Butts Garage, Llangarron

Herefordshire

Powells Chartered Surveyors

Technical Note 001_B – Drainage Strategy

CTP-21-0228

March 2022

1. Introduction

1.1 Cotswold Transport Planning (CTP) provide expert Transport Planning, Highways, Infrastructure and Flood Risk consultancy services throughout the UK.

1.2 CTP were appointed by Powells Chartered Surveyors to provide drainage consultancy in support of a planning application.

1.3 The proposed development consists of construction of a single residential dwelling along with associated parking provision, vehicular access, and landscaping. A proposed site plan is included in **Appendix A**.

1.4 This Technical Note will cover the existing drainage arrangement, the proposed surface water drainage arrangement, and demonstrate compliance with the principles of Sustainable Drainage Systems (SuDS).

2. Existing Site Conditions

2.1 The existing site consists of a disused garage and vehicle testing station, accessed via an area of bitmac hardstanding.

2.2 Existing ground levels fall generally from north-west to south-east, from an elevation of 30.20mAOD at the public highway to 18.51mAOD in the far south-eastern corner of the field within the client's ownership.

2.3 A topographical survey plan is included within **Appendix B**.

3. Existing Drainage

3.1 Welsh Water asset records (**Appendix C**) indicate no public drainage assets within the vicinity of the development. No manhole covers can be seen in the public highway adjacent to the development.

3.2 Investigation of planning applications for nearby developments in the village confirms the absence of a public foul or surface water sewer network. These nearby developments therefore rely on infiltration as a means of effluent and surface water discharge.

3.3 Furthermore, no highway gullies are present in the public highway next to the development. It is understood that surface water runoff arising from the main road is conveyed eastwards towards the village centre and collected by a traditional highway drain.

3.4 There is no existing below-ground drainage currently serving the development; surface water from the garage roof is currently discharged directly to ground, and no foul drainage is currently generated by the current use of the garage building.

3.5 Garren Brook (flowing in a south-westerly direction) is located approximately 50 metres south of the southern tip of the development field.

4. Existing Geology

4.1 Online British Geological Society (BGS) mapping indicates that the site is underlain by the Brownstones Formation (sandstone), with no superficial deposits recorded.

4.2 The Cranfield Soil and Agrifood Institute ‘Soilscapes’ online mapping tool indicates the local geology to be ‘freely draining slightly acid loamy soils’.

4.3 Infiltration testing was carried out in March 2021. A copy of the report is included within **Appendix D**.

4.4 Surface water infiltration testing to BRE Digest 365 carried out at two different locations.

4.5 Although a change in water level was observed over the period of testing, this represented only 110mm to 130mm of the starting 1900mm depth of water (6% to 7% change).

4.6 Surface water infiltration testing was abandoned after the first attempted test in each pit due to time constraints.

4.7 Ground water was encountered at a depth of 2.2m below ground level at the southern end of the field, representing a water table elevation of approximately 17.1mAOD.

4.8 Given the infeasibility of conveying surface water runoff to Garren Brook, it is proposed that a conservative surface water infiltration design is implemented.

4.9 **Appendix E** shows the calculation of surface water infiltration rates.

4.10 It should be noted that although the two surface water tests did not fall to 25% of the original water level during the testing period, infiltration rates have been calculated with the change in water depth that was observed.

4.11 The total change in water depth was used to interpolate the 75% and 25% critical measurements. The 'a_{s50}' variable was measured as the internal surface area of the trial pit up to the level of 50% of total water level change during the test (approximately 60mm below the starting water level).

4.12 With this method, infiltration rate values were obtained from the testing despite the slow rates encountered during the day of testing.

4.13 The calculated surface water infiltration rates are as follows:

Trial Pit A 8.2×10^{-7} m/sec **0.003 m/hr**

Trial Pit B 5.6×10^{-7} m/sec **0.002 m/hr**

4.14 Trial Pit A is located closest to the proposed surface water soakaway and therefore its rate (0.003 m/hr) has been taken forward for design.

4.15 Shallow foul infiltration testing to Building Regulations Approved Document H was carried out towards the lower end of the field, the results of which are shown in **Appendix D** and summarised below:

Test 1	Test 2	Test 3
42 minutes	84 minutes	133 minutes

Table 1 - time taken for water level to drop central 150mm

4.16 The average time taken for the water level to drop from 75% to 25% of its original level (150mm water level change) is 86.3 minutes.

4.17 The Vp value is therefore:

Vp = (86.3 x 60)/150 = **34.5 seconds/mm**

4.18 This Vp value falls within the range of 12 to 100 specified in Approved Document H and therefore it is considered appropriate to take an effluent soakaway solution forward for design.

5. Proposed Drainage

Surface Water Drainage

5.1 The drainage strategy drawing is included in **Appendix F**.

5.2 Surface water runoff shall be collected through gravity-fed gutters and downpipes for the proposed building and conveyed to a surface water soakaway located to the south.

5.3 The soakaway shall be constructed with a geocellular crate system to maximise available storage volume.

5.4 MicroDrainage calculations showing the required storage volume are shown in **Appendix G**.

5.5 A design infiltration rate of 0.003m/hr has been taken forward for design, based on the results of site infiltration testing. A safety factor of 2 has been applied during analysis.

5.6 The calculations show that a cellular soakaway with dimensions 8m long, 2m wide and 0.8m deep can safely store excess surface water flows in the 1 in 100yr (+40% climate change) design storm event.

5.7 The half-drain time has been calculated as 8479 minutes (approximately 6 days) for this design storm.

5.8 Although the above half-drain time is much longer than the 24 hour period usually stipulated, it is understood that this solution would provide a betterment on the existing drainage regime by providing this area of below-ground storage to accommodate excess flows in such an extreme storm event.

