ZE401 – Proposed houses, Ferrymoor, Ham, Richmond
SuDS strategy note 01
For PAG UK Ltd
February 2023

This note presents the proposed surface water management scheme with regards to the proposed redevelopment of a block of garages on Land adjacent 11 Ferrymoor, Ham, Richmond, TW10 7NB (see appended plans for a site location).

The site extends to circa 0.037 ha (370 m^2) and is impermeable, currently being laid to a block of garages and hardstanding. Runoff from the site currently flows overland to Ferrymoor (entering the road drainage network shown on topographical survey). As part of the proposed redevelopment of the site the impermeable area will be reduced to circa 0.02 ha (200 m^2), which will inherently help reduce runoff generated by the site.

Geological mapping (see appended SuDS infiltration GeoReport report) shows that the site is underlain by potentially permeable material. Infiltration testing at the site is not currently possible because of the significant disruption involved in breaking out the existing hardstanding. This note therefore includes two different surface water management schemes. A preferred scheme assuming a nominal infiltration rate, and a second scheme relying on minimal discharge rate (2.0 l/s) to the adopted Thames Water (TW) network. A pre application enquiry has been submitted to TW.

The infiltration scheme uses a nominal rate of 1 x 10^{-5} m/s. This is based on the superficial geology being described in the appended report as free draining with a high to very high permeability. Infiltration rates will be confirmed by on-site testing at the later Discharge of Conditions (DoC) and detailed design stages.

The rear gardens of the proposed properties are shown to be affected by a Root Protection Area (RPA) associated with the existing tree at the north-eastern corner of the site. To avoid the RPA the attenuation scheme comprises tanks beneath the private drive at the front of the proposed properties, with roof runoff being directed into them through overlying permeable paving.

The infiltration scheme comprises two elements to respond to the RPA:

- The hardstanding at the front of the proposed properties will manage its own runoff at source with an infiltration blanket sitting beneath the permeable paving at the front of the properties. The footprint of the blanket matches the footprint of the permeable paving on the appended surface water management drawing (the blanket allows for an offset from the proposed properties). The infiltration blanket will also serve to drain runoff from the cycle and bin stores and small area of paving between the permeable paving and the proposed properties. The limited area associated with the stores and area of paving means that the slight increase in the amount of water being released from the base of the blanket would not reasonably be considered as significant or something likely to impact ground stability.

- The proposed roof areas will drain to raised tanks in the back gardens which will outfall to a central infiltration/dispersal area. The Infiltration/dispersal area will comprise a layer of improved/engineered soil forming part of the make-up of the lawn. This effectively allows for a 'high spec' lawn to be installed rather than needing a stone blanket or drainage field formed from perforated pipes. The permeability of the improved/engineered soil (an off the shelf SuDS soil for example) need only meet the design infiltration rate, which will be informed by the actual infiltration rate (i.e. the result of the later stage investigations). Based on the nominal infiltration rate of 1 x 10^{-5} m/s and an infiltration/dispersal area of 20 m^2, each of the proposed properties will required a 5 m^3 tank. The discharge rate from each of the raised tanks will be controlled by an orifice (currently 10 mm diameter) in order to avoid overwhelming the infiltration/dispersal area.

For both schemes the single parking space in the north-east of the site (beneath the existing tree) will be permeably paved and will manage its own runoff at source via infiltration.

In the case of a storm exceeding the storage and freeboard in the system, overland flow would run (as existing) eastwards to Ferrymoor (and would enter the road drainage network).

According to Table 26.2 in the SuDS Manual (C753) the highest pollution hazard for the proposed development is low. Quoted pollution scores for the trafficked areas are 0.5, 0.4, and 0.4, and 0.2, 0.2, and 0.05 for the roof areas (for suspended solids, metals, and hydrocarbons respectively).

Post development runoff from the trafficked surfaces will be suitably treated by the permeable paving for both the infiltration and the attenuation schemes (permeable paving treatment scores are 0.7, 0.6, and 0.7). The permeable paving provides more than enough treatment for the roof runoff in the case of the attenuation scheme. In the case of the infiltration scheme roof runoff will be sufficiently treated by the infiltration/dispersal scheme, with treatment scores of 0.4, 0.3, and 0.3 being assigned to 300 mm depths of improved/engineered soil.

Maintenance of the majority of the scheme (i.e. all of the elements in private ownership) will remain the responsibility of the property owners. Suggested maintenance activities are appended. All proposals are subject to detailed design and the approval of relevant parties.

Appended information

SuDS plan
SuDS pro forma
Site location
Topographical survey
Calculations
Maintenance schedules
BGS GeoReport

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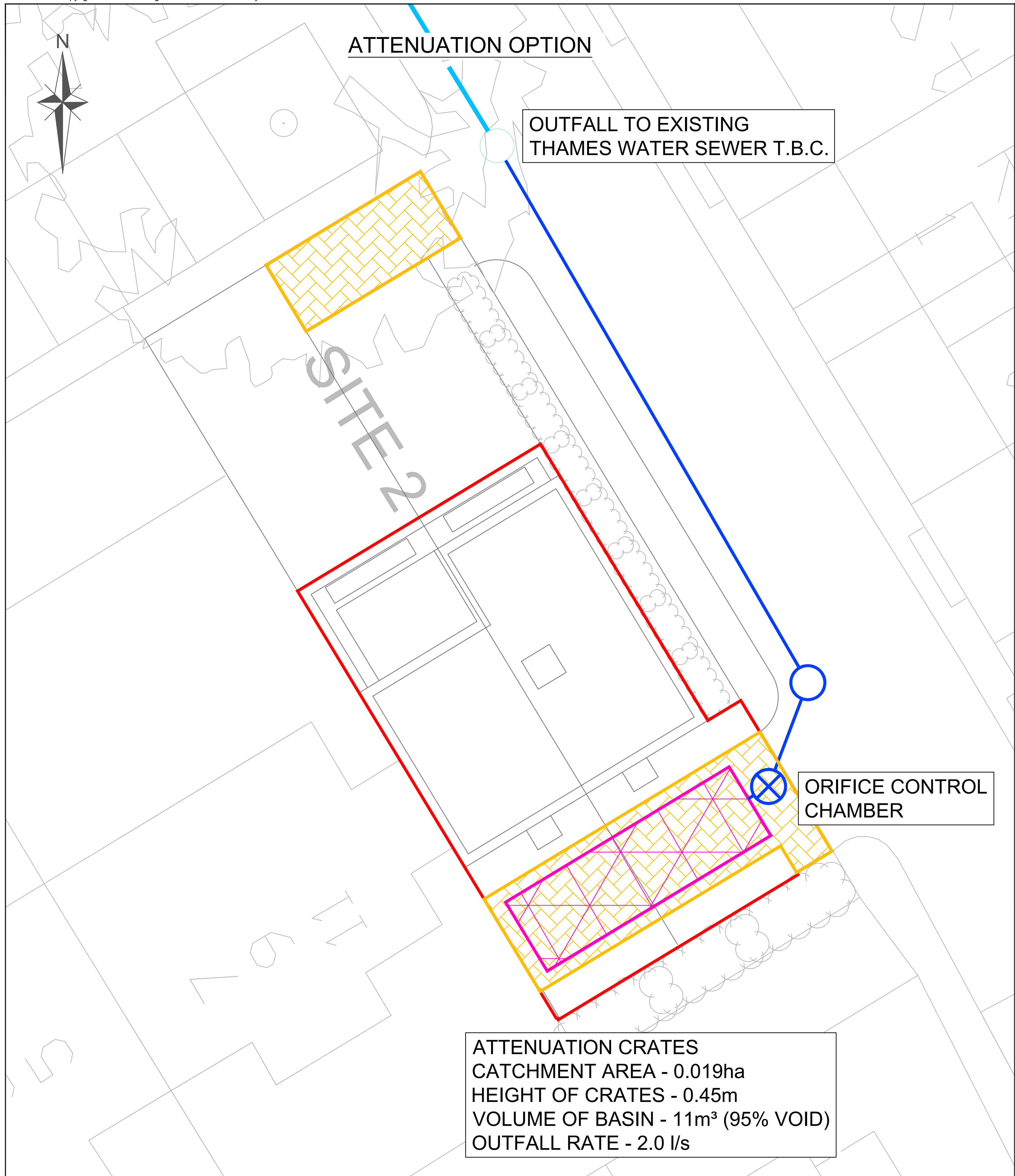
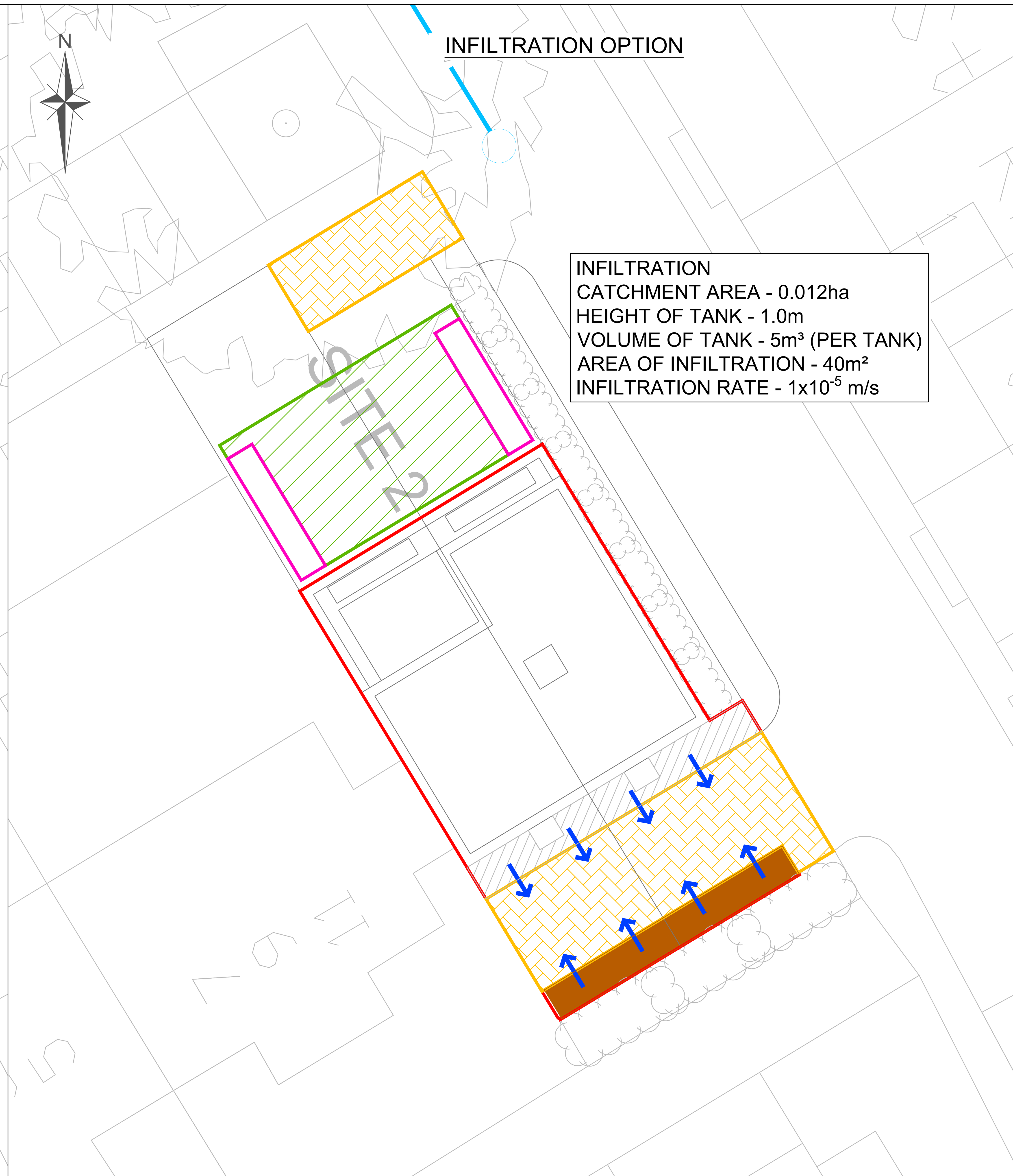




