Drainage Strategy
Barham Park
Drainage Improvements

London Borough of Brent

EPG-9091-DS-01

27.02.20
Rev 1.0

Project No: EPG 9091 Prepared by: John Roberts Date: 27/02/2020

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1 SUMMARY

The following proposal outlines the storm water management system proposed to improve the drainage of Barham Park to allow the large field to be functional year round. The park currently suffers from frequent ponding during the spring and summer months which cut the functionality of the park to host activities and events to dry months of the year. The development is accessed from Harrow Road which runs adjacent to the southern and western boundaries. The park area to be remediated generally falls at an average gradient of 1in50 from the southwest to north-northeast.

The runoff from the field will be collected via a series of pitch drains running at 4m centres. The pitch drains shall be collected by adequately sized collector drains sized to convey the 1in100+20% flow rate. A geocellular tank shall collect the runoff from the pitch drains and store and restrict the runoff to 7.4 l/s during the proposed 1in100+20% storm event. The Greenfield runoff rate, QBar has been calculated to be 7.7 l/s, therefore, the proposed discharge rate is a betterment to the Greenfield flow rate.

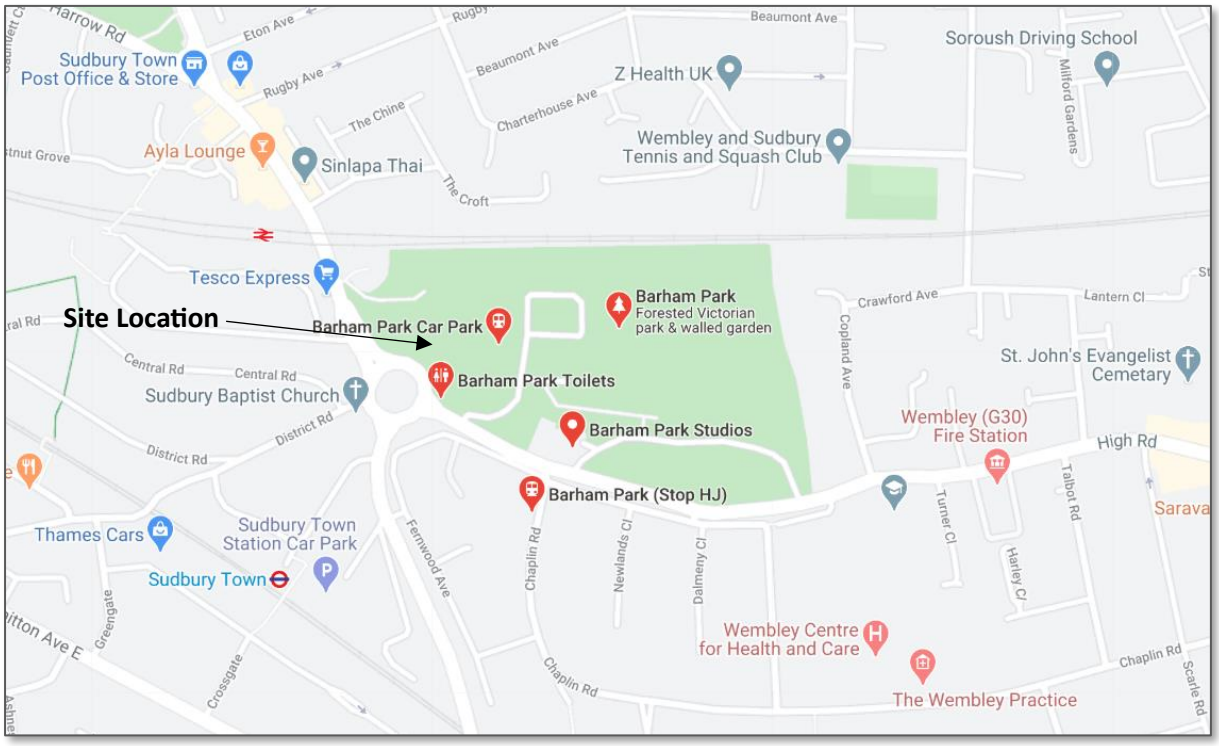


Fig 1. Proposed location plan

2 DRAINAGE PROPOSALS

2.1 Design Parameters

EPG has reviewed the information provided and considered an approach based on previous experience of similar sites and current SuDS guidance provided in:

- National Planning Policy Framework (NPPF 25)
- Local/Regional Sustainable drainage plans/requirements
- CIRIA report C753 (2016); The SUDS manual
- CIRIA report C680 (2008); Structural design of modular geocellular drainage tanks
- CIRIA Report C724 (2013) Creating water sensitive places-scoping the potential for water sensitive urban design in the UK
- BS-ISO 24536:2019 – Guidelines for stormwater management in urban areas.

The NPPF requires that surface water arising from a developed site should as far as practicable be managed in a sustainable manner to mimic the surface water flows arising from the site prior to re-development. Opportunities to reduce the surface water run-off and the associated flood risk should be identified and climate change should be taken into account. Building Regulations (Part H), NPPF and Environment Agency advice notes require the consideration of sustainable drainage techniques based on a hierarchical approach to the management of surface water, with the emphasis on the use of Source Control techniques and a treatment train as the preferred option.

