Tween Bridge Solar Farm

Environmental Statement
Appendix 10.1: Flood Risk Assessment
Part 3

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

APFP Regulation 5(2)(e)

Document Reference: 6.3.10.1

May 2026

Revision ~~23~~

Appendix M – Outline Surface Water Drainage Strategy Calculations

Greenfield runoff rate estimation tool

www.uksuds.com | Greenfield runoff rate estimation tool (https://www.uksuds.com/)

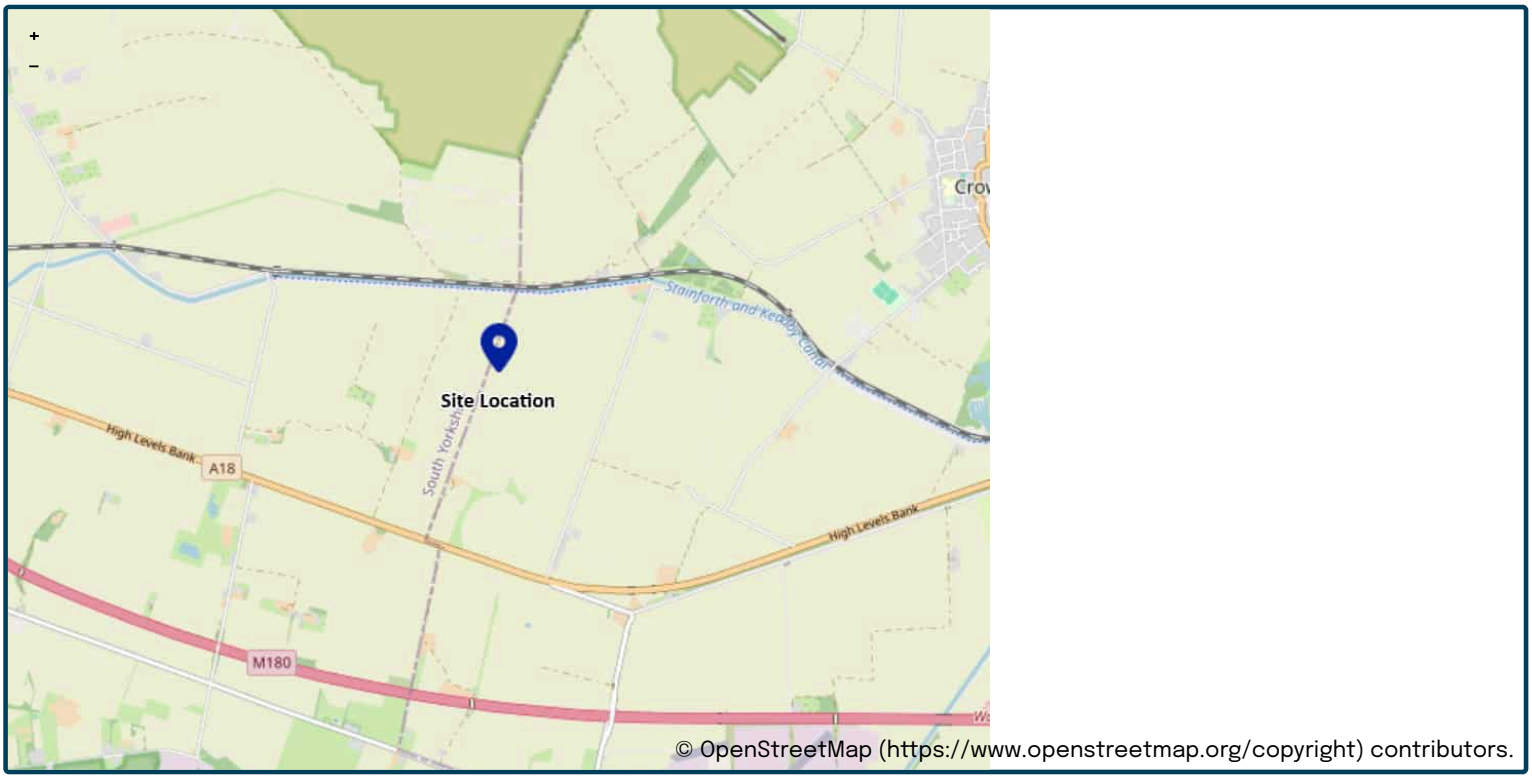
This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance “Rainfall runoff management for developments”, SC030219 (2013), the SuDS Manual C753 (CIRIA, 2015) and the non-statutory standards for SuDS (Defra, 2015).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

Project details

Date	11/06/2025
Calculated by	OM
Reference	P21-3484
Model version	2.0.1

Location

Site name	TWEEN BRIDGE
Site location	THORNE, SOUTH YORKSHIRE



Site easting	473603
Site northing	411330

Site details

Total site area (ha)	1 ha

Greenfield runoff

Method

Method	FEH statistical

FEH statistical

	My value		Map value
SAAR (mm)	579 mm		579
BFIHOST	0.439		
QMed-QBar conversion	1.124		1.124
QMed (l/s)	2 l/s		
QBar (FEH statistical) (l/s)	2.2 l/s		

Growth curve factors

	My value		Map value
Hydrological region	4		4
1 year growth factor	0.83		
2 year growth factor	0.89		
10 year growth factor	1.49		
30 year growth factor	2		
100 year growth factor	2.57		
200 year growth factor	3.04		

Results

Method	FEH statistical
Flow rate 1 year (l/s)	1.9 l/s
Flow rate 2 year (l/s)	2 l/s
Flow rate 10 years (l/s)	3.4 l/s
Flow rate 30 years (l/s)	4.5 l/s
Flow rate 100 years (l/s)	5.8 l/s
Flow rate 200 years (l/s)	6.8 l/s

Disclaimer

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 4339 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.206	0.706	0.0	6.5	6.5	1234.9	O K
30 min Summer	99.439	0.939	0.0	6.5	6.5	1641.8	O K
60 min Summer	99.550	1.050	0.0	6.5	6.5	2064.4	O K
120 min Summer	99.596	1.096	0.0	6.5	6.5	2407.8	O K
180 min Summer	99.620	1.120	0.0	6.5	6.5	2587.8	O K
240 min Summer	99.636	1.136	0.0	6.5	6.5	2707.8	O K
360 min Summer	99.657	1.157	0.0	6.5	6.5	2866.9	O K
480 min Summer	99.671	1.171	0.0	6.5	6.5	2964.2	O K
600 min Summer	99.679	1.179	0.0	6.5	6.5	3029.4	O K
720 min Summer	99.685	1.185	0.0	6.5	6.5	3074.9	O K
960 min Summer	99.693	1.193	0.0	6.5	6.5	3130.0	O K
1440 min Summer	99.698	1.198	0.0	6.5	6.5	3169.4	O K
2160 min Summer	99.695	1.195	0.0	6.5	6.5	3148.1	O K
2880 min Summer	99.687	1.187	0.0	6.5	6.5	3084.2	O K
4320 min Summer	99.666	1.166	0.0	6.5	6.5	2932.8	O K
5760 min Summer	99.652	1.152	0.0	6.5	6.5	2824.2	O K
7200 min Summer	99.642	1.142	0.0	6.5	6.5	2755.0	O K
8640 min Summer	99.636	1.136	0.0	6.5	6.5	2704.6	O K
10080 min Summer	99.630	1.130	0.0	6.5	6.5	2662.6	O K
15 min Winter	99.206	0.706	0.0	6.5	6.5	1234.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	155.749	0.0	512.0	19
30 min Summer	101.899	0.0	473.9	34
60 min Summer	63.594	0.0	989.0	64
120 min Summer	37.131	0.0	1032.4	124
180 min Summer	26.722	0.0	1050.4	184
240 min Summer	21.079	0.0	1057.6	244
360 min Summer	15.049	0.0	1063.2	364
480 min Summer	11.807	0.0	1064.6	484
600 min Summer	9.769	0.0	1064.2	604
720 min Summer	8.363	0.0	1062.8	722
960 min Summer	6.539	0.0	1057.5	962
1440 min Summer	4.630	0.0	1042.5	1442
2160 min Summer	3.291	0.0	2087.8	2160
2880 min Summer	2.594	0.0	2063.5	2880
4320 min Summer	1.870	0.0	1993.0	3716
5760 min Summer	1.495	0.0	3958.9	4440
7200 min Summer	1.265	0.0	3835.5	5192
8640 min Summer	1.109	0.0	3732.2	6048
10080 min Summer	0.994	0.0	3615.6	6864
15 min Winter	155.749	0.0	512.0	19

