TWEDDELL & SLATER
CONSULTING CIVIL & STRUCTURAL ENGINEERS

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PROPOSED RESIDENTIAL DEVELOPMENT
KELLS LEGION, WHITEHAVEN
DRAINAGE STRATEGY

Introduction

Tweddell and Slater Ltd have been appointed to prepare a surface water and foul drainage statement that is compliant with the National Planning Policy.

This report has been prepared in support of the proposed construction of a 10 dwelling residential development at Whitehaven in Cumbria. The closest postcode to the site is CA28 9ED and the development area is currently brownfield. The site is split in two by the existing Hilltop Road and was once the location of the Kells Royal British Legion and accompanying car park.

The layout of the proposed site is indicated in Figure 1 below.

Figure 1 – Proposed Site Location and Boundary

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In accordance with the recognised guidance, there is a hierarchy of where surface water should be discharged. This hierarchy where practicable, is as follows:

1) Infiltration
2) Watercourse
3) Public sewer

A site walkover was undertaken in June 2022. The existing site surface water appears to be uncontrolled and overland flow drains directly to Hill top road at an uncontrolled rate. An analysis of the area's topography has shown that the stie is relatively steep with the flow direction of overland flow in saturated conditions falling to the east due to the topography on site.

The EA flood risk maps and flood map for planning show that the entirety of the site is not identified as at risk from flooding from rivers and is categorised as Flood Zone 1. Flood Zone 1 is considered to be land having a 1 in 1000 or lesser annual probability of river or sea flooding.

By review of the government long term flood risk information, it has been determined that the site is at a very low risk from surface water flooding (Appendix D).

Existing Site Runoff

The greenfield runoff rate calculation for the site is shown within Appendix B. The greenfield runoff rates for the site are shown below:

Event	Greenfield Runoff Rate
1 in 1 year	1.66 l/s
Q Bar	1.91 l/s
1 in 30 years	3.25 l/s
1 in 100 years	3.97 l/s

Due to the lack of available space within the site boundary it has been determined that the use of soakaways is not viable.

The closest watercourse to the site is an unnamed watercourse leading to "Pow Beck". This watercourse is located approximately 540m northeast of the proposed development. Separating the development from the watercourse are several residential streets. This watercourse is classified as a main river by the Environment Agency (EA). Due to the significant distance to this watercourse and the land ownership issues involved, discharging to either of these watercourses is not considered to be a viable option for the development.

Surface Water Proposals

Sewer records obtained from United Utilities (UU) show that there are two 150mm diameter combined sewers located within close proximity to the site. One of these sewers is located beneath Hilltop Road, a short distance to the north of the development. The other combined sewer enters the southwest of the site and will require diversion to provide sufficient easement. There are no surface water or foul sewers located within close proximity to the site.

A surface water drainage strategy (Appendix A) has therefore been developed to discharge the runoff generated by the roof, access, yard and driveway areas of the proposed development to the combined sewer north of the development. This is in line with the drainage hierarchy as outlined above.

To achieve a discharge rate in line with the site's Q_{BAR} value it is proposed to attenuate surface water within three separate attenuation tanks on site and then have a controlled outflow to the existing combined sewer via multiple hydrobrake flow control devices. Multiple attenuation systems are required due to the level differences and split nature of the site.

The attenuation tank and surface water system will be designed such that it will not be surcharged in events up to 30 years recurrence and that there will be no flooding in events up to 100 years with an allowance for climate change of 40%.

The proposed surface water drainage system will be designed to building regulations to ensure the structural integrity under anticipated loading conditions over the design life, this includes the cover to pipes that have been designed in accordance with the manufacturer's requirements and specification.

Foul System Proposal

It is anticipated that foul discharge from the development will connect to the existing combined sewer located to the north of the site. The proposal is to collect all foul drainage from the new properties, and then connect to an existing manhole located in the Hill top road to the north of the site.

The use of a foul drainage field is not viable due to the ground conditions.

The proposed foul water drainage system will be designed to building regulations to ensure the structural integrity under anticipated loading conditions over the design life this includes the cover to pipes that have been designed in accordance with the manufacturer's requirements and specification.

Andy Poole BEng CEng MICE PCERT
For Tweddell & Slater Ltd
June 2022

APPENDIX A -
DRAINAGE STRATEGY DRAWING

Existing combined drainage positions are based on UU mapping and are approximate

Revision Notes
A 24/06/22 Adjustments to foul and SW drainage layouts

PRELIMINARY

Suitability --

Project
PROPOSED RESIDENTIAL DEVELOPMENT
KELLS LEGION, WHITEHAVEN

Client
MESSRS, MORTON

Drawing
OUTLINE DRAINAGE STRATEGY

Project no	Drawing no	Date	Drawn by	Rev	Scale	Sheet
7535	200	JUN 22	SJ	A	1:200	A1

