

Project Whitehorse

Detailed Drainage Strategy

Introduction

- 1.0 The surface water management strategy for the proposed development seeks to manage and reduce the flood risk posed by surface water run-off from the site. The surface water drainage arrangements for any development site should be such that the volume and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect.
- 2.0 This detailed drainage strategy seeks to build upon the drainage principles set out by Edenvale Young in their Flood Risk Assessment and Drainage Strategy dated 27th November 2025 and responds directly to consultation feedback received by the Lead Local Flood Authority during planning application ref: PL/2025/09391 for the following description of development;
- 3.0 Following submission of information in relation to planning application no. PL/2025/09391 the Lead Local Flood Authority provided the following suggested conditions.

RECOMMENDATION: no objection subject to the following conditions

1. The applicant must provide further information related to the surface water drainage strategy:
 - The applicant must confirm the existing surface water discharge rate into the Weston Cut for the whole site. The LLFA would note expect the discharge rate to increase post-development ([Standard 1: runoff destinations](#) & [Microsoft Word - Betterment Strategy June 2024 - FINAL v2](#)).
 - The applicant is required to submit calculations which demonstrate that the proposed drainage design provides a sufficient level of water treatment to prevent pollution of the receiving watercourse/groundwater in accordance with Standard 4 of the National Standards for SuDS ([Standard 4: water quality](#)).
 - In accordance with Standard 3 of the National Standards for SuDS, overland exceedance routes are to be identified and shown on the drainage plan for flows in excess of the 1 in 100 year plus climate change (40%) rainfall event to demonstrate no adverse flood risk to the development of elsewhere ([Standard 3: management of extreme rainfall and flooding](#)).
 - We note the applicant has provided some details related to maintenance in Section 10 of the FRA and DS, however the applicant must provide clear arrangements for the ownership and ongoing maintenance of the proposed drainage system (including SuDS features) over the lifetime of the development ([Standard 7: design of drainage for construction, operation, maintenance, decommissioning and structural integrity](#)).

4.0 This document addresses the suggested conditions.

Sub condition 1

- The applicant must confirm the existing surface water discharge rate into the Weston Cut for the whole site. The LLFA would note expect the discharge rate to increase post-development ([Standard 1: runoff destinations](#) & [Microsoft Word - Betterment Strategy June 2024 - FINAL v2](#)).

5.0 It is assumed the site in question is the extent of the new building and the link structure, that has an area of 2860m². The existing area discharges to the Weston Cut to the north via a series of existing surface water drains. The Modified Rational Method indicates the discharge from 2860m² of existing hardstanding would be as indicated in the following table. See brownfield discharge calculation in Appendix A.

Return Period	Brownfield Discharge Rate (l/s)
1yr	42.07
30yr	106.79
100yr	130.52

6.0 The area drains to the Weston Cut via a minimum of 2 no.150mm dia. surface water sewers with a minimum free discharge rate (assumed at minimum grade) of 14.45l/s per 150mm sewer (28.9l/s). Once the capacity of the sewers is exceeded, surface water would run over the surface as exceedance flows toward the north of the site, where it would initially pool against the kerb, prior to weiring over the kerb and discharging freely into the Weston Cut at the indicated brownfield discharge rates. The proposal limit discharge to 22l/s for all return periods and includes an allowance for the effects of climate change were rates and volumes of discharge would continue to increase.

Sub condition 2

- The applicant is required to submit calculations which demonstrate that the proposed drainage design provides a sufficient level of water treatment to prevent pollution of the receiving watercourse/groundwater in accordance with Standard 4 of the National Standards for SuDS ([Standard 4: water quality](#)).

7.0 Table 1 indicates the CIRIA 753 Simple Index Approach to consideration of the pollution hazard and pollution mitigation indexes for the proposal. The table indicates the proposals provide appropriate mitigation indices for the MEDIUM pollution hazard index for the proposed development.

Table 1 – CIRIA Simple Index Approach

CIRIA 753 Simple Index Approach	SS	Metal	Hydrocarbons
Hazard			
Medium	0.7	0.6	0.7
Mitigation			
Filter Drain	0.4	0.4	0.4
AquaSwirl*	(0.8) 0.4	(0.5) 0.25	(0.7) 0.35
Total Filter Drain and AquaSwirl	0.8	0.65	0.75

* take 50% of indices where treatment is a second stage. Full index in (X).

See Appendix B for AquaSwirl mitigation indices

Sub condition 3

- In accordance with Standard 3 of the National Standards for SuDS, overland exceedance routes are to be identified and shown on the drainage plan for flows in excess of the 1 in 100 year plus climate change (40%) rainfall event to demonstrate no adverse flood risk to the development of elsewhere ([Standard 3: management of extreme rainfall and flooding](#)).

8.0 See revised drawing (5116-30-P3) indicating overland exceedance routes. In Appendix C.

Sub-condition 4

- We note the applicant has provided some details related to maintenance in Section 10 of the FRA and DS, however the applicant must provide clear arrangements for the ownership and ongoing maintenance of the proposed drainage system (including SuDS features) over the lifetime of the development ([Standard 7: design of drainage for construction, operation, maintenance, decommissioning and structural integrity](#)).

Please see the Drainage Maintenance Plan in Appendix D.

Appendix A

Brownfield Discharge Rate Calculation

Colebrook-White Pipe Capacity Analysis

Project No.	5116	
Project Title	Project Whitehorse	
Client	Prime Design	
Sheet Ref	5116-01-BFR-1001	

Calcs by	JB
Checked by	JB
Approved by	JB
Date	20.03.2026
Revision	Initial Issue

Pipe capacity calculation based on the Colebrook White Equation (HR Wallingford, 1990);

$$V = -2\sqrt{(2gDS)} \log_{10} \left(\frac{k_s}{3.7D} + \frac{2.51\nu}{D\sqrt{(2gDS)}} \right)$$

Fluid type:

Surface

Where:

D	Pipe diameter	1 in	150	mm
S	Hydraulic gradient		150	m/m
k _s	Effective pipe roughness		0.6	mm
g	Gravitational acceleration		9.81	m/s ²
ν	kinematic viscosity		1.01E-06	m ² /s
A	Cross-sectional flow area		0.018	m ²
Q	Discharge		14.456	l/s
V	Velocity		0.82	m/s

Catchment area analysis based on Modified Rational Method equation (HR Wallingford, 1990);

$$Q_{BAR} = 2.78 \cdot i \cdot A$$

Hydrological Region:

8

 *see map

Where:

Q _{BAR}	Average discharge (l/s)	
i	Rainfall intensity (mm/hr)	50.0 mm/hr *see map
A	Catchment area (m ²)	

Return Period	1yr	30yr	100yr
Growth Factor (Q/QBAR)	0.78	1.98	2.42
Critical Area (ha)	0.1333	0.0525	0.0430

(area that can freely drain)

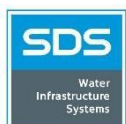
Brownfield flow rate analysis based on Modified Rational Method (HR Wallingford, 1990);

	1yr	30yr	100yr	QBAR
Area (ha): 0.388	42.07	106.79	130.52	53.93

Foul capacity analysis for dwellings based on Sewers for Adoption (6th Edition);

l/dwelling/day	0.046
No. dwellings served	312
No. dwellings served +10% infiltration	284

Appendix B
AquaSwirl Mitigation Indices



SDS Limited mitigation indices for stormwater treatment devices

The pollution mitigation indices provided below have been derived in accordance with the British Water Guide for applying the CIRIA SuDS Manual Simple Index Approach to proprietary / manufactured Stormwater Treatment Devices. The SDS Aqua-Swirl™ and the SDS Aqua-Filter™ have been tested in accordance with the New Jersey Corporation for Advanced Technology Verification Program – NJCAT.

SDS Aqua-Xchange™ has been tested in accordance with the British Water Assessment of Manufactured

The pollution mitigation indices are as follows:

Device	Total suspended solids mitigation index	Total metals mitigation index	Soluble metals mitigation index ¹	Hydrocarbons ³
Aqua-swirl™ vortex grit separator	0.8 (0.5 on trunk roads and motorways where the suspended solids level is very high)	0.5 ⁴	The Aquaswirl™ is not designed to remove soluble pollutants	0.7 ³
Aqua-filter™ stormwater filtration unit	0.8	0.8	0.6	0.7 ³
Aqua-swirl™ and Aqua-filter™ in sequence	1.2 ²	0.9	0.6	1.0 ^{2,3}
Aqua-Xchange™	0.8 when installed as a layer in a filter drain	0.9	1.0	0.7* when installed as a layer in a filter drain

These indices can only be assumed when the treatment device is properly sized for the anticipated rate of runoff and the level of pollution in the runoff is not unusually high.

¹ When drainage schemes are designed for road developments in accordance with the Design Manual for Roads and Bridges, the mitigation index for soluble metals is required because particulate metals are considered separately in the total suspended solids assessment

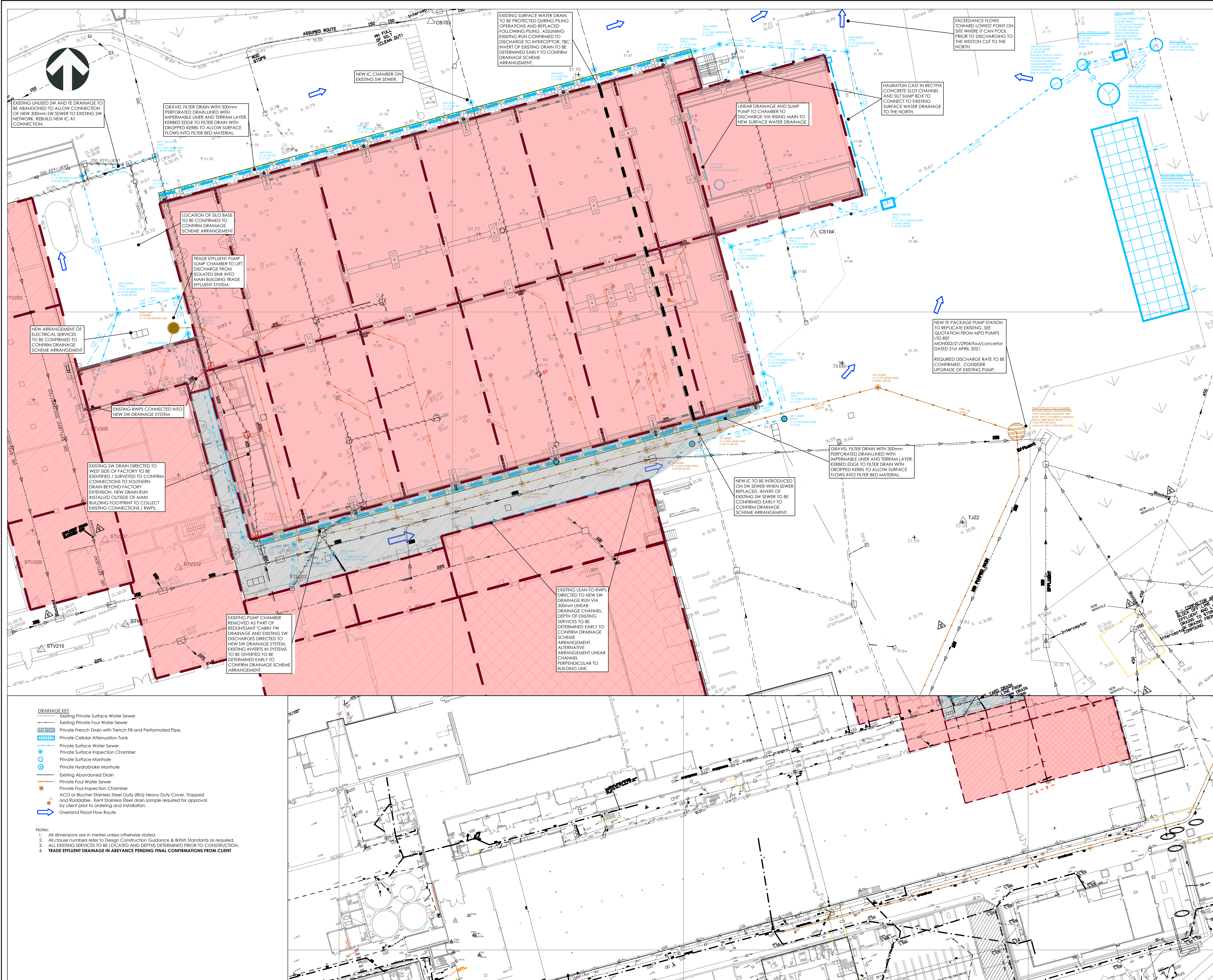
² When designing in accordance with the SuDS Manual (Ciria C753), when two devices are used in sequence to target the same pollutant, half of the mitigation index of the second component should be allowed in the calculation.