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	99.439	0.939	0.0	6.5	6.5	1641.8	O K
60 min Winter	99.550	1.050	0.0	6.5	6.5	2064.4	O K
120 min Winter	99.596	1.096	0.0	6.5	6.5	2408.3	O K
180 min Winter	99.620	1.120	0.0	6.5	6.5	2589.1	O K
240 min Winter	99.636	1.136	0.0	6.5	6.5	2709.3	O K
360 min Winter	99.658	1.158	0.0	6.5	6.5	2869.7	O K
480 min Winter	99.671	1.171	0.0	6.5	6.5	2968.0	O K
600 min Winter	99.680	1.180	0.0	6.5	6.5	3034.1	O K
720 min Winter	99.686	1.186	0.0	6.5	6.5	3081.2	O K
960 min Winter	99.694	1.194	0.0	6.5	6.5	3138.0	O K
1440 min Winter	99.700	1.200	0.0	6.5	6.5	3183.6	Flood Risk
2160 min Winter	99.699	1.199	0.0	6.5	6.5	3172.5	O K
2880 min Winter	99.691	1.191	0.0	6.5	6.5	3119.9	O K
4320 min Winter	99.671	1.171	0.0	6.5	6.5	2968.3	O K
5760 min Winter	99.653	1.153	0.0	6.5	6.5	2829.7	O K
7200 min Winter	99.640	1.140	0.0	6.5	6.5	2734.6	O K
8640 min Winter	99.628	1.128	0.0	6.5	6.5	2648.9	O K
10080 min Winter	99.618	1.118	0.0	6.5	6.5	2571.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	101.899	0.0	474.0	34
60 min Winter	63.594	0.0	989.0	64
120 min Winter	37.131	0.0	1032.0	122
180 min Winter	26.722	0.0	1049.7	182
240 min Winter	21.079	0.0	1056.7	242
360 min Winter	15.049	0.0	1061.5	360
480 min Winter	11.807	0.0	1062.3	478
600 min Winter	9.769	0.0	1061.5	596
720 min Winter	8.363	0.0	1059.1	714
960 min Winter	6.539	0.0	1052.8	950
1440 min Winter	4.630	0.0	1035.0	1414
2160 min Winter	3.291	0.0	2077.3	2100
2880 min Winter	2.594	0.0	2050.6	2768
4320 min Winter	1.870	0.0	1980.2	4020
5760 min Winter	1.495	0.0	3953.2	4560
7200 min Winter	1.265	0.0	3843.0	5480
8640 min Winter	1.109	0.0	3753.4	6400
10080 min Winter	0.994	0.0	3652.6	7360

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 473565 411325 SE 73565 11325
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	1.000
Cv (Winter)	1.000
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 3.430

Time (mins) From:	To:	Area (ha)
0	4	3.430

Model Details

Storage is Online Cover Level (m) 100.000

Complex Structure

Cellular Storage

Invert Level (m)	98.500	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	1840.0	0.0	1.500	1840.0	0.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	100.0
Membrane Percolation (mm/hr)	1000	Length (m)	190.0
Max Percolation (l/s)	5277.8	Slope (1:X)	10000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.500	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0115-6500-1300-6500
Design Head (m)	1.300
Design Flow (l/s)	6.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	115
Invert Level (m)	98.400
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.300	6.5
Flush-Flo™	0.384	6.5
Kick-Flo®	0.806	5.2
Mean Flow over Head Range	-	5.7

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.0	1.200	6.3	3.000	9.6	7.000	14.4
0.200	6.0	1.400	6.7	3.500	10.3	7.500	14.9
0.300	6.4	1.600	7.2	4.000	11.0	8.000	15.3
0.400	6.5	1.800	7.6	4.500	11.7	8.500	15.8
0.500	6.4	2.000	7.9	5.000	12.3	9.000	16.2
0.600	6.2	2.200	8.3	5.500	12.8	9.500	16.7
0.800	5.3	2.400	8.7	6.000	13.4		
1.000	5.7	2.600	9.0	6.500	13.9		

Nodes

Name	T of E (mins)	Cover Level (m)	Depth (m)
BESS Permeable Gravel Subbase	5.00	100.300	0.300
Crate Storage		100.300	1.200

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	BESS Permeable Gravel Subbase	Crate Storage	64.122	0.600	100.000	99.100	0.900	71.2	300	5.57	51.9

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	1.865	131.8	0.0	0.000	0.900	0.000	0.0	0	0.000

Simulation Settings

Rainfall Methodology	FEH-22	Winter CV	1.000	Drain Down Time (mins)	1440	Check Discharge Rate(s)	x
Rainfall Events	Singular	Analysis Speed	Normal	Additional Storage (m³/ha)	20.0	Check Discharge Volume	x
Summer CV	1.000	Skip Steady State	x	Starting Level (m)			

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0	100	0	0	0
2	0	0	0	100	40	0	0
30	0	0	0				

Node BESS Permeable Gravel Subbase Time-Area Diagram

Overrides Design Area	✓	Depression Storage Area (m²)	0	Evapo-transpiration (mm/day)	0
Overrides Design Additional Inflow	x	Depression Storage Depth (mm)	0		

Applies to All storms

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-15	0.461	15-30	0.461	30-45	0.461	45-60	0.461

Node Crate Storage Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	99.100	Product Number	CTL-SHE-0086-3500-1200-3500
Design Depth (m)	1.200	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	3.5	Min Node Diameter (mm)	1200

Node BESS Permeable Gravel Subbase Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	106.379	Depth (m)	0.300
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	100.000	Length (m)	106.379	Inf Depth (m)	0.300
Safety Factor	2.0	Time to half empty (mins)		Slope (1:X)	1000.0		

Node Crate Storage Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	99.100
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	855.0	855.0	1.200	855.0	979.4	1.201	0.0	979.4

Results for 1 year Critical Storm Duration. Lowest mass balance: 99.77%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	BESS Permeable Gravel Subbase	184	100.091	0.091	47.4	144.2626	0.0000	OK
960 minute summer	Crate Storage	930	99.449	0.349	19.4	283.7303	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)
240 minute summer	BESS Permeable Gravel Subbase	1.000	Crate Storage	26.9	1.713	0.204	2.2357	
960 minute summer	Crate Storage	Hydro-Brake®		3.5				375.9

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.77%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute summer	BESS Permeable Gravel Subbase	152	100.107	0.107	67.6	196.1573	0.0000	OK
960 minute summer	Crate Storage	1005	99.586	0.486	25.0	394.9225	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)
180 minute summer	BESS Permeable Gravel Subbase	1.000	Crate Storage	36.6	1.895	0.278	2.6417	
960 minute summer	Crate Storage	Hydro-Brake®		3.5				417.6

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.77%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute summer	BESS Permeable Gravel Subbase	122	100.181	0.181	169.0	454.4741	0.0000	OK
1440 minute winter	Crate Storage	1440	100.096	0.995	31.3	808.5729	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
120 minute summer	BESS Permeable Gravel Subbase	1.000	Crate Storage	90.8	2.296	0.689	3.6541	
1440 minute winter	Crate Storage	Hydro-Brake®		3.5				483.7

Results for 100 year Critical Storm Duration. Lowest mass balance: 99.77%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute summer	BESS Permeable Gravel Subbase	122	100.214	0.214	215.7	572.5891	0.0000	OK
1440 minute winter	Crate Storage	1440	100.161	1.061	39.0	861.7158	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
120 minute summer	BESS Permeable Gravel Subbase	1.000	Crate Storage	115.5	2.384	0.876	3.9847	
1440 minute winter	Crate Storage	Hydro-Brake®		3.5				504.3

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.77%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
2160 minute winter	BESS Permeable Gravel Subbase	2160	100.299	0.299	42.8	870.5765	0.0000	OK
2160 minute winter	Crate Storage	2160	100.299	1.199	37.7	973.5612	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)
2160 minute winter	BESS Permeable Gravel Subbase	1.000	Crate Storage	37.7	1.218	0.286	4.5133	
2160 minute winter	Crate Storage	Hydro-Brake®		3.5				665.7

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Depth (m)
Single TX Substation Permeable Gravel Subbase	0.173	5.00	100.300	0.300
Crate Storage	0.059	5.00	100.300	0.800