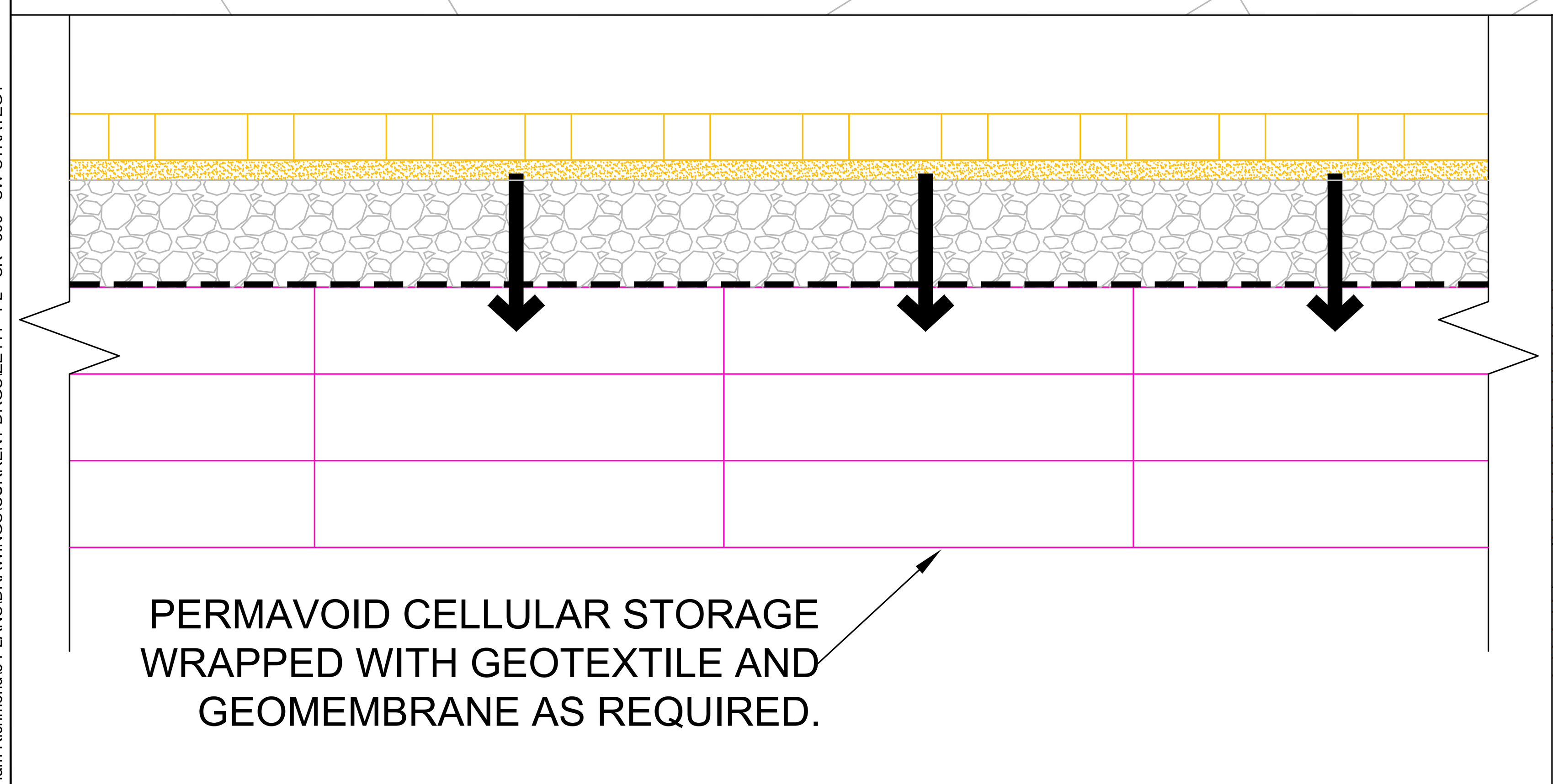
KEY

- EXISTING THAMES WATER SURFACE WATER SEWER
- PERMEABLE PAVING
- 3 x 0.15m HIGH PERMAVOID CELLULAR STORAGE OR SIMILAR APPROVED.
- RAISED TANKS 5 x 1 x 1m
- AREA OF INFILTRATION
- AREA OF FOOTPATH DRAINING TO BLANKET
- PROPOSED BIN STORE