³ The test procedures applied to manufactured treatment devices do not include measurement of hydrocarbon removal. Therefore, we have estimated that the Aqua-swirl™ removes free-phase hydrocarbons by flotation, and also removes hydrocarbons that are adhered to suspended solids. However, hydrocarbons are known to preferentially adhere to the smaller particles so the Aqua-filter™ will also remove a high proportion of those hydrocarbons as it is more effective at removing smaller suspended particles.

⁴ Where metals are present in the runoff in particulate form, particularly from vehicle emissions, the Aqua-swirl™ will effectively remove those particles in admixture with other suspended solids.

*C753 SuDS Manual uses the simple index approach, where the mitigation index of an individual component is insufficient, two components (or more) in series will be required, a factor of 0.5 is used to account for the reduced performance of the secondary or tertiary components associated with the already reduced inflow concentrations.

Appendix C
Drg 5116-30-P4 and FLOW calculations



DO NOT SCALE FROM THE DRAWING WORK ONLY TO FIGURED DIMENSIONS
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Area Summary Schedule

Gross Site Area	0.28ha
Existing and New Roof area taken to new SW system	0.33ha
Additional Hardstandings	0.05ha
Total Area to New Surface Drainage	0.38ha

Pre-development (Brownfield) Run-off

Brownfield run-off rates have been calculated for the Total Area taken to the New Surface Water Drainage system (388m²) using the Modified Rational Method.

Return Period	Brownfield Run-off Rates l/s
1yr	42.07
30yr	136.79
100yr	139.52

Note: Existing discharge from the site via existing drainage minimum 2m³/s. 150mm surface water sewers with pipe full capacity of 2 x 14.43m³/s (28.9l/s). Beyond the capacity of the existing drainage surface water currently exceeds the indicated location on site where it can pool and then well over the kerbs and into the Weston Cut at the brownfield discharge rates indicated.

Proposed Surface Water Drainage Scheme

Up to the 1yr event flow discharges via gravity at 22l/s. Above the 1yr event, flow is directed to the attenuation tank, where a pump operates at 22l/s to discharge surface water stored in the tank.

Attenuation Summary

Attenuation Tank

Ownership	Private
Porosity	95%
Hydraulic Control	Hydrobrake @ IL

Ref: CTL SHE-0214-2200-0450-2200
4500 pipe outlet @ Office 35mm @ IL 30.800m AOD

Tank Dimension

5.5mx23.00mx0.8m deep Polystorm
PSM45

Total 100yr+45%CC Volume 96.14m³

Total Flow:

1 year +40%CC	22 l/s
30 year +40%CC	22 l/s
100 year +45%CC	22 l/s

P4	26.03.26	Note to filter drain amended to include dropped kerbs. Perforated pipe to shown noted at 300mm diameter.	JB
P3	25.03.26	Text box background mask added. Overland flow routes added. Belowground drainage indicated as 316L. Issued for Condition Discharge. Internal gullies amended to ACO or Blucher, note added Re-sample of Kent Stainless drain required prior to ordering.	JB
P2	10.03.26	Adjusted in line with comments from Eden Vale Young. Issued for comment.	JB
T1	13.02.26	Issued for Tender	JB
P1	03.02.26	Issued for information.	JB
MK	DATE	REVISION	BY

JOB TITLE Project Whitehorse

CLIENT Prime Design

SCALES 1:200, 1:500 **DRG. SIZE** A1

DATE Feb 26 **ENG / TECH** JB **CHECKED** JB

DRAWING TITLE Drainage Plan

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DRAWING No. 5116 / 30 **REVISION** P4

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	5	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	1.500
CV	1.000	Preferred Cover Depth (m)	0.000
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Invert Level (m)
1	0.019	5.00	31.900			385878.286	160973.440	0.525	31.375
2	0.031	5.00	31.900			385888.874	160976.312	0.580	31.320
3	0.031	5.00	31.850			385900.456	160979.451	0.590	31.260
4	0.031	5.00	31.840			385912.036	160982.588	0.640	31.200
5	0.031	5.00	31.800			385923.618	160985.726	0.660	31.140
6	0.019	5.00	31.800			385935.200	160988.864	0.720	31.080
7			31.800	600		385936.986	160989.348	0.729	31.071
8	0.032	5.00	31.880			385904.839	160975.776	0.300	31.580
9	0.032	5.00	31.900			385916.600	160978.948	0.320	31.580
10			31.860	600		385927.796	160984.680	0.950	30.910
11			31.790	600		385938.502	160987.583	0.945	30.845
12			31.770	600		385936.095	160992.841	1.034	30.736
13	0.004	5.00	31.700	150		385930.873	161009.229	0.600	31.100
14			31.700	600		385932.335	161007.571	1.027	30.673
15	0.017	5.00	31.700	600		385938.385	161009.230	1.053	30.647
16	0.004	5.00	31.670	150		385944.053	161012.432	0.670	31.000
17			31.700			385946.254	161011.388	1.085	30.615
18			31.670	1350	900	385950.550	161012.567	1.223	30.447
19	0.014	5.00	31.690			385865.496	161013.325	0.450	31.240
20	0.025	5.00	31.700			385877.940	161016.701	0.513	31.187
21	0.025	5.00	31.730			385889.523	161019.839	0.593	31.137
22	0.025	5.00	31.850			385901.131	161022.987	0.763	31.087
23	0.025	5.00	31.800			385912.675	161026.112	0.762	31.038
24	0.015	5.00	31.800			385924.270	161029.227	0.812	30.988
25			31.600	600		385930.979	161031.067	0.876	30.724
26	0.004	5.00	31.650	150		385931.726	161026.886	0.150	31.500
27			31.600			385933.071	161030.935	0.876	30.724
28	0.004	5.00	31.650	150		385939.569	161029.017	0.150	31.500
29			31.600			385939.658	161030.556	0.903	30.697
30			31.550	600		385945.773	161030.203	0.878	30.672
24A			31.600			385928.788	161030.469	0.634	30.966
AquaSwirl			31.630	1200		385970.062	161026.504	1.243	30.387
HYDROBRAKE			31.640	1500		385973.124	161028.692	1.262	30.378
34			31.680	1350	900	385977.408	161029.851	1.320	30.360
35		5.00	31.960	1350		385990.042	160998.760	1.530	30.430
PUMP		5.00	31.700	2400		385976.146	161025.285	2.000	29.700
37			31.880	1350		385981.659	161030.999	1.533	30.347
38			31.590	1350		385978.680	161042.885	1.274	30.316
38_OUT			30.990	1350		385977.324	161048.450	1.150	29.840
39	0.026	5.00	31.880	600		385881.117	160968.110	0.968	30.912
40	0.026	5.00	31.880	600		385886.171	160971.746	0.970	30.910

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Invert Level (m)
41			31.900	600		385881.567	160973.041	1.038	30.862
42			32.050	600		385877.486	160972.528	1.230	30.820
43	0.018	5.00	32.130	600		385875.607	160973.833	1.449	30.681
44	0.052	5.00	32.400	150		385868.874	160991.786	1.163	31.237
45	0.004	5.00	31.750	150		385867.160	160995.522	0.561	31.189
46			31.750	600		385869.296	160997.487	1.169	30.581
47			31.770	600		385868.166	161001.717	1.207	30.563
48	0.028	5.00	32.400	150		385857.400	160988.746	1.258	31.142
49	0.004	5.00	31.750	150		385856.914	160992.812	0.667	31.083
50			31.920	600		385861.156	160999.858	1.387	30.533
51	0.015	5.00	31.880	600		385856.911	161015.761	1.414	30.466
51_OUT			31.830	600		385865.468	161018.044	1.400	30.430
9A			31.900			385922.796	160980.616	0.952	30.948

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)
4.000	1	2	10.971	0.600	31.375	31.320	0.055	200.0	300	5.17	50.0
4.001	2	3	12.000	0.600	31.320	31.260	0.060	200.0	300	5.35	50.0
4.002	3	4	11.997	0.600	31.260	31.200	0.060	200.0	300	5.53	50.0
4.003	4	5	12.000	0.600	31.200	31.140	0.060	200.0	300	5.71	50.0
4.004	5	6	12.000	0.600	31.140	31.080	0.060	200.0	300	5.89	50.0
4.005	6	7	1.850	0.600	31.080	31.071	0.009	200.0	300	5.91	50.0
4.006	7	12	3.605	0.600	31.071	30.736	0.335	10.8	300	5.93	50.0
CH2	8	9	12.181	0.600	31.580	31.580	0.000	0.0	300	5.20	50.0
CH3	9	9A	6.417	0.600	31.580	31.580	0.000	0.0	300	5.31	50.0
5.001	10	11	11.093	0.600	30.910	30.845	0.065	170.0	225	5.60	50.0
5.002	11	12	5.783	0.600	30.845	30.811	0.034	170.0	225	5.70	50.0
4.007	12	14	15.202	0.600	30.736	30.674	0.062	245.0	300	6.18	50.0
6.000	13	14	2.211	0.600	31.100	30.823	0.277	8.0	150	5.01	50.0
4.008	14	15	6.273	0.600	30.673	30.647	0.026	245.0	300	6.29	50.0
4.009	15	17	8.160	0.600	30.648	30.615	0.033	245.0	300	6.42	50.0

