



Consulting Civil Engineers

SuDS Maintenance and Management Plan

Merry England, Dappers Lane, Angmering

For

GD Group

Rev – P

Planning Application No A/91/18/PL

Reference C1149

Date 18th September 2019

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1. Introduction

CGS Civils Ltd have been appointed to undertake a detailed drainage design using sustainable techniques for a proposed development in Angmering, West Sussex.

The site will consist of the construction of 18 new dwellings. There are three private parking areas as well as individual driveways and an access road. Root protection zones run along the south of the site and in other areas. A drainage ditch runs south along the western flank of the site.

2. Sustainable Drainage Systems (SuDS)

The surface water management strategy has been developed using best practice Sustainable Drainage Systems (SuDS) techniques. Guidance on suitable techniques and methods has been obtained from the EA, and the SuDS manual (CIRIA C753).

The National Planning Policy Framework (NPPF) recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites and recommends that priority is given to the use of Sustainable Drainage Systems (SuDS) in new development.

The overall philosophy of SuDS is to replicate, as closely as possible, the natural drainage process of a site prior to development to mitigate the adverse effect of storm water runoff on the environment. SuDS not only provide the ability to control surface water flows, but also improve water quality, amenity and bio-diversity within the development.

The Building Regulations Requirement H3 and GCC Planning Policy stipulates 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:

- 1- Discharge into the ground
- 2- Discharge to a surface water body
- 3- Discharge to a surface water sewer

3. SuDS at Merry England

Soakage tests to the BRE 365 method were undertaken on site on 13th August 2019. Testing undertaken confirms moderate to poor rates as noted below in the extract from the Site Investigation Report. Trial pits TP2 and TP3 were not fully completed in accordance with BRE 365.

Test ref	Test Depth (m)	Initial fill level (mbgl)	Time at 75% fill depth (mins)	Time at 25% fill Depth (mins)	K (m/s)
TP1	1.40	0.53	40	180	1.4×10^{-5}
TP2	2.00	0.90	330 (estimated)	990 (estimated)	3.1×10^{-6} {Estimated}
TP3	1.70	0.83	55	240 (estimated)	1.1×10^{-5} {Estimated}

During the excavations in August, groundwater was noted up to 1.5mbgl. Further monitoring will be undertaken in the winter period however it is likely to rise above this level in places during the colder and wetter months. On this basis we have opted for a hybrid design of infiltration via shallow permeable surfaces in combination with a positive outfall into the existing drainage ditch at a discharge rate no great than QBar i.e. 2.3l/s. This will provide the most sustainable and practical scenario whilst ensuring protection to the properties from flooding related to high groundwater. The infiltration rates, whilst generally poor, will support self-draining permeable surfaces.

All roof areas and main access road areas will be discharged into the ditch via an attenuation tank and an offline detention basin at a restricted flow rate of 2.3l/s which is the calculated QBar rate.

All driveways and private parking areas are to be constructed with a resin bound permeable surface that will allow for direct infiltration into the ground.

All SuDS features have been designed to cater for and contain the 1 in 100-year storm + 40%.

4. Managing SuDS

The SuDS have been designed for easy maintenance and comprise:

- Regular day-to-day care – litter collection, regular gardening to control vegetation growth and checking inlets where water enters the SuDS feature
- Occasional tasks – checking the SUDS feature and removing any silt that builds up in the SuDS feature
- Remedial work – repairing damage where necessary

The client will, within the first 6-12 months of construction, form a maintenance company within the structure of the current company to facilitate the maintenance of the drainage system as per the requirements and specifications within this document.

Once design life has been met on the SuDS features then these will be repaired or replaced in part in accordance with the SuDS maintenance specification in Section 6 or fully replaced in accordance with the respective manufacturer's specifications.

The existing drainage ditch will be maintained from site via the south western car park. Parking and safe access will be provided.

5. Water Quality

The new SuDS Manual (Ciria C753, November 2015) introduces slightly different approach compared to the previous version for the water quality management of surface water. The Manual describes risks posed by the surface water runoff to the receiving environment as a function of:

- The pollution hazard at a particular site (i.e. the pollution source)
- The effectiveness of SuDS treatment components in reducing levels of pollutants to environmentally acceptable levels
- The sensitivity of the receiving environment

The EA website indicates that the site does not lie within a Source Protection Zone.