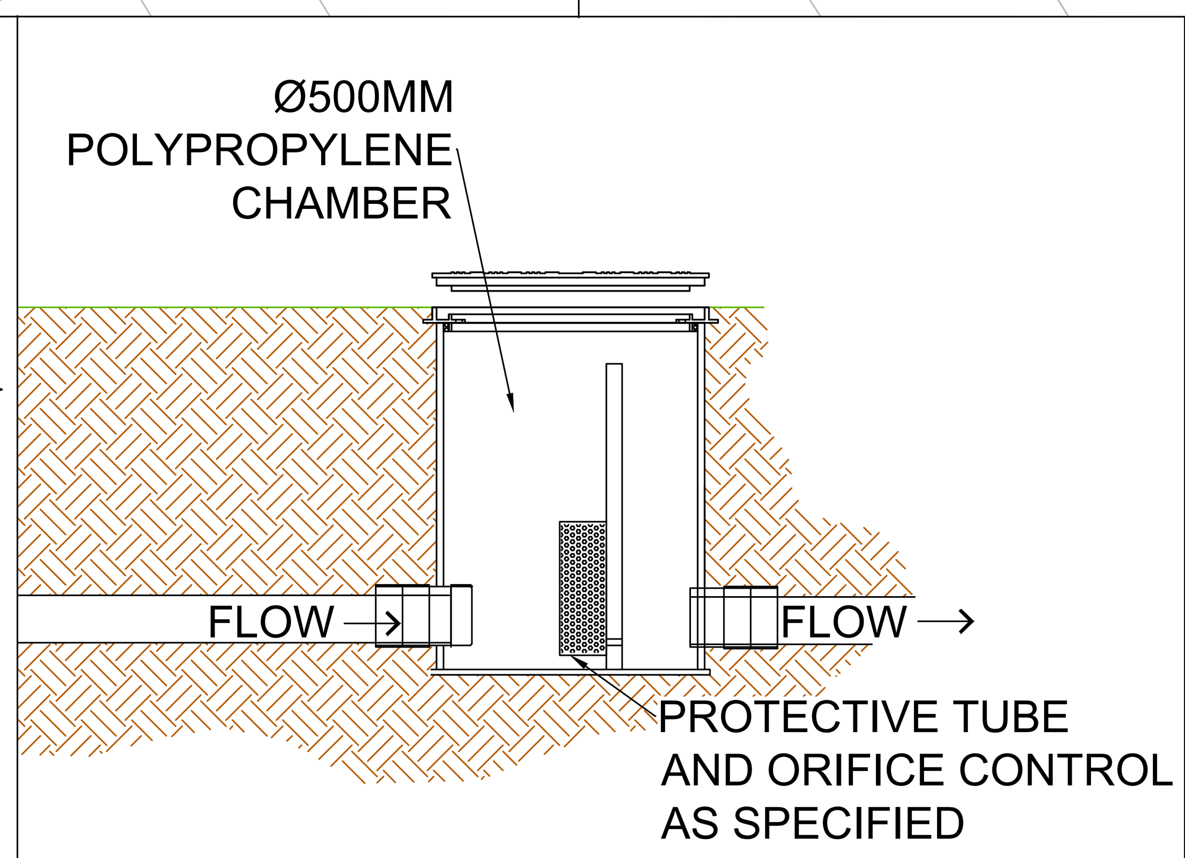
NOTES

PROPOSED IMPERMEABLE AREA (0.020ha)

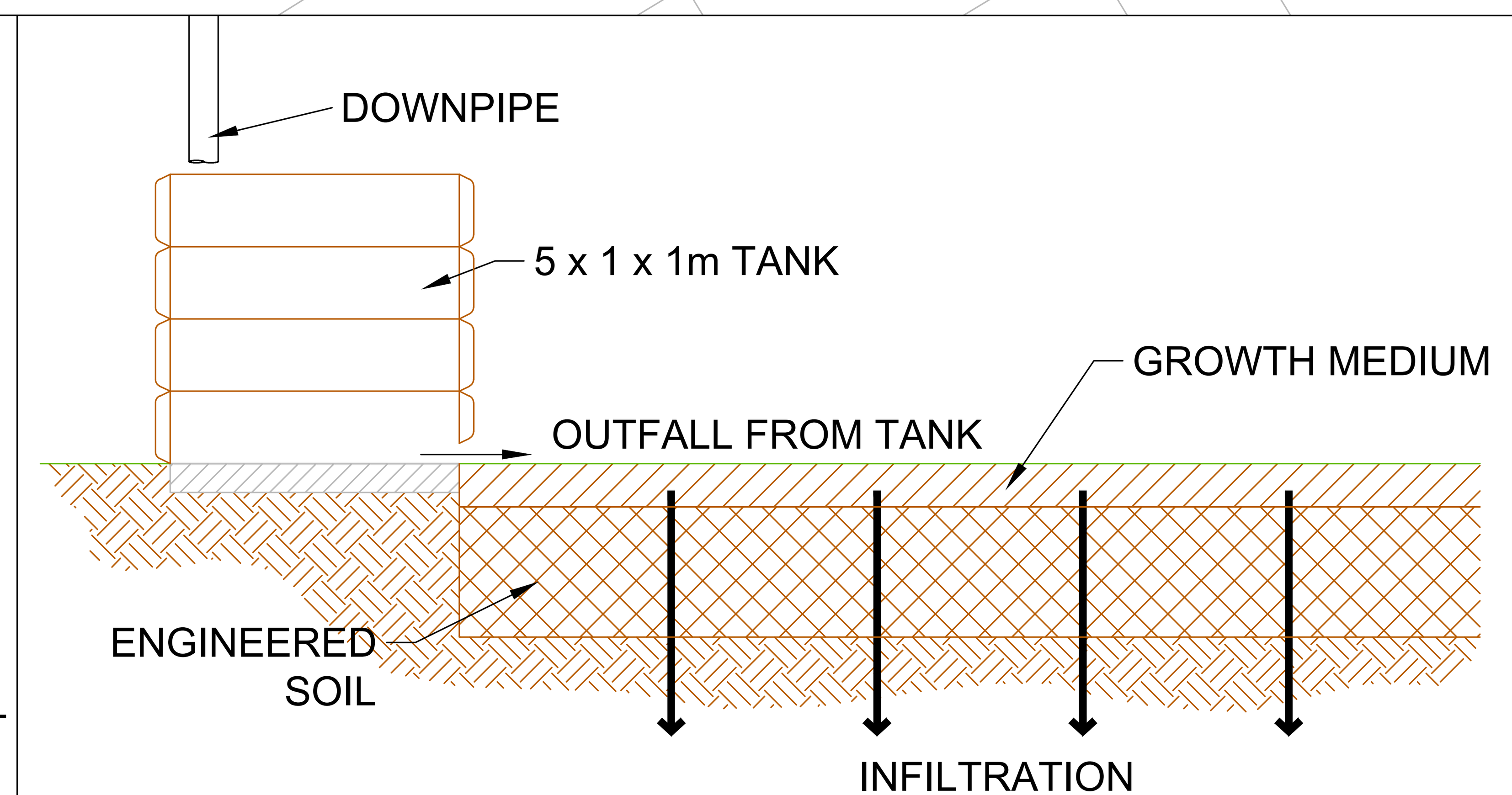
EXISTING IMPERMEABLE AREA (0.037ha)



TYPICAL PERMEABLE PAVING OVER CELLULAR STORAGE CRATES



ORIFICE CONTROL CHAMBER SECTION



TANK AND INFILTRATION GARDEN SECTION

REV	DESCRIPTION	DE	DR	CH	DATE

DESIGNED BY	DRAWN BY	CHECKED BY
-	DP	-

SCALE @ A1 SIZE	DATE
D.N.S.	27/02/2023

PROJECT TITLE

FERRYMOOR, HAM, RICHMOND

DRAWING TITLE

SURFACE WATER MANAGEMENT STRATEGY

CLIENT

NEW HILL LTD

CANNON CONSULTING ENGINEERS
Highways, Transport & Infrastructure Planning

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DRAWING NUMBER	REV.
ZD441 - PL - SK - 300	-

M:\ZE441 Ham Richmond\3 PLANS\DRAWINGS\CURRENT DRGS\ZE441 - PL - SK - 300 - SW STRATEGY

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LONDON BOROUGH OF RICHMOND UPON THAMES

LoDEG

1. Project & Site Details

Project / Site Name (including sub-catchment / stage / phase where appropriate)	FERRYMOOR GARAGE SITE
Address & post code	FERRYMOOR, HAM, RICHMOND, TW10 7NR
OS Grid ref. (Easting, Northing)	E 516801
	N 172151
LPA reference (if applicable)	
Brief description of proposed work	DEMOLITION OF EXISTING GARAGES AND ERCTION OF 2 PLOTS WITH PARKING
Total site Area	366 m^2
Total existing impervious area	366 m^2
Total proposed impervious area	200 m^2
Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	
Existing drainage connection type and location	
Designer Name	
Designer Position	
Designer Company	

2. Proposed Discharge Arrangements

2a. Infiltration Feasibility

Superficial geology classification	KEPTON PARK GRAVEL
Bedrock geology classification	LONDON CLAY FORMATION
Site infiltration rate	m/s
Depth to groundwater level	m below ground level
Is infiltration feasible?	