2.2 Calculation Inputs

Cv:	0.750 (summer) & 0.840 (winter)
M5-60:	20.800
Ratio, R:	0.438
Storm Durations:	15 mins to 10080 mins
Catchment Area:	1.184 ha
Infiltration:	7.91 x 10-9 m/s – Appendix A
Runoff Coeff:	30% (Landscaping)
Greenfield Flow Rate:	7.7 l/s (QBar) – Appendix C
Flow Rate 1in100+20% event:	7.4 l/s – Appendix C
Design Storm:	1in100 year
Climate Change:	20%

3 PROPOSED DESIGN & CALCULATIONS

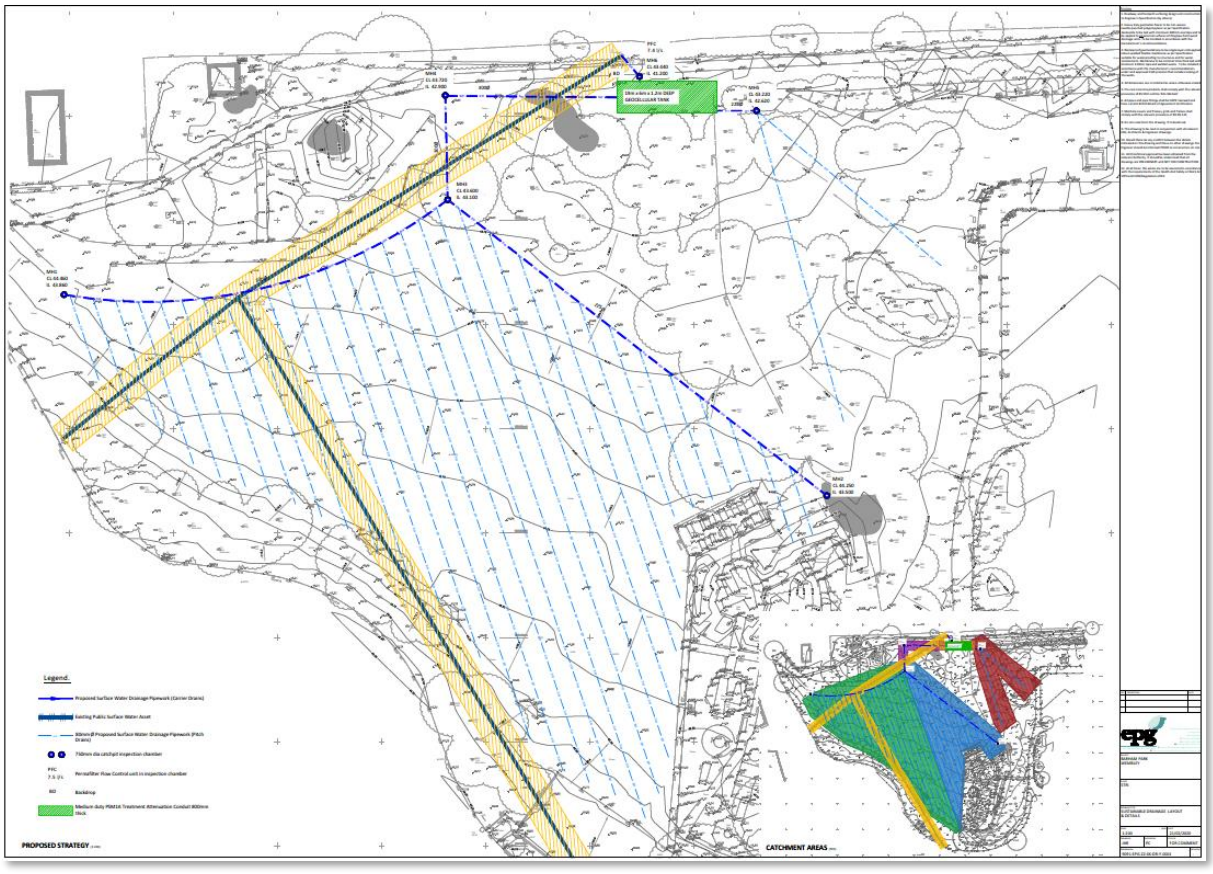


Fig 2. Snapshot of the proposed design

Infiltration as a method of discharge has been assessed with 4 no. percolation tests taken across the development. The trial holes discovered heavy CLAYS and the infiltration rates varied between 7.91 x 10-9 and 7.61 x 10-8 m/s (see Appendix A). Therefore, percolation as a method of discharge has been discounted.

The Thames Water extract below (Fig 3) shows a deep surface water culvert running through the site towards the rail tracks. Therefore, in line with the NPPF discharge hierarchy the proposed surface water system shall discharge into the culvert.