The recommended approaches for water quality risk management are given in the SuDS Manual Table 26.1.

Figure 7 Approaches to Water Quality Risk Management

TABLE 26.1	Approaches to water quality risk management			
	Design method	Hazard characterisation	Risk reduction	
			For surface water	For groundwater
	Simple index approach	Simple pollution hazard indices based on land use (eg Table 26.2 or equivalent)	Simple SuDS hazard mitigation indices (eg Table 26.3 or equivalent)	Simple SuDS hazard mitigation indices (eg Table 26.4 or equivalent)
	Risk screening	Factors characterising traffic density and extent of infiltration likely to occur (eg Table 26.5 or equivalent)	N/A	Factors characterising unsaturated soil depth and type, and predominant flow type through the soils (eg Table 26.5 or equivalent)
	Detailed risk assessment	Site specific information used to define likely pollutants and their significance	More detailed, component specific performance information used to demonstrate that the proposed SuDS components reduce the hazard to acceptable levels	
	Process-based treatment modelling	Time series rainfall used with generic pollution characteristics to determine statistical distributions of likely concentrations and loadings in the runoff	Models that represent the treatment processes in the proposed SuDS components give estimates of reductions in event mean discharge concentrations and total annual load reductions delivered by the system	

As per Table 26.1 Simple Index approach will be used as a design method for this site.

Table 26.2 will provide hazard classification of different land uses. The land uses for the surface water drainage for this site are;

- Residential Roofs
- Individual Property driveways and residential car parks
- Low traffic roads

To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index for each contaminant type that equals or exceeds the pollution hazard index for each contaminant type. Therefore, the following must be achieved for the surface running off the site.

Total SuDS mitigation index $\geq$ pollution hazard index

Pollution Hazard Indices are given for different land uses in Table 26.2 of the SuDS manual;

Figure 8 Pollution Hazard Indices for Different Land Use Classifications

TABLE 26.2 Pollution hazard indices for different land use classifications				
Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways ¹	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways ¹	High	0.8 ²	0.8 ²	0.9 ²

From Table 26.2 the following information is tabulated in Table 4

Table 4: Pollution hazard index and destination of runoff for the proposed site

Land Use	Destination of Runoff	Pollution Hazard Level	Total Suspended Solids	Metals	Hydrocarbons
Residential Roofs	Surface Waters	Very Low	0.2	0.2	0.05
Individual Driveways, Residential car parks and low traffic roads	Surface Waters	Low	0.5	0.4	0.4

The SuDS mitigation index will be obtained from Table 26.4 (for surface water) of the SuDS manual.

Figure 9 Indicative SuDS Mitigation Indices for discharges to surface waters

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters				
		Mitigation indices ¹		
Type of SuDS component	TSS	Metals	Hydrocarbons	
Filter strip	0.4	0.4	0.5	
Filter drain	0.4 ²	0.4	0.4	
Swale	0.5	0.6	0.6	
Bioretention system	0.8	0.8	0.8	
Permeable pavement	0.7	0.6	0.7	
Detention basin	0.5	0.5	0.6	
Pond ⁴	0.7 ³	0.7	0.5	
Wetland	0.8 ³	0.8	0.8	
Proprietary treatment systems ^{5,6}	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.			

SuDS mitigation index are tabulated in Table 5 as followed;

Runoff Source	Destination of Runoff	Mitigation Index Source	Mitigation Indices			
			Type of SuDS Component	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential Roof	Surface Waters	Table 26.3 (for surface waters)	Detention Basin	0.5	0.5	0.6
Individual Driveways and Residential Car parks	Surface Waters	Table 26.3 (for surface waters)	Permeable Pavement	0.7	0.6	0.7

Table 5: SuDS mitigation index

The above analysis demonstrates that the SuDS devices within the design will mitigate any pollution present within the surface water system.