5.9 Another intense storm is unlikely following such a design storm event.

5.10 If the capacity of the soakaway were to be exceeded in the unlikely event of repeated intense storm events, excess flows would surcharge the soakaway and flow overland as runoff would have done prior to development.

5.11 The proposed access and parking area to the front (north) of the property shall be constructed of permeable paving, with an adequate depth of freely-draining Type 3

granular sub-base material to store excess surface water flows during intense storm events.

5.12 Due to the sloping nature of the driveway area, internal baffles/terracing will be required within the sub-base zone to provide discrete pockets of surface water storage, and maximise storage and infiltration capacity.

5.13 Failure to construct baffles within the permeable paving would likely result in the majority of surface water runoff flowing towards the south and overflowing into the rear garden. It is therefore essential that these baffles are designed and constructed following confirmation of proposed finished site levels. Design should be undertaken by a competent drainage engineer to ensure minimum storage requirements are met.

Foul Drainage

5.14 Foul drainage generated from the development shall be conveyed a domestic wastewater treatment plant to the south of the dwelling providing primary and secondary effluent treatment, prior to further tertiary treatment and discharge via a drainage field.

5.15 The wastewater treatment plant shall be a Klargester BioDisc BA (or similar approved).

5.16 Following the methodology laid out in British Water's 'Flows and Loads' document, the treatment plant and drainage field shall be sized and designed to treat foul from a 'population' of 5 people, as the proposal is for a 3 bedroom dwelling.

5.17 The drainage field, which is to be located a minimum of 15m from any dwelling, has been sized using the British Standard BS 6297:2007+A1:2008 'Code of practice for the design and installation of drainage fields for use in wastewater treatment'.

5.18 The formula is as follows:

$A = p \times Vp \times 0.2$

$= 5 \times 34.5 \times 0.2$

$= \mathbf{34.5m^2}$

A = required drainage field floor area in square metres

p = number of people served by the treatment plant

Vp = percolation value (as calculated in paragraph 4.17)

5.19 Using linear trenches with width 0.9m, this translates into an overall trench length of 38m.

5.20 **Appendix F** shows a closed-loop drainage field layout with two parallel trenches each 20m long. The trenches shall have a minimum separation of 1m.

5.21 An upstream sampling/distribution chamber shall be constructed to ensure even dispersal of the effluent in addition to providing a convenient location to test the quality of treated effluent.

5.22 The drainage field is to be constructed parallel to the contours of the existing ground.

5.23 The drainage field shall comply with Building Regulation Approved Document H, and BS 6297:2007+A1:2008 ‘Code of practice for the design and installation of drainage fields for use in wastewater treatment’.

6. SuDS/Drainage Management

6.1 Maintenance of SuDS features is essential to ensure that the surface water drainage system operates effectively and that flooding of the site and surrounding areas is prevented.

6.2 The responsibility of maintaining drainage components that serve one property only would lie with the development landowner unless responsibility has been delegated to an appointed external Management Company.

6.3 A full maintenance regime should be carried out to ensure that the drainage system remains operational over its lifetime. Table 1 summarises an initial maintenance plan for the drainage components proposed within this development. The SuDS Manual (CIRIA C753) and manufacturer's guidelines should be referred to for further information.

Drainage Component	Required Action	Typical Frequency
Pipework, manholes, chambers, catch pits and silt traps	Stabilise adjacent areas	As required
	Remove weeds	As required
	Clear any poor performing structures.	As required
	Inspect all structures for poor operation	Six monthly, 48 hours after large storms in first six months
	Monitor inspection chambers. Inspect silt accumulation rates and determine silt clearance frequencies	Annually
Cellular soakaway device	Check upstream silt traps	Monthly and after large storms
Wastewater treatment plant	Check sludge accumulation	Every 3 months
	Empty sludge	Annually, or more frequently depending on rate of sludge accumulation
Effluent field	Check sampling/distribution chamber to ensure free flow of treated effluent	Every 3 months

Table 2 - Operation and Maintenance Summary

Appendix A

Street View
1 : 200

Site
1 : 200

Generic Notes

1 CONTRACTOR TO CHECK ALL DIMENSIONS ON SITE PRIOR TO COMMENCEMENT OF WORKS. ANY DISCREPANCIES TO BE BROUGHT TO THE ATTENTION OF THE ARCHITECT.
2 DO NOT SCALE FROM THIS DRAWING, USE ONLY DIMENSIONS SHOWN ON DRAWINGS. DIMENSIONS FIGURED ARE TO THE NEAREST 5MM.

Project Notes

1 THIS DRAWING WAS PREPARED USING SURVEY INFORMATION PROVIDED BY ROBOTIC SURVEYS.
2 TO BE READ WITH ALL RELEVANT DRAWINGS AND SPECIFICATIONS.
3 THIS DRAWING IS SUBJECT TO STATUTORY APPROVALS. CONTRACTOR TO SUBMIT DRAWINGS FOR BUILDING CONTROL INSPECTORS COMMENT / APPROVAL.
4 THIS DRAWING WAS PREPARED FOR PLANNING PURPOSE ONLY AND IS NOT A CONSTRUCTION ISSUE
5 ALL DEMOLITION AND EXCAVATION WORKS SUBJECT TO STRUCTURAL ENGINEERS APPROVAL AND FULL DESIGN AND SPECIFICATION.