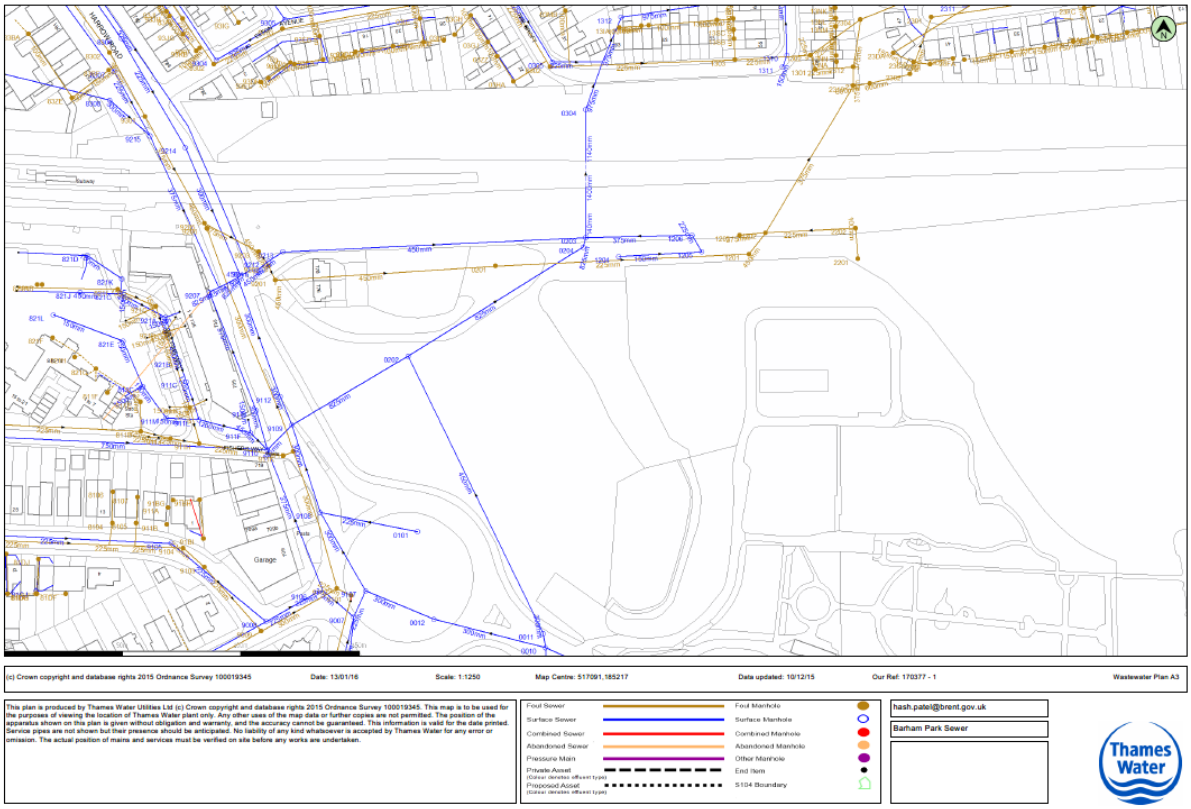


Fig 3. Thames Water Sewer Records

The SuDS system is designed to store below ground the 100-year return period storm event plus an additional 20% for climate change . The proposed drainage layout and construction details can be found in Appendix B.

Runoff shall be limited to a rate equal to or less than Greenfield Flow Rate which was calculated to be 7.7 l/s (QBar).

The runoff from the field will be collected via a series of pitch drains running at 4m centres. The pitch drains shall be collected by adequately sized collector drains sized to convey the 1in100+20% flow rate. A geocellular tank shall collect the runoff from the pitch drains and store and restrict the runoff to 7.4 l/s during the proposed 1in100+20% storm event. Runoff will be restricted using a filter protected orifice plate within the final catchpit chamber.

Microdrainage design software has been used to determine the storage volume required and the results can be found in Appendix C.

4 MAINTENANCE

We would recommend that Pre-handover inspections are undertaken.

Specific Maintenance - Attenuation Tank

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
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

General Maintenance

The following routine inspections and maintenance are also required:

- Monthly inspections of channels and gullies for signs of blockage and after a heavy rainfall event.
- Remove litter and blockages as required.
- Every 12 months inspect catchpit chambers and orifice flow control devices for evidence of blockage and remove as necessary.
-

Management

It is understood that The London Borough of Brent will undertake the maintenance and management duties for the pitch. The management team must be aware that the sub-base below the surfacing layer is necessary to manage the drainage of the pitch. They should inform any contractor working on any future repairs of the presence and requirement of the sub-base drainage system.

The London Borough of Brent should keep records of all inspections and maintenance.

5 APPENDIX A:

Percolation Results Extract

G7 Geotech

G7 Geotech Ltd
49, Church Rd
Leyland PR25 3AA

SOAKAGE TEST RESULT

Soakage Test No

TH1

Project Name:	Proposed Drainage Improvements	Job No 1224
Location:	Barham Park, Harrow Road, Wembley HA0 2HB	
Client:	STRI Ltd	

Soakage test undertaken within trial hole TH1 at 1.40m depth

SOAKAGE RATE

TP SOAKAGE TEST **TH1** **DEPTH** **1.40** **TEST No** **1** DATE : 19th February 2020

CASING DEPTH	0.00	m
DIMENSIONS		
WIDTH	0.20	m
LENGTH	0.35	m
DIAMETER		m
PERIMETER	1.100	m
BASE AREA	0.070	m^2

SOIL TYPE :-

Brown silty clayey TOPSOIL with flint and calcareous gravel to 0.20m depth BGL.
Brown grey SUBSOIL with brick, flint and calcareous gravel to 0.35m depth BGL.
Orange brown and grey silty CLAY with occasional flint gravel. With roots and rootlets. Becoming light brown below 0.70m depth.

Readings measured from **0.00** m above ground level

No	time	depth	Depth bgl	
1	**0**	**1.185**	1.185	<< top reading
2	**1**	**1.185**	1.185	
3	**2**	**1.185**	1.185	
4	**3**	**1.185**	1.185	
5	**4**	**1.185**	1.185	
6	**5**	**1.185**	1.185	<<bottom reading
7	**10**	**1.180**	1.180	
8	**15**	**1.175**	1.175	
9	**20**	**1.172**	1.172	
10	**30**	**1.168**	1.168	
11	**38**	**1.165**	1.165	
12	**60**	**1.160**	1.160	
13				
14				
15				
16				
17				
18				
19				
20				

		Water Level (m)	Time sec
Top WL	**1**	1.1850	0
Bottom WL	**6**	1.1851	300

Vol change	=	0.0000	m^3	V
Soakage area	=	0.3064	m^2	A
Time	=	300	sec	T

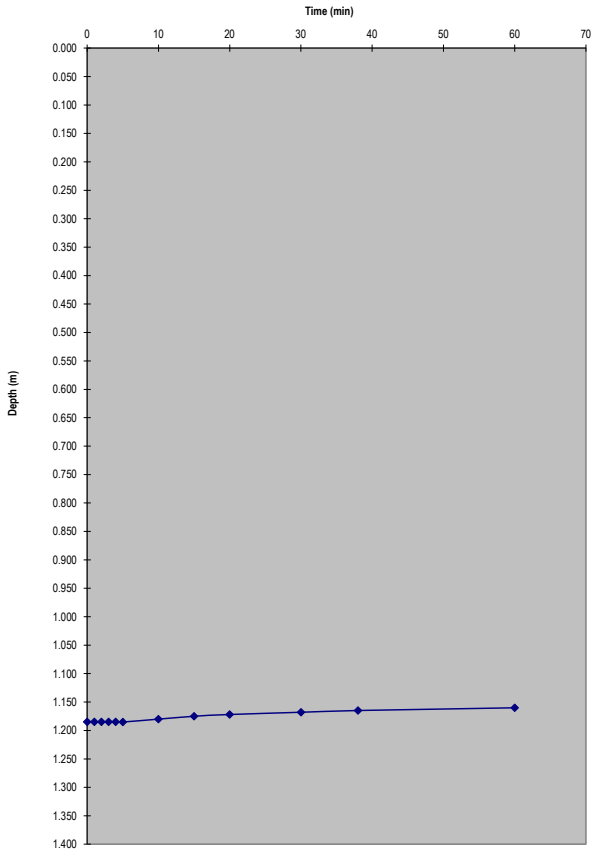
Soakage Rate **7.61E-08** **m/sec**

(Inferred Maximum Soakage Rate)