6. SuDS Drainage Maintenance Specification

6.1. Permeable Pavements

In order to maintain the functioning of the permeable paving, the following maintenance requirements should be adhered to:

TABLE 20.15	Operation and maintenance requirements for pervious pavements		
	Maintenance schedule	Required action	Typical frequency
	Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
	Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
		Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
	Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material		As required	
Rehabilitation of surface and upper substructure by remedial sweeping		Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)	
Monitoring	Initial inspection	Monthly for three months after installation	
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months	
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually	
	Monitor inspection chambers	Annually	

6.2. Attenuation Tank

In order to maintain the functioning of the attenuation tanks, the following maintenance requirements should be adhered to:

TABLE 21.3 Operation and maintenance requirements for attenuation storage tanks

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

6.3. Detention Basins

In order to maintain the functioning of Ponds and Wetlands, the following maintenance requirements should be adhered to:

TABLE 22.1	Operation and maintenance requirements for detention basins		
	Maintenance schedule	Required action	Typical frequency
Regular maintenance		Remove litter and debris	Monthly
		Cut grass – for spillways and access routes	Monthly (during growing season), or as required
		Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
		Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
		Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
		Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
		Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
		Check any penstocks and other mechanical devices	Annually
		Tidy all dead growth before start of growing season	Annually
		Remove sediment from inlets, outlet and forebay	Annually (or as required)
		Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter 23)
Occasional maintenance		Reseed areas of poor vegetation growth	As required
		Prune and trim any trees and remove cuttings	Every 2 years, or as required
		Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial actions		Repair erosion or other damage by reseedling or re-turfing	As required
		Realignment of rip-rap	As required
		Repair/rehabilitation of inlets, outlets and overflows	As required
		Relieve uneven surfaces and reinstate design levels	As required

7. General Drainage Maintenance Specification

7.1. Inlet Structures and Inspection Chambers

- Inlet structures such as rain water downpipes, road gullies and channel drains should be free from obstruction at all times to allow free flow through the SuDS.
- Inspection Chambers and rodding eyes are used on bends or where pipes come together. They allow access and cleaning to the system if necessary.

Inlet Structures and Inspection Chambers	
Regular Maintenance	Frequency
Inlet Structures Inspect rainwater downpipes, channel drains and road gullies, removing obstructions and silt as necessary. Check that there is no physical damage. Strim vegetation 1m min surround to structures and keep area free from silt and debris	Monthly
Inspections Chambers and below ground control chambers Remove cover and inspect, ensuring that the water is flowing freely and that the exit route for water is unobstructed. Remove debris and silt. Undertake inspection after leaf fall in Autumn	Annually
Occasional Maintenance Check topsoil levels are 20mm above edges of chambers to avoid mower damage.	As necessary
Remedial Work Repair physical damage if necessary	As required

7.2. Below ground drainage pipes

- Below ground drainage pipes convey water to the SuDS system. They should always be free from obstruction to allow free flow.

Below Ground Drainage Pipes	
Regular Maintenance	Frequency
Inspect and identify any areas that are not operating correctly. If required take remedial action.	Monthly for 3 months then annually
Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
Remove sediment from pre-treatment inlet structures and inspection chambers.	Annually or as required
Maintain vegetation to designed limits within the vicinity of below ground drainage pipes and tanks to avoid	Monthly or as required
Remedial Work	
Repair physical damage if necessary	As required
Monitoring	
Inspect all inlets, outlets and vents to ensure that they are in good conditions and operating as designed.	Annually
Survey inside of pipe runs for sediment build up and remove if necessary.	Every 5 years or as required

Appendix A

Drainage Strategy

DRAINAGE LEGEND (1:200)