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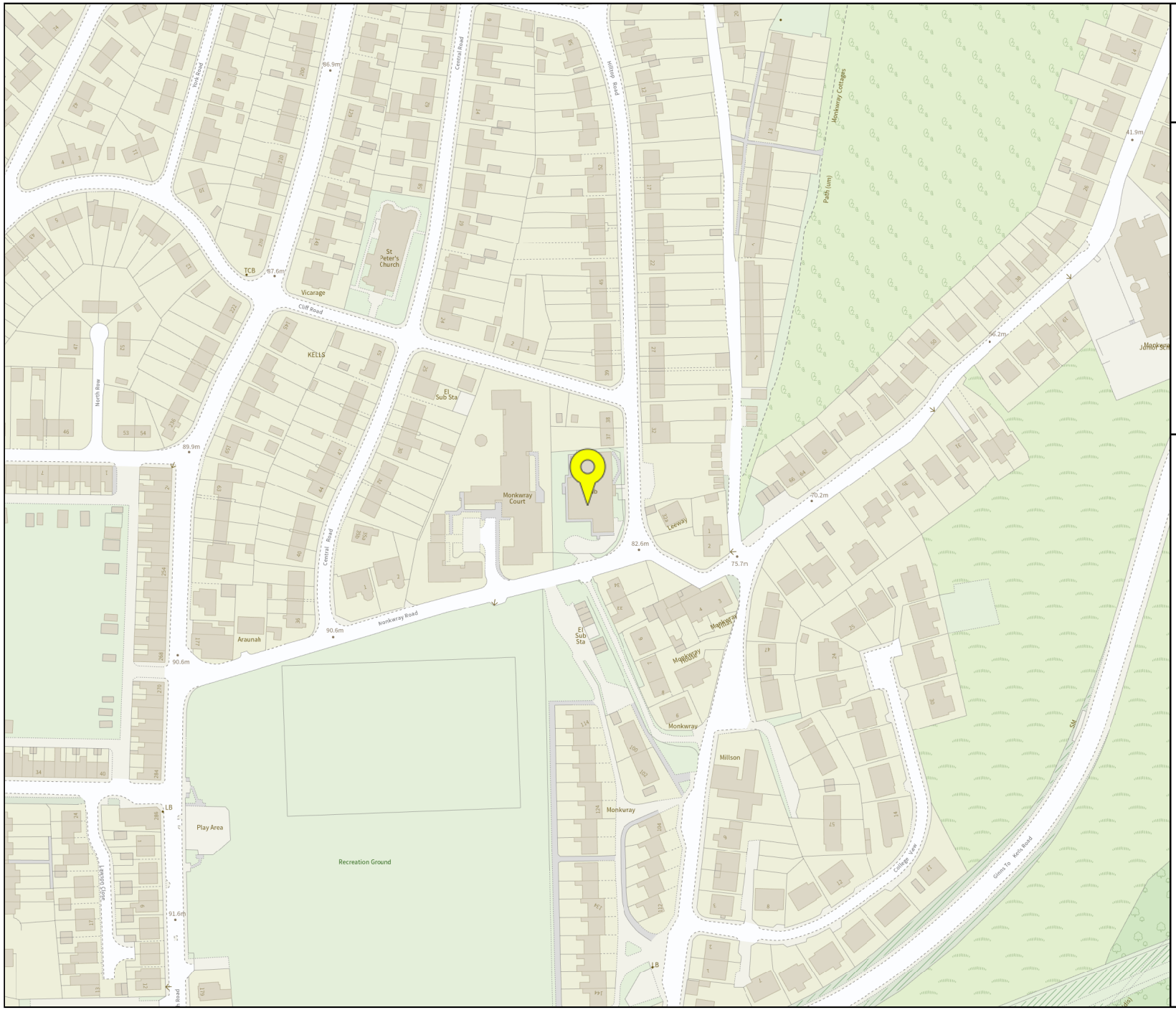
APPENDIX B -
GREENFIELD RUNOFF CALCULATIONS