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	Single TX Substation Permeable Gravel Subbase	Crate Storage	19.988	0.600	100.000	99.500	0.500	40.0	300	5.13	53.5

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	2.494	176.3	33.5	0.000	0.500	0.173	0.0	88	1.934

Simulation Settings

Rainfall Methodology	FEH-22	Winter CV	1.000	Drain Down Time (mins)	2880	Check Discharge Rate(s)	x
Rainfall Events	Singular	Analysis Speed	Normal	Additional Storage (m³/ha)	20.0	Check Discharge Volume	x
Summer CV	1.000	Skip Steady State	x	Starting Level (m)			

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0	100	0	0	0
2	0	0	0	100	40	0	0
30	0	0	0				

Node Single TX Substation Permeable Gravel Subbase Time-Area Diagram

Overrides Design Area	✓	Depression Storage Area (m²)	0	Evapo-transpiration (mm/day)	0
Overrides Design Additional Inflow	x	Depression Storage Depth (mm)	0		
		Applies to All storms			

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-15	0.043	15-30	0.043	30-45	0.043	45-60	0.043

Node Crate Storage Time-Area Diagram

Overrides Design Area	✓	Depression Storage Area (m²)	0	Evapo-transpiration (mm/day)	0
Overrides Design Additional Inflow	x	Depression Storage Depth (mm)	0		
		Applies to All storms			

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-15	0.015	15-30	0.015	30-45	0.015	45-60	0.015

Node Crate Storage Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	99.500	Product Number	CTL-SHE-0049-1000-0800-1000
Design Depth (m)	0.800	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	1.0	Min Node Diameter (mm)	1200

Node Single TX Substation Permeable Gravel Subbase Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	40.604	Depth (m)	0.300
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	100.000	Length (m)	40.604	Inf Depth (m)	0.300
Safety Factor	2.0	Time to half empty (mins)		Slope (1:X)	1000.0		

Node Crate Storage Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	99.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	70.0	70.0	0.800	70.0	93.7	0.801	0.0	93.7

Results for 1 year Critical Storm Duration. Lowest mass balance: 99.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute summer	Single TX Substation Permeable Gravel Subbase	140	100.031	0.031	4.5	5.9715	0.0000	OK
480 minute summer	Crate Storage	424	99.871	0.371	4.3	25.2559	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)
180 minute summer	Single TX Substation Permeable Gravel Subbase	1.000	Crate Storage	3.8	0.532	0.022	0.7262	
480 minute summer	Crate Storage	Hydro-Brake®		0.9				44.3

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute summer	Single TX Substation Permeable Gravel Subbase	140	100.036	0.036	6.3	8.2417	0.0000	OK
360 minute winter	Crate Storage	376	100.026	0.526	5.5	35.7700	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)
180 minute summer	Single TX Substation Permeable Gravel Subbase	1.000	Crate Storage	5.4	0.563	0.031	0.7512	
360 minute winter	Crate Storage	Hydro-Brake®		0.9				54.9

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	Single TX Substation Permeable Gravel Subbase	496	100.135	0.135	11.2	58.1201	0.0000	OK
480 minute winter	Crate Storage	496	100.135	0.635	9.0	43.1777	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)
480 minute winter	Single TX Substation Permeable Gravel Subbase	1.000	Crate Storage	6.4	0.563	0.036	1.0106	
480 minute winter	Crate Storage	Hydro-Brake®		0.9				125.1

Results for 100 year Critical Storm Duration. Lowest mass balance: 99.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
600 minute winter	Single TX Substation Permeable Gravel Subbase	615	100.187	0.187	9.8	84.3261	0.0000	OK
600 minute winter	Crate Storage	615	100.187	0.687	8.1	46.6928	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)
600 minute winter	Single TX Substation Permeable Gravel Subbase	1.000	Crate Storage	5.7	0.559	0.032	1.1642	
600 minute winter	Crate Storage	Hydro-Brake®		0.9				161.1

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
600 minute winter	Single TX Substation Permeable Gravel Subbase	615	100.296	0.296	12.8	139.6030	0.0000	OK
600 minute winter	Crate Storage	615	100.296	0.796	8.5	54.1193	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)
600 minute winter	Single TX Substation Permeable Gravel Subbase	1.000	Crate Storage	5.9	0.549	0.033	1.4057	
600 minute winter	Crate Storage	Hydro-Brake®		1.0				187.2

Appendix N – High Level SuDS Operation and Maintenance Manual Revision 2

INDICATIVE DRAINAGE OPERATION & MAINTENANCE MANUAL

Tween Bridge Solar Farm

On behalf of RWE Renewables UK Limited

Date: 19/0~~5~~6/202~~6~~5 | Pegasus Ref: P21-3484 – Author: Lucy Ginn

Document Management

Version	Date	Author	Checked/ Approved by:	Reason for revision
V01	09/12/2024	Samuel Opong	Simon Jacques	First Issue
V02	19/06/2025	Lucy Ginn	Simon Jacques	Updated Following Statutory Consultation. Typical Ditch Fence Maintenance Details Added.
V03	19/05/2026	Lucy Ginn	Rana Alidad	Minor Update

Contents

Figures & Tables

1. INTRODUCTION

1.1. This manual should be read alongside the associated Flood Risk Assessment and Surface Water Drainage Strategy.

1.2. The surface water drainage strategy details presented at this stage are high level in the absence of detailed site layout information to prepare more detailed drainage proposals.

1.3. This manual is intended to give an overview of the operation and maintenance for a wide range of SuDs features that may be proposed on site once the proposed surface water drainage strategy has been confirmed at detailed design post-consent of the DCO application. The guidance relates to typical details only.

1.4. Once the proposed surface water drainage strategy details for the site have been confirmed at detailed design and it has been confirmed who will be responsible for the maintenance of any SuDS on site, this manual must be updated.

1.5. Where proprietary products are specified the manufacturer's instructions and recommendations should be followed in priority to this document unless specifically noted otherwise due to project constraints.

1.6. The recommended operations and frequencies are typical only and should be more frequent initially to ensure that there are no unforeseen issues with the operation and then adjusted to suit the site requirements.

1.7. In addition to the presented typical SuDS operation and maintenance requirements included, indicative measures to maintain fencing across watercourses are also presented.

~~1.7.~~1.8. The Applicant would be responsible for the ongoing implementation of the SuDS maintenance regime, to include contracted management support if appropriate.

2. GEOCELLULAR/MODULAR SYSTEMS

2.1. Modular plastic geocellular systems with a high void ratio, that can be used to create a below ground storage structure.

2.2. The below ground crates are intended to be a surface water storage feature to attenuate the discharge from the site up to and including the 1 in 100 year plus 40% climate change event.

2.3. Regular inspection and maintenance is required to ensure the effective long-term operation of below ground modular storage systems. Maintenance responsibility for systems should be placed with the sites management company.

2.4. Specific maintenance needs of the system should be monitored, and maintenance schedules adjusted to suit requirements.

2.5. Sediment\material removal should be undertaken in consultation with the environmental regulator to confirm appropriate protocols, especially where run-off is taken from potentially contaminated areas such as car parks/service yards.

2.6. Maintenance requirements for modular systems are described in the table below.

Table 2.1 – Geocellular/Modular Systems Maintenance Requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then six monthly
	Debris removal from catchment surface (where may cause risks to performance)	Monthly
	Where rainfall infiltrates into blocks from above, check surface of 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
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

3. PERMEABLE PAVING

3.1. The permeable pavements have/will be designed in accordance with CIRIA C753 and BS7533-13.

3.2. Permeable pavements contain proprietary products and as such where used the manufacture's recommendations should be followed.

3.3. The permeable pavements are intended to be water quality and attenuation storage features. These features are intended to be dry except during rainfall events. The permeable pavements may also be utilised as an infiltration area or soakaway for other areas of the development (where permissible).

3.4. The surface has been designed to be porous or to contain gaps where rain can flow through the upper construction layers into the voided stone which makes up the subbase. Where these features are intended to be used as infiltration devices or soakaways any capping also needs to be permeable to permit the flows to the formation.

3.5. Regular inspection and maintenance is important for the effective operation of the pervious pavement. Maintenance responsibility for the pavement and its surrounding area should be placed with the site's management company.

3.6. Sediment\material removal should be undertaken in consultation with the environmental regulator to confirm appropriate protocols, as run-off is taken from potentially contaminated areas such as car parks/service yards.