PROPOSED FEATURES

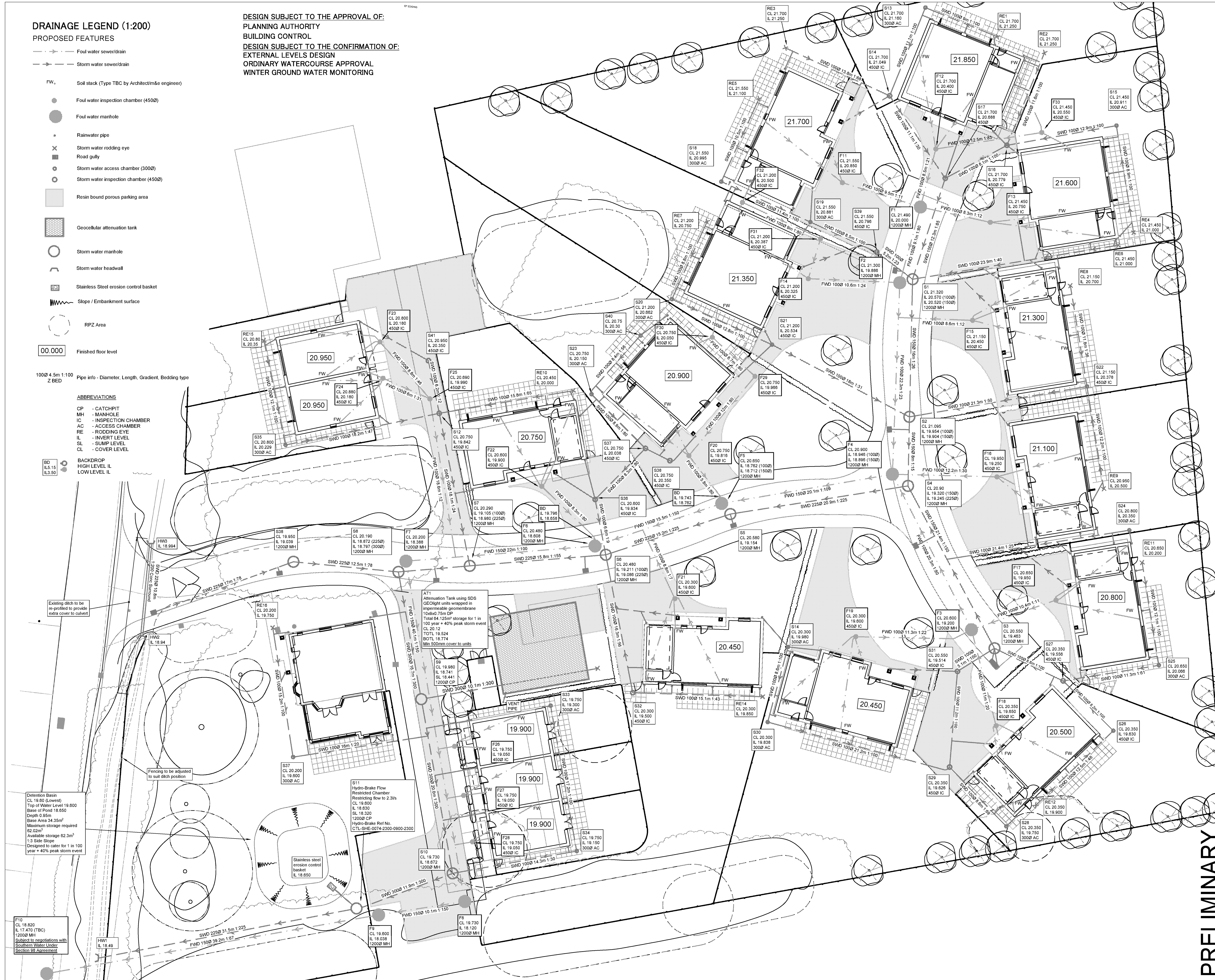
- Foul water sewer/drain
----- Storm water sewer/drain
- FW_s Soil stack (Type TBC by Architect/m&e engineer)
- Foul water inspection chamber (450Ø)
● Foul water manhole
● Rainwater pipe
× Storm water rodding eye
■ Road gully
● Storm water access chamber (300Ø)
● Storm water inspection chamber (450Ø)
- Resin bound porous parking area
- Geocellular attenuation tank
- Storm water manhole
○ Storm water headwall
- Stainless Steel erosion control basket
- ~~~~~ Slope / Embankment surface
- RPZ Area
- 00.000 Finished floor level
- 100Ø 4.5m 1:100 Z BED Pipe info - Diameter, Length, Gradient, Bedding type

ABBREVIATIONS

- CP - CATCHPIT
MH - MANHOLE
IC - INSPECTION CHAMBER
AC - ACCESS CHAMBER
RE - RODDING EYE
IL - INVERT LEVEL
SL - SUMP LEVEL
CL - COVER LEVEL

- BD HIGH LEVEL IL
BD LOW LEVEL IL

DESIGN SUBJECT TO THE APPROVAL OF:
PLANNING AUTHORITY
BUILDING CONTROL
DESIGN SUBJECT TO THE CONFIRMATION OF:
EXTERNAL LEVELS DESIGN
ORDINARY WATERCOURSE APPROVAL
WINTER GROUND WATER MONITORING



- STANDARD NOTES
- DO NOT SCALE FROM THIS DRAWING. REFER TO FIGURED DIMENSIONS ONLY. THE CONTRACTOR SHOULD CHECK ALL DIMENSIONS ON SITE.
 - ALL DIMENSIONS IN MILLIMETRES AND ALL LEVELS ARE IN METERS UNLESS NOTED OTHERWISE.
 - THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT ARCHITECT AND ENGINEERING DETAILS, DRAWINGS AND SPECIFICATIONS.
 - ANY DISCREPANCIES SHOULD BE REPORTED TO THE ARCHITECT AND/OR ENGINEER IMMEDIATELY, SO THAT CLARIFICATION CAN BE SOUGHT PRIOR TO THE COMMENCEMENT OF WORK.
 - BEFORE COMMENCING CONSTRUCTION THE CONTRACTOR MUST CHECK THE INVERT LEVELS OF EXISTING SEWERS TO WHICH CONNECTIONS ARE MADE. IN ADDITION THE CONTRACTOR MUST LOCATE AND DETERMINE INVERT LEVELS OF THE EXISTING SPURS TO WHICH CONNECTIONS ARE PROPOSED. ANY DISCREPANCIES ARE TO BE NOTIFIED TO THE ENGINEER IMMEDIATELY, PRIOR TO CONSTRUCTION.
 - ALL DRAINAGE WORKS SHOULD COMMENCE AT THE PROPOSED DOWNSTREAM CONNECTION POINT. THE WORKS CONTINUING UPSTREAM FOLLOWING CONFIRMATION OF THE TIE-IN INVERT LEVELS TO THE ENGINEER. CONNECTIONS TO MANHOLES OR LARGER SIZED PIPES ETC. SHOULD BE SOFFIT TO SOFFIT UNLESS OTHERWISE INSTRUCTED BY THE ENGINEER. IF THIS IS NOT POSSIBLE INFORM THE ENGINEER IMMEDIATELY.
 - COVER LEVELS SHOWN ARE APPROXIMATE. COVERS AND FRAMES SHALL BE SET TO FINISHED GROUND LEVELS AND FALLS.
 - ALL UN-REFERENCED PIPES ARE ASSUMED TO BE 100mm DIA.
 - ROAD GULLY OUTLET PIPES ARE TO BE 150mm DIA. WITH CONCRETE SURROUND AND FLEXIBLE JOINTS. ALL GULLIES SHALL BE FITTED WITH GRADE D400 GRATINGS AND FRAMES TO BS EN124. UNLESS OTHERWISE STATED.