Environment Agency

Flood map for planning

Your reference
Kells Legion

Location (easting/northing)
296968/516983

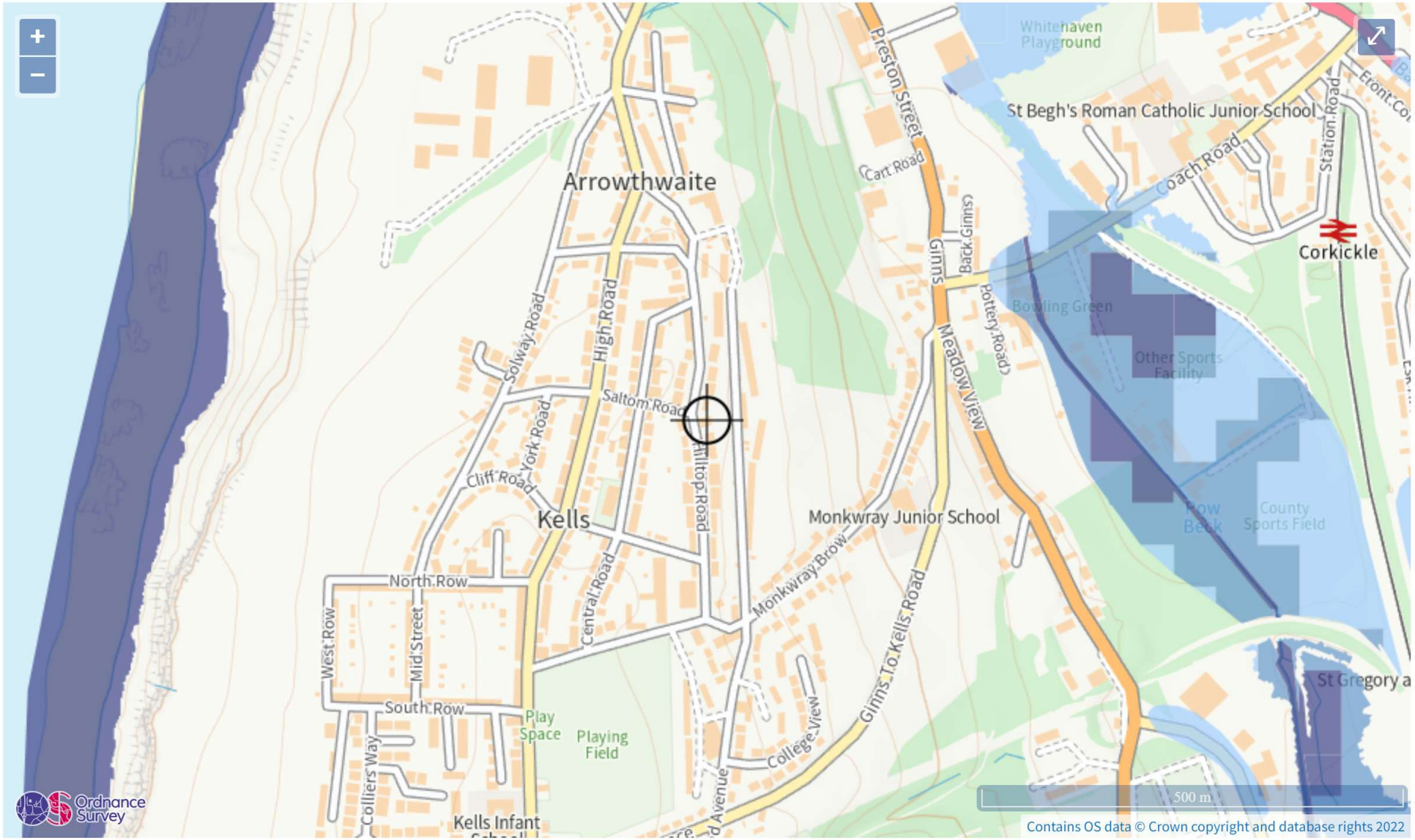
Scale
1:2500

Created
24 Jun 2022 11:14

- Selected point
- Flood zone 3
- Flood zone 3: areas benefitting from flood defences
- Flood zone 2
- Flood zone 1
- Flood defence
- Main river
- Water storage area

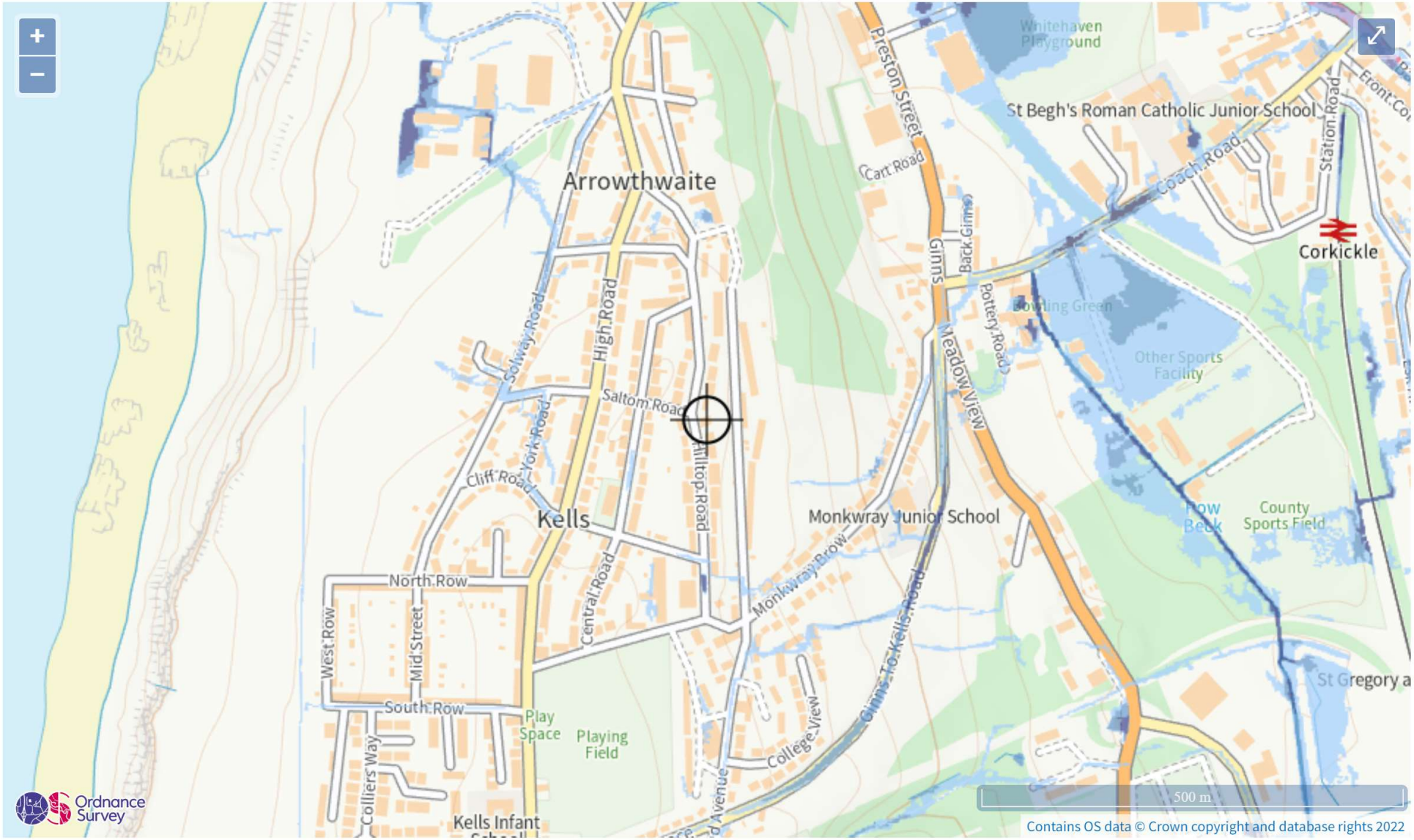
0 20 40 60m

APPENDIX C -
EA FLOOD MAP FOR PLANNING AND LONG-TERM FLOOD RISK



Extent of flooding from rivers or the sea

High Medium Low Very low Location you selected



Extent of flooding from surface water

High Medium Low Very low Location you selected

APPENDIX D -
SURFACE WATER CALCULATIONS

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	40	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	17.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.300	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	x
Time of Entry (mins)	2.00	Enforce best practice design rules	x