Table 3.1 – Permeable Paving Maintenance Requirements

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

4. PIPEWORK & MANHOLES

4.1. Pipes are proprietary products and the materials can vary across the site and as such where used the manufacture's recommendations should be followed. Regardless of the product used the pipes will be fully compliant with the drainage specification.

4.2. Pipes are intended to be the main conveyance across the development and where oversized they form the attenuation volume required by the limitation of the discharge rate. They are intended to be dry except during rainfall events. These have been designed to be self-cleaning where possible for smaller diameter pipes, and for larger diameters the risk is reduced due to the overall pipe size.

4.3. Access for maintenance is provided through access chambers, manholes, rodding plates and rodding eyes.

4.4. Regular inspection and maintenance is important to identify areas which may have been obstructed/clogged and may not be draining correctly thus exposing the development to a greater level of flood risk. Maintenance responsibility for the pipes should be placed with relevant water authority for public sewers and the individual resident ('riparian owner') for private drains, unless adopted as lateral drainage.

4.5. Sediment\material removal should be undertaken in consultation with the environmental regulator to confirm appropriate protocols, as run-off is taken from potentially contaminated areas such as car parks/service yards.

Table 4.1 – Pipework & Manholes Maintenance Requirements

Maintenance Schedule	Required Action	Typical Frequency
Occasional Maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Rod through poorly performing runs as initial remediation.	As required
	If continued poor performance jet and CCTV survey poorly performing runs.	As required
	Seek advice as to remediation techniques suitable for the type of performance issue and location.	As required if above does not improve performance
Monitoring	Initial inspection should be provided as post construction CCTV survey.	Monthly for three months after installation
	Inspect for evidence of poor operation via water level in chambers and if required, take remedial action	Three monthly, 48 hours after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

5. FLOW CONTROL CHAMBER

5.1. Flow control chambers are proprietary products and as such where used the manufacturer's recommendations should be followed. Regardless of the flow control used it will be fully compliant with the drainage specification.

5.2. Flow control chambers are intended to restrict the surface water runoff discharge rate from the site to a designed rate utilising techniques such as an orifice plate, vortex separator or mechanical float control.

5.3. Regular inspection and maintenance are important to identify areas which may have been obstructed/clogged and may not be draining correctly thus exposing the development to a greater level of flood risk. Maintenance responsibility for the flow control chamber should be placed with the relevant water authority if the drainage is to be adopted. If left private, then the management company should seek to consult with the manufacturer and appoint a contractor approved by the relevant water authority.

5.4. Should sediment/material result in a blockage within the outfall of the flow control chamber, a high-level overflow outfall will prevent flooding occurring on site as a result of the blockage.

5.5. Once the storm event has passed it will be necessary to remove the sediment/material to allow the flow control to operate correctly. The bypass penstock valve will discharge blocked water within the chamber to allow for safe entry and maintenance of the flow control chamber.

5.6. Sediment\material removal should be undertaken in consultation with the environmental regulator to confirm appropriate protocols, as run-off is taken from potentially contaminated areas such as car parks/service yards.

Table 5.1 – Flow Control Chamber Maintenance Requirements

Maintenance Schedule	Required Action	Typical Frequency
Occasional Maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Rod through poorly performing runs as initial remediation.	As required
	If continued poor performance jet and CCTV survey poorly performing runs.	As required
	Seek advice as to remediation techniques suitable for the type of performance issue and location.	As required if above does not improve performance
Monitoring	Initial inspection should be provided as post construction CCTV survey.	N/A
	Inspect for evidence of poor operation via water level in chambers and if required, take remedial action	Three monthly, 48 hours after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

6. ATTENUATION BASIN

6.1. The basins will require regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities along with likely machinery requirements and typical annual costs – within the Maintenance Plan. The treatment performance of basins is dependent on the maintenance, and robust management plans will be required to ensure maintenance is carried out in the long term. Different designs will have different operation and maintenance requirements.

6.2. Maintenance of the basins are relatively straightforward for landscape contractors, and typically there should only be a small amount of extra work (if any) required for a basin over and above what is required for standard public open space. Provided that landscape management is already required at site, basin maintenance should have marginal cost implications.

6.3. Adequate access should be provided to the basin areas for inspection and maintenance, including for appropriate equipment and vehicles. Litter and debris removal should be undertaken as part of general landscape maintenance for the site and before any other SuDS management task.

6.4. The major maintenance requirement for a basin is mowing. Mowing should ideally retain grass lengths of 75-100mm across the main treatment surface, to assist in filtering pollutants and retaining sediments and to reduce the risk of flattening during runoff events. However, longer vegetation lengths, where appropriate, are not considered to pose a significant risk to functionality.

6.5. Occasionally sediment will need to be removed (once exceeding 25mm in depth) although this can be minimised by ensuring that upstream areas are stabilised and by incorporating effective pre-treatment devices.

Table 6.1 – Basin Maintenance Requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surface for ponding, compaction, silt accumulation, record areas where water is ponding for >48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions if required	As required or if bare soil is exposed over 10% or more of the basin treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up soil deposits and prevent compaction of the soil surface	As required
	Remove build-up of Sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

7. SWALE

7.1. The swale will require regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities along with likely machinery requirements and typical annual costs – within the Maintenance Plan. The treatment performance of swale is dependent on the maintenance, and robust management plans will be required to ensure maintenance is carried out in the long term. Different designs will have different operation and maintenance requirements.

7.2. Maintenance of the swales are relatively straightforward for landscape contractors, and typically there should only be a small amount of extra work (if any) required for a swale over and above what is required for standard public open space. Provided that landscape management is already required at site, swale maintenance should have marginal cost implications.

7.3. Adequate access should be provided to the swale areas for inspection and maintenance, including for appropriate equipment and vehicles. Litter and debris removal should be undertaken as part of general landscape maintenance for the site and before any other SuDS management task.

7.4. The major maintenance requirement for a swale is mowing. Mowing should ideally retain grass lengths of 75-100mm across the main treatment surface, to assist in filtering pollutants and retaining sediments and to reduce the risk of flattening during runoff events. However, longer vegetation lengths, where appropriate, are not considered to pose a significant risk to functionality.

7.5. Occasionally sediment will need to be removed (once exceeding 25mm in depth) although this can be minimised by ensuring that upstream areas are stabilised and by incorporating effective pre-treatment devices.

Table 7.1 – Swale Maintenance Requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surface for ponding, compaction, silt accumulation, record areas where water is ponding for >48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up soil deposits and prevent compaction of the soil surface	As required
	Remove build-up of Sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

8. RAINWATER HARVESTING

8.1. Any property with an RWH system installed should be provided with appropriate information as to what equipment has been installed, it's purpose, it's operation and maintenance requirements, the actions needed to address any potential failure and the expected performance of the system. Information on the options for external maintenance support should also be provided.

8.2. Most systems require periodic checking and maintenance to ensure trouble-free and reliable operation. There are wide differences in the extent of maintenance required for different systems, and manufacturers' guidelines should always be followed. **Table 8.1** provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive, and some actions may not always be required.

8.3. Maintenance requirements are largely dependant on the runoff source and the runoff use (and thus treatment process provided). This will range from weekly input through to rare intervention. Routine inspection of the filter system at quarterly annual intervals I advised, even if they do not appear to need specific intervention. Pumps need very little attention, but their design life is generally regarded as only being 10 years. Where automatic provision of potable water occurs (if and when rainwater is either not available or the system has failed), it is useful to have sensor warnings relayed in such a manner as o inform the user of the current status of the system.

8.4. RWH systems should be designed so that when there is an absence of rain, or a need to disconnect the system for maintenance or repair, that potable water is safely available for all appliances to avoid inconvenience.

8.5. Tanks should be accessible for internal inspection, and the cover should preferably be lockable.

8.6. The maintenance responsibility for an RWH system is usually with the owner of the property, but any communal systems require the participating community to be informed of the system, as detailed, but also be provided with information of who the organisation is that is maintaining the system and any financial commitments and any legally binding maintenance agreements.