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)
4.000	1.108	78.3	3.4	0.225	0.280	0.019	0.0	42	0.560
4.001	1.108	78.3	9.0	0.280	0.290	0.050	0.0	68	0.744
4.002	1.108	78.3	14.6	0.290	0.340	0.081	0.0	88	0.855
4.003	1.108	78.3	20.2	0.340	0.360	0.112	0.0	103	0.932
4.004	1.108	78.3	25.8	0.360	0.420	0.143	0.0	119	0.998
4.005	1.108	78.3	29.3	0.420	0.429	0.162	0.0	127	1.030
4.006	4.819	340.6	29.3	0.429	0.734	0.162	0.0	59	2.985
CH2	1.000	89.9	5.8	0.000	0.020	0.032	0.0	300	0.000
CH3	1.000	89.9	11.6	0.020	0.020	0.064	0.0	300	0.000
5.001	1.000	39.7	11.6	0.725	0.720	0.064	0.0	83	0.870
5.002	1.000	39.7	11.6	0.720	0.734	0.064	0.0	83	0.870
4.007	1.000	70.7	40.8	0.734	0.726	0.226	0.0	164	1.035
6.000	3.589	63.4	0.7	0.450	0.727	0.004	0.0	11	1.200
4.008	1.000	70.7	41.6	0.727	0.753	0.230	0.0	166	1.039
4.009	1.000	70.7	44.6	0.752	0.785	0.247	0.0	173	1.055

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)
7.000	16	17	2.436	0.600	31.000	30.765	0.235	10.4	150	5.01	50.0
4.010	17	18	4.455	0.600	30.615	30.597	0.018	245.0	300	6.50	50.0
1.006	24A	25	2.271	0.600	30.966	30.724	0.242	9.4	300	6.09	50.0
1.000	19	20	12.894	0.600	31.240	31.187	0.053	243.3	300	5.21	50.0
1.001	20	21	12.001	0.600	31.187	31.137	0.050	240.0	300	5.41	50.0
1.002	21	22	12.027	0.600	31.137	31.087	0.050	240.5	300	5.61	50.0
1.003	22	23	11.959	0.600	31.087	31.038	0.049	244.1	300	5.81	50.0
1.004	23	24	12.006	0.600	31.038	30.988	0.050	240.1	300	6.01	50.0
1.005	24	24A	4.686	0.600	30.988	30.966	0.022	213.0	300	6.08	50.0
1.007	25	27	2.096	0.600	30.733	30.724	0.009	245.0	300	6.12	50.0
2.000	26	27	4.267	0.600	31.500	30.874	0.626	6.8	150	5.02	50.0
1.008	27	29	6.598	0.600	30.724	30.697	0.027	245.0	300	6.23	50.0
3.000	28	29	1.542	0.600	31.500	30.847	0.653	2.4	150	5.00	50.0
1.009	29	30	6.125	0.600	30.697	30.672	0.025	245.0	300	6.34	50.0
1.010	30	18	18.272	0.600	30.672	30.597	0.075	245.0	300	6.64	50.0
1.011	18	AquaSwirl	23.978	0.600	30.447	30.387	0.060	400.0	450	7.04	50.0
1.012	AquaSwirl	HYDROBRAKE	3.763	0.600	30.387	30.378	0.009	400.0	450	7.10	50.0
1.013	HYDROBRAKE	34	4.438	0.600	30.378	30.360	0.018	245.0	300	7.17	50.0
1.014	34	37	2.357	0.600	30.360	30.350	0.010	235.7	300	7.21	50.0
8.000	35	37	33.311	0.600	30.430	30.347	0.083	400.0	450	5.55	50.0
9.000	PUMP	37	7.940	0.600	29.700	30.350	-0.650	-12.2	225	19.20	38.4
1.015	37	38	12.254	0.600	30.347	30.316	0.031	400.0	450	19.40	38.2
1.016	38	38_OUT	5.728	0.600	30.316	29.840	0.476	12.0	450	19.42	38.2
10.000	39	41	4.951	0.600	30.912	30.862	0.050	99.0	150	5.08	50.0

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)
7.000	3.147	55.6	0.7	0.520	0.785	0.004	0.0	12	1.088
4.010	1.000	70.7	45.4	0.785	0.773	0.251	0.0	175	1.059
1.006	5.161	364.8	23.3	0.334	0.576	0.129	0.0	51	2.927
1.000	1.003	70.9	2.5	0.150	0.213	0.014	0.0	38	0.476
1.001	1.010	71.4	7.0	0.213	0.293	0.039	0.0	63	0.647
1.002	1.009	71.3	11.6	0.293	0.463	0.064	0.0	81	0.746
1.003	1.002	70.8	16.1	0.463	0.462	0.089	0.0	97	0.815
1.004	1.010	71.4	20.6	0.462	0.512	0.114	0.0	110	0.876
1.005	1.073	75.9	23.3	0.512	0.334	0.129	0.0	114	0.948
1.007	1.000	70.7	23.3	0.567	0.576	0.129	0.0	118	0.898
2.000	3.884	68.6	0.7	0.000	0.576	0.004	0.0	11	1.255
1.008	1.000	70.7	24.0	0.576	0.603	0.133	0.0	120	0.907
3.000	6.609	116.8	0.7	0.000	0.603	0.004	0.0	8	1.813
1.009	1.000	70.7	24.8	0.603	0.578	0.137	0.0	122	0.913
1.010	1.000	70.7	24.8	0.578	0.773	0.137	0.0	122	0.913
1.011	1.010	160.7	70.1	0.773	0.793	0.388	0.0	208	0.977
1.012	1.010	160.7	70.1	0.793	0.812	0.388	0.0	208	0.977
1.013	1.000	70.7	70.1	0.962	1.020	0.388	0.0	245	1.133
1.014	1.020	72.1	70.1	1.020	1.230	0.388	0.0	240	1.156
8.000	1.010	160.7	0.0	1.080	1.083	0.000	0.0	0	0.000
9.000	0.009	0.4	0.0	1.775	1.305	0.000	0.0	0	0.000
1.015	1.010	160.7	53.5	1.083	0.824	0.388	0.0	178	0.911
1.016	5.884	935.9	53.5	0.824	0.700	0.388	0.0	72	3.245
10.000	1.010	17.8	4.7	0.818	0.888	0.026	0.0	52	0.852

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)
11.000	40	41	4.783	0.600	30.910	30.862	0.048	99.6	150	5.08	50.0
10.001	41	42	4.113	0.600	30.862	30.820	0.042	97.9	150	5.15	50.0
10.002	42	43	2.288	0.600	30.820	30.797	0.023	99.5	150	5.19	50.0
10.003	43	46	24.481	0.600	30.681	30.581	0.100	244.8	300	5.60	50.0
12.000	44	46	5.717	0.600	31.237	30.731	0.506	11.3	150	5.03	50.0
13.000	45	46	2.902	0.600	31.189	30.731	0.458	6.3	150	5.01	50.0
10.004	46	47	4.378	0.600	30.581	30.563	0.018	243.2	300	5.67	50.0
10.005	47	50	7.252	0.600	30.563	30.533	0.030	241.7	300	5.79	50.0
14.000	48	50	11.730	0.600	31.142	30.683	0.459	25.6	150	5.10	50.0
15.000	49	50	8.215	0.600	31.083	30.683	0.400	20.5	150	5.06	50.0
10.006	50	51	16.460	0.600	30.533	30.466	0.067	245.7	300	6.06	50.0
10.007	51	51_OUT	8.856	0.600	30.466	30.430	0.036	246.0	300	6.21	50.0
5.000	9A	10	6.443	0.600	30.948	30.910	0.038	169.6	225	5.42	50.0

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)
11.000	1.006	17.8	4.7	0.820	0.888	0.026	0.0	52	0.850
10.001	1.015	17.9	9.4	0.888	1.080	0.052	0.0	77	1.027
10.002	1.007	17.8	9.4	1.080	1.183	0.052	0.0	78	1.022
10.003	1.000	70.7	12.6	1.149	0.869	0.070	0.0	85	0.760
12.000	3.014	53.3	9.4	1.013	0.869	0.052	0.0	42	2.278
13.000	4.029	71.2	0.7	0.411	0.869	0.004	0.0	11	1.302
10.004	1.003	70.9	22.8	0.869	0.907	0.126	0.0	116	0.895
10.005	1.007	71.2	22.8	0.907	1.087	0.126	0.0	116	0.898
14.000	2.000	35.3	5.1	1.108	1.087	0.028	0.0	38	1.427
15.000	2.232	39.4	0.7	0.517	1.087	0.004	0.0	14	0.866
10.006	0.998	70.6	28.6	1.087	1.114	0.158	0.0	133	0.947
10.007	0.998	70.5	31.3	1.114	1.100	0.173	0.0	140	0.968
5.000	1.001	39.8	11.6	0.727	0.725	0.064	0.0	83	0.871

Simulation Settings

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

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	40	0	0
100	45	0	0

Node HYDROBRAKE Online Head/Flow Control

Flap Valve	x	Invert Level (m)	30.378	Design Flow (l/s)	22.0
Replaces Downstream Link	✓	Design Depth (m)	0.450		

Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
0.001	0.000	3.000	0.000

Node PUMP Online Pump Control

Flap Valve	x	Replaces Downstream Link	✓	Switch on depth (m)	0.001
Downstream Link	9.000	Invert Level (m)	29.700	Switch off depth (m)	0.000

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.001	22.000	3.000	22.000

Node 34 Online Orifice Control

Flap Valve	✓	Invert Level (m)	30.360	Discharge Coefficient	0.600
Replaces Downstream Link	x	Diameter (m)	0.600		

Node HYDROBRAKE Offline Orifice Control

Flap Valve	x	Invert Level (m)	30.800	Discharge Coefficient	0.600
Loop to Node	PUMP	Diameter (m)	0.450		

Node PUMP Soakaway Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	29.700	Depth (m)	0.800
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	40	Inf Depth (m)	
Safety Factor	2.0	Pit Width (m)	5.500	Number Required	1
Porosity	0.95	Pit Length (m)	23.000		