Rev	Description	Date
A	Boundary line amended	16.06.2021
B	building footprint amended	15.12.2021
C	Boundary Line to suit drainage	09.02.2022

Drawing Status
Preliminary

Client:
Powells

Project:
Butt Garage, Llangarron

Drawing Title:
Proposed Site Plan and Street View

Project Number: 3178

Date: 03.06.2021

Scale at A1: 1 : 200

Drawing Number: 20-290

Revision: C

OWEN TOMS ARCHITECTS
ARCHITECTURE & DESIGN

Contact:
M: 07811946172
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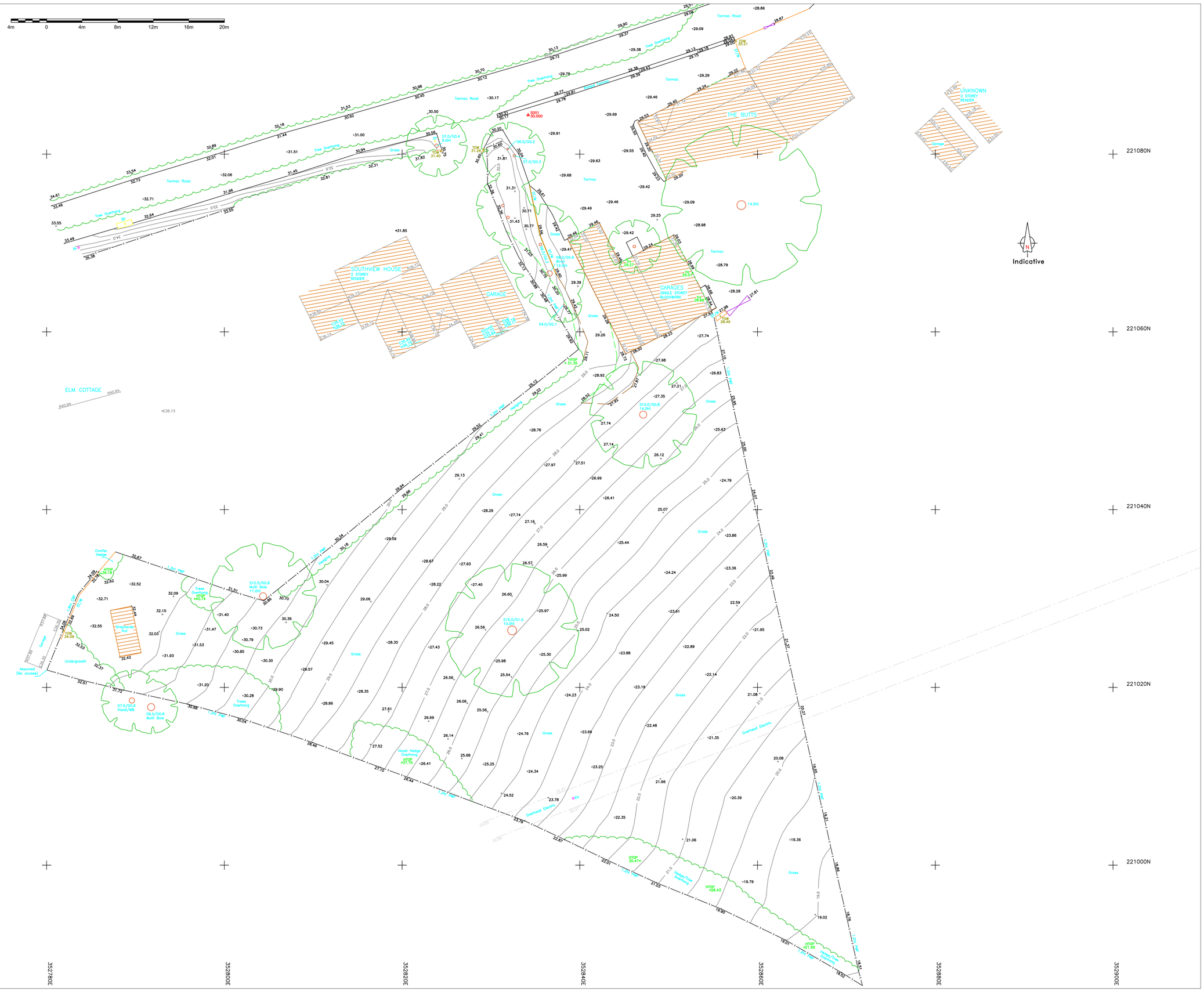
Appendix B



Survey Control Co-Ordinates

Name	Type	Easting(X)	Northing(Y)	Level(Z)
S001	Survey Nail	352834.194	221084.399	30.000
S002	Survey Nail	352883.397	221105.075	28.162

Grid Orientation: Graphical best fit to the OS
Level Datum: Arbitrary Datum based on level of S001

Drawing Notes

1. All dimensions are in Metres
2. Certain levels have been frozen on the "HTOMIT" Layer to prevent text overwriting
3. A qualified arboriculturalist should be consulted if tree species are crucial
4. Tree heights are approximate to the nearest metre
5. 3D drawing available upon request