Table 8.1 – Rainwater Harvesting Maintenance Requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspection of the tank for debris and sediment build-up, inlets/outlets/withdrawal devices, overflow areas, pumps, filters.	Annually (and following poor performance)
	Cleaning of tank, inlets, outlets, utters, withdrawal devices and roof drain filters of silts and other debris.	Annually (and following poor performance)
Occasional maintenance	Cleaning and/or replacement of any filters.	Three monthly (or as required)
Remedial actions	Repair of overflow erosion damage or damage to tank.	As required
	Pump repairs.	As required

9. GREEN ROOFS

9.1. Intensive green roofs are likely to require regular inspection and maintenance. Grassed areas may require mowing weekly or fortnightly, plant beds may require weeding on a weekly or fortnightly basis during the growing season, and wildflower meadow may require annual mowing with the cuttings removed. Extensive green roofs should normally only require biannual or annual visits to remove litter, check fire breaks and drains and, in some cases, remove unwanted invasive plants. The most maintenance is generally required during the establishment stage (12 months to 15 months), and this should usually be made the responsibility of the green roof provider. Maintenance contractors with specialist training in green roof care should be used, where possible.

9.2. **Table 9.1** provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive, and some actions may not always be required. Actual requirements will depend on the planting, the desired aesthetic and visual effect and the biodiversity objectives for the system. Maintenance specifications and schedules should therefore be specified for any individual green roofs.

9.3. If mechanical systems are located on the roof, then spill prevention measures should be exercised to ensure that roof runoff is not contaminated. The mechanical system area should be provided with separate drainage.

9.4. All maintenance actions carried out at roof level must be in full compliance with the appropriate health and safety regulations, and particularly those specifically dealing with working at height. Training and guidance information on operating and maintaining the roof should be provided to all property owners and tenants. Safety fastenings will be required for personnel working on the roof.

9.5. Access routes to the roof should be designed and maintained to be safe and efficient, and walkways should always be kept clear of obstructions. Secure points for harness attachments should be provided when access near to the roof edges is required.

9.6. Specific maintenance needs of the green roof should be monitored, and maintenance schedules adjusted to suit requirements.

Table 9.1 – Green Roofs Maintenance Requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure of proper operation, integrity of waterproofing and structural stability.	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources.	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system.	Annually and after severe storms
	Inspect underside of roof for evidence of leakage	Annually and after severe storms
Occasional maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	During establishment (ie year one), replace dead plants as required.	Monthly (but usually responsibility of manufacturer)
	Post establishment, replace dead plants as required (where >5% of coverage)	Annually (in Autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled.	As required
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate.	As required

10. INFILTRATION SYSTEMS – SOAKAWAYS, TRENCHES AND BLANKETS

10.1. The design of soakaways, infiltration trenches and blankets should include monitoring points where the water level in the system can be observed or measured. This can either be via an inspection well or inspection cover (where the attenuation storage space is a void). For larger installations the inspection access should provide clear view of the infiltration surface (even if the storage zone is filled). For small, filled soakaways, a 50mm perforated pipe is adequate.

10.2. The useful life and effective operation of an infiltration component is related to the frequency of maintenance and the risk of sediment being introduced into the system.

10.3. An easement should be considered where multiple properties discharge to a single soakaway, to ensure long-term access for maintenance purposes.

10.4. Maintenance will usually be carried out manually, although a suction tanker can be used for sediment/debris removal for large systems. If maintenance is not undertaken for long periods, deposits can become hard-packed and require considerable effort to remove.

10.5. Replacement of the aggregate or geocellular units will be necessary if the system becomes blocked with silt. Effective monitoring will give information on changes in infiltration rate and provide a warning of potential failure in the long term.

10.6. Roads and/or parking areas drainage to infiltration components should be regularly swept to prevent silt being washed off the surface. This will minimise the need for maintenance.

10.7. Maintenance responsibility should be placed with an appropriate organisation, and maintenance schedules should be developed during the design phase.

Table 10.1 – Infiltration systems – Soakaways, Trenches, and blankets maintenance requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	Annually
	Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
	Trimming any roots that may be causing blockages	Annually (or as required based on inspections)
Occasional maintenance	Remove sediment and debris from pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings.	As required
Remedial actions	Reconstruct soakaway and/or replace or clean void fill, if performance deteriorates or failure occurs	As required
	Replacement of clogged geotextile (will require reconstruction of soakaway)	As required
Monitoring	Inspect silt traps and note rate of sediment accumulation.	Monthly in the first year and then annually
	Check soakaway to ensure emptying is occurring	Annually

11. INFILTRATION SYSTEMS – BASINS

11.1. Regular inspection and maintenance is important for the effective operation of infiltration basins as designed. Maintenance responsibility for an infiltration basin and its surrounding area should be placed with a responsible organisation.

11.2. Regular mowing in and around infiltration basins is only required along maintenance access routes, amenity areas (e.g. footpaths), across embankments and across the main storage area. The remaining areas can be managed as "meadow" or other appropriate vegetation unless additional management is required for landscaping purposes. Grass cutting may need to accommodate specific sward mixes and specialist seed or turf supplier recommendations. As described earlier in this chapter, deep-rooting vegetation can maintain infiltration rates and minimise the need for remedial maintenance. All vegetation management activities should take account of the need to maximise biosecurity and prevent the spread of invasive species.

Table 11.1 – Infiltration Systems – Basins

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter, deris and trash	Monthly
	Cut grass – for landscaped areas and access routes	Monthly (during growing season) or as required
	Cut grass – meadow grass in and around basin	Half yearly: Spring (before nesting season) and Autumn
	Manage other vegetation and remove nuisance plants	Monthly at start and then as required
Occasional maintenance	Reseed areas of poor vegetation growth	Annually, or as required
	Prune and trim trees and remove cuttings	As required
	Remove sediment from pre-treatment system when 50% full	As required
Remedial actions	Repair erosion or other damage by reseeding or returfing	As required
	Realign the rip-rap	As required
	Repair or rehabilitate inlets, outlets and overflows	As required
	Repair or rehabilitate infiltration surface using scarifying and spiking techniques if performance deteriorates	As required
	Relevel uneven surfaces and reinstate design levels	As required
Monitoring	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and pre-treatment systems for silt accumulation; establish appropriate silt removal frequencies	Half yearly
	Inspect infiltration surfaces for compaction and ponding	Monthly

12. PROPRIETARY TREATMENT SYSTEMS

12.1. Proprietary treatment systems will require routine maintenance to ensure continuing operation to design performance standards. Because of the wide range of different designs and performance, all manufacturers should provide detailed specifications and frequencies for the required maintenance activities along with likely machinery requirements and typical annual costs for any given site. The treatment performance of proprietary systems is strongly dependant on maintenance, and robust management plans will be required to ensure that maintenance is carried out in the long term. There are examples where not undertaking maintenance has led to pollution, and the companies involved have been fined. The cost of maintenance would have been much less than the subsequent fine and clean-up costs. Different proprietary treatment devices will have different operations and maintenance requirements, but this section gives some generic guidance. Ease of access for maintenance and inspection is essential. In particular, access lids and covers should be kept as lightweight as practicable.

12.2. Many proprietary systems are beneath are ground, and malfunctioning is not easy to detect, and it is therefore often ignored unless alarms are provided or the system is designed to cause localised surface ponding if full. If systems lead to other surface features, early warning of maintenance being required may be easily observed at the inlet to the feature (which should be designed to prevent it entering the main part of the component). Preference should be given to systems or designs that give some easily observable indication that maintenance is required.

12.3. Lack of routine maintenance is more likely to cause poor outflow water quality than with other SuDS due to resuspension of solids and anaerobic conditions developing within the device. For example, anaerobic conditions can develop in deep sumps and catchpits that result in nutrients and metals being released from captured sediments. During the first few months after installation, subsurface treatment units should be visually inspected after rainfall events, and the amount of deposition measured to give the operator an idea of the expected rate of sediment and oil deposition. After this initial period, systems should be inspected every six months to verify the appropriate level of maintenance. During these inspections, the floating debris and any floating oils should normally be removed. This may be done using a van-mounted system, without the need for a larger tanker. Silt should be removed when it reaches 75% of the capacity of the sump. In most situations, the units should fully be cleaned out at least annually. If there is a significant spill of oil (or other pollutant) the system should be cleaned immediately.

12.4. Hilliges et al (2013) recommends cleaning treatment channels out every six months, in Spring and after the Summer. This was based on observed silt build up for a busy road (AADT 57 000 vehicles per day) and this frequency could possibly be reduced in less trafficked areas. Experience with other channels in less trafficked areas shows silt removal may only be required every 10 years.