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 99.94%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	12	31.598	0.223	9.2	0.1614	0.0000	OK
15 minute winter	2	13	31.592	0.272	31.7	0.6675	0.0000	OK
15 minute winter	3	12	31.590	0.330	39.3	0.8786	0.0000	FLOOD RISK
15 minute winter	4	12	31.589	0.389	48.0	1.0703	0.0000	FLOOD RISK
15 minute winter	5	13	31.565	0.425	59.7	1.1979	0.0000	FLOOD RISK
15 minute winter	6	13	31.547	0.467	61.7	1.1636	0.0000	FLOOD RISK
15 minute winter	7	13	31.535	0.464	53.7	0.1313	0.0000	FLOOD RISK
15 minute winter	8	10	31.717	0.137	15.6	0.2920	0.0000	OK
15 minute winter	9	10	31.708	0.128	30.8	0.2562	0.0000	OK
15 minute winter	10	12	31.578	0.668	29.2	0.1891	0.0000	FLOOD RISK
15 minute winter	11	12	31.540	0.695	28.7	0.1966	0.0000	FLOOD RISK
15 minute winter	12	12	31.513	0.777	77.5	0.2199	0.0000	FLOOD RISK
15 minute winter	13	12	31.407	0.307	4.0	0.0463	0.0000	FLOOD RISK
15 minute winter	14	12	31.405	0.732	79.0	0.2073	0.0000	FLOOD RISK
15 minute winter	15	12	31.340	0.693	85.3	0.4199	0.0000	SURCHARGED
15 minute winter	16	13	31.273	0.272	1.9	0.0373	0.0000	SURCHARGED
15 minute winter	17	13	31.272	0.657	86.3	0.0000	0.0000	SURCHARGED
15 minute winter	18	13	31.227	0.780	133.3	0.9473	0.0000	SURCHARGED
15 minute winter	19	12	31.347	0.107	6.8	0.0665	0.0000	OK
15 minute winter	20	12	31.360	0.173	18.8	0.4438	0.0000	OK
15 minute winter	21	12	31.352	0.215	30.4	0.5021	0.0000	OK
15 minute winter	22	12	31.344	0.257	41.0	0.5566	0.0000	OK
15 minute winter	23	12	31.336	0.298	46.7	0.6602	0.0000	OK
15 minute winter	24	13	31.324	0.336	50.4	0.6821	0.0000	SURCHARGED
15 minute winter	25	13	31.309	0.585	45.0	0.1656	0.0000	FLOOD RISK

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	1	4.000	2	17.5	0.490	0.224	0.6688	
15 minute winter	2	4.001	3	24.2	0.738	0.310	0.8258	
15 minute winter	3	4.002	4	33.8	0.878	0.432	0.8448	
15 minute winter	4	4.003	5	45.6	0.977	0.582	0.8450	
15 minute winter	5	4.004	6	53.0	1.075	0.677	0.8450	
15 minute winter	6	4.005	7	53.7	1.784	0.686	0.1303	
15 minute winter	7	4.006	12	54.5	1.112	0.160	0.2539	
15 minute winter	8	CH2	9	15.2	0.384	0.170	0.4843	
15 minute winter	9	CH3	9A	30.3	0.882	0.337	0.2208	
15 minute winter	10	5.001	11	28.7	0.771	0.721	0.4412	
15 minute winter	11	5.002	12	28.9	0.727	0.727	0.2300	
15 minute winter	12	4.007	14	77.9	1.106	1.102	1.0705	
15 minute winter	13	6.000	14	-2.2	1.178	-0.035	0.0389	
15 minute winter	14	4.008	15	78.8	1.119	1.115	0.4417	
15 minute winter	15	4.009	17	85.1	1.208	1.204	0.5746	
15 minute winter	16	7.000	17	3.4	1.092	0.060	0.0429	
15 minute winter	17	4.010	18	86.1	1.223	1.218	0.3137	
15 minute winter	18	1.011	AquaSwirl	133.5	0.843	0.831	3.7992	
15 minute winter	19	1.000	20	6.7	0.409	0.095	0.4158	
15 minute winter	20	1.001	21	18.3	0.643	0.256	0.5762	
15 minute winter	21	1.002	22	28.9	0.767	0.406	0.7110	
15 minute winter	22	1.003	23	35.3	0.865	0.499	0.8044	
15 minute winter	23	1.004	24	43.5	0.983	0.609	0.8449	
15 minute winter	24	1.005	24A	45.7	1.691	0.602	0.3300	
15 minute winter	25	1.007	27	44.2	0.816	0.626	0.1476	

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 99.94%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	26	10	31.517	0.017	1.9	0.0095	0.0000	OK
15 minute winter	27	13	31.301	0.577	45.9	0.0000	0.0000	FLOOD RISK
15 minute winter	28	10	31.513	0.013	1.9	0.0072	0.0000	OK
15 minute winter	29	13	31.290	0.593	47.1	0.0000	0.0000	SURCHARGED
15 minute winter	30	13	31.273	0.601	47.6	0.1702	0.0000	FLOOD RISK
15 minute winter	24A	13	31.317	0.351	45.7	0.0000	0.0000	FLOOD RISK
15 minute winter	AquaSwirl	13	31.168	0.781	133.5	0.8830	0.0000	SURCHARGED
15 minute winter	HYDROBRAKE	13	31.143	0.765	133.5	1.3521	0.0000	SURCHARGED
15 minute summer	34	1	30.360	0.000	0.0	0.0000	0.0000	OK
15 minute winter	35	11	30.456	0.026	1.2	0.0372	0.0000	OK
60 minute winter	PUMP	52	30.284	0.584	93.8	72.8393	0.0000	SURCHARGED
15 minute summer	37	12	30.454	0.107	22.6	0.1527	0.0000	OK
15 minute winter	38	12	30.368	0.052	22.4	0.0746	0.0000	OK
15 minute winter	38_OUT	12	29.888	0.048	22.4	0.0000	0.0000	OK
15 minute winter	39	11	31.191	0.279	12.6	0.2288	0.0000	SURCHARGED
15 minute winter	40	11	31.190	0.280	12.6	0.2295	0.0000	SURCHARGED
15 minute winter	41	11	31.156	0.294	23.8	0.0831	0.0000	SURCHARGED
15 minute winter	42	11	31.029	0.209	23.8	0.0593	0.0000	SURCHARGED
15 minute winter	43	11	30.908	0.227	32.0	0.1205	0.0000	OK
15 minute winter	44	9	31.314	0.077	25.3	0.0699	0.0000	OK
15 minute winter	45	10	31.206	0.017	1.9	0.0027	0.0000	OK
15 minute winter	46	11	30.890	0.309	56.9	0.0873	0.0000	SURCHARGED
15 minute winter	47	11	30.862	0.299	56.6	0.0846	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	26	2.000	27	1.9	1.415	0.028	0.0399	
15 minute winter	27	1.008	29	45.8	0.842	0.648	0.4646	
15 minute winter	28	3.000	29	1.9	2.048	0.016	0.0141	
15 minute winter	29	1.009	30	47.6	0.862	0.673	0.4313	
15 minute winter	30	1.010	18	48.1	0.721	0.680	1.2867	
15 minute winter	24A	1.006	25	45.0	1.236	0.123	0.1599	
15 minute winter	AquaSwirl	1.012	HYDROBRAKE	133.5	0.843	0.831	0.5962	
15 minute winter	HYDROBRAKE	Head/Flow	34	0.0				
15 minute winter	HYDROBRAKE	Orifice	PUMP	133.6				78.7
15 minute summer	34	1.014	37	-1.6	0.097	-0.022	0.0474	
15 minute winter	35	8.000	37	-1.2	-0.108	-0.008	0.5273	
60 minute winter	PUMP	Pump	37	22.0				
15 minute summer	37	1.015	38	22.3	1.191	0.139	0.2376	
15 minute winter	38	1.016	38_OUT	22.4	2.355	0.024	0.0547	78.7
15 minute winter	39	10.000	41	11.9	0.677	0.668	0.0872	
15 minute winter	40	11.000	41	11.9	0.677	0.670	0.0842	
15 minute winter	41	10.001	42	23.8	1.353	1.327	0.0724	
15 minute winter	42	10.002	43	23.8	1.351	1.336	0.0394	
15 minute winter	43	10.003	46	31.8	0.564	0.450	1.5619	
15 minute winter	44	12.000	46	25.3	2.555	0.474	0.0743	
15 minute winter	45	13.000	46	1.9	1.309	0.027	0.0271	
15 minute winter	46	10.004	47	56.6	0.804	0.798	0.3081	
15 minute winter	47	10.005	50	56.5	0.803	0.793	0.5096	

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 99.94%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
15 minute winter	48	10	31.206	0.064	13.6	0.0298	0.0000	OK
15 minute winter	49	10	31.105	0.022	1.9	0.0031	0.0000	OK
15 minute winter	50	11	30.829	0.296	71.1	0.0836	0.0000	OK
15 minute winter	51	11	30.742	0.276	77.8	0.1365	0.0000	OK
15 minute winter	51_OUT	11	30.647	0.217	77.6	0.0000	0.0000	OK
15 minute winter	9A	12	31.599	0.651	30.3	0.0000	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m ³)	Discharge Vol (m ³)
15 minute winter	48	14.000	50	13.5	1.670	0.383	0.1432	
15 minute winter	49	15.000	50	1.9	0.952	0.048	0.0782	
15 minute winter	50	10.006	51	70.9	1.024	1.004	1.1356	
15 minute winter	51	10.007	51_OUT	77.6	1.252	1.100	0.5423	38.7
15 minute winter	9A	5.000	10	29.2	0.895	0.735	0.2562	

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 99.94%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	13	31.885	0.510	17.8	0.3694	0.0000	FLOOD RISK
15 minute winter	2	12	31.860	0.540	32.6	1.6178	0.0000	FLOOD RISK
15 minute winter	3	12	31.850	0.590	50.0	1.9381	0.0000	FLOOD RISK
15 minute winter	4	12	31.840	0.640	52.6	2.0921	0.0000	FLOOD RISK
15 minute winter	5	12	31.800	0.660	63.8	2.2306	0.0000	FLOOD RISK
15 minute winter	6	13	31.796	0.716	70.9	2.0160	0.0000	FLOOD RISK
15 minute winter	7	13	31.777	0.706	68.1	0.1998	0.0000	FLOOD RISK
15 minute winter	8	13	31.839	0.259	20.7	0.5517	0.0000	OK
15 minute winter	9	13	31.835	0.255	40.7	0.5091	0.0000	OK
15 minute winter	10	13	31.803	0.893	36.3	0.2529	0.0000	FLOOD RISK
15 minute winter	11	13	31.764	0.919	36.1	0.2601	0.0000	FLOOD RISK
15 minute winter	12	13	31.739	1.003	93.4	0.2840	0.0000	FLOOD RISK
15 minute winter	13	13	31.582	0.482	7.0	0.0728	0.0000	FLOOD RISK
15 minute winter	14	13	31.582	0.909	95.4	0.2571	0.0000	FLOOD RISK
15 minute winter	15	13	31.486	0.839	101.8	0.5086	0.0000	FLOOD RISK
15 minute winter	16	13	31.389	0.389	3.9	0.0532	0.0000	FLOOD RISK
15 minute winter	17	13	31.388	0.773	103.6	0.0000	0.0000	SURCHARGED
15 minute winter	18	13	31.320	0.873	163.8	1.0608	0.0000	SURCHARGED
15 minute winter	19	12	31.529	0.289	17.2	0.1799	0.0000	OK
15 minute winter	20	12	31.532	0.345	25.5	0.9575	0.0000	FLOOD RISK
15 minute winter	21	12	31.526	0.389	36.7	1.0370	0.0000	FLOOD RISK
15 minute winter	22	13	31.517	0.430	48.8	1.1118	0.0000	SURCHARGED
15 minute winter	23	13	31.503	0.465	55.0	1.2304	0.0000	FLOOD RISK
15 minute winter	24	13	31.479	0.491	63.0	1.1858	0.0000	SURCHARGED
15 minute winter	25	13	31.454	0.729	56.0	0.2064	0.0000	FLOOD RISK