Survey Legend

AB	Air Brick	Building	
ACU	Air Conditioning Unit	Building Ridge	Rxx.xx
AV	Air Valve	Building Eaves	Exx.xx
A/R	Assumed Route		
BB	Belisha Beacon	Drainage Ditch/Cover	
BK/W	Brick Wall	Embankment Top	
BLK/W	Block Wall	Embankment Bottom	
BO	Bollard	Fence	
BX	Box	Gate	
BS	Bus Stop Sign	Kerb	
BT	British Telecom Cover	Kerb Top	
CA	Camera	Dropped Kerb	
CE	Cellar	Door Opening	
CL	Cover Level	Major Contours (1m)	— ht —
CSU	Ceiling Slopes Up	Minor Contours (0.5m)	
DPC	Damp Proof Course	Canopy/Overhang	
DR	Drain	Overhead Electric Line	Oxxx
DH	Door Height	Overhead Telecom Line	Qxxx
ER	Earth Rod	Service Cover	
EC	Electricity Cover	Street Furniture	
EP	Electricity Pole	Surface Change	
FH	Fire Hydrant	Vegetation	
FL	Flood Light	Walls/Columns	
FW	Foul Water	Top of Wall (TOW)	
GA	Gas Valve	Waterline	
GU	Gully	C=Cill level	Windows
HTOP	Top of Hedge Height	H=Head level	
IC	Inspection Cover		
IL	Invert Level	Girth/Spread Species Height	Tree
KI	Kerb Inlet		
LP	Lamp Post	Sapling	Shrub
MB	Multibole/Stem Tree		
MH	Manhole	Bush	Hedge
MK	Marker Post		
MO	Mooring	Survey Control Station	
NPV	No Pipe Visible	Station Level	50.000
NSV	No Service Visible		
PB	Post Box	Fence Abbreviations	
PO	Post	BWF Barb Wire	
PM	Parking Meter	CBF Close Board	
PS	Private Sign	CLF Chain Link	
RE	Rodding Eye	IRF Iron Railings	
RP	Reflector Post	PAF Palisade	
RS	Road Sign	PCF Post & Chain	
RWP	Rainwater Pipe	PRF Post & Rail	
SO	Soffit Level	PWF Post & Wire	
SP	Sign Post	UTL Unable To Lift	
ST	Stop Tap	USB Underside of Beam	
ST/W	Stone Wall	WPF Wooden Panel	
SV	Stop Valve		
SVP	Soil Vent Pipe		
SW	Surface Water		
TB	Telephone Box		
TH	Threshold Level		
TM	Telephone Mast		
TOB	Top of Beam		
TP	Telegraph Pole		
TL	Traffic Light		
TV	Cable TV Cover		
WL	Water Level		
WM	Water Meter		
WO	Wash Out		
UTL	Unable To Lift		
USB	Underside of Beam		

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Drawing No.	Date	Scale	Sheet Size	Revision
PLS451	MAR 21	1:200	A1	-

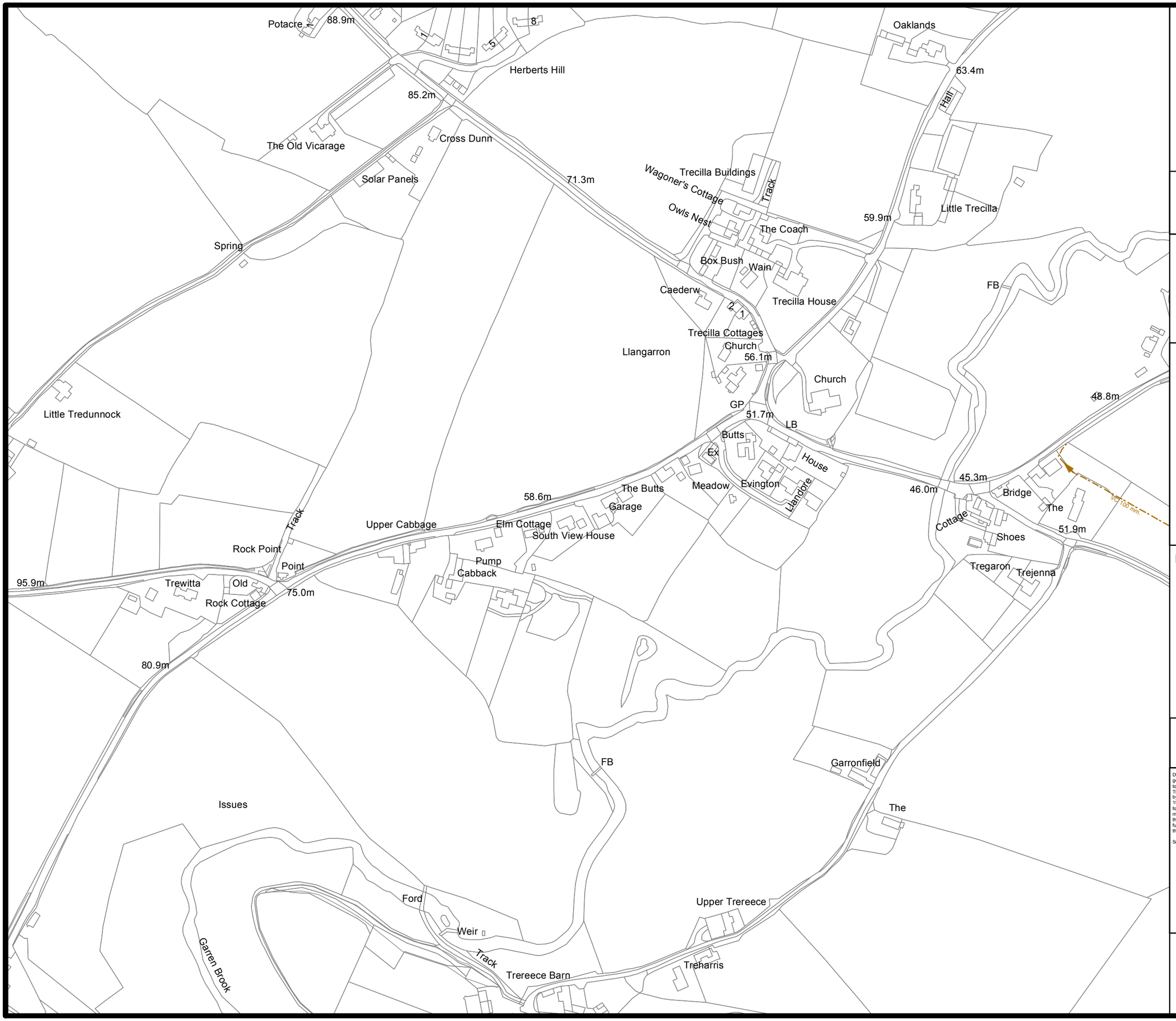
Drawing Title

TOPOGRAPHICAL SURVEY

Project

Land Adj. The Butts, Llangarron, HR9 6PA

Appendix C



Dŵr Cymru Welsh Water

Ross-on-Wye, Herefordshire

N
W E
S

LEGEND(Representative of most common features)