12.5. Proper disposal of oil, solids and floating debris removed from components must be ensured, and the environmental regulator should be approached for advice

where there are any doubts concerning disposal options. A small portion of water will be removed along with the pollutants during the clean-out process, which should be considered when costing sedimental disposal processes.

12.6. Harmful vapours may develop in subsurface filtration or hydrodynamic separation units, as hydrocarbons may remain there for extended periods of time. Appropriate testing for harmful vapours and venting should be undertaken whenever access for maintenance is required. Removal of oil, silt and other pollutants must be in accordance with the appropriate waste management legislation.

12.7. Maintenance responsibility for all systems should be placed with an appropriate organisation, and Maintenance Plans and schedules should be developed during the design phase.

12.8. CDM 2015 requires designers to ensure that all maintenance risks have been identified, eliminated, reduced and/or controlled where appropriate. This information will be required as part of the health and safety file.

Table 12.1 – PROPRIETARY TREATMENT SYSTEMS – MAINTENANCE REQUIREMENTS

Maintenance Schedule	Required Action	Typical Frequency
Routine Maintenance	Remove litter and debris and inspect for sediment, oil and grease accumulation	Six monthly
	Change the filter media	As recommended by manufacturer
	Remove sediment, oil, grease and floatable	As necessary – indicated by system inspections or immediately following significant spill
Remedial maintenance	Replace malfunctioning parts of structures	As required
Monitoring	Inspect for evidence of poor operation	Six monthly
	Inspect filter media and establish appropriate replacement frequencies	Six monthly
	Inspect sediment accumulation rates and established appropriate removal frequencies.	Monthly during first half year of operation, then every six months

13. FILTER STRIPS

13.1. Filter strips will require regular maintenance to ensure continuing operation to design standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities along with likely machinery requirements and typical annual costs – within the Maintenance Plan. The treatment performance of filter strips is dependent on maintenance, and robust management plans will be required to ensure that maintenance is carried out in the long term. Different designs will have different operation and maintenance requirements, but this section gives some generic guidance.

13.2. Maintenance of filter strips is relatively straight forward to landscape contractors and typically there should only be a small amount of extra work (if any) required for a filter strip over and above what is necessary for standard public open space. Providing landscape management is already required at site, filter strip maintenance should therefore have marginal cost implications. However, regular inspection and maintenance is important for the effective operation of filter strips as designed. Maintenance responsibility for a filter strip should always be placed with an appropriate organisation. If filter strips are implemented within private property, owners should be educated on their routine maintenance needs, and should understand the long-term Maintenance Plan and any legally binding maintenance agreement.

13.3. Access for maintenance vehicles should always be available. However, this is not usually a constraint due to the likely location of the filter strip adjacent to impermeable areas. Litter and debris removal should be undertaken as part of general landscape maintenance for the site and before any other SuDS management task. All litter should be removed.

13.4. The major maintenance requirement for filter strips is mowing. This should ideally retain grass lengths of 75-150mm across the main "treatment" surface to assist in filtering pollutants and retaining sediments and to reduce the risk of flattening during runoff events. However, longer vegetation lengths, where appropriate, are not considered to pose a significant risk to functionality.

13.5. Grass clippings should be disposed of either off site or outside the area of the filter strip to remove nutrients and pollutants. All vegetation management activities should take account of the need to maximise biosecurity and prevent the spread of invasive species.

13.6. Occasionally, sediment will need to be removed (eg once deposits exceed 25mm in depth), although this can be minimised by ensuring that upstream areas are fully stabilised in advance. Available evidence from monitoring studies indicates that small distributed infiltration practices such as filter strips do not contaminate underlying soils, even after more than 10 years of operation (TRCA, 2008). Sediments excavated from a filter strip that receives runoff from residential or standard road and roof areas are generally not of toxic or hazardous material and can therefore be safely disposed of by either land application or landfilling. However, consultation should take place with the environmental regulator to confirm

appropriate protocols. Sediment testing may be required before sediment excavation to determine its classification and appropriate disposal methods. For runoff from streets with high vehicle traffic, sediment testing will be essential. In the majority of cases, it will be acceptable to distribute the sediment on site if there is an appropriate safe and acceptable location to do so.

Table 13.1 – Filter strips – Maintenance requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect filter strip surface to identify evidence of erosion, poor vegetation growth, compaction, ponding, sedimentation and contamination.	Monthly (at start, then as required)
	Check flow spreader and filter strip surface for even gradients	Monthly (at start, then as required)
	Inspect gravel flow spreader upstream of filter strip for clogging	Monthly (at start, then as required)
	Inspect silt accumulation rates and establish appropriate removal frequencies.	Monthly (at start, then as required)
Remedial maintenance	Reseed areas of poor vegetation growth; alter plant types of better	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

14. FILTER DRAINS

14.1. Filter drains will require regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities along with likely machinery requirements and typical annual costs – within the Maintenance Plan. The treatment performance of filter drains is dependant on maintenance, and robust management plans will be required to ensure that maintenance is carried out in the ling term. Different designs will have different operation and maintenance requirements.

14.2. Regular inspection and maintenance is important for the effective operation of filter drains as designed. Maintenance responsibility for a filter drain should always be placed with an appropriate organisation. Adequate access should always be provided to the filter drain for inspection and maintenance. If filter drains are implemented within private property, owners should be educated on their routine maintenance needs, and should understand the long-term Maintenance Plan and legally binding maintenance agreement.

14.3. Litter (including leaf litter) and debris removal should be undertaken as part of general landscape maintenance for the site and before any other SuDS management task. All litter should be removed from site.

14.4. Sediments excavated from upstream pre-treatment devices that receive runoff from residential or standard road and roof areas are generally not toxic or hazardous material and can therefore be safely disposed of by either land application or landfilling. However, consultation should take place with the environment regulator to confirm appropriate waste management protocols and compliance with legislation. Sediment testing may be required before sediment excavation to determine its classification and appropriate disposal methods. For industrial site runoff, sediment testing will be essential. In the majority of cases, it will be acceptable to distribute the sediment on site, if there is an appropriate safe and acceptable location to do so. Any damage due to sediment removal or erosion should be repaired and immediately reseeded or planted.

Table 14.1 – Filter Drains – Maintenance requirements

Maintenance Schedule	Required Action	Typical 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.	Six monthly
	Remove sediment from pre-treated devices	Six monthly, or as required
Occasional Maintenance	Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods.	As required
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium.	Five yearly, or as required
	Clear perforated pipework for blockages	As required

15. BIORETENTION SYSTEMS

15.1. Dalrymple (2013) concluded that bioretention systems will typically require approximately 2.5 times more maintenance than typical landscape designs. Bioretention systems will require regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities along with likely machinery requirements and typical annual costs – within the Maintenance Plan. The treatment performance of bioretention systems is dependent on maintenance, and robust management plans will be required to ensure that maintenance is carried out in the long term. Different designs will have different operation and maintenance requirements, but this section gives some generic guidance. Ease of access for maintenance and inspection is essential.

15.2. The main cause of failure of bioretention systems is clogging of the surface, which is easily visible. Underdrains and drainage layers are beneath the ground, and malfunctioning is not so easy to detect and therefore could potentially be ignored. However, the results of any malfunction are likely to cause surface ponding. The clogging of the surface or drainage layers can cause poor outflow water quality due to water bypassing the filter medium to the overflow more frequently than allowed for. During the first few months after installation, the system should be visually inspected after rainfall events, and the amount of deposition measured, to give the operator an idea of the expected of sediment deposition. After this initial period, systems should be inspected each quarter, to verify the appropriate level of maintenance.

15.3. Adequate access should be provided for all bioretention areas for inspection and maintenance, including for the appropriate equipment and vehicles.

15.4. Litter picking should be frequent, as rubbish is detrimental to the visual appearance of bioretention systems. Frequent street sweeping in the catchment area will increase the time between cleaning out forebays or the filter surface and will reduce the loading of fine suspended solids that can potentially clog the filter medium.

15.5. All vegetation management activities should take account of the need to maximise biosecurity and prevent the spread of invasive species.

15.6. Maintenance responsibility for all systems should be placed with an appropriate organisation, and Maintenance Plans and schedules should be developed during the design phase. **Table 15.1** provides guidance on the type of operation and maintenance schedule that may be appropriate. The list of actions is not exhaustive, and some actions may not always be required. The most intensive maintenance is required during the establishment period. Herbicides and pesticides (such as Roundup) and fertilizers should not be used on bioretention systems. This is because these pollutants will wash through the system quite easily.