Soakage Rate is calculated using two selected water levels and is based on BRE Digest 365: 2016: Soakaway Design

The selected water levels are normally approximations based on the 25% and 75% effective depth of the proposed soakaway. In this case the water level rose during the test due to surface water ingress following rainfall. On the basis that no discernible fall in water level was noted in the early stages of the test, the stated maximum soakage rate has assumed a maximum 0.1mm fall in water level.

Water Level v Time Graph



G7 Geotech

G7 Geotech Ltd
49, Church Rd
Leyland PR25 3AA

SOAKAGE TEST RESULT

Soakage Test No

TH2

Sheet 1 of 1

Project Name:	Proposed Drainage Improvements	Job No 1224
Location:	Barham Park, Harrow Road, Wembley HA0 2HB	
Client:	STRI Ltd	

Soakage test undertaken within trial hole TH2 at 0.50m depth

SOAKAGE RATE

TP SOAKAGE TEST **TH2** **DEPTH** **0.50** **TEST No** **1** DATE : 19th February 2020

CASING DEPTH	0.00	m
DIMENSIONS		
WIDTH	0.20	m
LENGTH	0.35	m
DIAMETER		m
PERIMETER	1.100	m
BASE AREA	0.070	m^2

SOIL TYPE :-

Brown silty clayey TOPSOIL with flint and calcareous gravel to 0.12m depth BGL.
Orange brown & grey brown silty clay SUBSOIL with natural organic deposits and brick fragments to 0.30m depth BGL.
Orange brown and grey silty CLAY with occasional flint gravel. With rootlets.

Readings measured from **0.00** m above ground level

No	time	depth	Depth bgl	
1	**0**	**0.4260**	0.4260	<< top reading
2	**1**	**0.4260**	0.4260	
3	**2**	**0.4260**	0.4260	
4	**3**	**0.4260**	0.4260	
5	**4**	**0.4260**	0.4260	
6	**5**	**0.4260**	0.4260	
7	**10**	**0.4260**	0.4260	
8	**15**	**0.4260**	0.4260	
9	**20**	**0.4260**	0.4260	
10	**30**	**0.4261**	0.4261	
11	**40**	**0.4261**	0.4261	
12	**50**	**0.4261**	0.4261	
13	**60**	**0.4261**	0.4261	<<bottom reading
14				
15				
16				
17				
18				
19				
20				

		Water Level (m)	Time sec
Top WL	**1**	0.4260	0
Bottom WL	**13**	0.4261	3600

Vol change	=	0.0000	m^3	V
Soakage area	=	0.1513	m^2	A
Time	=	3600	sec	T

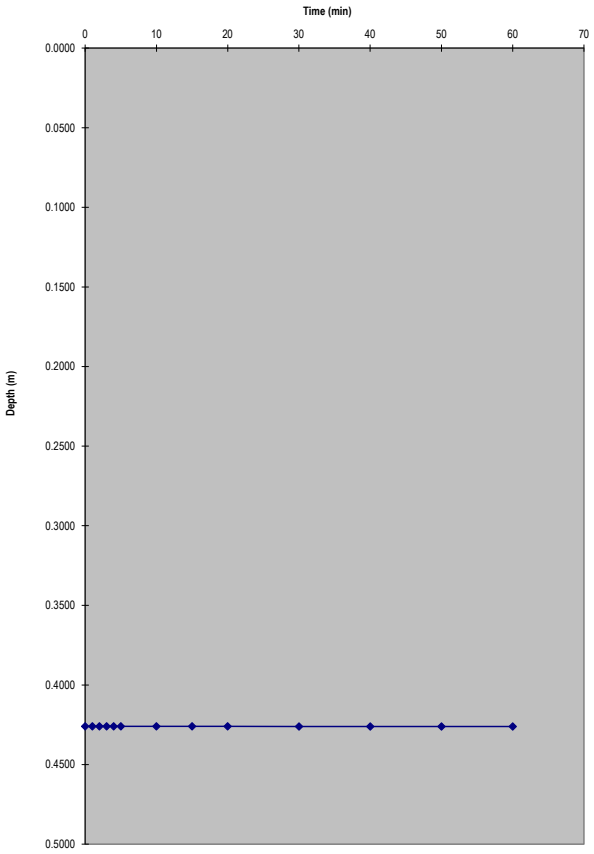
Soakage Rate **1.28E-08** **m/sec**

(Inferred Maximum Soakage Rate)

Soakage Rate is calculated using two selected water levels and is based on BRE Digest 365: 2016: Soakaway Design

The selected water levels are normally approximations based on the 25% and 75% effective depth of the proposed soakaway. In this case there was no discernible fall in water level during the test. The stated maximum soakage rate has assumed a maximum 0.1mm fall in water level.

Water Level v Time Graph



G7 Geotech	G7 Geotech Ltd 49, Church Rd Leyland PR25 3AA	**SOAKAGE TEST RESULT**	Soakage Test No **TH3** Sheet 1 of 1

Project Name:	Proposed Drainage Improvements	Job No 1224	
Location:	Barham Park, Harrow Road, Wembley HA0 2HB		Soakage test undertaken within trial hole TH3 at 1.00m depth
Client:	STRI Ltd		

SOAKAGE RATE

TP SOAKAGE TEST **TH3** **DEPTH** **1.00** **TEST No** **1** DATE : 19th February 2020

CASING DEPTH	0.00	m
DIMENSIONS		
WIDTH	0.20	m
LENGTH	0.35	m
DIAMETER		m
PERIMETER	1.100	m
BASE AREA	0.070	m^2

SOIL TYPE :-

Brown silty clayey TOPSOIL with flint and calcareous gravel to 0.18m depth BGL.
MADE GROUND : Dark grey clayey silt with charcoal, brick and flint to 0.30m depth BGL.
Orange brown and grey silty CLAY with occasional flint gravel. With rootlets.