 - ALL PRIVATE DRAINAGE TO BE IN ACCORDANCE WITH THE BUILDING REGULATIONS APPROVED DOCUMENT PART-H. AND TO THE SATISFACTION OF THE BUILDING CONTROL INSPECTOR.
 - THE CONTRACTOR IS TO KEEP A RECORD OF ANY VARIATIONS MADE ON SITE, INCLUDING THE RELOCATION OF SEWERS OR DRAINS. SO THAT AN AS CONSTRUCTED DRAWING CAN BE PREPARED UPON COMPLETION OF THE PROJECT.
 - IF ANY SUB SOIL DRAINAGE SYSTEMS ARE UNCOVERED DURING THE WORKS CONTACT THE ENGINEER FOR INSTRUCTIONS. SUB SOIL DRAINS ARE TO BE DIVERTED AROUND NEW WORKS AND CONNECTED INTO THE SURFACE WATER.
 - NO PRIVATE AREAS ARE TO DRAIN ONTO ADOPTABLE AREAS AND VICE VERSA.
 - ALL EXISTING MANHOLE COVER'S, GULLIES, ETC. ARE TO BE RAISED/LOWERED TO SUIT NEW LEVELS.
 - MANHOLE AND CHAMBER COVER GRADES:
 - 'A15' IN ALL LANDSCAPED AREAS AND ON FOOTPATHS
 - 'B125' IN ALL DRIVEWAYS AND PRIVATE PARKING AREAS
 - 'C250' IN CARRIAGEWAY/ACCESS ROAD

PRELIMINARY
NOT FOR CONSTRUCTION

P-	18.09.19	PRELIMINARY ISSUE	LH	CS	CS
REV	DATE	DESCRIPTION	BY	CHK	APP
cgs civils Consulting Civil Engineers					
CLIENT		GD GROUP			
ARCHITECT		CITYZEN			
JOB TITLE		MERRY ENGLAND ANGMERING			
DRAWING TITLE		DRAINAGE LAYOUT			
DRAWN	LH	ENGINEER	CS	CHECKED	CS
DATE	SEPT 2019		SCALE @ A1 1:200		
JOB No.	C1249	STATUS	P	DRAWING No.	100
REV	P-				

PRELIMINARY

Appendix B

Greenfield Runoff Calculations

Calculated by:

Site name:

Site location:

Site coordinates

Latitude:

Longitude:

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", WS-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Reference:

Date:

Methodology	IH124
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Site characteristics

Total site area (ha)	1.14
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Methodology

Qbar estimation method	Calculate from SPR and SAAR	
SPR estimation method	Calculate from SOIL type	
	Default	Edited
SOIL type	2	2
HOST class	---	---
SPR/SPRHOST	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm)	761	761
Hydrological region	7	7
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 30 year	2.3	2.3
Growth curve factor: 100 year	3.19	3.19

Notes:

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

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

Where flow rates are less than 5.0 l/s consents are usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set in which case blockage work must be addressed by using appropriate drainage elements.

(3) Is $SPR/SPRHOST \leq 0.3$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite may be a requirement for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	2.29	2.29
1 in 1 year (l/s)	1.95	1.95
1 in 30 years (l/s)	5.27	5.27
1 in 100 years (l/s)	7.31	7.31

Appendix C

Surface Water Drainage Calculations

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	50.0