15.7. Sediments excavated from pre-treatment devices that receive runoff from residential or standard road and roof areas are generally not toxic or hazardous material and can therefore be safely disposed of by either land application or

landfilling. However, consultation should take place with the environmental regulator to confirm appropriate protocols. Sediment testing may be required before sediment excavation, to determine its classification and appropriate disposal methods. For industrial site runoff, sediment testing will be essential. In the majority of cases, it will be acceptable to distribute the sediment on site, if there is an appropriate safe and acceptable location to do so. Proper disposal of sediment and debris removed must be ensured, and the environmental regulator should be approached for advice where there are any doubts concerning disposal options.

Table 15.1 – Bioretention Systems Maintenance Requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary	Quarterly
	Check operation of underdrains by inspection of flows after rain	Annually
	Assess plants for disease infection, poor growth, invasive species etc and replace as necessary	Quarterly
	Inspect inlets and outlets for blockages	Quarterly
Regular Maintenance	Remove litter and surface debris and weeds	Quarterly (or more frequently for tidiness or aesthetic reasons)
	Replace and plants, to maintain planting density	As required
	Remove sediment, litter and debris build-up from around inlets or from forebays	Quarterly to biannually
Occasional maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch	As required
Remedial actions	Remove and replace filter medium and vegetation above.	As required but likely to be >20 years

16. TREES

16.1. Maintenance requirements of trees will be the greatest during the first few years, when the tree is becoming established. Early maintenance should involve regular inspection, removal of invasive vegetation and possibly irrigation during long dry periods, particularly in soils with high void ratios. Tree roots need to establish good root-soil contact before they can efficiently extract water from the soil. The expertise of a arboriculturist/landscape architect with local knowledge should be sought regarding appropriate irrigation schedules. Maintenance responsibility for a tree pit or planter should always be placed with an appropriate organisation.

16.2. Sediments excavated from a tree pit or planter the receive runoff from residential or standard road and roof areas are generally not toxic or hazardous material and can therefore be safely disposed of by either land application or landfilling . However, consultation should take place with the environmental regulator to confirm appropriate protocols. Sediment testing may be required before sediment excavation to determine its classification and appropriate disposal methods. For runoff, from busy streets with high vehicle traffic sediment testing will be essential.

Table 16.1 – Trees – Maintenance Requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove littler and debris	Monthly (or as required)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets and outlets	Inspect monthly
Occasional maintenance	Check tree health and manage tree appropriately	Annually
	Remove silt build-up from inlets and surface and replace mulch as necessary	Annually, or as required
	Water	As required (in periods of drought)
Monitoring	Inspect silt accumulation rates and establish appropriate removal frequencies	Half yearly

17. PERVIOUS PAVEMENTS

17.1. Regular inspection and maintenance is important for the effective operation of previous pavements. Maintenance responsibility for a previous pavement and its surrounding area should be placed with an appropriate responsible organisation. Before handing over the pavement to the client, it should be inspected for clogging, litter, weeds and water ponding, and all failures should be rectified. After handover, the pavement should be inspected regularly, preferably during and after heavy rainfall to check effective operation and to identify any areas of ponding.

17.2. Pervious pavements need to be regularly cleaned of silt and other sediments to preserve their infiltration capacity. Extensive experience suggests that sweeping once per year should be sufficient to maintain an acceptable infiltration rate on most sites. However, in some instances, more or less sweeping may be required and the frequency should be adjusted to suit site-specific circumstances and should be informed by inspection reports.

17.3. A brush and suction cleaner (which can be a lorry-mounted device or a smaller precint sweeper) should be used for regular sweeping. Care should be taken in adjusting vacuuming equipment to avoid removal of jointing material. Any lost material should be replaced. It is also possible to clean the surface using lightweight rotating brush cleaners combined with power spraying using hot water.

17.4. If the surface water has clogged then a more specialist sweeper with water jetting and oscillating and rotating brushes may be required, especially for porous asphalt surfaces, to restore the surface infiltration rate to an acceptable level. The specialist equipment should be adjusted so that it does not strip binder from the aggregate in the asphalt.

17.5. The likely design life of the grass reinforcement will be dictated by trafficking and is likely to be about 20 years if designed correctly. For concrete block permeable paving the design life should be no different from standard paving, assuming that an effective maintenance regime is in place to minimise risks of infiltration clogging. Porous asphalt will lose strength and begin to fatigue due to oxidation of the binder. This is likely to occur slightly faster in porous asphalt than normal asphalt, so the design life will be reduced slightly. Porous concrete should have similar design life to a normal concrete slab.

17.6. The reconstruction of failed areas of concrete clock pavement should be less costly and disruptive than the rehabilitation of continuous concrete or asphalt porous surfaces due to the reduced area that is likely to be affected. Materials removed from the voids or the layers below the surface may contain heavy metals and hydro carbons and may need to be disposed of as controlled waste. Sediment testing should be carried out before disposal to confirm its classification and appropriate disposal methods.

Table 17.1 – Pervious Pavements

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

18. ATTENUATION STORAGE TANKS

18.1. Regular inspection and maintenance is required to ensure the effective long-term operation of below-ground storage systems. Maintenance responsibility for systems should be placed with a responsible organisation. **Table 18.1** provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive, and some actions may not always be required.

18.2. Maintenance Plans and schedules should be developed during the design phase and will be specific to the type of tank that is adopted. Specific maintenance needs of the system should be monitored, and maintenance schedules adjusted to suit requirements.

18.3. CDM 2015 requires designers to ensure that all maintenance risks have been identified, eliminated, reduced and/or controlled where appropriate. This information will be required as part of the health and safety file.

Table 18.1 – Attenuation Storage Tanks – Maintenance Requirements

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

19. DETENTION BASINS

19.1. Detention basins will require ongoing regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities along with likely machinery requirements and typical annual costs – within the Maintenance Plan. The treatment performance of bioretention systems is dependent on maintenance, and robust management plans will be required to ensure maintenance is carried out in the long term. Different designs will have different operation and maintenance requirements, but this section gives some generic guidance.

19.2. Maintenance of detention basins is relatively straightforward for landscape contractors, and typically there should only be a small amount of extra work (if any) required for a SuDS detention basin over and above what is necessary for standard public open space.

19.3. Maintenance responsibility for a basin should always be placed with an appropriate organisation. Adequate access should be provided to all detention basin areas for inspection and maintenance, including for appropriate equipment and vehicles. Litter and debris removal should be undertaken as part of general landscape maintenance for the site and before any other SuDS management task. All litter should be removed from site.

19.4. The major maintenance requirement for detention basins is usually mowing. Regular mowing in and around detention basins is only required along maintenance access routes, amenity areas (eg footpaths), across any embankment and across the main storage area. The remaining areas can be managed as "meadow", unless additional management is required for landscape/amenity/recreational or aesthetic reasons.

19.5. Mowing should ideally retain grass lengths of 75mm – 110mm across the main "treatment" surface to assist in filtering pollutants and retaining sediments and to reduce the risk of flattening during runoff events. Longer lengths of vegetation may be appropriate, depending on the functionality of the component, and it's associated design criteria and are not considered to pose a significant risk to functionality.

19.6. Shorter lengths may be required when recreational facilities form part of the basin, but in this case the basin will be dealing with exceedance flows only and not treatment.

19.7. Grass clippings should be disposed of off-site or outside the detention basin area to remove nutrients and pollutants. Where a detention basin has a small permanent pool at the outlet, the submerged and emergent aquatic vegetation should be managed as for ponds or wetlands. Plant management, to achieve the desired habitat effect, should be clearly specified in a maintenance schedule. All vegetation management activities should take account of the need to maximise biosecurity and prevent the spread of invasive species.

19.8. Occasionally sediment will need to be removed (eg once deposits exceed 25 mm in depth). Sediments excavated from a detention basin that receives runoff from residential or standard road and roof areas are generally not toxic or hazardous and can therefore be safely disposed of by either land application or landfilling. However, consultant should take place with the environmental regulator to confirm appropriate protocols. Sediment testing may be required before sediment excavation to determine its classification and appropriate disposal methods. For runoff from busy streets with high vehicle traffic, sediment testing will be essential. In the majority of cases, it will be acceptable to distribute the sediment on-site if there is an appropriate safe and acceptable location to do so. Any damage due to sediment removal or erosion and scour resulting from major events should be repaired and immediately reseeded or planted.