Readings measured from **0.00** m above ground level

No	time	depth	Depth bgl	
1	**0**	**0.8400**	0.8400	<< top reading
2	**1**	**0.8400**	0.8400	
3	**2**	**0.8400**	0.8400	
4	**3**	**0.8400**	0.8400	
5	**4**	**0.8400**	0.8400	
6	**5**	**0.8400**	0.8400	
7	**10**	**0.8400**	0.8400	
8	**15**	**0.8400**	0.8400	
9	**20**	**0.8400**	0.8400	
10	**30**	**0.8401**	0.8401	
11	**40**	**0.8401**	0.8401	
12	**50**	**0.8401**	0.8401	
13	**60**	**0.8401**	0.8401	<<bottom reading
14				
15				
16				
17				
18				
19				
20				

		Water Level (m)	Time sec
Top WL	**1**	0.8400	0
Bottom WL	**13**	0.8401	3600

Vol change	=	0.0000	m^3	V
Soakage area	=	0.2459	m^2	A
Time	=	3600	sec	T

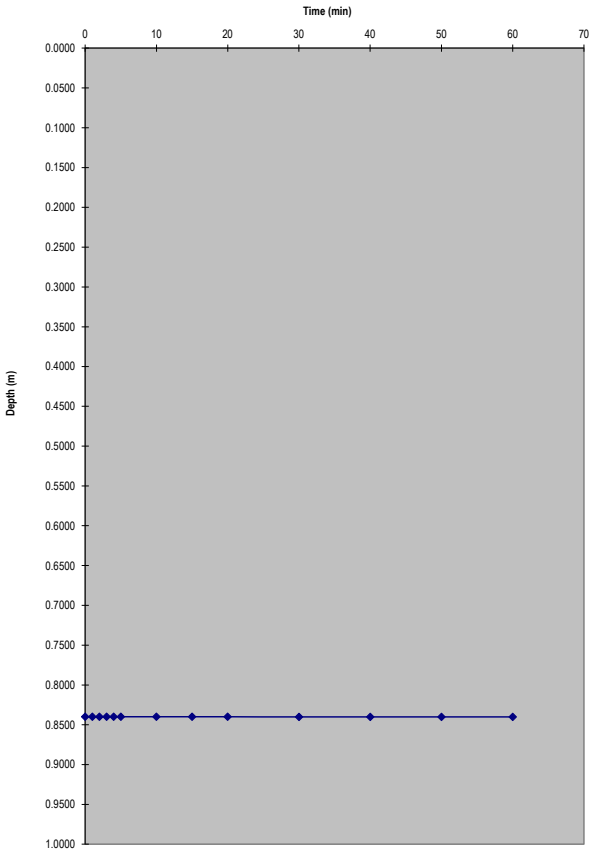
Soakage Rate **7.91E-09** **m/sec**

(Inferred Maximum Soakage Rate)

Soakage Rate is calculated using two selected water levels and is based on BRE Digest 365: 2016: Soakaway Design

The selected water levels are normally approximations based on the 25% and 75% effective depth of the proposed soakaway. In this case there was no discernible fall in water level during the test. The stated maximum soakage rate has assumed a maximum 0.1mm fall in water level.

Water Level v Time Graph



G7 Geotech

G7 Geotech Ltd
49, Church Rd
Leyland PR25 3AA

SOAKAGE TEST RESULT

Soakage Test No
TH4
Sheet 1 of 1

Project Name:	Proposed Drainage Improvements	Job No 1224
Location:	Barham Park, Harrow Road, Wembley HA0 2HB	
Client:	STRI Ltd	

Soakage test undertaken within trial hole TH4 at 1.00m depth

SOAKAGE RATE

TP SOAKAGE TEST **TH4** **DEPTH** **1.00** **TEST No** **1** DATE : 19th February 2020

CASING DEPTH	0.00	m
DIMENSIONS		
WIDTH	0.30	m
LENGTH	0.35	m
DIAMETER		m
PERIMETER	1.300	m
BASE AREA	0.105	m^2

Readings measured from **0.00** m above ground level

SOIL TYPE :-

Brown silty clayey TOPSOIL with flint and brick gravel to 0.22m depth BGL.
Dark brown clayey SUBSOIL with brick and charcoal to 0.50m depth BGL.
Orange brown and grey silty CLAY with rootlets.
Slight seepage at 0.95m depth BGL.

No	time	depth	Depth bgl	
1	**0**	**0.6600**	0.6600	<< top reading
2	**1**	**0.6600**	0.6600	
3	**2**	**0.6600**	0.6600	
4	**3**	**0.6600**	0.6600	
5	**4**	**0.6600**	0.6600	
6	**5**	**0.6600**	0.6600	
7	**10**	**0.6600**	0.6600	
8	**15**	**0.6600**	0.6600	
9	**20**	**0.6601**	0.6601	<<bottom reading
10	**30**	**0.6550**	0.6550	
11	**40**	**0.6500**	0.6500	
12	**50**	**0.6450**	0.6450	
13	**60**	**0.6400**	0.6400	
14				
15				
16				
17				
18				
19				
20				