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Depth (m)
SW1	0.007	2.00	82.100	1200	0.850
SW2	0.003	2.00	82.100	1200	0.955
SW3	0.006	2.00	82.100	1200	1.150
SW4	0.009	2.00	82.100	1200	1.450
TANK INLET			82.100		1.550
TANK OUTLET			82.050		1.540
SW5	0.009	2.00	82.050	1200	1.560
COM1			82.050	1200	1.576

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	SW1	SW2	10.334	0.600	81.250	81.145	0.105	98.4	150	2.17	50.0
1.001	SW2	SW3	17.783	0.600	81.145	80.950	0.195	91.2	150	2.45	50.0
1.002	SW3	SW4	14.995	0.600	80.950	80.650	0.300	50.0	150	2.63	50.0
1.003	SW4	TANK INLET	2.534	0.600	80.650	80.550	0.100	25.3	150	2.65	50.0
1.004	TANK INLET	TANK OUTLET	8.000	0.600	80.550	80.510	0.040	200.0	400	2.72	50.0
1.005	TANK OUTLET	SW5	1.530	0.600	80.510	80.490	0.020	76.5	150	2.74	50.0
1.006	SW5	COM1	1.604	0.600	80.490	80.474	0.016	100.0	150	2.77	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)
1.000	1.013	17.9	1.8	0.700	0.805	0.007	0.0	32	0.647
1.001	1.053	18.6	2.5	0.805	1.000	0.010	0.0	37	0.736
1.002	1.426	25.2	4.0	1.000	1.300	0.016	0.0	41	1.051
1.003	2.008	35.5	6.3	1.300	1.400	0.025	0.0	42	1.517
1.004	1.937	3099.8	6.3	1.150	1.140	0.025	0.0	7	0.232
1.005	1.150	20.3	6.3	1.390	1.410	0.025	0.0	57	1.015
1.006	1.005	17.8	8.6	1.410	1.426	0.034	0.0	74	0.996

Simulation Settings

Rainfall Methodology	FSR	Skip Steady State	x
FSR Region	England and Wales	Drain Down Time (mins)	240
M5-60 (mm)	17.000	Additional Storage (m³/ha)	20.0
Ratio-R	0.300	Check Discharge Rate(s)	✓
Summer CV	1.000	1 year (l/s)	1.6
Winter CV	1.000	30 year (l/s)	3.2
Analysis Speed	Detailed	100 year (l/s)	3.9

Simulation Settings

Check Discharge Volume	✓	100 year +40% 360 minute (m³)	109

Storm Durations

15	30	60	120	180	240	360

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	40	0	0
30	40	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.95
Greenfield Method	IH124	Growth Factor 100 year	2.48
Positively Drained Area (ha)	0.239	Betterment (%)	0
SAAR (mm)	1058	QBar	1.9
Soil Index	4	Q 1 year (l/s)	
SPR	0.47	Q 30 year (l/s)	
Region	10	Q 100 year (l/s)	
Growth Factor 1 year	0.85		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	40
Positively Drained Area (ha)	0.239	Storm Duration (mins)	360
Soil Index	4	Betterment (%)	0
SPR	0.47	PR	0.535
CWI	125.145	Runoff Volume (m³)	109

Node SW5 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	80.490	Product Number	CTL-SHE-0054-1000-0450-1000
Design Depth (m)	0.450	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	1.0	Min Node Diameter (mm)	1200

Approval Settings

Node Size	x	Backdrops	x	Return Period (years)	100
Node Losses	x	Full Bore Velocity	x	Discharge Rates	✓
Link Size	x	Proportional Velocity	x	1 year (l/s)	1.0
Link Length	x	Surcharged Depth	x	30 year (l/s)	1.0
Coordinates	x	Flooding	✓	100 year (l/s)	1.0
Crossings	x	Return Period (years)	100	Discharge Volume	✓
Cover Depth	x	Time to Half Empty	✓	100 year +40% 360 minute (m³)	109

Approval Results

The network has been designed for a 1 in 100 year storm using FSR rainfall
It contains 8 nodes (1 outfall) and 7 links
The total impermeable area is 0.034 ha
1 online control has been defined
No additional storage is present
Simulations have been completed using FSR summer and winter storms from 15 to 1440 minute duration

The node size test has not been completed

The node losses test has not been completed

The link size test has not been completed

The link length test has not been completed

The coordinates test has not been completed

The crossings test has not been completed

The cover depth test has not been completed

The backdrops test has not been completed

The full bore velocity test has not been completed

The proportional velocity test has not been completed

The surcharged depth test has not been completed

No nodes flood during the 100 year return period

No infiltrating structures failed to half empty in 1440 minutes during the 100 year return period

No outfalls have a discharge rate greater than 1.0l/s during the 1 year return period

No outfalls have a discharge rate greater than 1.0l/s during the 30 year return period

No outfalls have a discharge rate greater than 1.0l/s during the 100 year return period

No outfalls have a discharge volume greater than 109m³ during the 100 year 360 minute storm