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)	0.600
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	0.054	5.00	21.320	1200	507352.312	105089.631	0.800
S2	0.032	5.00	21.095	1200	507353.618	105073.686	1.191
S3	0.038	5.00	20.550	1200	507366.224	105047.965	1.087
S4	0.022	5.00	20.900	1200	507353.786	105065.559	1.655
S5	0.007	5.00	20.580	1200	507334.079	105060.292	1.426
S6	0.024	5.00	20.480	1200	507320.177	105054.080	1.394
S7	0.022	5.00	20.300	1200	507302.989	105051.499	1.320
S8	0.015	5.00	20.190	1200	507296.994	105050.492	1.393
S9	0.000		19.980	1200	507301.066	105033.576	1.239
S10	0.030	5.00	19.730	1200	507307.299	105012.033	1.058
S11			19.600	1200	507295.823	105008.712	0.970
S12	0.010	5.00	20.750	1200	507298.237	105072.915	0.700
S38	0.006	5.00	19.950	1200	507277.019	105047.901	0.911
HW1			19.250		507266.606	104999.862	0.760

Links (Input)

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	15.998	0.600	20.520	19.904	0.616	26.0	150	5.13	50.0
1.001	S2	S4	8.129	0.600	19.904	19.320	0.584	13.9	150	5.18	50.0
1.002	S3	S4	21.547	0.600	19.463	19.320	0.143	150.7	150	5.44	50.0
2.000	S4	S5	20.399	0.600	19.245	19.154	0.091	225.0	225	5.83	50.0
2.001	S5	S6	15.227	0.600	19.154	19.086	0.068	225.0	225	6.12	50.0
2.002	S6	S7	17.381	0.600	19.092	18.980	0.112	155.2	225	6.40	50.0
2.003	S7	S8	6.079	0.600	18.980	18.872	0.108	56.3	225	6.46	50.0
3.000	S8	S9	17.399	0.600	18.797	18.741	0.056	310.7	300	6.79	50.0
3.001	S9	S10	22.427	0.600	18.741	18.672	0.069	325.0	300	7.22	50.0
3.002	S10	S11	11.947	0.600	18.672	18.630	0.042	284.4	300	7.43	50.0
3.003	S11	HW1	30.528	0.600	18.630	18.490	0.140	218.1	225	8.01	50.0
4.000	S12	S7	21.937	0.600	20.050	19.110	0.940	23.3	100	5.23	50.0
5.000	S38	S8	20.142	0.600	19.039	18.950	0.089	226.3	150	5.51	50.0

Simulation Settings

Rainfall Methodology	FSR	Drain Down Time (mins)	240
FSR Region	England and Wales	Additional Storage (m ³ /ha)	20.0
M5-60 (mm)	20.000	Check Discharge Rate(s)	✓
Ratio-R	0.400	1 year (l/s)	1.9
Summer CV	0.750	30 year (l/s)	5.5
Winter CV	0.840	100 year (l/s)	7.3
Analysis Speed	Normal	Check Discharge Volume	x
Skip Steady State	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 %)
30	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 years	2.40
Greenfield Method	IH124	Growth Factor 100 years	3.19
Positively Drained Area (ha)	1.140	Betterment (%)	0
SAAR (mm)	761	QBar	2.3
Soil Index	2	Q 1 year (l/s)	1.9
SPR	0.30	Q 30 year (l/s)	5.5
Region	7	Q 100 year (l/s)	7.3
Growth Factor 1 year	0.85		

Node S11 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	18.630	Product Number	CTL-SHE-0074-2300-0900-2300
Design Depth (m)	0.900	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.3	Min Node Diameter (mm)	1200