		Water Level (m)	Time sec
Top WL	**1**	0.6600	0
Bottom WL	**9**	0.6601	1200

Vol change	=	0.0000	m^3	V
Soakage area	=	0.5469	m^2	A
Time	=	1200	sec	T

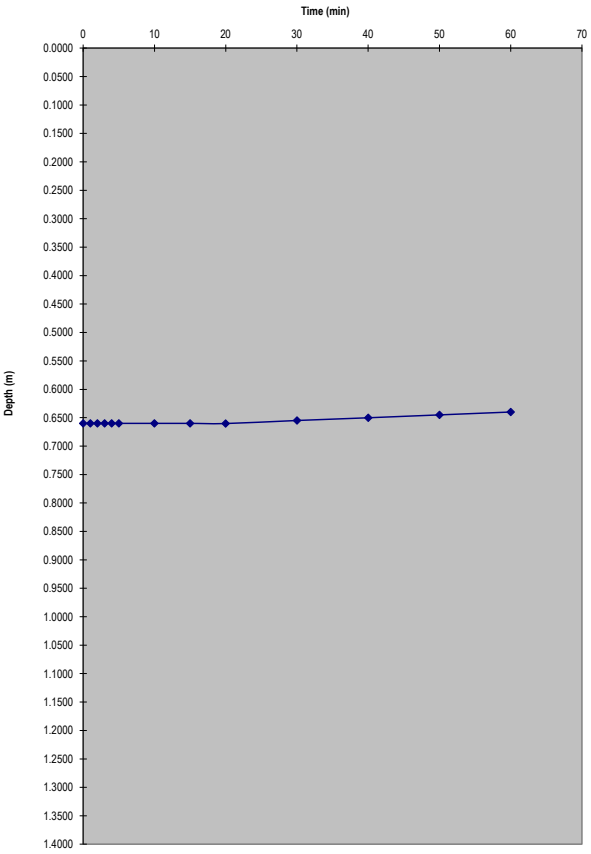
Soakage Rate **1.60E-08** **m/sec**

(Inferred Maximum Soakage Rate)

Soakage Rate is calculated using two selected water levels and is based on BRE Digest 365: 2016: Soakaway Design

The selected water levels are normally approximations based on the 25% and 75% effective depth of the proposed soakaway. In this case the water level rose during the test due to surface water ingress following rainfall. On the basis that no discernible fall in water level was noted in the early stages of the test, the stated maximum soakage rate has assumed a maximum 0.1mm fall in water level.

Water Level v Time Graph



6 APPENDIX B:

Proposed Drainage layout & Details

MH4
CL 43.720
IL 42.900
MANHOLE FITTED WITH
VENTED COVER

PFC
7.4 l/s

MH6
CL 43.440
IL 41.200

BD

19m x 6m x 1.2m DEEP
GEOCELLULAR TANK

MH5
CL 43.220
IL 42.620
MANHOLE FITTED WITH
VENTED COVER

300Ø

225Ø

MH3
CL 43.600
IL 43.100
MANHOLE FITTED
WITH VENTED COVER

MH1
CL 44.460
IL 43.860
MANHOLE FITTED
WITH VENTED COVER

MH2
CL 44.250
IL 43.500
MANHOLE FITTED WITH
VENTED COVER

Legend.

- Proposed Surface Water Drainage Pipework (Carrier Drains)
- Existing Public Surface Water Asset
- SW — 80mm Ø Proposed Surface Water Drainage Pipework (Pitch Drains)
- 750mm dia catchpit inspection chamber
- PFC 7.5 l/s — Permafilter Flow Control unit in inspection chamber
- BD — Backdrop
- Medium duty PSM1A Treatment Attenuation Conduit 800mm thick

PROPOSED STRATEGY (1:200)

CATCHMENT AREAS (NTS)

Notes

1. Roadway and footpath surfacing design and construction to Engineer's Specification (by others).

2. Heavy duty geotextile fleece to be non-woven needle-punched polypropylene as per Specification. Geotextile to be laid with minimum 300mm overlaps and to be applied to all external surfaces of Polypipe-Permavoid drainage units. To be installed in accordance with the manufacturer's recommendations.

3. Waterproof geomembrane to be single layer cold applied robust welded flexible membrane as per Specification suitable for waterproofing to structures and for water containment. Membrane to be nominal 1mm thick laid with minimum 120mm laps and welded seams. To be installed in accordance with the manufacturer's recommendations under and approved CQA protocol that includes testing of the welds.

4. All dimensions are in millimetres unless otherwise stated.

5. Pre-cast concrete products shall comply with the relevant provisions of BS 5911 and be 'Kite Marked'.

6. All pipes and pipe fittings shall be HDPE twinwall and have current British Board of Agreement Certification.

7. Manhole covers and frames, grids and frames shall comply with the relevant provisions of BS EN 124.

8. Do not scale from this drawing. If in doubt ask.

9. This drawing to be read in conjunction with all relevant EPG, Architects & Engineers drawings.

10. Should there be any conflict between the details indicated on this drawing and those on other drawings the Engineer should be informed PRIOR to construction on site.

11. Until technical approval has been obtained from the relevant Authority, it should be understood that all drawings are PRELIMINARY and NOT FOR CONSTRUCTION.

12. At all times the works are to be executed in accordance with the requirements of the Health And Safety at Work Act 1974 and CDM Regulations 2015.

REV	DESCRIPTION	DATE

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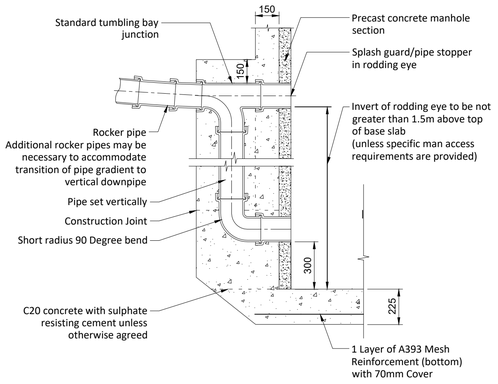
PROJECT
BARHAM PARK
WEMBLEY