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	SW1	9	81.283	0.033	1.9	0.0433	0.0000	OK
15 minute summer	SW2	9	81.184	0.039	2.7	0.0462	0.0000	OK
15 minute summer	SW3	9	80.991	0.041	4.2	0.0506	0.0000	OK
15 minute summer	SW4	9	80.700	0.050	6.5	0.0630	0.0000	OK
120 minute summer	TANK INLET	78	80.610	0.060	2.5	0.0000	0.0000	OK
120 minute summer	TANK OUTLET	80	80.610	0.100	3.0	0.0000	0.0000	OK
120 minute summer	SW5	78	80.611	0.121	2.7	0.1507	0.0000	OK
15 minute summer	COM1	1	80.474	0.000	1.0	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW1	1.000	SW2	1.9	0.586	0.106	0.0336	
15 minute summer	SW2	1.001	SW3	2.7	0.708	0.142	0.0666	
15 minute summer	SW3	1.002	SW4	4.1	0.924	0.163	0.0679	
15 minute summer	SW4	1.003	TANK INLET	6.5	2.654	0.182	0.0076	
15 minute summer	TANK INLET	1.004	TANK OUTLET	6.1	0.062	0.002	1.8654	
120 minute winter	TANK OUTLET	1.005	SW5	3.3	0.404	0.163	0.0197	
120 minute summer	SW5	Hydro-Brake®	COM1	1.0				6.7

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

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	SW1	9	81.304	0.054	4.6	0.0698	0.0000	OK
15 minute summer	SW2	9	81.208	0.063	6.6	0.0754	0.0000	OK
15 minute summer	SW3	9	81.019	0.069	10.5	0.0852	0.0000	OK
120 minute winter	SW4	114	80.811	0.161	6.1	0.2020	0.0000	SURCHARGED
120 minute winter	TANK INLET	114	80.811	0.261	8.9	0.0000	0.0000	OK
120 minute winter	TANK OUTLET	114	80.811	0.301	6.3	0.0000	0.0000	SURCHARGED
120 minute winter	SW5	114	80.811	0.321	2.3	0.3999	0.0000	SURCHARGED
15 minute summer	COM1	1	80.474	0.000	1.0	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW1	1.000	SW2	4.6	0.724	0.257	0.0657	
15 minute summer	SW2	1.001	SW3	6.6	0.883	0.355	0.1329	
15 minute summer	SW3	1.002	SW4	10.4	1.198	0.413	0.1302	
15 minute summer	SW4	1.003	TANK INLET	16.1	2.796	0.454	0.0286	
15 minute winter	TANK INLET	1.004	TANK OUTLET	10.2	0.083	0.003	5.3130	
15 minute summer	TANK OUTLET	1.005	SW5	-4.6	-0.419	-0.227	0.0269	
480 minute winter	SW5	Hydro-Brake®	COM1	1.0				24.1

Results for 100 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	SW1	9	81.312	0.062	5.9	0.0808	0.0000	OK
15 minute summer	SW2	9	81.218	0.073	8.4	0.0869	0.0000	OK
15 minute summer	SW3	9	81.031	0.081	13.5	0.0997	0.0000	OK
180 minute winter	SW4	164	80.984	0.334	5.8	0.4186	0.0000	SURCHARGED
180 minute winter	TANK INLET	164	80.983	0.433	9.3	0.0000	0.0000	SURCHARGED
180 minute winter	TANK OUTLET	164	80.984	0.474	6.5	0.0000	0.0000	SURCHARGED
180 minute winter	SW5	164	80.983	0.493	2.5	0.6145	0.0000	SURCHARGED
15 minute summer	COM1	1	80.474	0.000	1.0	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW1	1.000	SW2	5.9	0.767	0.330	0.0795	
15 minute summer	SW2	1.001	SW3	8.4	0.927	0.452	0.1612	
15 minute summer	SW3	1.002	SW4	13.4	1.247	0.533	0.1615	
15 minute summer	SW4	1.003	TANK INLET	20.6	2.603	0.579	0.0388	
15 minute summer	TANK INLET	1.004	TANK OUTLET	10.9	0.112	0.004	6.9204	
15 minute summer	TANK OUTLET	1.005	SW5	-6.1	-0.460	-0.300	0.0269	
180 minute winter	SW5	Hydro-Brake®	COM1	1.0				24.3

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	40	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	17.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.300	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	x
Time of Entry (mins)	2.00	Enforce best practice design rules	x

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Depth (m)
SW5	0.009	2.00	85.000	1200	0.950
SW6	0.006	2.00	85.000	1200	1.010
SW7	0.020	2.00	86.000	1200	2.170
TANK 2 INLET			86.200		2.620
TANK 2 OUTLET			86.225		2.673
SW8	0.035	2.00	86.225	1200	2.698
SW9			86.000	1200	2.536
SW10	0.014	2.00	83.800	1200	0.700
SW11	0.014	2.00	83.800	1200	0.811
SW12	0.014	2.00	83.800	1200	0.800
SW13	0.014	2.00	83.800	1200	1.550
SW14			83.800	1200	1.800
TANK 3 INLET			83.800		1.900
TANK 3 OUTLET			83.800		1.930
SW15			83.800	1200	1.945
SW16			83.800	1200	1.965
SW17			82.600	1200	1.150
COM2			82.100	1200	1.760