2b. Drainage Hierarchy

	Feasible (Y/N)	*Proposed (Y/N)*
1 store rainwater for later use		
2 use infiltration techniques, such as porous surfaces in non-clay areas		
3 attenuate rainwater in ponds or open water features for gradual release		
4 attenuate rainwater by storing in tanks or sealed water features for gradual release		
5 discharge rainwater direct to a watercourse		
6 discharge rainwater to a surface water sewer/drain		
7 discharge rainwater to the combined sewer.		

2c. Proposed Discharge Details

Proposed discharge location	EXISTING SURFACE WATER SEWER
Has the owner/regulator of the discharge location been consulted?	

LONDON BOROUGH OF RICHMOND UPON THAMES

LoDEG

3. Drainage Strategy

3a. Discharge Rates & Required Storage				
	Greenfield (GF) runoff rate (l/s)	*Existing discharge rate (l/s)*	*Required storage for GF rate (m^3)*	*Proposed discharge rate (l/s)*
Qbar				
1 in 1				
1 in 30				
1 in 100				
1 in 100 + CC				
Climate change allowance used		40%		
3b. Principal Method of Flow Control		ORIFICE		

3c. Proposed SuDS Measures			
	Catchment area (m^2)	*Plan area (m^2)*	*Storage vol. (m^3)*
Rainwater harvesting	0		0
Infiltration systems	0		0
Green roofs	0	0	0
Blue roofs	0	0	0
Filter strips	0	0	0
Filter drains	0	0	0
Bioretention / tree pits	0	0	0
Pervious pavements	17	42	1.5
Swales	0	0	0
Basins/ponds	0	0	0
Attenuation tanks	183		10.7
Total	200	42	12.2

4. Supporting Information

4a. Discharge & Drainage Strategy	*Page/section of drainage report*
Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	
Drainage hierarchy (2b)	
Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	
Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	
Proposed SuDS measures & specifications (3b)	

4b. Other Supporting Details	*Page/section of drainage report*
Detailed Development Layout	
Detailed drainage design drawings, including exceedance flow routes	
Detailed landscaping plans	
Maintenance strategy	
Demonstration of how the proposed SuDS measures improve:	
a) water quality of the runoff?	
b) biodiversity?	
c) amenity?	

NOTES

ORIGINAL A3

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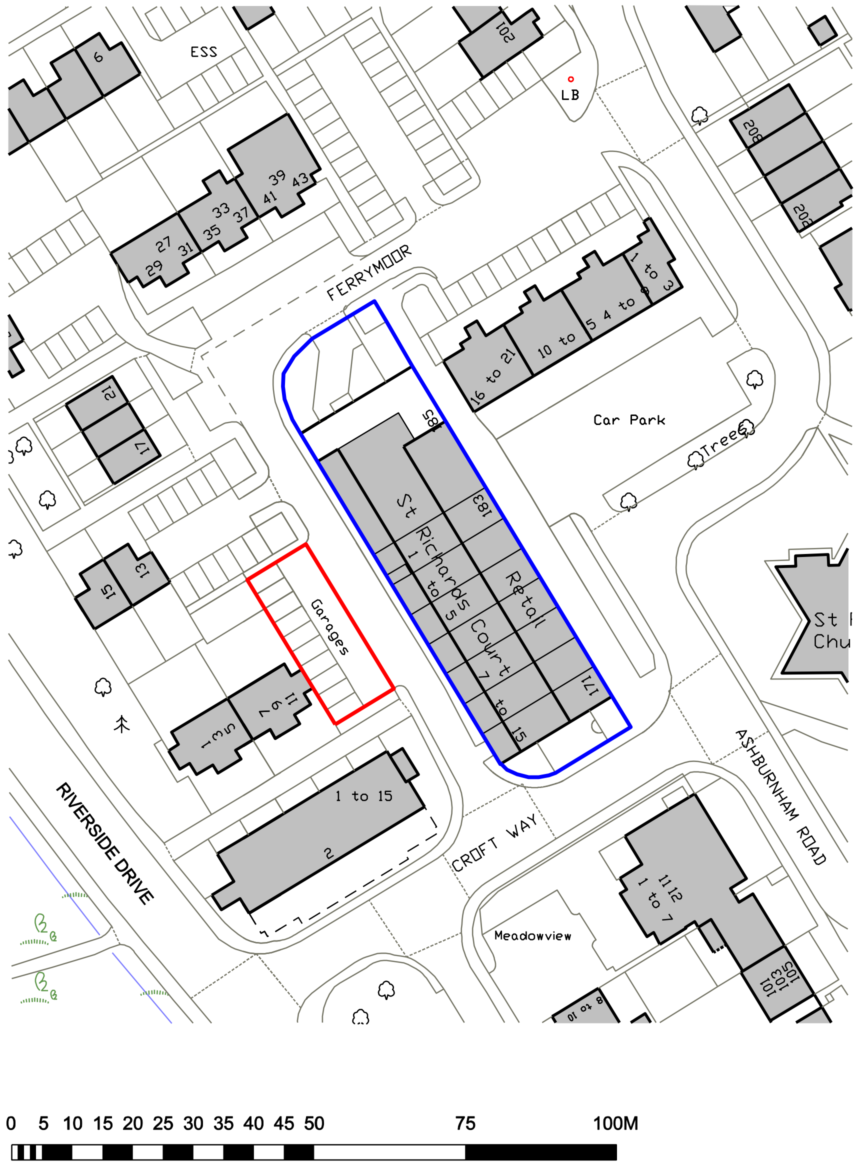

REVISIONS

SCALE	DATE	DRAWN	CHECKED
1:1250	06.10.21	SD	

PROJECT

FERRYMOOR
GARAGE SITE - 2
HAM

DRAWING

LOCATION PLAN

Zuber
Dobson
Architects

DRAWING No. REV

19021-P-120

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The accuracy of this survey corresponds to accuracy band F of the Measured Surveys of Land, Buildings & Utilities RICS Guidance Note 3rd Edition (2014). Any scaling should only be undertaken using a stable media print produced using the original data.

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All ground features that were visible at the time of the survey have been located, however there may have been items obscured. Pipe sizes and flow direction have been visually assessed from the surface and should be considered as approximate only.

Fences shown are not necessarily legal boundaries.

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Abbreviations

Fences

CBF Close Board Fence
CLF Chain Link Fence
CPF Chestnut Pailing Fence
CSF Concrete Slab Fence
IRF Iron Railing Fence
LLF Larch Lap Fence
OBF Open Board Fence
PRF Post and Rail Fence
PSB Pedestrian Safety Barrier
PWF Post and Wire Fence

Walls

BW Brick Wall
CW Concrete Wall
GW Gabion Wall
RET Retaining Wall
SW Stone Wall
TW Timber Wall

Surfaces

BPav Block Paved
Conc Concrete
CPS Concrete Paved Slabs
CZP Crazy Paved
FB Flower Bed
Tmac Tarmac
TPav Tactile Paved
SW Stone Wall

Covers/Drainage

AV Air Valve
CL Cover Level
COH Coal Hole
CP Catch Pit
CTV Cable TV
DC Drainage Channel
EC Electric Cover
FH Fire Hydrant
GU Gully
GV Gas Valve
IC Inspection Cover
IL Invert Level
Int Interceptor
KO Kerb Outlet
MH Manhole
PInt Petrol Interceptor
RE Rodding Eye
SAway Soakaway
SC Stop Cock
SV Service Valve
TC Telecoms Cover
UTL Unable to Lift
WC Water Cover
WM Water Meter
WO Wash Out

Street Furniture

ACU Air Conditioning Unit
BB Belisha Beacon
BO Bollard
BS Bus Stop
CO Column
EP Electricity Pole
FP Flag Pole
GP Gate Post
JB Junction Box
LB Litter Bin
LP Lamp Post
LW Light Well
MK Marker
PB Post Box
PM Parking Meter
PT Post
RS Road Sign
RSC Rolled Steel Column
RWP Rain Water Pipe
TBM Temporary Benchmark
TCB Telephone Call Box
TK Tank
TL Traffic Light
TP Telegraph Pole
VP Vent Pipe

Levels

ACL Arch Crown Level
ASL Arch Spring Level
DCL Door Cill Level
DHL Door Head Level
DPCL Damp Proof Course Level
EL Eave Level
FL Floor Level
FRL Flat Roof Level
PL Parapet Level
RL Ridge Level
SSL Structural Slab Level
TFL Top of Fence Level
THL Threshold Level
TWL Top of Wall Level
UBL Underside of Beam Level
USL Generic Underside Level
WCL Window Cill Level
WHL Window Head Level

Notes

Survey Station — STN
Spot Level — +20.00
Arch
Gate
Contours — 25.50
Hedge
Foul Pipe
Storm Pipe
Step/Stairs Up
Top of Bank
Bottom of Bank

Grid & Datum

Survey Grid

The survey grid is a local, plane grid coincident with Ordnance Survey National Grid and orientated to grid north.