CLIENT
STRI

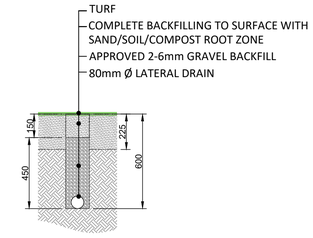
DRAWING TITLE
SUSTAINABLE DRAINAGE LAYOUT & DETAILS

SCALE	@A0	DATE
1:200		21/02/2020
DRAWN BY	CHECKED BY	STATUS
JHR	PC	FOR COMMENT
DRAWING No.		REVISION
9091-EPG-ZZ-XX-DR-Y-0001		-

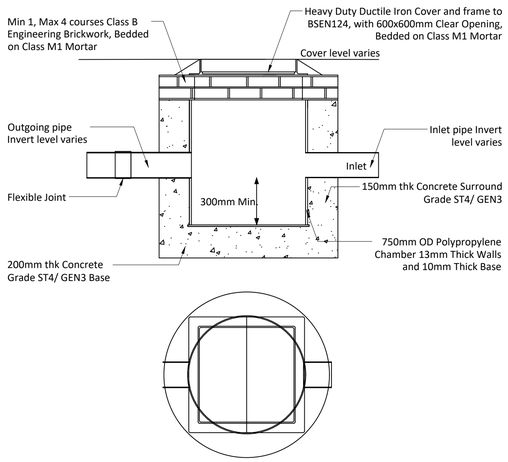


TYPICAL VERTICAL BACKDROP TO CATCHPIT CHAMBER DETAIL

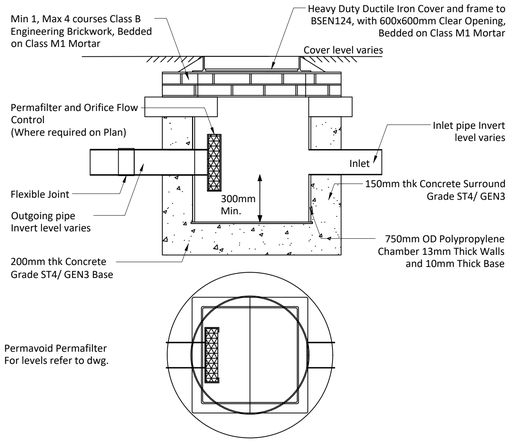
(Note: Where the backdrop is not excessive a 45 degree drop pipe may be used)



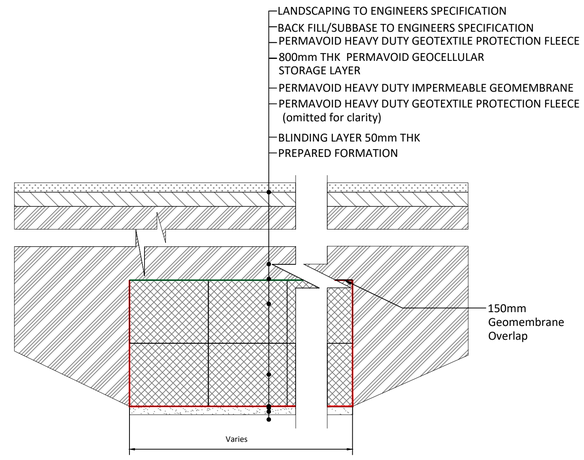
80mm LATERAL DRAIN DETAIL



750Ø PERMAVOID CATCHPIT INSPECTION CHAMBER



750Ø PERMAVOID CATCHPIT INSPECTION CHAMBER INCORPORATING FLOW CONTROL AND DEBRIS DEVICE (900Ø Similar)



TYPICAL SECTION THROUGH 800 THK PERMAVOID ATTENUATION TANK

Notes

1. Roadway and footpath surfacing design and construction to Engineer's Specification (by others).

2. Heavy duty geotextile fleece to be non-woven needle-punched polypropylene as per Specification. Geotextile to be laid with minimum 300mm overlaps and to be applied to all external surfaces of Polypipe-Permavoid drainage units. To be installed in accordance with the manufacturer's recommendations.

3. Waterproof geomembrane to be single layer cold applied robust welded flexible membrane as per Specification suitable for waterproofing to structures and for water containment. Membrane to be nominal 1mm thick laid with minimum 120mm laps and welded seams. To be installed in accordance with the manufacturer's recommendations under and approved CQA protocol that includes testing of the welds.

4. All dimensions are in millimetres unless otherwise stated.

5. Pre-cast concrete products shall comply with the relevant provisions of BS 5911 and be 'Kite Marked'.

6. All pipes and pipe fittings shall be HDPE twinwall and have current British Board of Agreement Certification.

7. Manhole covers and frames, grids and frames shall comply with the relevant provisions of BS EN 124.

8. Do not scale from this drawing. If in doubt ask.

9. This drawing to be read in conjunction with all relevant EPG, Architects & Engineers drawings.

10. Should there be any conflict between the details indicated on this drawing and those on other drawings the Engineer should be informed PRIOR to construction on site.

11. Until technical approval has been obtained from the relevant Authority, It should be understood that all drawings are PRELIMINARY and NOT FOR CONSTRUCTION.

12. At all times the works are to be executed in accordance with the requirements of the Health And Safety at Work Act 1974 and CDM Regulations 2015.

REV	DESCRIPTION	DATE

epg
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PROJECT
BARHAM PARK
WEMBLEY

CLIENT
STRI

DRAWING TITLE
SUSTAINABLE DRAINAGE LAYOUT & DETAILS

SCALE @A1	DATE
1:20	21/02/2020

DRAWN BY	CHECKED BY	STATUS
JHR	PC	FOR COMMENT

DRAWING No	REVISION
9091-EPG-ZZ-XX-DR-Y-0010	-

7 APPENDIX C:

Existing Greenfield Runoff Rates & Proposed Microdrainage Calculations

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	John Roberts
Site name:	Barham Park
Site location:	

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

Site Details

Latitude:	51.55334° N
Longitude:	0.31246° W
Reference:	1725163408
Date:	Feb 21 2020 15:20

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha): 1.5

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Calculate from dominant HOST
HOST class:	25
BFI / BFIHOST:	0.17
Q_{MED} (l/s):	6.77
Q_{BAR} / Q_{MED} factor:	1.14

Hydrological characteristics

	Default	Edited
SAAR (mm):	640	640
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

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

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

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

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

(3) Is SPR/SPRHOST ≤ 0.3?