Node S11 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.03600	Safety Factor	2.0	Invert Level (m)	18.630
Side Inf Coefficient (m/hr)	0.03600	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	34.4	34.4	0.900	113.4	113.4

Node S9 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	18.741
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

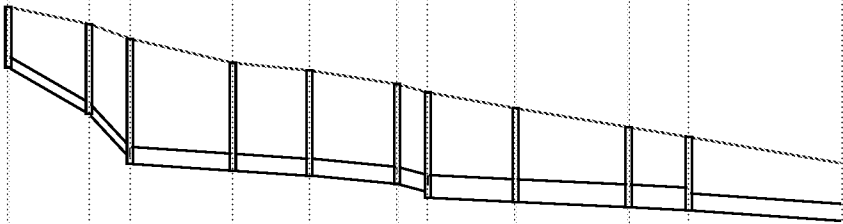
Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	90.0	0.0	0.750	90.0	0.0	0.751	0.0	0.0

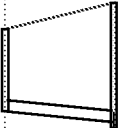
Results for 30 year Critical Storm Duration. Lowest mass balance: 99.79%

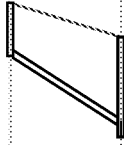
Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	10	20.598	0.078	18.7	0.1942	0.0000	OK
15 minute winter	S2	11	20.023	0.119	29.8	0.1978	0.0000	OK
15 minute winter	S3	12	19.865	0.402	13.1	0.7356	0.0000	SURCHARGED
15 minute winter	S4	11	19.759	0.514	45.3	0.7177	0.0000	SURCHARGED
15 minute winter	S5	12	19.579	0.425	46.3	0.5221	0.0000	SURCHARGED
15 minute winter	S6	12	19.419	0.333	53.2	0.4918	0.0000	SURCHARGED
15 minute winter	S7	12	19.191	0.211	63.1	0.3093	0.0000	OK
180 minute winter	S8	176	19.131	0.334	18.5	0.4496	0.0000	SURCHARGED
180 minute winter	S9	176	19.131	0.390	18.1	33.7841	0.0000	SURCHARGED
180 minute winter	S10	176	19.131	0.459	10.1	0.7792	0.0000	SURCHARGED
180 minute winter	S11	176	19.131	0.501	9.6	28.8033	0.0000	SURCHARGED
15 minute winter	S12	10	20.086	0.036	3.5	0.0509	0.0000	OK
180 minute winter	S38	176	19.131	0.092	0.5	0.1162	0.0000	OK
15 minute summer	HW1	1	18.490	0.000	2.3	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	18.7	1.763	0.532	0.1906	
15 minute winter	S2	1.001	S4	28.5	2.083	0.594	0.1323	
15 minute winter	S3	1.002	S4	12.0	0.737	0.835	0.3793	
15 minute winter	S4	2.000	S5	44.0	1.106	1.275	0.8113	
15 minute winter	S5	2.001	S6	46.1	1.160	1.338	0.6056	
15 minute winter	S6	2.002	S7	53.2	1.337	1.277	0.6823	
15 minute winter	S7	2.003	S8	62.6	1.763	0.901	0.2127	
180 minute winter	S8	3.000	S9	18.1	0.795	0.288	1.2252	
180 minute winter	S9	3.001	S10	8.3	0.471	0.136	1.5793	
180 minute winter	S10	3.002	S11	9.6	0.518	0.147	0.8413	
180 minute winter	S11	Hydro-Brake®	HW1	2.3				49.8
180 minute winter	S11	Infiltration		0.4				
15 minute winter	S12	4.000	S7	3.5	1.225	0.274	0.1017	
180 minute winter	S38	5.000	S8	0.8	0.343	0.064	0.2913	

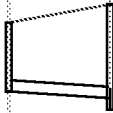
Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.79%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	12	21.320	0.800	33.8	1.9848	0.2923	FLOOD
15 minute winter	S2	12	21.027	1.123	41.2	1.8731	0.0000	FLOOD RISK
15 minute winter	S3	11	20.550	1.087	23.9	1.9892	1.6817	FLOOD