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)
2.000	SW5	SW6	5.808	0.600	84.050	83.990	0.060	96.8	150	2.09	50.0
2.001	SW6	SW7	16.005	0.600	83.990	83.830	0.160	100.0	150	2.36	50.0
2.002	SW7	TANK 2 INLET	24.853	0.600	83.830	83.580	0.250	99.4	150	2.77	50.0
2.003	TANK 2 INLET	TANK 2 OUTLET	5.500	0.600	83.580	83.552	0.028	200.0	1200	2.80	50.0
2.004	TANK 2 OUTLET	SW8	2.500	0.600	83.552	83.527	0.025	100.0	150	2.84	50.0
2.005	SW8	SW9	6.278	0.600	83.527	83.464	0.063	100.0	150	2.94	50.0
2.006	SW9	SW16	7.139	0.600	83.464	81.835	1.629	4.4	150	2.97	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)
2.000	1.021	18.0	2.3	0.800	0.860	0.009	0.0	36	0.701
2.001	1.004	17.7	3.8	0.860	2.020	0.015	0.0	47	0.802
2.002	1.008	17.8	8.9	2.020	2.470	0.035	0.0	75	1.006
2.003	3.439	16505.4	8.9	1.420	1.473	0.035	0.0	8	0.255
2.004	1.005	17.8	8.9	2.523	2.548	0.035	0.0	75	1.003
2.005	1.005	17.8	17.7	2.548	2.386	0.070	0.0	123	1.142
2.006	4.847	85.7	17.7	2.386	1.815	0.070	0.0	46	3.827

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)
3.000	SW10	SW11	11.132	0.600	83.100	82.989	0.111	100.0	150	2.18	50.0
3.001	SW11	SW13	13.204	0.600	82.989	82.250	0.739	17.9	150	2.28	50.0
4.000	SW12	SW13	9.808	0.600	83.000	82.250	0.750	13.1	150	2.06	50.0
3.002	SW13	SW14	2.879	0.600	82.250	82.000	0.250	11.5	150	2.29	50.0
3.003	SW14	TANK 3 INLET	1.438	0.600	82.000	81.900	0.100	14.4	150	2.30	50.0
3.004	TANK 3 INLET	TANK 3 OUTLET	6.000	0.600	81.900	81.870	0.030	200.0	800	2.34	50.0
3.005	TANK 3 OUTLET	SW15	1.500	0.600	81.870	81.855	0.015	100.0	150	2.36	50.0
3.006	SW15	SW16	1.975	0.600	81.855	81.835	0.020	98.8	150	2.39	50.0
2.007	SW16	SW17	19.648	0.600	81.835	81.450	0.385	51.0	150	3.20	50.0
2.008	SW17	COM2	10.239	0.600	81.450	80.340	1.110	9.2	150	3.25	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)
3.000	1.005	17.8	3.5	0.550	0.661	0.014	0.0	45	0.786
3.001	2.394	42.3	7.1	0.661	1.400	0.028	0.0	41	1.781
4.000	2.800	49.5	3.5	0.650	1.400	0.014	0.0	27	1.635
3.002	2.985	52.8	14.2	1.400	1.650	0.056	0.0	53	2.539
3.003	2.670	47.2	14.2	1.650	1.750	0.056	0.0	57	2.345
3.004	2.818	9018.0	14.2	1.100	1.130	0.056	0.0	11	0.313
3.005	1.005	17.8	14.2	1.780	1.795	0.056	0.0	102	1.114
3.006	1.011	17.9	14.2	1.795	1.815	0.056	0.0	101	1.120
2.007	1.411	24.9	31.9	1.815	1.000	0.126	0.0	150	1.438
2.008	3.337	59.0	31.9	1.000	1.610	0.126	0.0	79	3.404

Simulation Settings

Rainfall Methodology	FSR	Drain Down Time (mins)	240
FSR Region	England and Wales	Additional Storage (m³/ha)	20.0
M5-60 (mm)	17.000	Check Discharge Rate(s)	✓
Ratio-R	0.300	1 year (l/s)	1.6
Summer CV	1.000	30 year (l/s)	3.2
Winter CV	1.000	100 year (l/s)	3.9
Analysis Speed	Detailed	Check Discharge Volume	✓
Skip Steady State	x	100 year +40% 360 minute (m³)	109

Storm Durations

15	30	60	120	180	240	360

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	40	0	0
30	40	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Region	10
Greenfield Method	IH124	Growth Factor 1 year	0.85
Positively Drained Area (ha)	0.239	Growth Factor 30 year	1.95
SAAR (mm)	1058	Growth Factor 100 year	2.48
Soil Index	4	Betterment (%)	0
SPR	0.47	QBar	1.9

Pre-development Discharge Rate

Q 1 year (l/s)	Q 100 year (l/s)
Q 30 year (l/s)	

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	40
Positively Drained Area (ha)	0.239	Storm Duration (mins)	360
Soil Index	4	Betterment (%)	0
SPR	0.47	PR	0.535
CWI	125.145	Runoff Volume (m^3)	109

Node SW8 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	83.527	Product Number	CTL-SHE-0066-2100-1200-2100
Design Depth (m)	1.200	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.1	Min Node Diameter (mm)	1200

Node SW15 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	81.855	Product Number	CTL-SHE-0068-1900-0800-1900
Design Depth (m)	0.800	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	1.9	Min Node Diameter (mm)	1200

Approval Settings

Node Size	x	Backdrops	x	Return Period (years)	100
Node Losses	x	Full Bore Velocity	x	Discharge Rates	✓
Link Size	x	Proportional Velocity	x	1 year (l/s)	4.0
Link Length	x	Surcharged Depth	x	30 year (l/s)	4.0
Coordinates	x	Flooding	✓	100 year (l/s)	4.0
Crossings	x	Return Period (years)	100	Discharge Volume	✓
Cover Depth	x	Time to Half Empty	✓	100 year +40% 360 minute (m^3)	109

Approval Results

The network has been designed for a 1 in 100 year storm using FSR rainfall
It contains 18 nodes (1 outfall) and 17 links
The total impermeable area is 0.126 ha
2 online controls have been defined
No additional storage is present
Simulations have been completed using FSR summer and winter storms from 15 to 1440 minute duration