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

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	7.69	7.69
1 in 1 year (l/s):	6.53	6.53
1 in 30 years (l/s):	17.68	17.68
1 in 100 year (l/s):	24.52	24.52
1 in 200 years (l/s):	28.75	28.75

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	20.700	Add Flow / Climate Change (%)	0
Ratio R	0.438	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.511	4-8	0.655	8-12	0.018

Total Area Contributing (ha) = 1.184

Total Pipe Volume (m³) = 12.977

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	78.000	0.760	102.6	0.187	6.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	92.000	0.409	224.9	0.107	6.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	6.84	43.860	0.187	0.0	0.0	0.0	1.55	109.7	25.3
2.000	50.00	7.77	43.500	0.107	0.0	0.0	0.0	0.87	34.5	14.5

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.001	20.000	0.200	100.0	0.007	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	24.900	0.249	100.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.000	7.000	0.070	100.0	0.054	6.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	5.000	0.050	100.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.001	50.00	7.98	42.900	0.301	0.0	0.0	0.0	1.57	111.1	40.8
1.002	50.00	8.24	42.700	0.301	0.0	0.0	0.0	1.57	111.1	40.8
3.000	50.00	6.09	42.620	0.054	0.0	0.0	0.0	1.31	52.0	7.3
1.003	50.00	8.30	41.200	0.355	0.0	0.0	0.0	1.57	111.1	48.1

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003		43.300	41.150	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	4.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Region England and Wales
Return Period (years) 100 M5-60 (mm) 20.700

Synthetic Rainfall Details

Ratio R	0.438	Cv (Winter)	0.840
Profile Type	Summer	Storm Duration (mins)	30
Cv (Summer)	0.750		

Online Controls for Storm

Orifice Manhole: Tank, DS/PN: 1.003, Volume (m³): 4.3

Diameter (m) 0.052 Discharge Coefficient 0.600 Invert Level (m) 41.200

Storage Structures for Storm

Cellular Storage Manhole: Tank, DS/PN: 1.003

Invert Level (m) 41.600 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	114.0	114.0	1.300	0.0	174.0
1.200	114.0	174.0			

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	4.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.438
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.800	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status ON
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 20

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
1.000	SW1	15 minute 1 year Winter I+0%	15	44.460	43.960	-0.200	0.000	0.24
2.000	SW2	15 minute 1 year Winter I+0%	15	44.250	43.604	-0.121	0.000	0.44
1.001	SW3	15 minute 1 year Winter I+0%	15	43.600	43.036	-0.164	0.000	0.42
1.002	SW4	15 minute 1 year Winter I+0%	15	43.720	42.834	-0.166	0.000	0.41
3.000	SW5	15 minute 1 year Winter I+0%	15	43.220	42.688	-0.157	0.000	0.20
1.003	Tank	60 minute 1 year Winter I+0%	60	43.300	41.837	0.337	0.000	0.07

PN	US/MH Name	Overflow (l/s)	Maximum Vol (m³)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	SW1		0.108	13.061	25.6	OK
2.000	SW2		0.112	7.484	14.7	OK
1.001	SW3		0.148	21.051	40.5	OK
1.002	SW4		0.323	21.049	40.6	OK
3.000	SW5		0.071	3.773	7.4	OK

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Overflow (l/s)	Maximum Vol (m³)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.003	Tank		26.372	27.333	4.4	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	4.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.438
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.800	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status ON
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 20

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
1.000	SW1	15 minute 30 year Winter I+0%	15	44.460	44.028	-0.132	0.000	0.59
2.000	SW2	15 minute 30 year Winter I+0%	15	44.250	43.717	-0.008	0.000	0.98
1.001	SW3	15 minute 30 year Winter I+0%	15	43.600	43.141	-0.059	0.000	1.00
1.002	SW4	15 minute 30 year Winter I+0%	15	43.720	42.935	-0.065	0.000	0.97
3.000	SW5	15 minute 30 year Winter I+0%	15	43.220	42.731	-0.114	0.000	0.49
1.003	Tank	120 minute 30 year Winter I+0%	120	43.300	42.330	0.830	0.000	0.10

PN	US/MH Name	Overflow (l/s)	Maximum Vol (m³)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	SW1		0.184	32.074	61.9	OK
2.000	SW2		0.240	18.380	33.0	OK
1.001	SW3		0.368	51.691	96.6	OK
1.002	SW4		0.822	51.691	96.3	OK
3.000	SW5		0.121	9.267	18.3	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Overflow (l/s)	Maximum Vol (m³)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.003	Tank		80.344	71.494	5.9	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	4.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.438
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.800	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status ON
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 20

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
1.000	SW1	15 minute 100 year Winter I+20%	15	44.460	44.089	-0.071	0.000
2.000	SW2	15 minute 100 year Winter I+20%	15	44.250	44.145	0.420	0.000
1.001	SW3	15 minute 100 year Winter I+20%	15	43.600	43.477	0.277	0.000
1.002	SW4	15 minute 100 year Winter I+20%	15	43.720	43.136	0.136	0.000
3.000	SW5	120 minute 100 year Winter I+20%	120	43.220	42.940	0.095	0.000
1.003	Tank	120 minute 100 year Winter I+20%	120	43.300	42.938	1.438	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	SW1	0.91		0.253	50.077	95.9	OK
2.000	SW2	1.26		0.724	28.695	42.4	FLOOD RISK
1.001	SW3	1.30		4.608	80.703	125.9	FLOOD RISK
1.002	SW4	1.27		1.761	80.701	125.8	SURCHARGED
3.000	SW5	0.25		0.356	27.231	9.3	FLOOD RISK

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.003	Tank	0.12		137.294	86.315	7.4	SURCHARGED