Survey Datum

The survey is based on Ordnance Survey datum (Newlyn).

Trees

All trees sizes and heights are approximate and species have been identified to the best of the Surveyors knowledge. Where guaranteed tree species becomes important, the services of an Arborist should be employed.

Notation : Diameter of Trunk / Height / Spread

Trees that have multiple boles will be annotated MB

Individual tree canopies are shown in a separate layer named CANOPIES, which for presentation purposes has been turned off.

Drainage

Where drainage covers have been lifted, data has been recorded for each individual manhole from the surface and connections to other manholes, pipes or gullys are assumed. Where information is required by accessing the manhole or tracing to other manholes then a services trace will be needed.

Notes

Building Level Information

Eaves level indicates lowest point of roof pitch.

Ridge Level
Roof
Eaves Level
Soffit Level

SURVEY STATIONS			
Name	Easting	Northing	Height
1STN	516838.066	172115.162	7.419
2STN	516788.018	172199.691	7.984
3STN	516813.794	172209.301	7.970
4STN	516857.930	172141.865	7.708

Scale Bar
0 1 5 10

Scale in Metres 1:200 @ A1

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Client: Client Name Here

Drawing Title: Topographical Survey

Project: Ashburnham Road, Richmond, TW10 7NR

Drawn by S.L. | Checked: W.S. | Status: FINAL | Rev:

Date: 08/10/20 | SD Ref No:20249_01 | Sheet: 01 of 01

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.950	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	500.0		

Nodes

Name	Area (ha)	Cover Level (m)	Depth (m)
BASIN	0.019	100.000	1.000

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Normal	Additional Storage (m³/ha)	20.0
Summer CV	0.950	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	0.950	Drain Down Time (mins)	240	Check Discharge Volume	x

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 %)
2	0	0	0
30	35	0	0
100	40	0	0
100	40	5	0

Node BASIN Online Orifice Control

Flap Valve	x	Design Depth (m)	0.450	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Design Flow (l/s)	2.0		
Invert Level (m)	99.000	Diameter (m)	0.038		

Node BASIN Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	99.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	60

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	25.0	0.0	0.450	25.0	0.0	0.451	0.0	0.0

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Results for 2 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute summer	BASIN	76	99.064	0.064	1.6	1.5552	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
120 minute summer	BASIN	Orifice	0.6	3.1

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Results for 30 year +35% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute summer	BASIN	80	99.243	0.243	5.3	5.8631	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
120 minute summer	BASIN	Orifice	1.4	10.4

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Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute summer	BASIN	82	99.341	0.341	7.1	8.2338	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
120 minute summer	BASIN	Orifice	1.7	14.1

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Results for 100 year +40% CC +5% A Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status
120 minute summer	BASIN	82	99.363	0.363	7.5	8.7565	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m^3)
120 minute summer	BASIN	Orifice	1.8	14.8

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.950	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	500.0		

Nodes

Name	Area (ha)	Cover Level (m)	Depth (m)
BLANKET	0.007	100.000	1.000

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Normal	Additional Storage (m^3/ha)	20.0
Summer CV	0.950	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	0.950	Drain Down Time (mins)	240	Check Discharge Volume	x

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 %)
2	0	0	0
30	35	0	0
100	40	0	0
100	40	5	0

Node BLANKET Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.03600	Safety Factor	2.0	Invert Level (m)	99.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	176

Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)
0.000	43.0	43.0	0.350	43.0	43.0	0.351	0.0	43.0

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Results for 2 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status
180 minute summer	BLANKET	112	99.050	0.050	0.5	0.6526	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)
180 minute summer	BLANKET	Infiltration	0.2

Results for 30 year +35% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status
180 minute summer	BLANKET	136	99.210	0.210	1.5	2.7421	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)
180 minute summer	BLANKET	Infiltration	0.2

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute summer	BLANKET	148	99.315	0.315	2.0	4.1101	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)
180 minute summer	BLANKET	Infiltration	0.2

Results for 100 year +40% CC +5% A Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	BLANKET	168	99.337	0.337	1.4	4.3928	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)
180 minute winter	BLANKET	Infiltration	0.2

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Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.950	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	500.0		

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Normal	Additional Storage (m^3/ha)	20.0
Summer CV	0.950	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	0.950	Drain Down Time (mins)	10080	Check Discharge Volume	x

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 %)
2	0	0	0
30	35	0	0
100	40	0	0
100	40	5	0

Node RAISED TANK Online Orifice Control

Flap Valve	x	Design Depth (m)	0.900	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Design Flow (l/s)	0.2		
Invert Level (m)	99.000	Diameter (m)	0.010		

Node RAISED TANK Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	99.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	260

Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)
0.000	5.0	0.0	1.000	5.0	0.0

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Results for 2 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute summer	RAISED TANK	248	99.147	0.147	0.3	0.7540	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
360 minute summer	RAISED TANK	Orifice	0.1	1.2

Results for 30 year +35% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute summer	RAISED TANK	248	99.550	0.550	0.8	2.8175	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
360 minute summer	RAISED TANK	Orifice	0.2	4.7

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Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	RAISED TANK	224	99.760	0.760	1.0	3.8937	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
240 minute winter	RAISED TANK	Orifice	0.2	5.5

Results for 100 year +40% CC +5% A Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	RAISED TANK	228	99.803	0.803	1.0	4.1169	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
240 minute winter	RAISED TANK	Orifice	0.2	5.8

Pervious Pavement Maintenance

Maintenance schedule	Required action	Frequency
Regular maintenance	Brushing and vacuuming.	Annual, depending on site conditions and any specific recommendations (from the manufacturer).
Occasional maintenance	Removal of weed.	As required, annual on high use pavements
	Stabilise and mow areas which shed flow to the paving	As required
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving.	As required.
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users.	As required.
	Rehabilitation of surface and upper sub-structure.	As required
Monitoring	Initial inspection	Monthly for 3 months post installation
	Inspect for evidence of poor performance (pooling of water in areas for example) and for weed growth, correct as necessary	Quarterly and up to 48 hours after large storm events
	Inspect silt accumulation and adjust brushing if necessary	Annually
	Inspect flow control, connecting pipework and manholes/inspection chambers (clean as necessary)	Quarterly

(Based on advice in CIRIA C753)

Crate Maintenance

Maintenance schedule	Required action	Frequency
Regular maintenance	Inspect to identify any area of underperformance and correct (repair, improve etc)	Monthly for 3 months then annually
	Remove debris from drained area to prevent entry to the system	Monthly
	Check any infiltration surfaces which allow water to percolate into the tanks for blockages, correct as necessary	Annually
	Remove sediment from traps	Annually/as required
Remedial actions	Repair/replace inlets, outlets, overflows, and vents	As required.
Monitoring	Check that outlets, inlets, vents, and overflows are in good condition and working as intended	Annually
	Inspect tank internally, remove any sediment if present and if required	Every 5 years (or more frequently if necessary)

(Based on advice in CIRIA C753)

Infiltration Blanket/Trench

Maintenance schedule	Required action	Frequency
	Inspect traps/chambers for sediment accumulation and remove	Six monthly, until a pattern of accumulation is established, then as required
	Remove sediment from traps	Annually/as required
Remedial actions	Repair/replace inlets	As required.
Occasional Maintenance	Check inlets functioning as intended	Annually
	Check for root ingress to blanket/trench and trim as necessary (in accordance with appropriate guidance on vegetation management)	Annually or less frequently depending on proximity and type of planting

(Based on advice in CIRIA C753)

GeoReports

British Geological Survey

David Pearson
Cannon Consulting Engineers
Cambridge House
Lanwades Business Park
Kennett
Newmarket
CB8 7PN

Infiltration SuDS GeoReport:

This report provides information on the suitability of the subsurface for the installation of infiltration sustainable drainage systems (SuDS). It provides information on the properties of the subsurface with respect to significant constraints, drainage, ground stability and groundwater quality protection.

