595	6.5	11.1940	0.0000	SURCHARGED
15 minute summer	S6	1	59.158	0.000	1.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S1	1.000	S2	7.0	0.874	0.354	0.1309	
15 minute winter	S2	1.001	S3	9.4	1.076	0.473	0.1146	
120 minute winter	S3	1.002	S4	4.3	0.733	0.074	0.6287	
120 minute winter	S4	1.003	S5 (FCMH)	5.1	0.725	0.087	0.5647	
120 minute winter	S5 (FCMH)	Orifice	S6	1.8				20.6

Results for 100 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	10	60.260	0.060	6.5	0.0308	0.0000	OK
15 minute winter	S2	10	60.070	0.073	8.8	0.0282	0.0000	OK
60 minute winter	S3	58	59.912	0.153	6.6	0.0623	0.0000	OK
60 minute winter	S4	58	59.912	0.351	8.5	0.1384	0.0000	SURCHARGED
60 minute winter	S5 (FCMH)	59	59.912	0.528	9.6	9.9381	0.0000	SURCHARGED
15 minute summer	S6	1	59.158	0.000	1.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S1	1.000	S2	6.4	0.857	0.323	0.1221	
15 minute winter	S2	1.001	S3	8.6	1.054	0.433	0.1071	
60 minute winter	S3	1.002	S4	6.6	0.845	0.113	0.5439	
60 minute winter	S4	1.003	S5 (FCMH)	7.4	0.855	0.127	0.5647	
60 minute winter	S5 (FCMH)	Orifice	S6	1.7				15.4

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute winter	S1	94	60.318	0.118	3.1	0.0611	0.0000	OK
120 minute winter	S2	94	60.318	0.321	4.2	0.1241	0.0000	SURCHARGED
120 minute winter	S3	94	60.317	0.558	5.9	0.2267	0.0000	SURCHARGED
120 minute winter	S4	94	60.318	0.757	6.9	0.2981	0.0000	SURCHARGED
120 minute winter	S5 (FCMH)	94	60.317	0.933	8.3	14.3509	0.0000	SURCHARGED
15 minute summer	S6	1	59.158	0.000	1.7	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
120 minute winter	S1	1.000	S2	3.1	0.726	0.156	0.2642	
120 minute winter	S2	1.001	S3	4.3	0.873	0.216	0.2301	
120 minute winter	S3	1.002	S4	5.3	0.714	0.091	0.6307	
120 minute winter	S4	1.003	S5 (FCMH)	6.4	0.734	0.110	0.5647	
120 minute winter	S5 (FCMH)	Orifice	S6	2.3				26.7