19.9. **Table 19.1** provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive, and some actions may not always be required.

19.10. Maintenance Plans and schedules should be developed during the design phase. Specific maintenance needs of the detention basins should be monitored, and maintenance schedules adjusted to suit requirements.

19.11. CDM 2015 requires designers to ensure that all maintenance risks have been identified, eliminated, reduced and/or controlled where appropriate. This information will be required as part of the health and safety file.

19.12. Many of the specific maintenance activities for detention basins can be undertaken as part of a general landscape management contract and therefore, if landscape management is already required at site, should have marginal cost implications. If basins are implemented within private property, owners should be educated on their routine maintenance needs, and should understand the long-term Maintenance Plan and any legally binding maintenance agreement.

Table 19.1 – Detention basins – Maintenance requirements

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

20. PONDS AND WETLANDS

20.1. Ponds and wetlands will require regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities, along with likely machinery requirements and typical annual costs – within the Maintenance Plan. The treatment performance of ponds and wetlands is dependant on maintenance, and robust management plans will be required to ensure maintenance requirements, but this section gives some generic guidance.

20.2. Maintenance of ponds is relatively straightforward for landscape contractors, and typically there should only be a small amount of extra work required for a SuDS Pond or wetland feature over and above what is necessary for standard public open space.

20.3. Regular inspection and maintenance are important for the effective operation of ponds as designed. Maintenance responsibility for a pond and it's surrounding area should always be placed with a responsible organisation. Litter and debris removal should be undertaken as part of general landscape maintenance for the site and before any other SuDS management task. All litter should be removed from site.

20.4. Any invasive maintenance work such as silt or vegetation removal is only required intermittently, but it should be planned to be sympathetic to the requirements of wildlife in a pond. Care should be taken to avoid disturbance to nesting birds during the breeding season and habitats to target species (eg great crested newt and water voles) at critical times. The window for carrying out maintenance to achieve this is usually towards the end of the growing season (typically September/October), although this will vary with species). Invasive silt and vegetation removal should only be carried out to limited areas at any one time (25-30% of the pond area on one occasion each year to minimise the impact on biodiversity). Plant management, to achieve particular desired habitat effects, should be clearly specified in a maintenance schedule.

20.5. Site vegetation should be trimmed as necessary to keep the pond free of leaves and to maintain the aesthetic appearance of the site. Slope areas that have become bare should be re-vegetated and any eroded areas should be regraded before replanting.

20.6. Maintenance access (or "easement") should be provided to the pond from a public or private road. An assessment should be made at the planning stage regarding the maintenance and associated access requirements. Ideally, access should be at least 3.5m wide, have a maximum cross fall of 1 in 7, and be sufficiently robust to withstand maintenance equipment and vehicles. However, temporary access routes for infrequent operations could be considered where permanent routes are not appropriate. The access should extend to any forebay, safety and aquatic benches, inlet and outlet infrastructure. Consideration should be given as to whether maintenance vehicles will need to turn around. Wherever possible SuDS ponds and wetlands should be designed so that special machinery is not required to undertake maintenance.

20.7. **Table 20.1** provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required. Consideration should be given to the need to control risks to biosecurity during maintenance operations.

20.8. Sediments excavated from ponds or forebays that receive runoff from residential or standard road and roof areas should be safely disposed of in accordance with current waste management legislation. However, consultation should take place with the environmental regulator to confirm appropriate protocols. Chemical testing of the sediment may be required, before sediment excavation, to determine it's classification and appropriate disposal methods. For industrial site runoff, sediment testing will be acceptable to distribute the sediment on site, if there is an appropriate safe and acceptable location to do so. If ponds are to be drawn down, care should be taken to prevent downstream discharge of sediments and anoxic water. The environmental regulator should be notified before such activities.

20.9. New ponds may become rapidly dominated by invasive native plants, particularly common bulrush (Typha latifolia). As it is not desirable for all new ponds to be bulrush dominated, it should be ensured that in the first five years, while vegetation is establishing, certain plant growth is controlled. After this time, ponds can usually be allowed to develop naturally recognising that, unless the margins are occasionally managed, they are likely to be dominated by trees and shrubs.

20.10. Eutrophication of SuDS ponds can occur during the summer months. This is best alleviated by controlling the nutrient source of providing a continuous baseflow to the pond. Unless eutrophication is severe, aeration can be used as a stop-gap measure to save aquatic animal species and reduce risks to receiving waters. However, the addition of barley straw bales, dredging or rendering the nutrients inactive by chemical means can also be successful.

20.11. Maintenance Plans and schedules should be developed during the design phase. Specific maintenance needs of a pond should be monitored, and maintenance schedules adjusted to suit requirements.

20.12. CDM 2015 requires designers to ensure that all maintenance risks have been identified, eliminated, reduced and/or controlled where appropriate. This information will be required as part of the health and safety file.

Table 20.1 – Ponds and Wetlands – Maintenance requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass – public areas	Monthly (or as required
	Cut the meadow grass	Spring and Autumn
	Inspect marginal and bankside vegetation and remove nuisance plants (for first 3 years)	Monthly at start, then as required
	Inspect inlets, outlets, banksides, structures, pipework etc for evidence of blockage and/or physical damage	Monthly
	Inspect water body for signs of poor water quality	Monthly (May – October)
	Inspect silt accumulation rates in any forebay and in main body of the pond and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
	Check any mechanical devices e.g. penstocks	Half yearly
	Hand cut submerged and emergent aquatic plants (at minimum of 0.1m above pond base; include max 25% of pond surface)	Annually
	Remove 25% of bank vegetation from water's edge to a minimum of 1m above sea level	Annually
	Tidy all dead growth (scrub clearance) before start of growing season (Note; tree maintenance is usually part of overall landscape management contract)	Annually
	Remove sediment from any forebay	Every 1-5 years, or as required
	Remove sediment and planting from one quadrant of the main body of ponds without sediment forebays	Every 5 years, or as required
Occasional maintenance	Remove sediment from the main body of big ponds when pool volume is reduced by 20%	With effective pre-treatment, this will only be every 25-50 years
Remedial actions	Repair erosion or other damage	As required
	Replant, where necessary	As required
	Aerate pond when signs of eutrophication are detected	As required
	Realign rip-rap or repair other damage	As required
	Repair/rehabilitation inlets, outlets and overflows	As required

21. DITCH FENCE CROSSINGS

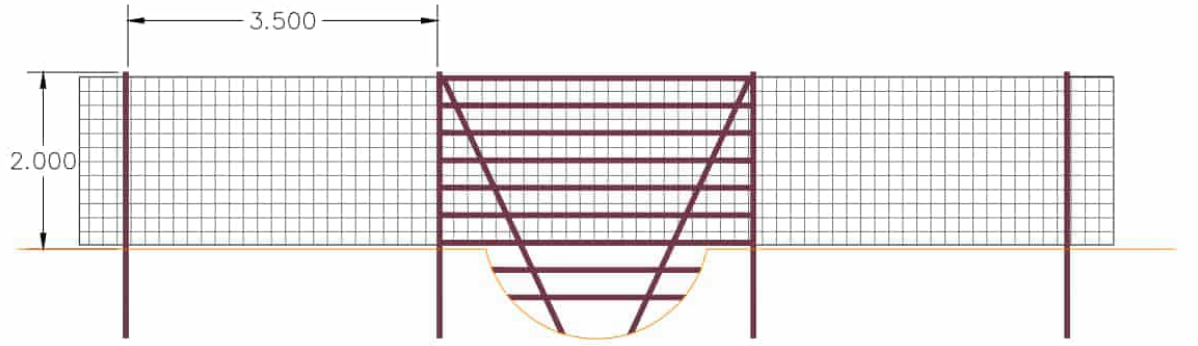
21.1. The below figure shows "Typical Fence Details – Ditch Crossing".

21.2. Maintenance will be required to ensure the ditch fencing does not experience a build up of debris which could then impact the existing water flows through the ditches and may impact flood risk.

21.3. Regular inspections will be required to remove any debris against the proposed fencing and in the immediate vicinity.

21.4. Inspections are initially suggested to be carried out monthly, with this to be reviewed should any issues be observed. It is also recommended to carry out an inspection after any significant storm events that may cause increase build-up of debris.

Figure 21.1 - Typical Fence Details - Ditch Crossing



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