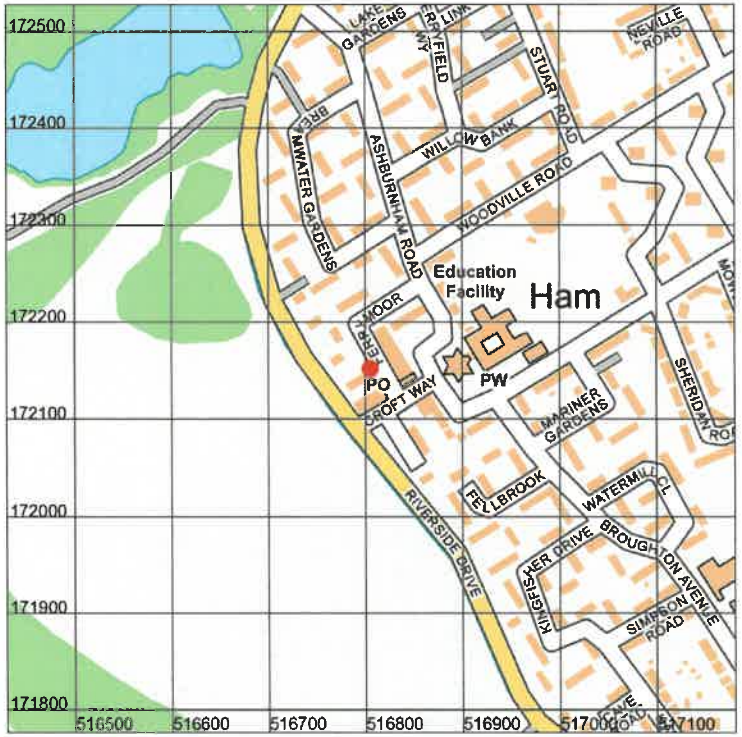
Report Id: *BGS_331164/42380*

Client reference: ZE441 - Ham Richmond

GeoReports

British Geological Survey

Search location



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Search location indicated in red

Point centred at: 516805,172152

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Assessment for an infiltration sustainable drainage system

Introduction

Sustainable drainage systems (SuDS) are drainage solutions that manage the volume and quality of surface water close to where it falls as rain. They aim to reduce flow rates to rivers, increase local water storage capacity and reduce the transport of pollutants to the water environment. There are four main types of SuDS, which are often designed to be used in sequence. They comprise:

- **source control:** systems that control the rate of runoff
- **pre-treatment:** systems that remove sediments and pollutants
- **retention:** systems that delay the discharge of water by providing surface storage
- **infiltration:** systems that mimic natural recharge to the ground.

This report focuses on infiltration SuDS. It provides subsurface information on the properties of the ground with respect to drainage, ground stability and groundwater quality protection. It is intended principally for those involved in the preliminary assessment of the suitability of the ground for infiltration SuDS, and those involved in assessing proposals from others for sustainable drainage, but it may also be useful to help house-holders judge whether or not further professional advice should be sought. If in doubt, users should consult a suitably-qualified professional about the results in this report before making any decisions based upon it.

This GeoReport is structured in two parts:

- **Part 1. Summary data.**

  Comprises three maps that summarise the data contained within Part 2.

- **Part 2. Detailed data.**

  Comprises a further 24 maps in four thematic sections:

  - **Very significant constraints.** Maps highlight areas where infiltration may result in adverse impacts due to factors including: ground instability (soluble rocks, non-coal shallow mining and landslide hazards); persistent shallow groundwater, or the presence of made ground, which may represent a ground stability or contamination hazard.
  - **Drainage potential**. Maps indicate the drainage potential of the ground, by considering subsurface permeability, depth to groundwater and the presence of floodplain deposits.
  - **Ground stability**. Maps indicate the presence of hazards that have the potential to cause ground instability resulting in damage to some buildings and structures, if water is infiltrated to the ground.
  - **Groundwater protection**. Maps provide key indicators to help determine whether the groundwater may be susceptible to deterioration in quality as a result of infiltration.

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This report considers the suitability of the subsurface for the installation of infiltration SuDS, such as soakaways, infiltration basins or permeable pavements. It provides subsurface data to indicate whether, and which type of infiltration system may be appropriate. It does not state that infiltration SuDS are, or are not, appropriate as this is highly dependent on the design of the individual system. This report therefore describes the subsurface conditions at the site, allowing the reader to determine the suitability of the site for infiltration SuDS.

The map and text data in this report is similar to that provided in the *'Infiltration SuDS Map: Detailed'* national map product. For further information about the data, consult the *'User Guide for the Infiltration SuDS Map: Detailed'*, available from http://nora.nerc.ac.uk/16618/.

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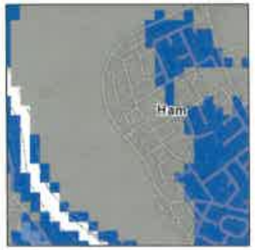
PART 1: SUMMARY DATA

This section provides a summary of the data.

In terms of the drainage potential, is the ground suitable for infiltration SuDS?



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Light blue	Highly compatible for infiltration SuDS. The subsurface is likely to be suitable for free-draining infiltration SuDS.
Mid blue	Probably compatible for infiltration SuDS. The subsurface is probably suitable although the design may be influenced by the ground conditions.
Dark blue	Opportunities for bespoke infiltration SuDS. The subsurface is potentially suitable although the design will be influenced by the ground conditions.
Grey	Very significant constraints are indicated. There is a very significant potential for one or more hazards associated with infiltration.

Is ground instability likely to be a problem?

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Light green	Increased infiltration is very unlikely to result in ground instability.
Mid green	Ground instability problems may be present or anticipated, but increased infiltration is unlikely to result in ground instability.
Dark green	Ground instability problems are probably present. Increased infiltration may result in ground instability.
Grey	There is a very significant potential for one or more geohazards associated with infiltration.

Is the groundwater susceptible to deterioration in quality?

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Light pink	The groundwater is not expected to be especially vulnerable to contamination.
Mid pink	The groundwater may be vulnerable to contamination.
Dark red	The groundwater is likely to be vulnerable to contaminants.
Grey	Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

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PART 2: DETAILED DATA

This section provides further information about the properties of the ground and will help assess the suitability of the ground for infiltration SuDS.

Section 1. Very significant constraints

Where maps are overlain by grey polygons, geological or hydrogeological hazards may exist that could be made worse by infiltration. The following hazards are considered:

- soluble rocks
- landslides
- shallow mining (not including coal)
- shallow groundwater
- made ground

For more information read 'Explanation of terms' at the end of this report.

Soluble rock hazard

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Grey	Very significant soluble rock hazard. Soluble rocks are present with a very significant possibility of localised subsidence that could be initiated or made worse by infiltration. The site investigation should consider whether the potential for or the consequences of subsidence as a result of infiltration are significant.
White	Very significant soluble rock hazards are not present; however this hazard may still need to be considered. See Part 3.

Landslide hazard

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Grey	Very significant landslide hazard. Slope instability problems are almost certainly present and may be active. An increase in moisture content as a result of infiltration may cause the slope to fail. The site investigation should consider whether the potential for or the consequences of landslide as a result of infiltration are significant.
White	Very significant landslide hazards are not present; however this hazard may still need to be considered. See Part 3.

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Shallow mining hazard (not including coal)	
 Contains OS data © Crown Copyright and database right 2023	Very significant mining hazard. Shallow mining is likely to be present with a very significant possibility of localised subsidence that could be initiated or made worse by increased infiltration. Also, infiltration may increase the possibility of remobilising pollutants. The site investigation should consider whether the potential for or consequences of subsidence and/or remobilisation of pollutants as a result of infiltration are significant.
	Very significant mining hazards are not present; however this hazard may still need to be considered. See Part 3.

Persistent shallow groundwater	
 Contains OS data © Crown Copyright and database right 2023	Very high likelihood of persistent or seasonally shallow groundwater. Persistent or seasonally shallow groundwater is likely to be present. Infiltration may increase the likelihood of soakaway inundation, or groundwater emergence at the surface. The site investigation should consider whether the potential for or the consequences of groundwater level rise as a result of infiltration are significant.
	See Part 2 for the likely depth to water table.

Made ground	
 Contains OS data © Crown Copyright and database right 2023	Made ground present. Made ground is present at the surface. Infiltration may affect ground stability or increase the possibility of remobilising pollutants. The site investigation should consider whether the potential for or consequences of ground instability and/or pollutant leaching as a result of infiltration are significant.
	None recorded

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Section 2. Drainage potential

The following pages contain maps that will help you assess the drainage potential of the ground by considering the:

- depth to water table
- permeability of the superficial deposits
- thickness of the superficial deposits
- permeability of the bedrock
- presence of floodplains

Superficial deposits are not present everywhere and therefore some areas of the *superficial deposit permeability* map may not be coloured. Where this is the case, the *bedrock permeability* map shows the likely permeability of the ground. Superficial deposits in some places are very thin and hence in these places you may wish to consider both the permeability of the superficial deposits and the permeability of the bedrock. The *superficial thickness* map will tell you whether the superficial deposits are thin (< 3 m thick) or thick (>3 m). Where they are over 3 m thick, the permeability of the bedrock may not be relevant.