Waste network:

	Foul chamber		Outfall
	Surface water chamber	LH	Lamphole
	Combined chamber		Storm Overflow
CO	Combined sewer overflow		Rising main
SPC	Special purpose chamber		Gravity sewer
	Treatment works		Private sewer
	Pumping station	S 104	Private sewer subject to Sect. 104 adoption agreement
			Private Sewer Transfer
			Lateral Drain
			Inspection Chamber

NB: Sewer symbol colour indicates the type.

RED - Combined
GREEN - Surface Water
BROWN - Foul
Purple - Former 524 sewers (for indicative purposes only)

Notes:

Whilst every reasonable effort has been taken to correctly record the pipe material of DCWW assets, there is a possibility that in some cases pipe material (other than Asbestos Cement or Pitch Fibre) may be found to be asbestos cement (AC) or Pitch Fibre (PF) . It is therefore advisable that the possible presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation

EXACT LOCATIONS OF ALL APPARATUS TO BE DETERMINED ON SITE.

Map Ref:	352834,221076
Map scale:	1:3000
Printed by:	Emma John
Printed on:	24 Mar 2021

Appendix D

PERCOLATIONTESTS.CO.UK

LAND AT THE FORMER BUTTS GARAGE
LLANGARRON
ROSS ON WYE
HEREFORDHIRE
HR9 6PA

SOAKAWAY ASSESSMENT

MARCH 2021

Job Number: PT1165

Site Address: Former Butts Garage, Llangarron, Ross-On-Wye, HR9 6NL

Weather Conditions: Dry

Trial Pit A – Surface Water Test- Size of Hole: **W:** 400mm **L:** 1200mm **D:** 1900mm

TEST 1		TEST 2		TEST 3	
TIME	FALL	TIME	FALL	TIME	FALL
10.30	0				
11.00	10mm				
12.00	40mm				
13.30	100mm				
14.30	110mm				
15.30	120mm				
16.30	130mm				
Further testing abandoned due to poor infiltration rate					

Trial Pit B – Surface Water Test- Size of Hole: **W:** 400mm **L:** 1200mm **D:** 1900mm

TEST 1		TEST 2		TEST 3	
TIME	FALL	TIME	FALL	TIME	FALL
10.50	0				
11.00	0				
12.00	30mm				
13.30	75mm				
14.30	90mm				
15.30	100mm				
16.30	110mm				
Further testing abandoned due to poor infiltration rate					

Trial Pit C – Foul Test Test- Size of Hole: **300mm sump @ 800mm deep**

TEST 1	TEST 2	TEST 3
42 mins	84 mins	133 mins

Ground water (Trial Pit D)

A 2.9m deep trail pit was excavated and left open for the duration of the day. Ground water settled at a depth of 2.2m BGL.

Site Layout


Butts Meadow
Butts Orchard
Lower Butts
58.6m
The Butts
Elm Cottage
South View House
A
ack Lodge
Pump
ack
C
B
D

Photos:

Trail Pit A – BRE365 Test	Trail Pit B – BRE365 Test
	
Trail Pit C – Foul Test	**Trail Pit D – Ground Water**
	

Appendix E

Soil Infiltration Calculation

In accordance with BRE365 methodology

COTSWOLD TRANSPORT PLANNING

Project No: 21-0228
Project Name: The Butts Garage Site, Llangarron
Date: 01-Mar-21
Conditions:

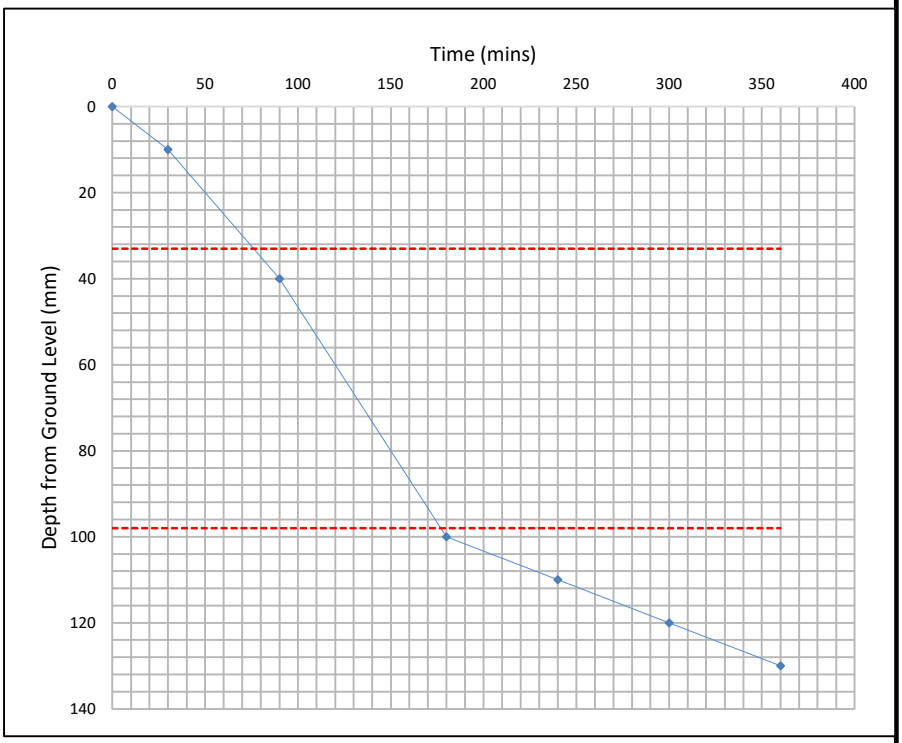
Pit Number: TP A
TEST 1

Pit Dimensions:

Length =	1.200	m
Width =	0.400	m
Depth =	1.900	m

Depth/Time measurements:

Depth below Ground Lvl (mm)	Time (min)
0	0
10	30
40	90
100	180
110	240
120	300
130	360



Testing Result

Start depth from Ground to water level =	0.000	m
Finish depth from Ground to water level =	0.130	m
Total drop from start to finish level =	0.130	m

75% of effective depth below ground level =	0.033	m	Time, t_{75} =	75.0	mins
25% of effective depth below ground level =	0.098	m	Time, t_{25} =	175.0	mins

Effective Storage V_{p75-25} =	0.031	m3	t_{p75-25} =	100.0	mins
Internal Storage Area A_{p50} =	6.352	m2			

Soil infiltration rate, f =	**8.2E-07**	m/sec
Soil infiltration rate, f =	**0.003**	m/hr

Soil Infiltration Calculation

In accordance with BRE365 methodology

COTSWOLD TRANSPORT PLANNING

Project No: 21-0228
Project Name: The Butts Garage Site, Llangarron
Date: 01-Mar-21
Conditions:

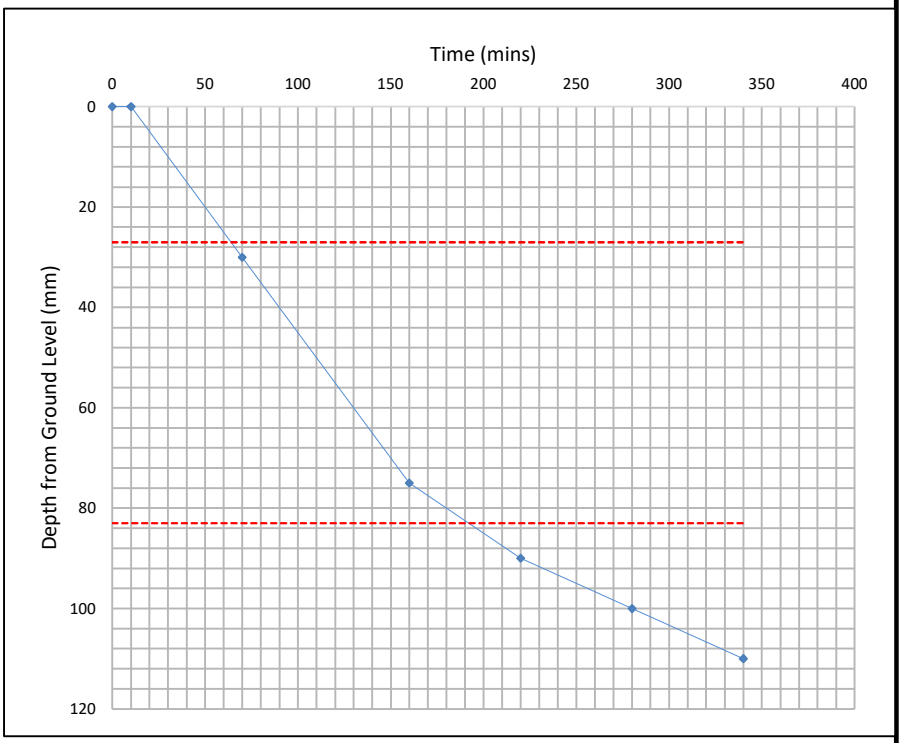
Pit Number: TP B
TEST 1

Pit Dimensions:

Length =	1.200	m
Width =	0.400	m
Depth =	1.900	m

Depth/Time measurements:

Depth below Ground Lvl (mm)	Time (min)
0	0
0	10
30	70
75	160
90	220
100	280
110	340