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	1	4.000	2	16.9	0.498	0.216	0.7726	
15 minute winter	2	4.001	3	30.0	0.745	0.383	0.8450	
15 minute winter	3	4.002	4	36.8	0.880	0.470	0.8448	
15 minute winter	4	4.003	5	48.0	0.997	0.614	0.8450	
15 minute winter	5	4.004	6	61.3	1.107	0.782	0.8450	
15 minute winter	6	4.005	7	68.1	1.627	0.870	0.1303	
15 minute winter	7	4.006	12	67.6	1.135	0.198	0.2539	
15 minute winter	8	CH2	9	20.0	0.418	0.222	0.9377	
15 minute winter	9	CH3	9A	36.8	0.941	0.409	0.4812	
15 minute winter	10	5.001	11	36.1	0.909	0.909	0.4412	
15 minute winter	11	5.002	12	36.2	0.910	0.911	0.2300	
15 minute winter	12	4.007	14	93.8	1.331	1.327	1.0705	
15 minute winter	13	6.000	14	-5.0	1.137	-0.079	0.0389	
15 minute winter	14	4.008	15	95.5	1.356	1.351	0.4417	
15 minute winter	15	4.009	17	102.0	1.448	1.443	0.5746	
15 minute winter	16	7.000	17	-1.9	1.173	-0.034	0.0429	
15 minute winter	17	4.010	18	103.7	1.472	1.467	0.3137	
15 minute winter	18	1.011	AquaSwirl	163.9	1.035	1.020	3.7992	
15 minute winter	19	1.000	20	10.3	0.422	0.146	0.9030	
15 minute winter	20	1.001	21	21.5	0.649	0.302	0.8451	
15 minute winter	21	1.002	22	33.7	0.771	0.472	0.8469	
15 minute winter	22	1.003	23	40.2	0.881	0.568	0.8421	
15 minute winter	23	1.004	24	53.9	0.965	0.755	0.8455	
15 minute winter	24	1.005	24A	56.4	1.648	0.744	0.3300	
15 minute winter	25	1.007	27	56.2	0.870	0.796	0.1476	

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 99.94%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	26	10	31.520	0.020	2.6	0.0110	0.0000	OK
15 minute winter	27	13	31.440	0.716	57.8	0.0000	0.0000	FLOOD RISK
15 minute winter	28	10	31.515	0.015	2.6	0.0084	0.0000	OK
15 minute winter	29	13	31.421	0.724	59.6	0.0000	0.0000	FLOOD RISK
15 minute winter	30	13	31.394	0.722	59.9	0.2042	0.0000	FLOOD RISK
15 minute winter	24A	13	31.467	0.501	56.4	0.0000	0.0000	FLOOD RISK
60 minute winter	AquaSwirl	57	31.282	0.895	118.7	1.0118	0.0000	SURCHARGED
60 minute winter	HYDROBRAKE	57	31.281	0.903	118.7	1.5954	0.0000	SURCHARGED
15 minute summer	34	1	30.360	0.000	0.0	0.0000	0.0000	OK
30 minute winter	35	13	30.456	0.026	1.1	0.0373	0.0000	OK
60 minute winter	PUMP	57	31.278	1.578	118.7	103.3400	0.0000	SURCHARGED
15 minute summer	37	12	30.454	0.107	23.1	0.1529	0.0000	OK
30 minute summer	38	15	30.368	0.052	22.4	0.0746	0.0000	OK
30 minute summer	38_OUT	15	29.888	0.048	22.4	0.0000	0.0000	OK
15 minute winter	39	11	31.487	0.575	16.8	0.4716	0.0000	SURCHARGED
15 minute winter	40	11	31.486	0.576	16.8	0.4717	0.0000	SURCHARGED
15 minute winter	41	12	31.434	0.572	29.5	0.1619	0.0000	SURCHARGED
15 minute winter	42	11	31.251	0.431	29.3	0.1221	0.0000	SURCHARGED
15 minute winter	43	11	31.127	0.446	39.4	0.2366	0.0000	SURCHARGED
15 minute winter	44	11	31.356	0.119	33.6	0.1089	0.0000	OK
15 minute winter	45	10	31.209	0.020	2.6	0.0031	0.0000	OK
15 minute winter	46	11	31.086	0.505	72.8	0.1430	0.0000	SURCHARGED
15 minute winter	47	11	31.039	0.476	72.6	0.1348	0.0000	SURCHARGED

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	26	2.000	27	2.6	1.546	0.038	0.0405	
15 minute winter	27	1.008	29	58.1	0.872	0.822	0.4646	
15 minute winter	28	3.000	29	2.6	1.993	0.022	0.0143	
15 minute winter	29	1.009	30	59.9	0.854	0.847	0.4313	
15 minute winter	30	1.010	18	60.1	0.854	0.851	1.2867	
15 minute winter	24A	1.006	25	56.0	1.323	0.153	0.1599	
60 minute winter	AquaSwirl	1.012	HYDROBRAKE	118.7	0.749	0.739	0.5962	
60 minute winter	HYDROBRAKE	Head/Flow	34	0.0				
60 minute winter	HYDROBRAKE	Orifice	PUMP	118.7				183.2
15 minute summer	34	1.014	37	-1.8	0.099	-0.025	0.0474	
30 minute winter	35	8.000	37	-1.1	-0.093	-0.007	0.5288	
60 minute winter	PUMP	Pump	37	22.0				
15 minute summer	37	1.015	38	22.4	1.191	0.139	0.2383	
30 minute summer	38	1.016	38_OUT	22.4	2.353	0.024	0.0547	128.0
15 minute winter	39	10.000	41	14.8	0.838	0.827	0.0872	
15 minute winter	40	11.000	41	14.8	0.838	0.829	0.0842	
15 minute winter	41	10.001	42	29.3	1.667	1.636	0.0724	
15 minute winter	42	10.002	43	30.6	1.737	1.718	0.0403	
15 minute winter	43	10.003	46	40.5	0.576	0.573	1.7239	
15 minute winter	44	12.000	46	33.1	2.541	0.621	0.0933	
15 minute winter	45	13.000	46	2.6	1.385	0.036	0.0275	
15 minute winter	46	10.004	47	72.6	1.031	1.024	0.3083	
15 minute winter	47	10.005	50	72.5	1.029	1.019	0.5107	

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 99.94%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	48	10	31.225	0.083	18.1	0.0385	0.0000	OK
15 minute winter	49	10	31.109	0.026	2.6	0.0036	0.0000	OK
15 minute winter	50	11	30.980	0.447	92.0	0.1265	0.0000	SURCHARGED
15 minute winter	51	11	30.818	0.352	101.0	0.1744	0.0000	SURCHARGED
15 minute winter	51_OUT	11	30.676	0.246	101.0	0.0000	0.0000	OK
15 minute winter	9A	13	31.825	0.877	36.8	0.0000	0.0000	FLOOD RISK

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	48	14.000	50	17.9	1.658	0.506	0.1621	
15 minute winter	49	15.000	50	2.6	0.924	0.065	0.0807	
15 minute winter	50	10.006	51	91.9	1.306	1.303	1.1591	
15 minute winter	51	10.007	51_OUT	101.0	1.453	1.432	0.5859	51.6
15 minute winter	9A	5.000	10	36.3	0.912	0.911	0.2562	

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	5	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	1.500
CV	1.000	Preferred Cover Depth (m)	0.000
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Invert Level (m)
1	0.019	5.00	31.900			385878.286	160973.440	0.525	31.375
2	0.031	5.00	31.900			385888.874	160976.312	0.580	31.320
3	0.031	5.00	31.850			385900.456	160979.451	0.590	31.260
4	0.031	5.00	31.840			385912.036	160982.588	0.640	31.200
5	0.031	5.00	31.800			385923.618	160985.726	0.660	31.140
6	0.019	5.00	31.800			385935.200	160988.864	0.720	31.080
7			31.800	600		385936.986	160989.348	0.729	31.071
8	0.032	5.00	31.880			385904.839	160975.776	0.300	31.580
9	0.032	5.00	31.900			385916.600	160978.948	0.320	31.580
10			31.860	600		385927.796	160984.680	0.950	30.910
11			31.790	600		385938.502	160987.583	0.945	30.845
12			31.770	600		385936.095	160992.841	1.034	30.736
13	0.004	5.00	31.700	150		385930.873	161009.229	0.600	31.100
14			31.700	600		385932.335	161007.571	1.027	30.673
15	0.017	5.00	31.700	600		385938.385	161009.230	1.053	30.647
16	0.004	5.00	31.670	150		385944.053	161012.432	0.670	31.000
17			31.700			385946.254	161011.388	1.085	30.615
18			31.670	1350	900	385950.550	161012.567	1.223	30.447
19	0.014	5.00	31.690			385865.496	161013.325	0.450	31.240
20	0.025	5.00	31.700			385877.940	161016.701	0.513	31.187
21	0.025	5.00	31.730			385889.523	161019.839	0.593	31.137
22	0.025	5.00	31.850			385901.131	161022.987	0.763	31.087
23	0.025	5.00	31.800			385912.675	161026.112	0.762	31.038
24	0.015	5.00	31.800			385924.270	161029.227	0.812	30.988
25			31.600	600		385930.979	161031.067	0.876	30.724
26	0.004	5.00	31.650	150		385931.726	161026.886	0.150	31.500
27			31.600			385933.071	161030.935	0.876	30.724
28	0.004	5.00	31.650	150		385939.569	161029.017	0.150	31.500
29			31.600			385939.658	161030.556	0.903	30.697
30			31.550	600		385945.773	161030.203	0.878	30.672
24A			31.600			385928.788	161030.469	0.634	30.966
AquaSwirl			31.630	1200		385970.062	161026.504	1.243	30.387
HYDROBRAKE			31.640	1500		385973.124	161028.692	1.262	30.378
34			31.680	1350	900	385977.408	161029.851	1.320	30.360
35		5.00	31.960	1350		385990.042	160998.760	1.530	30.430
PUMP		5.00	31.700	2400		385976.146	161025.285	2.000	29.700
37			31.880	1350		385981.659	161030.999	1.533	30.347
38			31.590	1350		385978.680	161042.885	1.274	30.316
38_OUT			30.990	1350		385977.324	161048.450	1.150	29.840
39	0.026	5.00	31.880	600		385881.117	160968.110	0.968	30.912
40	0.026	5.00	31.880	600		385886.171	160971.746	0.970	30.910

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Invert Level (m)
41			31.900	600		385881.567	160973.041	1.038	30.862
42			32.050	600		385877.486	160972.528	1.230	30.820
43	0.018	5.00	32.130	600		385875.607	160973.833	1.449	30.681
44	0.052	5.00	32.400	150		385868.874	160991.786	1.163	31.237
45	0.004	5.00	31.750	150		385867.160	160995.522	0.561	31.189
46			31.750	600		385869.296	160997.487	1.169	30.581
47			31.770	600		385868.166	161001.717	1.207	30.563
48	0.028	5.00	32.400	150		385857.400	160988.746	1.258	31.142
49	0.004	5.00	31.750	150		385856.914	160992.812	0.667	31.083
50			31.920	600		385861.156	160999.858	1.387	30.533
51	0.015	5.00	31.880	600		385856.911	161015.761	1.414	30.466
51_OUT			31.830	600		385865.468	161018.044	1.400	30.430
9A			31.900			385922.796	160980.616	0.952	30.948