For more information read 'Explanation of terms' at the end of this report.

Depth to groundwater table	
 Contains OS data © Crown Copyright and database right 2023	Groundwater is likely to be **more than 5 m** below the ground surface throughout the year.
	Groundwater is likely to be between **3 and 5 m** below the ground surface for at least part of the year.
	Groundwater is likely to be **less than 3 m** below the ground surface for at least part of the year.

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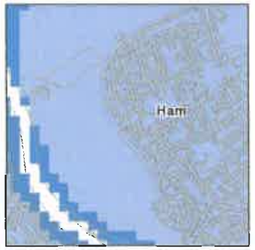
Superficial deposit permeability



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Superficial deposits are likely to be **free-draining**.

The superficial deposit permeability is **spatially variable**, but likely to permit moderate infiltration.

Superficial deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

- Very Low
- Low
- Moderate
- High
- Very High

Minimum

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Maximum

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Superficial deposit thickness

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The thickness of superficial deposits is **< 3 m** and hence the permeability of the ground may be dependent on both the superficial deposits (where present) and underlying bedrock (see below).

The thickness of superficial deposits is **> 3 m** and hence the permeability of the superficial deposits is likely to determine the permeability of the ground.

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GeoReports

British Geological Survey

Bedrock permeability

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Bedrock deposits are likely to be **free-draining**.

The bedrock permeability is **spatially variable**, but likely to permit moderate infiltration.

Bedrock deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

Key

- Very Low
- Low
- Moderate
- High
- Very High

Minimum

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Maximum

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Geological indicators of flooding

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Superficial floodplain deposits or low-lying coastal areas have been identified. Groundwater levels may rise in response to high river or tide levels, potentially causing inundation of subsurface infiltration SuDS.

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Section 3. Ground stability

The following pages contain maps that will help you assess whether infiltration may impact the stability of the ground. They consider hazards associated with:

- soluble rocks
- landslides
- shallow mining
- running sands
- swelling clays
- compressible ground, and
- collapsible ground

In the following maps, geohazards that are identified in green are unlikely to prevent infiltration SuDS from being installed, but they should be considered during design. For more information read 'Explanation of terms' at the end of this report.

Soluble rocks

 Contains OS data © Crown Copyright and database right 2023	Increased infiltration is unlikely to result in subsidence.
	Increased infiltration is unlikely to cause localised subsidence, but potential impacts should be considered.
	Increased infiltration may result in localised subsidence. The potential for or the consequences of subsidence associated with soluble rocks should be considered.
	Very significant possibility of localised subsidence that could be initiated or made worse by infiltration.

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Landslides

 Contains OS data © Crown Copyright and database right 2023	Increased infiltration is unlikely to lead to slope instability.
	Slope instability problems may be present or anticipated, but increased infiltration is unlikely to cause instability
	Slope instability problems are probably present or have occurred in the past, and increased infiltration may result in slope instability.
	Slope instability problems are almost certainly present and may be active. An increase in moisture content as a result of infiltration may cause the slope to fail.

Shallow mining

 Contains OS data © Crown Copyright and database right 2023	Increased infiltration is unlikely to lead to subsidence.
	Shallow mining is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
	Shallow mining could be present with a significant possibility that localised subsidence could be initiated or made worse by increased infiltration.
	Shallow mining is likely to be present, with a very significant possibility that localised subsidence may be initiated or made worse by increased infiltration.

Running sand

 Contains OS data © Crown Copyright and database right 2023	Increased infiltration is unlikely to cause ground collapse associated with running sands.
	Running sand is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
	Significant possibility for running sand problems. Increased infiltration may result in a geohazard.

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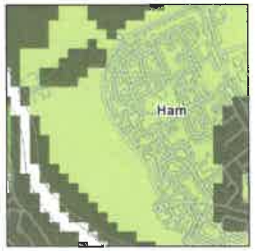
Swelling clays	
 Contains OS data © Crown Copyright and database right 2023	Increased infiltration is unlikely to cause shrink-swell ground movement.
	Ground is susceptible to shrink-swell ground movement. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
	Ground is susceptible to shrink-swell ground movement. Increased infiltration may result in a geohazard.
Compressible ground	
 Contains OS data © Crown Copyright and database right 2023	Increased infiltration is unlikely to lead to ground compression.
	Compressibility and uneven settlement hazards are probably present. Increased infiltration may result in a geohazard.
Collapsible ground	
 Contains OS data © Crown Copyright and database right 2023	Increased infiltration is unlikely to result in subsidence.
	Deposits with potential to collapse when loaded and saturated are possibly present in places. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
	Deposits with potential to collapse when loaded and saturated are probably present in places. Increased infiltration may result in a geohazard.

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Section 4. Groundwater quality protection

The following pages contain maps showing some of the information required to ensure the protection of groundwater quality. Data presented includes:

- groundwater source protection zones (Environment Agency data)
- predominant flow mechanism
- made ground

For more information read 'Explanation of terms' at the end of this report.

Groundwater source protection zones	
 Contains OS data © Crown Copyright and database right 2023 Derived in part from Source Protection Zone data provided under licence from the Environment Agency © Environment Agency 2023.	Groundwater is not within a source protection zone.
	Source protection zone IV
	Source protection zone III
	Source protection zone II
	Source protection zone I
Predominant flow mechanism	
 Contains OS data © Crown Copyright and database right 2023	Water is likely to percolate through the unsaturated zone to the groundwater through either the pore space in granular media or through porespace and fractures; these processes have some potential for contaminant removal and breakdown.
	Water is likely to percolate through the unsaturated zone to the groundwater through fractures, a process which has little potential for contaminant removal and breakdown.

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Made ground	
 Contains OS data © Crown Copyright and database right 2023	Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

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Section 5. Geological Maps

The following maps show the artificial, superficial and bedrock geology within the area of interest.

Artificial deposits

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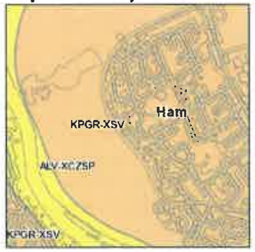
Superficial deposits



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Bedrock

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Fault

Coal, ironstone or mineral vein

Note: Faults and Coals, ironstone & mineral veins are shown for illustration and to aid interpretation of the map. Not all such features are shown and their absence on the map face does not necessarily mean that none are present

Key to Artificial deposits:

Map colour	Computer Code	Rock name	Rock type
⊠	WMGR-ARTDP	INFILLED GROUND	ARTIFICIAL DEPOSIT
▨	WGR-VOID	WORKED GROUND (UNDIVIDED)	VOID

Key to Superficial deposits:

Map colour	Computer Code	Rock name	Rock type
	ALV-XCZSP	ALLUVIUM	CLAY, SILT, SAND AND PEAT
	KPGR-XSV	KEMPTON PARK GRAVEL MEMBER	SAND AND GRAVEL

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Key to Bedrock geology:

Map colour	Computer Code	Rock name	Rock type
▢	LC-XCZ	LONDON CLAY FORMATION	CLAY AND SILT

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Limitations of this report:

- This report is concerned with the potential for infiltration-to-the-ground to be used as a SuDS technique at the site described. It only considers the subsurface beneath the search area and does NOT consider potential surface or subsurface impacts outside of that area.
- This report is NOT an alternative for an on-site investigation or soakaway test, which might reach a different conclusion.
- This report must NOT be used to justify disposal of foul waste or grey water.
- This report is based on and limited to an interpretation of the records held by the British Geological Survey (BGS) at the time the search is performed. The datasets used (with the exception of that showing depth to water table) are based on 1:50 000 digital geological maps and not site-specific data.
- Other more specific and detailed ground instability information for the site may be held by BGS, and an assessment of this could result in a modified assessment.
- To interpret the maps correctly, the report must be viewed and printed in colour.
- The search does NOT consider the suitability of sites with regard to:
    - previous land use,
    - potential for, or presence of contaminated land
    - presence of perched water tables
    - shallow mining hazards relating to coal mining. Searches of coal mining should be carried out via The Coal Authority Mine Reports Service: www.coalminingreports.co.uk.
    - made ground, where not recorded
    - proximity to landfill sites (searches for landfill sites or contaminated land should be carried out through consultation with local authorities/Environment Agency)
    - zones around private water supply boreholes that are susceptible to groundwater contamination.
- This report is supplied in accordance with the GeoReports Terms & Conditions available separately, and the copyright restrictions described at the end of this report