Testing Result

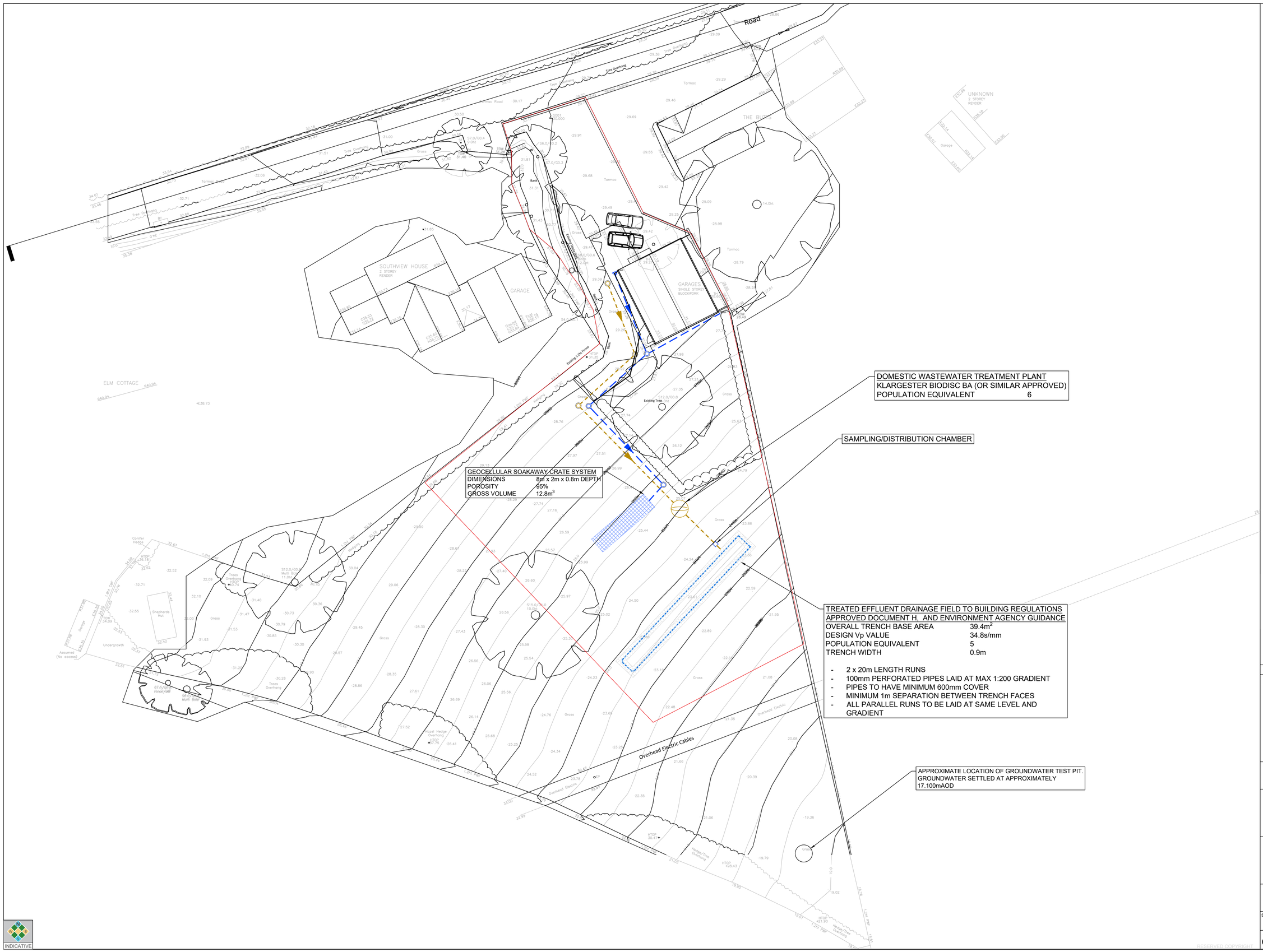
Start depth from Ground to water level =	0.000	m
Finish depth from Ground to water level =	0.110	m
Total drop from start to finish level =	0.110	m

75% of effective depth below ground level =	0.027	m	Time, t_{75} =	65.0	mins
25% of effective depth below ground level =	0.083	m	Time, t_{25} =	190.0	mins

Effective Storage V_{p75-25} =	0.027	m3	t_{p75-25} =	125.0	mins
Internal Storage Area A_{p50} =	6.384	m2			

Soil infiltration rate, f =	**5.6E-07**	m/sec
Soil infiltration rate, f =	**0.002**	m/hr

Appendix F



DOMESTIC WASTEWATER TREATMENT PLANT
KLARGESTER BIODISC BA (OR SIMILAR APPROVED)
POPULATION EQUIVALENT 6

SAMPLING/DISTRIBUTION CHAMBER

GEOCELLULAR SOAKAWAY CRATE SYSTEM

DIMENSIONS	8m x 2m x 0.8m DEPTH
POROSITY	95%
GROSS VOLUME	12.8m^3

TREATED EFFLUENT DRAINAGE FIELD TO BUILDING REGULATIONS APPROVED DOCUMENT H, AND ENVIRONMENT AGENCY GUIDANCE

OVERALL TRENCH BASE AREA	39.4m^2
DESIGN Vp VALUE	34.8s/mm
POPULATION EQUIVALENT	5
TRENCH WIDTH	0.9m

- 2 x 20m LENGTH RUNS
- 100mm PERFORATED PIPES LAID AT MAX 1:200 GRADIENT
- PIPES TO HAVE MINIMUM 600mm COVER
- MINIMUM 1m SEPARATION BETWEEN TRENCH FACES
- ALL PARALLEL RUNS TO BE LAID AT SAME LEVEL AND GRADIENT

APPROXIMATE LOCATION OF GROUNDWATER TEST PIT. GROUNDWATER SETTLED AT APPROXIMATELY 17.100mAOD

INDICATIVE

NOTES:

1. DO NOT SCALE FROM THIS DRAWING. ALL DIMENSIONS ARE IN METRES, UNLESS STATED OTHERWISE.
2. THIS DRAWING IS BASED ON THE ARCHITECTS' LAYOUT RECEIVED FROM OWENTOMS ARCHITECTS ON 03.06.21.
3. ORDNANCE SURVEY, (C) CROWN COPYRIGHT 2020. ALL RIGHTS RESERVED. LICENCE NUMBER 100022432.
4. DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER DRAWINGS. ANY DISCREPANCIES ARE TO BE REPORTED TO THE ENGINEER 5 WORKING DAYS IN ADVANCE OF UNDERTAKING ANY WORK.
5. THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION.
6. RAINWATER DOWNPIPE ARE SHOWN AS INDICATIVE ONLY, AND ARE SUBJECT TO FURTHER DESIGN.