15 minute winter	S4	12	20.509	1.264	61.7	1.7657	0.0000	SURCHARGED
15 minute winter	S5	12	20.208	1.054	61.2	1.2953	0.0000	SURCHARGED
15 minute winter	S6	12	19.936	0.850	73.5	1.2539	0.0000	SURCHARGED
360 minute winter	S7	344	19.517	0.537	17.5	0.7861	0.0000	SURCHARGED
360 minute winter	S8	352	19.517	0.720	18.7	0.9687	0.0000	SURCHARGED
360 minute winter	S9	352	19.517	0.776	18.6	65.0450	0.0000	SURCHARGED
360 minute winter	S10	352	19.517	0.845	11.7	1.4341	0.0000	FLOOD RISK
360 minute winter	S11	352	19.517	0.887	11.5	65.9913	0.0000	FLOOD RISK
15 minute winter	S12	10	20.100	0.050	6.3	0.0706	0.0000	OK
360 minute winter	S38	352	19.517	0.478	0.5	0.6033	0.0000	SURCHARGED
15 minute summer	HW1	1	18.490	0.000	2.3	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	25.0	1.789	0.712	0.2816	
15 minute winter	S2	1.001	S4	38.0	2.157	0.792	0.1431	
15 minute winter	S3	1.002	S4	14.7	0.833	1.017	0.3793	
15 minute winter	S4	2.000	S5	57.1	1.435	1.655	0.8113	
15 minute winter	S5	2.001	S6	60.6	1.524	1.758	0.6056	
15 minute winter	S6	2.002	S7	72.5	1.824	1.742	0.6913	
360 minute winter	S7	2.003	S8	17.1	1.231	0.246	0.2418	
360 minute winter	S8	3.000	S9	18.6	0.763	0.296	1.2252	
360 minute winter	S9	3.001	S10	9.1	0.442	0.149	1.5793	
360 minute winter	S10	3.002	S11	11.5	0.514	0.176	0.8413	
360 minute winter	S11	Hydro-Brake®	HW1	2.3				72.0
360 minute winter	S11	Infiltration		0.6				
15 minute winter	S12	4.000	S7	6.2	1.188	0.494	0.1286	
360 minute winter	S38	5.000	S8	0.4	0.320	0.035	0.3546	

Node Name	S1	S2	S4	S5	S6	S7	S8	S9	S10	S11	HW1
A4 drawing Hor Scale 1500 Ver Scale 100 Datum (m) 14.000											
Link Name	1.000	1.000	2.000	2.001	2.002	2.003	3.000	3.001	3.002	3.003	
Section Type	150mm	150	225mm	225mm	225mm	225mm	300mm	300mm	300mm	225mm	
Slope (1:X)	26.0	13.5	225.0	225.0	155.2	56	310.7	325.0	284.4	218.1	
Cover Level (m)	21.320	21.095	20.900		20.580	20.480	20.300	20.190	19.980	19.730	19.600
Invert Level (m)	20.520	19.904	19.924	19.245	19.154	19.154	19.086	19.092	18.980	18.880	18.797
Length (m)	15.998	8.1	20.399	15.227	17.381	6.0	17.399	22.427	11.94	30.528	

Node Name	S3	S4
A4 drawing Hor Scale 1500 Ver Scale 100 Datum (m) 14.000		
Link Name	1.002	
Section Type	150mm	
Slope (1:X)	150.7	
Cover Level (m)	20.550	20.550
Invert Level (m)	19.463	19.320
Length (m)	21.547	

Node Name	S12	S7
A4 drawing Hor Scale 1500 Ver Scale 100 Datum (m) 14.000		
Link Name	4.000	
Section Type	100mm	
Slope (1:X)	23.3	
Cover Level (m)	20.750	20.750
Invert Level (m)	20.050	19.110
Length (m)	21.937	

Node Name	S38	S8
A4 drawing Hor Scale 1500 Ver Scale 100 Datum (m) 14.000		
Link Name	5.000	
Section Type	150mm	
Slope (1:X)	226.3	
Cover Level (m)	19.950	19.950
Invert Level (m)	19.039	18.950
Length (m)	20.142	