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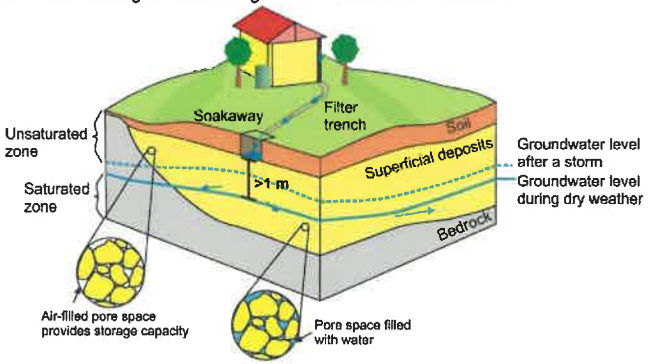
Explanation of terms

Depth to groundwater

In the shallow subsurface, the ground is commonly unsaturated with respect to water. Air fills the spaces within the soil and the underlying superficial deposits and bedrock. At some depth below the ground surface, there is a level below which these spaces are full of water. This level is known as the groundwater level, and the water below it is termed the groundwater. When water is infiltrated, the groundwater level may rise temporarily. To ensure that there is space in the unsaturated zone to accommodate this, there should be a minimum thickness of 1 m between the base of the infiltration system and the water table. An estimate of the *depth to groundwater* is therefore useful in determining whether the ground is suitable for infiltration.



Groundwater flooding

Groundwater flooding occurs when a rise in groundwater level results in very shallow groundwater or the emergence of groundwater at the surface. If infiltration systems are installed in areas that are susceptible to groundwater flooding, it is possible that the system could become inundated. The susceptibility map seeks to identify areas where the geological conditions and water tables indicate that groundwater level rise could occur under certain circumstances. A high susceptibility to groundwater flooding classification does not mean that groundwater flooding has ever occurred in the past, or will do so in the future as the susceptibility maps do not contain information on how often flooding may occur. The susceptibility maps are designed for planning; identifying areas where groundwater flooding might be an issue that needs to be taken into account.

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Geological indicators of flooding

In floodplain deposits, groundwater level can be influenced by the water level in the adjacent river. Groundwater level may increase during periods of fluvial flood and therefore this should be taken into account when designing infiltration systems on such deposits. The *geological indicators of flooding* dataset shows where there is geological evidence (floodplain deposits) that flooding has occurred in the past.

For further information on flood-risk, the likely frequency of its recurrence in relation to any proposed development of the site, and the status of any flood prevention measures in place, you are advised to contact the local office of the Environment Agency (England and Wales) at www.environment-agency.gov.uk/ or the Scottish Environment Protection Agency (Scotland) at www.sepa.org.uk.

Artificial ground

Artificial ground comprises deposits and excavations that have been created or modified by human activity. It includes ground that is worked (quarries and road cuttings), infilled (back-filled quarries), landscaped (surface re-shaping), disturbed (near surface mineral workings) or classified as made ground (embankments and spoil heaps). The composition and properties of artificial ground are often unknown. In particular, the permeability and chemical composition of the artificial ground should be determined to ensure that the ground will drain and that any contaminants present will not be remobilised.

Superficial permeability

Superficial deposits are those geological deposits that were formed during the most recent period of geological time (as old as 2.6 million years before present). They generally comprise relatively thin deposits of gravel, sand, silt and clay and are present beneath the pedological soil in patches or larger spreads over much of Britain. The ease with which water can percolate through these deposits is controlled by their permeability and varies widely depending on their composition. Those deposits comprising clays and silts are less permeable and thus infiltration is likely to be slow, such that water may pool on the surface. In comparison, deposits comprising sands and gravels are more permeable allowing water to percolate freely.

Bedrock permeability

Bedrock forms the main mass of rock forming the Earth. It is present everywhere, commonly beneath superficial deposits. Where the superficial deposits are thin or absent, the ease with which water will percolate into the ground depends on the permeability of the bedrock.

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Natural ground instability
Natural ground instability refers to the propensity for upward, lateral or downward movement of the ground that can be caused by a number of natural geological hazards (e.g. ground dissolution/compressible ground). Some movements associated with particular hazards may be gradual and of millimetre or centimetre scale, whilst others may be sudden and of metre or tens of metres scale. Significant natural ground instability has the potential to cause damage to buildings and structures, especially when the drainage characteristics of a site are altered. It should be noted, however, that many buildings, particularly more modern ones, are built to such a standard that they can remain unaffected in areas of significant ground movement.

Shrink-swell
A shrinking and swelling clay changes volume significantly according to how much water it contains. All clay deposits change volume as their water content varies, typically swelling in winter and shrinking in summer, but some do so to a greater extent than others. Contributory circumstances could include drought, leaking service pipes, tree roots drying-out the ground or changes to local drainage patterns, such as the creation of soakaways. Shrinkage may remove support from the foundations of buildings and structures, whereas clay expansion may lead to uplift (heave) or lateral stress on part or all of a structure; any such movements may cause cracking and distortion.

Landslides (slope stability)
A landslide is a relatively rapid outward and downward movement of a mass of ground on a slope, due to the force of gravity. A slope is under stress from gravity but will not move if its strength is greater than this stress. If the balance is altered so that the stress exceeds the strength, then movement will occur. The stability of a slope can be reduced by removing ground at the base of the slope, by placing material on the slope, especially at the top, or by increasing the water content of the materials forming the slope. Increase in subsurface water content beneath a soakaway could increase susceptibility to landslide hazards. The assessment of landslide hazard refers to the stability of the present land surface. It does not encompass a consideration of the stability of excavations.

Soluble rocks (dissolution)
Some rocks are soluble in water and can be progressively removed by the flow of water through the ground. This process tends to create cavities, potentially leading to the collapse of overlying materials and possibly subsidence at the surface. The release of water into the subsurface from infiltration systems may increase the dissolution of rock or destabilise material above or within a cavity. Dissolution cavities may create a pathway for rapid transport of contaminated water to an aquifer or water course.

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Compressible ground
Many ground materials contain water-filled pores (the spaces between solid particles). Ground is compressible if a building (or other load) can cause the water in the pore space to be squeezed out, causing the ground to decrease in thickness. If ground is extremely compressible the building may sink. If the ground is not uniformly compressible, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. The compressibility of the ground may alter as a result of changes in subsurface water content caused by the release of water from soakaways.

Collapsible deposits
Collapsible ground comprises certain fine-grained materials with large pore spaces (the spaces between solid particles). It can collapse when it becomes saturated by water and/or a building (or other structure) places too great a load on it. If the material below a building collapses it may cause the building to sink. If the collapsible ground is variable in thickness or distribution, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. The subsurface underlying a soakaway will experience an increase in water content that may affect the stability of the ground. This hazard is most likely to be encountered only in parts of southern England.

Running sand
Running sand conditions occur when loosely-packed sand, saturated with water, flows into an excavation, borehole or other type of void. The pressure of the water filling the spaces between the sand grains reduces the contact between the grains and they are carried along by the flow. This can lead to subsidence of the surrounding ground. Running sand is potentially hazardous during the drainage system installation. During installation, excavation of the ground may create a space into which sand can flow, potentially causing subsidence of surrounding ground.

Shallow mining hazards (non coal)
Current or past underground mining for coal or for other commodities can give rise to cavities at shallow or intermediate depths, which may cause fracturing, general settlement, or the formation of crown-holes in the ground above. Spoil from mineral workings may also present a pollution hazard. The release of water into the subsurface from soakaways may destabilise material above or within a cavity. Cavities arising as a consequence of mining may also create a pathway for rapid transport of contaminated water to an aquifer or watercourse. The mining hazards map is derived from the geological map and considers the potential for subsidence associated with mining on the basis of geology type. Therefore if mining is known to occur within a certain rock, the map will highlight the potential for a hazard within the area covered by that geology.

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For more information regarding underground and opencast **coal mining**, the location of mine entries (shafts and adits) and matters relating to subsidence or other ground movement induced by **coal mining** please contact the Coal Authority, Mining Reports, 200 Lichfield Lane, Mansfield, Nottinghamshire, NG18 4RG; telephone 0845 762 6848 or at www.coal.gov.uk. For more information regarding other types of mining (i.e. non-coal), please contact the British Geological Survey.

Groundwater source protection zones
In England and Wales, the Environment Agency has defined areas around wells, boreholes and springs that are used for the abstraction of public drinking water as source protection zones. In conjunction with Groundwater Protection Policy the zones are used to restrict activities that may impact groundwater quality, thereby preventing pollution of underlying aquifers, such that drinking water quality is upheld. The Environment Agency can provide advice on the location and implications of source protection zones in your area (www.environment-agency.gov.uk/)

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