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)
4.000	1	2	10.971	0.600	31.375	31.320	0.055	200.0	300	5.17	50.0
4.001	2	3	12.000	0.600	31.320	31.260	0.060	200.0	300	5.35	50.0
4.002	3	4	11.997	0.600	31.260	31.200	0.060	200.0	300	5.53	50.0
4.003	4	5	12.000	0.600	31.200	31.140	0.060	200.0	300	5.71	50.0
4.004	5	6	12.000	0.600	31.140	31.080	0.060	200.0	300	5.89	50.0
4.005	6	7	1.850	0.600	31.080	31.071	0.009	200.0	300	5.91	50.0
4.006	7	12	3.605	0.600	31.071	30.736	0.335	10.8	300	5.93	50.0
CH2	8	9	12.181	0.600	31.580	31.580	0.000	0.0	300	5.20	50.0
CH3	9	9A	6.417	0.600	31.580	31.580	0.000	0.0	300	5.31	50.0
5.001	10	11	11.093	0.600	30.910	30.845	0.065	170.0	225	5.60	50.0
5.002	11	12	5.783	0.600	30.845	30.811	0.034	170.0	225	5.70	50.0
4.007	12	14	15.202	0.600	30.736	30.674	0.062	245.0	300	6.18	50.0
6.000	13	14	2.211	0.600	31.100	30.823	0.277	8.0	150	5.01	50.0
4.008	14	15	6.273	0.600	30.673	30.647	0.026	245.0	300	6.29	50.0
4.009	15	17	8.160	0.600	30.648	30.615	0.033	245.0	300	6.42	50.0

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)
4.000	1.108	78.3	3.4	0.225	0.280	0.019	0.0	42	0.560
4.001	1.108	78.3	9.0	0.280	0.290	0.050	0.0	68	0.744
4.002	1.108	78.3	14.6	0.290	0.340	0.081	0.0	88	0.855
4.003	1.108	78.3	20.2	0.340	0.360	0.112	0.0	103	0.932
4.004	1.108	78.3	25.8	0.360	0.420	0.143	0.0	119	0.998
4.005	1.108	78.3	29.3	0.420	0.429	0.162	0.0	127	1.030
4.006	4.819	340.6	29.3	0.429	0.734	0.162	0.0	59	2.985
CH2	1.000	89.9	5.8	0.000	0.020	0.032	0.0	300	0.000
CH3	1.000	89.9	11.6	0.020	0.020	0.064	0.0	300	0.000
5.001	1.000	39.7	11.6	0.725	0.720	0.064	0.0	83	0.870
5.002	1.000	39.7	11.6	0.720	0.734	0.064	0.0	83	0.870
4.007	1.000	70.7	40.8	0.734	0.726	0.226	0.0	164	1.035
6.000	3.589	63.4	0.7	0.450	0.727	0.004	0.0	11	1.200
4.008	1.000	70.7	41.6	0.727	0.753	0.230	0.0	166	1.039
4.009	1.000	70.7	44.6	0.752	0.785	0.247	0.0	173	1.055

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)
7.000	16	17	2.436	0.600	31.000	30.765	0.235	10.4	150	5.01	50.0
4.010	17	18	4.455	0.600	30.615	30.597	0.018	245.0	300	6.50	50.0
1.006	24A	25	2.271	0.600	30.966	30.724	0.242	9.4	300	6.09	50.0
1.000	19	20	12.894	0.600	31.240	31.187	0.053	243.3	300	5.21	50.0
1.001	20	21	12.001	0.600	31.187	31.137	0.050	240.0	300	5.41	50.0
1.002	21	22	12.027	0.600	31.137	31.087	0.050	240.5	300	5.61	50.0
1.003	22	23	11.959	0.600	31.087	31.038	0.049	244.1	300	5.81	50.0
1.004	23	24	12.006	0.600	31.038	30.988	0.050	240.1	300	6.01	50.0
1.005	24	24A	4.686	0.600	30.988	30.966	0.022	213.0	300	6.08	50.0
1.007	25	27	2.096	0.600	30.733	30.724	0.009	245.0	300	6.12	50.0
2.000	26	27	4.267	0.600	31.500	30.874	0.626	6.8	150	5.02	50.0
1.008	27	29	6.598	0.600	30.724	30.697	0.027	245.0	300	6.23	50.0
3.000	28	29	1.542	0.600	31.500	30.847	0.653	2.4	150	5.00	50.0
1.009	29	30	6.125	0.600	30.697	30.672	0.025	245.0	300	6.34	50.0
1.010	30	18	18.272	0.600	30.672	30.597	0.075	245.0	300	6.64	50.0
1.011	18	AquaSwirl	23.978	0.600	30.447	30.387	0.060	400.0	450	7.04	50.0
1.012	AquaSwirl	HYDROBRAKE	3.763	0.600	30.387	30.378	0.009	400.0	450	7.10	50.0
1.013	HYDROBRAKE	34	4.438	0.600	30.378	30.360	0.018	245.0	300	7.17	50.0
1.014	34	37	2.357	0.600	30.360	30.350	0.010	235.7	300	7.21	50.0
8.000	35	37	33.311	0.600	30.430	30.347	0.083	400.0	450	5.55	50.0
9.000	PUMP	37	7.940	0.600	29.700	30.350	-0.650	-12.2	225	19.20	38.4
1.015	37	38	12.254	0.600	30.347	30.316	0.031	400.0	450	19.40	38.2
1.016	38	38_OUT	5.728	0.600	30.316	29.840	0.476	12.0	450	19.42	38.2
10.000	39	41	4.951	0.600	30.912	30.862	0.050	99.0	150	5.08	50.0

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)
7.000	3.147	55.6	0.7	0.520	0.785	0.004	0.0	12	1.088
4.010	1.000	70.7	45.4	0.785	0.773	0.251	0.0	175	1.059
1.006	5.161	364.8	23.3	0.334	0.576	0.129	0.0	51	2.927
1.000	1.003	70.9	2.5	0.150	0.213	0.014	0.0	38	0.476
1.001	1.010	71.4	7.0	0.213	0.293	0.039	0.0	63	0.647
1.002	1.009	71.3	11.6	0.293	0.463	0.064	0.0	81	0.746
1.003	1.002	70.8	16.1	0.463	0.462	0.089	0.0	97	0.815
1.004	1.010	71.4	20.6	0.462	0.512	0.114	0.0	110	0.876
1.005	1.073	75.9	23.3	0.512	0.334	0.129	0.0	114	0.948
1.007	1.000	70.7	23.3	0.567	0.576	0.129	0.0	118	0.898
2.000	3.884	68.6	0.7	0.000	0.576	0.004	0.0	11	1.255
1.008	1.000	70.7	24.0	0.576	0.603	0.133	0.0	120	0.907
3.000	6.609	116.8	0.7	0.000	0.603	0.004	0.0	8	1.813
1.009	1.000	70.7	24.8	0.603	0.578	0.137	0.0	122	0.913
1.010	1.000	70.7	24.8	0.578	0.773	0.137	0.0	122	0.913
1.011	1.010	160.7	70.1	0.773	0.793	0.388	0.0	208	0.977
1.012	1.010	160.7	70.1	0.793	0.812	0.388	0.0	208	0.977
1.013	1.000	70.7	70.1	0.962	1.020	0.388	0.0	245	1.133
1.014	1.020	72.1	70.1	1.020	1.230	0.388	0.0	240	1.156
8.000	1.010	160.7	0.0	1.080	1.083	0.000	0.0	0	0.000
9.000	0.009	0.4	0.0	1.775	1.305	0.000	0.0	0	0.000
1.015	1.010	160.7	53.5	1.083	0.824	0.388	0.0	178	0.911
1.016	5.884	935.9	53.5	0.824	0.700	0.388	0.0	72	3.245
10.000	1.010	17.8	4.7	0.818	0.888	0.026	0.0	52	0.852

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)
11.000	40	41	4.783	0.600	30.910	30.862	0.048	99.6	150	5.08	50.0
10.001	41	42	4.113	0.600	30.862	30.820	0.042	97.9	150	5.15	50.0
10.002	42	43	2.288	0.600	30.820	30.797	0.023	99.5	150	5.19	50.0
10.003	43	46	24.481	0.600	30.681	30.581	0.100	244.8	300	5.60	50.0
12.000	44	46	5.717	0.600	31.237	30.731	0.506	11.3	150	5.03	50.0
13.000	45	46	2.902	0.600	31.189	30.731	0.458	6.3	150	5.01	50.0
10.004	46	47	4.378	0.600	30.581	30.563	0.018	243.2	300	5.67	50.0
10.005	47	50	7.252	0.600	30.563	30.533	0.030	241.7	300	5.79	50.0
14.000	48	50	11.730	0.600	31.142	30.683	0.459	25.6	150	5.10	50.0
15.000	49	50	8.215	0.600	31.083	30.683	0.400	20.5	150	5.06	50.0
10.006	50	51	16.460	0.600	30.533	30.466	0.067	245.7	300	6.06	50.0
10.007	51	51_OUT	8.856	0.600	30.466	30.430	0.036	246.0	300	6.21	50.0
5.000	9A	10	6.443	0.600	30.948	30.910	0.038	169.6	225	5.42	50.0

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)
11.000	1.006	17.8	4.7	0.820	0.888	0.026	0.0	52	0.850
10.001	1.015	17.9	9.4	0.888	1.080	0.052	0.0	77	1.027
10.002	1.007	17.8	9.4	1.080	1.183	0.052	0.0	78	1.022
10.003	1.000	70.7	12.6	1.149	0.869	0.070	0.0	85	0.760
12.000	3.014	53.3	9.4	1.013	0.869	0.052	0.0	42	2.278
13.000	4.029	71.2	0.7	0.411	0.869	0.004	0.0	11	1.302
10.004	1.003	70.9	22.8	0.869	0.907	0.126	0.0	116	0.895
10.005	1.007	71.2	22.8	0.907	1.087	0.126	0.0	116	0.898
14.000	2.000	35.3	5.1	1.108	1.087	0.028	0.0	38	1.427
15.000	2.232	39.4	0.7	0.517	1.087	0.004	0.0	14	0.866
10.006	0.998	70.6	28.6	1.087	1.114	0.158	0.0	133	0.947
10.007	0.998	70.5	31.3	1.114	1.100	0.173	0.0	140	0.968
5.000	1.001	39.8	11.6	0.727	0.725	0.064	0.0	83	0.871

Simulation Settings

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

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 %)
1	40	0	0

Node HYDROBRAKE Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	30.378	Product Number	CTL-SHE-0214-2200-0450-2200
Design Depth (m)	0.450	Min Outlet Diameter (m)	0.300
Design Flow (l/s)	22.0	Min Node Diameter (mm)	1500