The node size test has not been completed

The node losses test has not been completed

The link size test has not been completed

The link length test has not been completed

The coordinates test has not been completed

The crossings test has not been completed

The cover depth test has not been completed

The backdrops test has not been completed

The full bore velocity test has not been completed

The proportional velocity test has not been completed

The surcharged depth test has not been completed

No nodes flood during the 100 year return period

No infiltrating structures failed to half empty in 1440 minutes during the 100 year return period

No outfalls have a discharge rate greater than 4.0l/s during the 1 year return period

No outfalls have a discharge rate greater than 4.0l/s during the 30 year return period

No outfalls have a discharge rate greater than 4.0l/s during the 100 year return period

No outfalls have a discharge volume greater than 109m³ during the 100 year 360 minute storm

Results for 1 year +40% CC Critical Storm Duration. Lowest mass balance: 99.30%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	SW5	9	84.089	0.039	2.4	0.0515	0.0000	OK
15 minute summer	SW6	9	84.038	0.048	4.0	0.0600	0.0000	OK
15 minute summer	SW7	9	83.909	0.079	9.4	0.1042	0.0000	OK
120 minute summer	TANK 2 INLET	80	83.793	0.213	3.6	0.0000	0.0000	OK
120 minute summer	TANK 2 OUTLET	80	83.793	0.241	2.7	0.0000	0.0000	SURCHARGED
120 minute summer	SW8	80	83.792	0.265	3.6	0.3689	0.0000	SURCHARGED
120 minute summer	SW9	80	83.479	0.015	1.9	0.0174	0.0000	OK
15 minute summer	SW10	9	83.149	0.049	3.8	0.0756	0.0000	OK
15 minute summer	SW11	9	83.032	0.043	7.6	0.0636	0.0000	OK
15 minute summer	SW12	9	83.028	0.028	3.8	0.0417	0.0000	OK
15 minute summer	SW13	9	82.314	0.064	15.2	0.0843	0.0000	OK
15 minute summer	SW14	9	82.069	0.069	15.2	0.0775	0.0000	OK
60 minute summer	TANK 3 INLET	44	82.056	0.156	8.8	0.0000	0.0000	OK
60 minute summer	TANK 3 OUTLET	43	82.056	0.186	13.2	0.0000	0.0000	SURCHARGED
60 minute summer	SW15	45	82.057	0.202	3.2	0.2286	0.0000	SURCHARGED
120 minute summer	SW16	78	81.878	0.043	3.7	0.0484	0.0000	OK
60 minute summer	SW17	43	81.476	0.026	3.7	0.0298	0.0000	OK
60 minute summer	COM2	43	80.366	0.026	3.7	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW5	2.000	SW6	2.4	0.566	0.133	0.0246	
15 minute summer	SW6	2.001	SW7	4.0	0.557	0.223	0.1144	
15 minute summer	SW7	2.002	TANK 2 INLET	9.5	1.265	0.531	0.2653	
15 minute summer	TANK 2 INLET	2.003	TANK 2 OUTLET	6.5	0.044	0.000	3.5578	
15 minute summer	TANK 2 OUTLET	2.004	SW8	-7.1	-0.584	-0.403	0.0440	
120 minute summer	SW8	Hydro-Brake®	SW9	1.9				
120 minute summer	SW9	2.006	SW16	1.9	1.169	0.022	0.0181	
15 minute summer	SW10	3.000	SW11	3.8	0.825	0.214	0.0513	
15 minute summer	SW11	3.001	SW13	7.6	1.342	0.179	0.0751	
15 minute summer	SW12	4.000	SW13	3.8	0.858	0.077	0.0465	
15 minute summer	SW13	3.002	SW14	15.2	2.019	0.288	0.0217	
15 minute summer	SW14	3.003	TANK 3 INLET	15.2	2.911	0.321	0.0124	
60 minute summer	TANK 3 INLET	3.004	TANK 3 OUTLET	13.2	0.059	0.001	4.0972	
60 minute winter	TANK 3 OUTLET	3.005	SW15	3.2	0.424	0.180	0.0264	
60 minute summer	SW15	Hydro-Brake®	SW16	1.9				
120 minute summer	SW16	2.007	SW17	3.7	1.222	0.150	0.0610	
60 minute summer	SW17	2.008	COM2	3.7	1.838	0.063	0.0208	18.8