KEY:

- RWP — RAINWATER DOWNPIPE (POSITIONS ASSUMED)
- SURFACE WATER RODDING EYE
- SURFACE WATER INSPECTION CHAMBER/MANHOLE
- SURFACE WATER SEWER
- FOUL WATER INSPECTION CHAMBER/MANHOLE
- FOUL WATER SEWER

Rev	Date	Details	Drawn by	Checked by
C	06.03.22	Drainage updated in accordance with Architectural revisions	CG	KT
B	11.01.22	Strategy updated following new layout	CG	KT
A	20.11.21	Strategy updated	CG	KT

COTSWOLD TRANSPORT PLANNING

CLIENT: POWELLS CHARTERED SURVEYORS

PROJECT: BUTTS GARAGE LLANGARRON

TITLE: DRAINAGE STRATEGY

STATUS: PLANNING

SCALE @ A1:	DATE:	DRAWN:	CHECKED:	APPROVED:
1:200	28/06/21	CG	DM	DM

JOB NO:	DRAWING NO:	REVISION:
CTP-20-228	C001	C

Appendix G

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

Half Drain Time : 8479 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	23.663	0.163	0.0	2.5	O K
30 min Summer	23.719	0.219	0.0	3.3	O K
60 min Summer	23.781	0.281	0.0	4.3	O K
120 min Summer	23.847	0.347	0.0	5.3	O K
180 min Summer	23.888	0.388	0.0	5.9	O K
240 min Summer	23.916	0.416	0.0	6.3	O K
360 min Summer	23.955	0.455	0.0	6.9	O K
480 min Summer	23.985	0.485	0.0	7.4	O K
600 min Summer	24.008	0.508	0.0	7.7	O K
720 min Summer	24.027	0.527	0.0	8.0	O K
960 min Summer	24.056	0.556	0.0	8.5	O K
1440 min Summer	24.096	0.596	0.0	9.1	O K
2160 min Summer	24.130	0.630	0.0	9.6	O K
2880 min Summer	24.150	0.650	0.0	9.9	O K
4320 min Summer	24.165	0.665	0.0	10.1	O K
5760 min Summer	24.164	0.664	0.0	10.1	O K
7200 min Summer	24.157	0.657	0.0	10.0	O K
8640 min Summer	24.149	0.649	0.0	9.9	O K
10080 min Summer	24.142	0.642	0.0	9.8	O K
15 min Winter	23.682	0.182	0.0	2.8	O K
30 min Winter	23.745	0.245	0.0	3.7	O K
60 min Winter	23.814	0.314	0.0	4.8	O K
120 min Winter	23.889	0.389	0.0	5.9	O K
180 min Winter	23.935	0.435	0.0	6.6	O K
240 min Winter	23.966	0.466	0.0	7.1	O K
360 min Winter	24.011	0.511	0.0	7.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	120.318	0.0	19
30 min Summer	80.922	0.0	34
60 min Summer	52.002	0.0	64
120 min Summer	32.313	0.0	124
180 min Summer	24.121	0.0	184
240 min Summer	19.472	0.0	244
360 min Summer	14.306	0.0	364
480 min Summer	11.500	0.0	484
600 min Summer	9.700	0.0	604
720 min Summer	8.436	0.0	724
960 min Summer	6.762	0.0	964
1440 min Summer	4.942	0.0	1442
2160 min Summer	3.604	0.0	2164
2880 min Summer	2.877	0.0	2880
4320 min Summer	2.090	0.0	4320
5760 min Summer	1.664	0.0	5760
7200 min Summer	1.394	0.0	6272
8640 min Summer	1.205	0.0	7088
10080 min Summer	1.067	0.0	7776
15 min Winter	120.318	0.0	19
30 min Winter	80.922	0.0	34
60 min Winter	52.002	0.0	64
120 min Winter	32.313	0.0	124
180 min Winter	24.121	0.0	182
240 min Winter	19.472	0.0	242
360 min Winter	14.306	0.0	360

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
480 min Winter	24.044	0.544	0.0	8.3	O K
600 min Winter	24.070	0.570	0.0	8.7	O K
720 min Winter	24.092	0.592	0.0	9.0	O K
960 min Winter	24.126	0.626	0.0	9.5	O K
1440 min Winter	24.172	0.672	0.0	10.2	O K
2160 min Winter	24.213	0.713	0.0	10.8	O K
2880 min Winter	24.237	0.737	0.0	11.2	O K
4320 min Winter	24.260	0.760	0.0	11.5	O K
5760 min Winter	24.264	0.764	0.0	11.6	O K
7200 min Winter	24.259	0.759	0.0	11.5	O K
8640 min Winter	24.248	0.748	0.0	11.4	O K
10080 min Winter	24.238	0.738	0.0	11.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
480 min Winter	11.500	0.0	480
600 min Winter	9.700	0.0	598
720 min Winter	8.436	0.0	716
960 min Winter	6.762	0.0	952
1440 min Winter	4.942	0.0	1426
2160 min Winter	3.604	0.0	2120
2880 min Winter	2.877	0.0	2824
4320 min Winter	2.090	0.0	4192
5760 min Winter	1.664	0.0	5528
7200 min Winter	1.394	0.0	6776
8640 min Winter	1.205	0.0	7960
10080 min Winter	1.067	0.0	8168

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.400	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.011

Time (mins) From:	To:	Area (ha)
0	4	0.011

Model Details

Storage is Online Cover Level (m) 25.500

Cellular Storage Structure

Invert Level (m) 23.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00300 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00300

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	16.0	16.0	0.800	16.0	32.0	0.801	0.0	32.0