Node PUMP Online Pump Control

Flap Valve	x	Replaces Downstream Link	✓	Switch on depth (m)	0.001
Downstream Link	9.000	Invert Level (m)	29.700	Switch off depth (m)	0.000

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.001	22.000	3.000	22.000

Node 34 Online Orifice Control

Flap Valve	✓	Invert Level (m)	30.360	Discharge Coefficient	0.600
Replaces Downstream Link	x	Diameter (m)	0.600		

Node HYDROBRAKE Offline Orifice Control

Flap Valve	x	Invert Level (m)	30.800	Discharge Coefficient	0.600
Loop to Node	PUMP	Diameter (m)	0.450		

Node PUMP Soakaway Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	29.700	Depth (m)	0.800
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Inf Depth (m)	
Safety Factor	2.0	Pit Width (m)	5.500	Number Required	1
Porosity	0.95	Pit Length (m)	23.000		

Results for 1 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	1	10	31.408	0.033	2.0	0.0236	0.0000	OK
15 minute winter	2	11	31.372	0.052	5.3	0.1020	0.0000	OK
15 minute winter	3	11	31.326	0.066	8.4	0.1427	0.0000	OK
15 minute winter	4	11	31.278	0.078	11.4	0.1753	0.0000	OK
15 minute winter	5	11	31.228	0.088	14.6	0.1998	0.0000	OK
15 minute winter	6	11	31.173	0.093	16.5	0.1764	0.0000	OK
15 minute winter	7	11	31.116	0.045	16.5	0.0126	0.0000	OK
15 minute winter	8	11	31.639	0.059	3.4	0.1253	0.0000	OK
15 minute winter	9	11	31.635	0.055	6.6	0.1093	0.0000	OK
15 minute winter	10	11	30.975	0.065	6.6	0.0184	0.0000	OK
15 minute winter	11	11	30.911	0.066	6.6	0.0187	0.0000	OK
15 minute winter	12	11	30.864	0.128	23.0	0.0362	0.0000	OK
15 minute summer	13	11	31.109	0.009	0.4	0.0013	0.0000	OK
15 minute winter	14	11	30.810	0.137	23.3	0.0387	0.0000	OK
15 minute winter	15	15	30.803	0.156	24.7	0.0945	0.0000	OK
15 minute summer	16	11	31.009	0.009	0.4	0.0013	0.0000	OK
15 minute winter	17	15	30.802	0.187	24.9	0.0000	0.0000	OK
15 minute winter	18	15	30.801	0.354	38.0	0.4295	0.0000	OK
15 minute winter	19	10	31.270	0.030	1.5	0.0185	0.0000	OK
15 minute winter	20	11	31.235	0.048	4.2	0.0965	0.0000	OK
15 minute winter	21	11	31.198	0.061	6.7	0.1283	0.0000	OK
15 minute winter	22	11	31.160	0.073	9.1	0.1467	0.0000	OK
15 minute winter	23	11	31.119	0.081	11.6	0.1700	0.0000	OK
15 minute winter	24	11	31.071	0.083	13.1	0.1505	0.0000	OK
15 minute winter	25	11	30.827	0.103	13.0	0.0292	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	1	4.000	2	2.0	0.330	0.025	0.0666	
15 minute winter	2	4.001	3	5.1	0.532	0.065	0.1164	
15 minute winter	3	4.002	4	8.3	0.645	0.106	0.1555	
15 minute winter	4	4.003	5	11.5	0.726	0.147	0.1905	
15 minute winter	5	4.004	6	14.6	0.818	0.187	0.2148	
15 minute winter	6	4.005	7	16.5	1.354	0.210	0.0232	
15 minute winter	7	4.006	12	16.5	0.985	0.048	0.0634	
15 minute winter	8	CH2	9	3.3	0.192	0.036	0.2073	
15 minute winter	9	CH3	9A	6.6	0.480	0.073	0.0878	
15 minute winter	10	5.001	11	6.6	0.685	0.166	0.1066	
15 minute winter	11	5.002	12	6.6	0.709	0.165	0.0534	
15 minute winter	12	4.007	14	22.9	0.769	0.324	0.4527	
15 minute summer	13	6.000	14	0.4	0.977	0.006	0.0009	
15 minute winter	14	4.008	15	23.1	0.755	0.327	0.2111	
15 minute winter	15	4.009	17	24.5	0.839	0.346	0.3377	
15 minute summer	16	7.000	17	0.4	0.901	0.007	0.0011	
15 minute winter	17	4.010	18	24.6	0.893	0.349	0.2159	
15 minute winter	18	1.011	AquaSwirl	30.1	0.582	0.187	3.4246	
15 minute winter	19	1.000	20	1.5	0.278	0.021	0.0692	
15 minute winter	20	1.001	21	4.0	0.465	0.056	0.1046	
15 minute winter	21	1.002	22	6.6	0.565	0.092	0.1403	
15 minute winter	22	1.003	23	9.1	0.640	0.129	0.1707	
15 minute winter	23	1.004	24	11.6	0.742	0.163	0.1882	
15 minute winter	24	1.005	24A	13.0	1.275	0.172	0.0497	
15 minute winter	25	1.007	27	13.0	0.712	0.184	0.0384	

Results for 1 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 summer	26	11	31.508	0.008	0.4	0.0046	0.0000	OK
15 minute winter	27	11	30.814	0.090	13.4	0.0000	0.0000	OK
15 minute summer	28	11	31.507	0.007	0.4	0.0037	0.0000	OK
15 minute winter	29	15	30.801	0.104	13.8	0.0000	0.0000	OK
15 minute winter	30	15	30.801	0.129	13.7	0.0365	0.0000	OK
15 minute winter	24A	11	31.005	0.039	13.0	0.0000	0.0000	OK
15 minute winter	AquaSwirl	15	30.799	0.412	30.1	0.4659	0.0000	OK
15 minute winter	HYDROBRAKE	15	30.798	0.420	24.0	0.7426	0.0000	SURCHARGED
15 minute winter	34	16	30.503	0.143	22.0	0.1740	0.0000	OK
15 minute summer	35	14	30.456	0.026	1.0	0.0366	0.0000	OK
15 minute summer	PUMP	1	29.700	0.000	0.0	0.0000	0.0000	OK
15 minute winter	37	15	30.453	0.106	22.3	0.1524	0.0000	OK
15 minute winter	38	15	30.368	0.052	22.4	0.0745	0.0000	OK
15 minute winter	38_OUT	15	29.888	0.048	22.4	0.0000	0.0000	OK
15 minute winter	39	10	30.953	0.041	2.8	0.0336	0.0000	OK
15 minute winter	40	10	30.951	0.041	2.8	0.0338	0.0000	OK
15 minute winter	41	10	30.926	0.064	5.5	0.0182	0.0000	OK
15 minute winter	42	10	30.885	0.065	5.5	0.0183	0.0000	OK
15 minute winter	43	11	30.745	0.064	7.3	0.0342	0.0000	OK
15 minute winter	44	10	31.272	0.035	5.6	0.0317	0.0000	OK
15 minute summer	45	11	31.197	0.008	0.4	0.0013	0.0000	OK
15 minute winter	46	11	30.683	0.102	13.1	0.0288	0.0000	OK
15 minute winter	47	11	30.662	0.099	13.1	0.0280	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 summer	26	2.000	27	0.4	1.047	0.006	0.0016	
15 minute winter	27	1.008	29	13.4	0.735	0.189	0.1210	
15 minute summer	28	3.000	29	0.4	1.541	0.003	0.0004	
15 minute winter	29	1.009	30	13.7	0.758	0.193	0.1555	
15 minute winter	30	1.010	18	14.0	0.753	0.198	0.7295	
15 minute winter	24A	1.006	25	13.0	1.027	0.036	0.0303	
15 minute winter	AquaSwirl	1.012	HYDROBRAKE	24.0	0.565	0.149	0.5759	
15 minute winter	HYDROBRAKE	Hydro-Brake®	34	22.0				
15 minute winter	HYDROBRAKE	Orifice	PUMP	0.0				0.0
15 minute winter	34	1.014	37	22.0	0.833	0.305	0.0623	
15 minute summer	35	8.000	37	-1.0	-0.086	-0.006	0.5274	
15 minute summer	PUMP	Pump	37	0.0				
15 minute winter	37	1.015	38	22.4	1.193	0.139	0.2376	
15 minute winter	38	1.016	38_OUT	22.4	2.353	0.024	0.0546	19.0
15 minute winter	39	10.000	41	2.8	0.503	0.155	0.0275	
15 minute winter	40	11.000	41	2.8	0.500	0.155	0.0266	
15 minute winter	41	10.001	42	5.5	0.756	0.305	0.0298	
15 minute winter	42	10.002	43	5.4	0.812	0.305	0.0153	
15 minute winter	43	10.003	46	7.3	0.460	0.103	0.3925	
15 minute winter	44	12.000	46	5.6	1.879	0.104	0.0169	
15 minute summer	45	13.000	46	0.4	1.065	0.006	0.0011	
15 minute winter	46	10.004	47	13.1	0.633	0.184	0.0904	
15 minute winter	47	10.005	50	13.1	0.625	0.184	0.1522	

Results for 1 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	48	10	31.172	0.030	3.0	0.0140	0.0000	OK
15 minute summer	49	11	31.094	0.011	0.4	0.0015	0.0000	OK
15 minute winter	50	11	30.637	0.104	16.4	0.0294	0.0000	OK
15 minute winter	51	11	30.577	0.111	17.9	0.0548	0.0000	OK
15 minute winter	51_OUT	11	30.532	0.102	17.9	0.0000	0.0000	OK
15 minute winter	9A	11	31.012	0.064	6.6	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	48	14.000	50	3.0	1.198	0.084	0.0291	
15 minute summer	49	15.000	50	0.4	0.712	0.010	0.0046	
15 minute winter	50	10.006	51	16.4	0.725	0.233	0.3729	
15 minute winter	51	10.007	51_OUT	17.9	0.804	0.254	0.1974	8.4
15 minute winter	9A	5.000	10	6.6	0.698	0.165	0.0607	

Appendix D

Drainage Maintenance Plan

DRAINAGE MAINTANENCE PLAN

PROJECT WHITEHORSE

1. INTRODUCTION

1. The maintenance of drainage networks is fundamental to secure their long- term operation and functionality. If the maintenance regimes are not adhered to, the systems design capacity and performance will deteriorate over time, reducing the level of protection offered to the development and its downstream catchment.
2. Whilst the maintenance regimes covered by this document are based on best practice guidance for the surface water management system, those responsible for maintenance must acknowledge the need to appraise the effectiveness of the recommended actions and frequencies, so that any variations in site or drainage conditions can be controlled throughout the developments lifetime.
3. This maintenance plan must be read in conjunction with the final drainage plans or as-built records, so that all drainage features can be identified and located on site.
4. A schedule has been provided at the rear of this maintenance plan to document any variations which might be implemented through the developments lifetime.