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 99.30%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute winter	SW5	112	84.329	0.279	1.5	0.3679	0.0000	SURCHARGED
120 minute winter	SW6	112	84.329	0.339	2.5	0.4234	0.0000	SURCHARGED
120 minute winter	SW7	112	84.329	0.499	5.8	0.6558	0.0000	SURCHARGED
120 minute winter	TANK 2 INLET	114	84.328	0.748	5.5	0.0000	0.0000	OK
120 minute winter	TANK 2 OUTLET	114	84.328	0.776	5.0	0.0000	0.0000	SURCHARGED
120 minute winter	SW8	114	84.328	0.801	5.7	1.1136	0.0000	SURCHARGED
30 minute winter	SW9	127	83.479	0.015	1.9	0.0174	0.0000	OK
15 minute summer	SW10	9	83.182	0.082	9.2	0.1250	0.0000	OK
15 minute summer	SW11	9	83.058	0.069	18.4	0.1022	0.0000	OK
15 minute summer	SW12	9	83.044	0.044	9.2	0.0650	0.0000	OK
180 minute summer	SW13	132	82.455	0.205	10.7	0.2687	0.0000	SURCHARGED
180 minute summer	SW14	132	82.454	0.454	10.7	0.5139	0.0000	SURCHARGED
180 minute summer	TANK 3 INLET	132	82.454	0.554	10.7	0.0000	0.0000	OK
180 minute summer	TANK 3 OUTLET	132	82.454	0.584	7.8	0.0000	0.0000	SURCHARGED
180 minute summer	SW15	132	82.454	0.599	2.4	0.6773	0.0000	SURCHARGED
360 minute summer	SW16	176	81.878	0.043	3.8	0.0486	0.0000	OK
360 minute summer	SW17	176	81.476	0.026	3.8	0.0299	0.0000	OK
360 minute summer	COM2	176	80.366	0.026	3.8	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW5	2.000	SW6	6.1	0.699	0.339	0.0715	
15 minute summer	SW6	2.001	SW7	8.3	0.657	0.468	0.2729	
15 minute summer	SW7	2.002	TANK 2 INLET	17.7	1.377	0.996	0.4375	
15 minute summer	TANK 2 INLET	2.003	TANK 2 OUTLET	9.4	0.046	0.001	10.0302	
15 minute summer	TANK 2 OUTLET	2.004	SW8	-19.0	-1.077	-1.068	0.0440	
30 minute winter	SW8	Hydro-Brake®	SW9	1.9				
30 minute winter	SW9	2.006	SW16	1.9	1.192	0.022	0.0182	
15 minute summer	SW10	3.000	SW11	9.2	1.037	0.518	0.0987	
15 minute summer	SW11	3.001	SW13	18.4	1.528	0.435	0.1620	
15 minute summer	SW12	4.000	SW13	9.2	0.961	0.186	0.1024	
15 minute summer	SW13	3.002	SW14	35.9	2.239	0.680	0.0492	
15 minute summer	SW14	3.003	TANK 3 INLET	34.5	3.087	0.731	0.0253	
15 minute summer	TANK 3 INLET	3.004	TANK 3 OUTLET	16.7	0.130	0.002	8.4908	
15 minute summer	TANK 3 OUTLET	3.005	SW15	4.0	0.525	0.225	0.0264	
15 minute summer	SW15	Hydro-Brake®	SW16	1.9				
360 minute summer	SW16	2.007	SW17	3.8	1.224	0.151	0.0614	
360 minute summer	SW17	2.008	COM2	3.8	1.842	0.064	0.0210	83.3

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.30%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	SW5	164	84.661	0.611	1.5	0.8060	0.0000	SURCHARGED
180 minute winter	SW6	164	84.661	0.671	2.3	0.8382	0.0000	SURCHARGED
180 minute winter	SW7	164	84.660	0.830	5.3	1.0920	0.0000	SURCHARGED
180 minute winter	TANK 2 INLET	164	84.659	1.079	4.6	0.0000	0.0000	OK
180 minute winter	TANK 2 OUTLET	164	84.659	1.107	4.6	0.0000	0.0000	SURCHARGED
180 minute winter	SW8	164	84.659	1.132	5.7	1.5738	0.0000	SURCHARGED
180 minute winter	SW9	164	83.480	0.016	2.0	0.0181	0.0000	OK
15 minute summer	SW10	9	83.196	0.096	11.8	0.1469	0.0000	OK
15 minute summer	SW11	9	83.074	0.085	23.6	0.1254	0.0000	OK
15 minute summer	SW12	9	83.050	0.050	11.8	0.0739	0.0000	OK
180 minute winter	SW13	144	82.691	0.441	9.2	0.5791	0.0000	SURCHARGED
180 minute winter	SW14	144	82.691	0.691	8.8	0.7812	0.0000	SURCHARGED
180 minute winter	TANK 3 INLET	144	82.690	0.790	12.9	0.0000	0.0000	OK
180 minute winter	TANK 3 OUTLET	144	82.690	0.820	8.5	0.0000	0.0000	SURCHARGED
180 minute winter	SW15	144	82.690	0.835	2.5	0.9444	0.0000	SURCHARGED
180 minute winter	SW16	148	81.879	0.044	4.0	0.0499	0.0000	OK
180 minute winter	SW17	148	81.477	0.027	4.0	0.0306	0.0000	OK
180 minute winter	COM2	148	80.366	0.026	4.0	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW5	2.000	SW6	7.0	0.725	0.388	0.1022	
15 minute summer	SW6	2.001	SW7	9.3	0.629	0.527	0.2818	
15 minute summer	SW7	2.002	TANK 2 INLET	18.9	1.342	1.062	0.4375	
15 minute summer	TANK 2 INLET	2.003	TANK 2 OUTLET	-11.7	0.046	-0.001	12.9643	
15 minute summer	TANK 2 OUTLET	2.004	SW8	-25.2	-1.430	-1.418	0.0440	
180 minute winter	SW8	Hydro-Brake®	SW9	2.0				
180 minute winter	SW9	2.006	SW16	2.0	1.083	0.024	0.0190	
15 minute summer	SW10	3.000	SW11	11.8	1.062	0.664	0.1235	
15 minute summer	SW11	3.001	SW13	23.1	1.492	0.545	0.1842	
15 minute summer	SW12	4.000	SW13	11.8	0.948	0.238	0.1115	
15 minute summer	SW13	3.002	SW14	42.2	2.396	0.799	0.0507	
15 minute summer	SW14	3.003	TANK 3 INLET	40.2	3.263	0.851	0.0253	
15 minute summer	TANK 3 INLET	3.004	TANK 3 OUTLET	24.1	0.120	0.003	11.0058	
15 minute winter	TANK 3 OUTLET	3.005	SW15	4.8	0.560	0.268	0.0264	
180 minute winter	SW15	Hydro-Brake®	SW16	1.9				
180 minute winter	SW16	2.007	SW17	4.0	1.241	0.159	0.0636	
180 minute winter	SW17	2.008	COM2	4.0	1.868	0.067	0.0217	88.4