2. OVERVIEW OF MAINTENANCE REQUIRED FOR SUSTAINABLE DRAINAGE SYSTEMS (SuDS)

5. It is important to ensure that thought is given to the long-term maintenance of SuDS features during the feasibility and planning stages. By ensuring SuDS features are correctly monitored and maintained throughout their lifetime, the amount of deterioration in performance that could occur over time is prevented or limited. This ensures that the feature will continue to work at full capacity as required in the design.
6. The type of required maintenance is determined by many factors, including;
 - Type of SuDS scheme
 - The size of the contributing catchment relating to each SuDS component
 - Land-use associated with contributing catchment
 - Level of construction ongoing within the contributing catchment
 - Planting types
 - Habitat types that have been created
 - Amenity and visual requirements of the area

7. Maintenance regimes should be regularly assessed to make sure that the approach is still meeting the drainage, landscape and any other objectives.
8. In accordance with CIRIA C753 – ‘The SuDS Manual’, maintenance can be split into three main categories; Regular maintenance (including inspections and monitoring), Occasional maintenance and Remedial maintenance.
 - **Regular maintenance** covers basic tasks which are carried out on a predictable and frequent schedule. Such activities include inspections, vegetation management and litter/debris removal.
 - **Occasional maintenance** includes tasks which are likely to be required infrequently and cannot be predicted as easily as regular maintenance tasks. This covers tasks such as sediment removal.
 - **Remedial maintenance** covers tasks which are required to resolve faults within the system found during regular inspections. Although in good design the requirement of this type of maintenance is limited, faults still occur. These faults and the corresponding maintenance actions required are generally site specific and difficult to predict.
9. Detailed information for the maintenance required for the SuDS features applicable to this project can be found in the following sections of this document.

3. PRIVATE DRAINAGE

10. Private drainage must be designed and installed in accordance with the approved Building Regulations Part H. Once the drainage has been signed-off by Building Control it must be maintained by the Site Operator.
11. Ownership/Responsibility
Private drainage will be the responsibility of the site operator and must be maintained by them, or other appointed person on their behalf.
12. Maintenance Regime
This private drainage will be maintained using the following regime;

Maintenance Schedule	Required Action	Recommended Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. Take remedial action where required.	Monthly for 3 months, then six monthly
	Remove debris from gullies, manholes and flow controls.	Every 6 months
	Remove debris from catchpits upstream of private attenuation.	Every 6 months

Maintenance Schedule	Required Action	Recommended Frequency
	Inspect gullies, manholes, flow controls and attenuation.	Annually
	Jetting of pipes.	Every 5 years
	Internal inspection of pipes (CCTV).	Every 10 years
Occasional Maintenance	Repair/rehabilitate gullies, pipes, manholes and flow controls.	As required
	Repair/rehabilitate private attenuation.	As required

4. GEOCELLULAR/MODULAR ATTENUATION SYSTEMS

13. Modular high void ratio, plastic geocellular systems used to create an underground storage structure.

14. Ownership/Responsibility

On-site Geocellular Attenuation will be retained under private ownership of the site operator, who will be responsible for its future operation and maintenance in perpetuity.

15. Maintenance Regime

Geocellular/modular systems are designed in accordance with CIRIA guidelines and should be maintained using the following regime;

Maintenance Schedule	Required Action	Recommended Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then six monthly
	Debris removal from catchment surface (where may cause risks to performance).	Monthly
	Where rainfall infiltrates into blocks from above, check surface or filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary.	Monthly (and after large storms)
	Remove sediment from pre-treatment structures.	Annually, or as required
Remedial Actions	Repair/ rehabilitation of inlets, outlet, overflows and vents.	As required

Maintenance Schedule	Required Action	Recommended Frequency
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually and after large storms

5. FILTER DRAINS

16. Filter drains are shallow trenches filled with stone/gravel that create temporary subsurface storage for the attenuation, conveyance and filtration of surface water runoff.

17. Ownership/Responsibility

On-site filter drains will be retained under private ownership of the site operator, who will be responsible for their future operation and maintenance in perpetuity.

18. Maintenance Regime

Filter drain systems are designed in accordance with CIRIA guidelines and should be maintained using the following regime;

Maintenance Schedule	Required Action	Recommended Frequency
Regular Maintenance	Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices.	Monthly (or as required)
	Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage.	Monthly
	Inspect pre-treatment systems, inlets and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies.	Every 6 months
	Remove sediment from pre-treatment devices.	Every 6 months, or as required
Occasional Maintenance	Remove or control tree roots where they are encroaching into sides of the filter drain, using recommended methods (e.g. NJUG, 2007 or BS 3998:2010).	As required
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium.	Every 5 years, or as required

	Clear perforated pipework of blockages.	As required
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6. SURFACE WATER PUMPSTATION

19. Pumps allow the lifting of water from a lower level to a higher level, and are arranged as a pump unit in a pump chamber. The pump is controlled and monitored by a telemetry and control kiosk as required by the drainage design.

20. Ownership/Responsibility

On-site Surface Water Pumpstation will be retained under private ownership of the site operator, who will be responsible for its future operation and maintenance in perpetuity. The site operator already has pumpstations on-site and a maintenance team that looks after them.

21. Maintenance Regime

Surface water pumpstations systems are designed by the manufacturers and suppliers and should be maintained following the manufacturers/suppliers guidance but a typical regime is indicated below;

Maintenance Schedule	Required Action	Recommended Frequency
Regular Maintenance	Visual inspection of the station, covers, kiosk/panel, vents and surrounding area; check for damage, standing water, leakage or vandalism.	Monthly
	Check duty and standby status, run indications, alarms, telemetry/auto-dialler, power healthy light and general control panel condition.	Monthly
	Check pump operation through a normal cycle, including automatic start and stop from level controls.	Monthly
	Check the wet well for silt, grit, debris or construction residue; remove minor debris accessible from the surface.	Monthly
	Record run hours, starts, alarm history and any abnormal noise or vibration.	Monthly
	Full service visit by specialist contractor: inspect pumps, controls, floats/level sensors, pipework, valves and non-return valves; wash down the wet well as needed; grease lids and seals.	Every 6 months

Maintenance Schedule	Required Action	Recommended Frequency
	Electrical and mechanical inspection including overload settings, cable condition, earth/bonding checks and confirmation of correct standby changeover.	Annually
	Running-in checks after commissioning or major repair.	Daily for first week
Occasional Maintenance	Desilt or wash down the wet well and remove accumulated grit, sand or debris by tanker or jetting contractor.	As required
	Clean or free blocked pumps, impellers, inlets, floats or level sensors.	As required
	Exercise, clean or repair isolation valves and non-return valves where poor operation is noted.	As required
	Repair damaged covers, frames, seals, kiosks, ladders, guide rails or pipe supports.	As required
	Attend after alarm, power failure, flooding, storm exceedance or prolonged no-flow period to confirm full return to service.	After each incident
	Major overhaul or pump replacement where performance drops, run time rises materially, or power consumption becomes abnormal.	As required

7. TRADE EFFLUENT PUMPSTATION

22. Pumps allow the lifting of water from a lower level to a higher level, and are arranged as a pump unit in a pump chamber. The pump is controlled and monitored by a telemetry and control kiosk as required by the drainage design.
23. Ownership/Responsibility
On-site trade effluent pump stations will be retained under private ownership of the site operator, who will be responsible for its future operation and maintenance in perpetuity. The site operator already has pumpstations on-site and a maintenance team that looks after them.
24. Maintenance Regime
Trade effluent pumpstations systems are designed by the manufacturers and suppliers and should be maintained following the manufacturers/suppliers guidance but a typical regime is indicated below;

Maintenance Schedule	Required Action	Recommended Frequency
Regular Maintenance	Visual inspection of the station, covers, kiosk/panel, vents and surrounding area; check for leaks, odour, surcharge evidence and vermin/insect issues.	Monthly
	Check duty and standby status, alarms, telemetry/auto-dialler and control panel health.	Monthly
	Check pump operation through a normal automatic cycle, including high-level alarm function and standby changeover.	Monthly
	Inspect the wet well condition for fats, grease, ragging and solids accumulation.	Monthly
	Record run hours, starts, alarm history and any abnormal noise or vibration.	Monthly
	Full specialist service visit: inspect pumps, controls, floats/level sensors, pipework, isolation valves and non-return valves; hose off fat/solids build-up; grease lids and seals.	Every 6 months
	Electrical and mechanical inspection and performance review.	Annually
	Running-in checks after commissioning or major repair.	Daily for first week
Occasional Maintenance	Wet well washdown or tanker clean to remove sludge, fat, grease and settled solids.	As required
	De-rag pumps and clean impellers, pump inlets, guide rails and floats/level sensors.	As required
	Jet or clean the rising main if there is evidence of blockage, poor discharge or recurrent alarms.	As required
	Clean or repair non-return valves and isolating valves if sticking, leaking or passing.	As required
	Emergency attendance after a high-level alarm, pump trip, power outage, blockage or surcharge event.	After each incident

Maintenance Schedule	Required Action	Recommended Frequency
	Major overhaul or pump replacement where reliability falls, run time/power draw rises or repeated blockages occur.	As required

8. SDS AQUASWIRL – PROPRIETARY TREATMENT UNIT

25. Proprietary Treatment Units are engineered devices that increase water quality by removal of Suspended Solids, Heavy Metals and Hydrocarbons. Units can be supplied with telemetry and alert functions operated through a kiosk.

26. Ownership/Responsibility

On-site proprietary treatment units will be retained under private ownership of the site operator, who will be responsible for its future operation and maintenance in perpetuity.

27. Maintenance Regime

Proprietary treatment systems are designed by the manufacturers and suppliers and should be maintained following the manufacturers/suppliers guidance but a typical regime is indicated below;

Maintenance Schedule	Required Action	Recommended Frequency
Regular Maintenance	Inspect from the surface via the access cover; check for sediment accumulation, floatables, oil, blockage, odour and visible structural issues.	Quarterly in year 1
	Inspect the bypass/diversion structure at the same time as the separator inspection.	Quarterly in year 1
	Review year-1 loading and reset the ongoing inspection interval.	End of year 1
	Ongoing inspection where year-1 loading was modest.	Annually after year 1
	Ongoing inspection where year-1 loading reached capacity within 12 months, or where site history warrants.	Every 6 months after year 1
	Planned clean-out of the separator, regardless of whether full storage capacity has been reached.	Annually

Maintenance Schedule	Required Action	Recommended Frequency
	Additional first-year / construction-phase check if the unit is installed before the site is fully stabilised.	At end of construction, then quarterly in first year
Occasional Maintenance	Vacuum tanker clean-out to remove sediment, oil and floatables when inspections show the unit is approaching its maintenance trigger or has materially accumulated pollutants.	As required
	Clean and maintain bypass/diversion structures if blocked or damaged.	As required
	Remove unusual debris loads after storm events, spillages or construction-related contamination.	After each incident
	Inspect and repair any structural damage, cover/frame defects or internal baffle/access defects.	As required
	Review whether inspection frequency needs to be increased because loading is higher than expected.	As required

9. SCHEDULE OF CHANGES

28. This schedule has been provided to enable those responsible for maintenance of the drainage systems to document changes made to the actions and frequencies of maintenance, in direct response to changing site/drainage conditions;

[illegible]