

Duchy Homes Ltd.
4100 Park Approach
Thorpe Park
Leeds
LS15 8GB

PR/AJK/LW 45521-003

30 November 2020

For the attention of Mr L. Foxon

Dear Lee,

Mount Vernon Road, Worsborough
Infiltration Testing

We write to formally record the results of soil infiltration testing recently undertaken by Eastwood & Partners at your proposed development site, located off Mount Vernon Road in Worsborough.

It was expected, due to the topography of the site, that a piped drainage solution would be required, with on-site attenuation. The proposed development layout includes provision for an attenuation tank in the south eastern corner, with a restricted discharge into an existing 225mm diameter combined sewer just to the east of the site. Infiltration rates within Coal Measures strata, as recorded to be present below this site, can be variable, and may not always be sufficient to support surface water disposal by soakaway.

Eastwood & Partners attended site on 18 November 2020 to carry out infiltration testing. Four trial pits were excavated across the site, to give good coverage. SA04 was excavated in the area of the proposed attenuation tank in order to determine the depth to rockhead, in order to collect information to assist with the design of the excavation.

The trial pits were excavated to depths of between 1.1 m and 2.8 m bgl, all being terminated due to encountering dense strata, through which further excavation was difficult. Sandstone bedrock was encountered at the base of SA01 to SA02 and SA04. Within SA03, clay underlain by mudstone bedrock was encountered.

Water was placed into the pits from a mobile bowser, and the level monitored until the pit had drained or until three hours had passed. In accordance with BRE365, the test within SA04 were repeated a further two times due to the water draining rapidly. Two tests were carried out in

SA01, where the water drained at a moderate rate, but only one test was completed in both SA02 to SA03 due to low infiltration rate.

The results of the testing are summarised in the table below:

Test	Depth (m)	Soil Type	Infiltration Rates	
			BRE365 Infiltration Rate ($\times 10^{-6}$) m/s	Average Infiltration Rate ($\times 10^{-6}$) m/s
SA01 (1)	1.1	Clayey gravelly SAND (sandstone at base)	41	50
SA01 (2)			25	33
SA02 (1)	1.1	Clayey gravelly SAND (sandstone at base)	14	19
SA03 (1)	2.8	Thinly bedded MUDSTONE	N/A	0.0
SA04 (1)	1.7	Clayey gravelly SAND (sandstone at base)	440	270
SA04 (2)			320	260
SA04 (3)			240	220

The tests carried out in SA01 to SA02 were successful, with the water draining past 25% effective depth in between 66 and 165 minutes. The second test in SA01, however, showed a significant reduction in the infiltration rate, suggesting that the sides and base of the test pit had silted up during the previous test.

All three tests within SA04 were successful, with water draining away in between 17 and 22 minutes. No significant reduction in rate was noted between subsequent tests, suggesting that significant amounts of silt were not washed out by the repeated inundation.

The single test carried out within SA03 was unsuccessful. No water drained from the pit for the duration of the test, which was allowed to run for 3 hours.

Discussion

The results of the testing indicate the ground to be highly variable in terms of its suitability to receive flows from soakaways. It appears that although in some areas of the site, the sandstone is fairly permeable, where as other it is less so. There also appear to be mudstone bands within the sandstone which are impermeable.

The existing slope of the site must be taken into account within the drainage design, particularly as there are existing dwellings located adjacent to the base of the slope. Given the variable infiltration rates and impermeable bands, the re-emergence of water onto the lower ground cannot be ruled out. It may also not be possible to create falls within pipe connections where the soakaway chamber is uphill of the plot, given the existing slope.

It is therefore considered that a piped drainage system with on-site attenuation, as originally proposed, is most suitable. It may be possible to consider the use of localise infiltration features, such as permeable paving, in suitable areas which may allow a small reduction in the attenuation volume, although this would be subject to detailed design and would need to be agreed by the regulatory bodies.

Within SA03 and SA04, which were excavated within the area in which the attenuation tank is to be constructed, hard strata were encountered from between approximately 1.7 m and 2.8 m bgl. The trial pits were excavated using a JCB 3CX backhoe excavator, fitted with a 600 mm wide toothed bucket. It is not expected that a significant issue will be presented to excavation of the attenuation tank, which will be around 3.5 m deep measured from current ground level, when using an excavator of much larger capacity, fitted with an appropriately toothed bucket.

We trust that this meets with your approval.

Yours sincerely,

A handwritten signature in black ink, reading 'Andrew Kerslake'.

A Kerslake

Associate

Enc: Photographs of Soakaway Pits
 Exploratory Hole Location Plan – Drawing 45521/015
 Soakaway Test Log and Infiltration Rate Calculations



SA01



SA01 Arisings



SA02



SA02 Arisings



SA03



SA3 Arisings



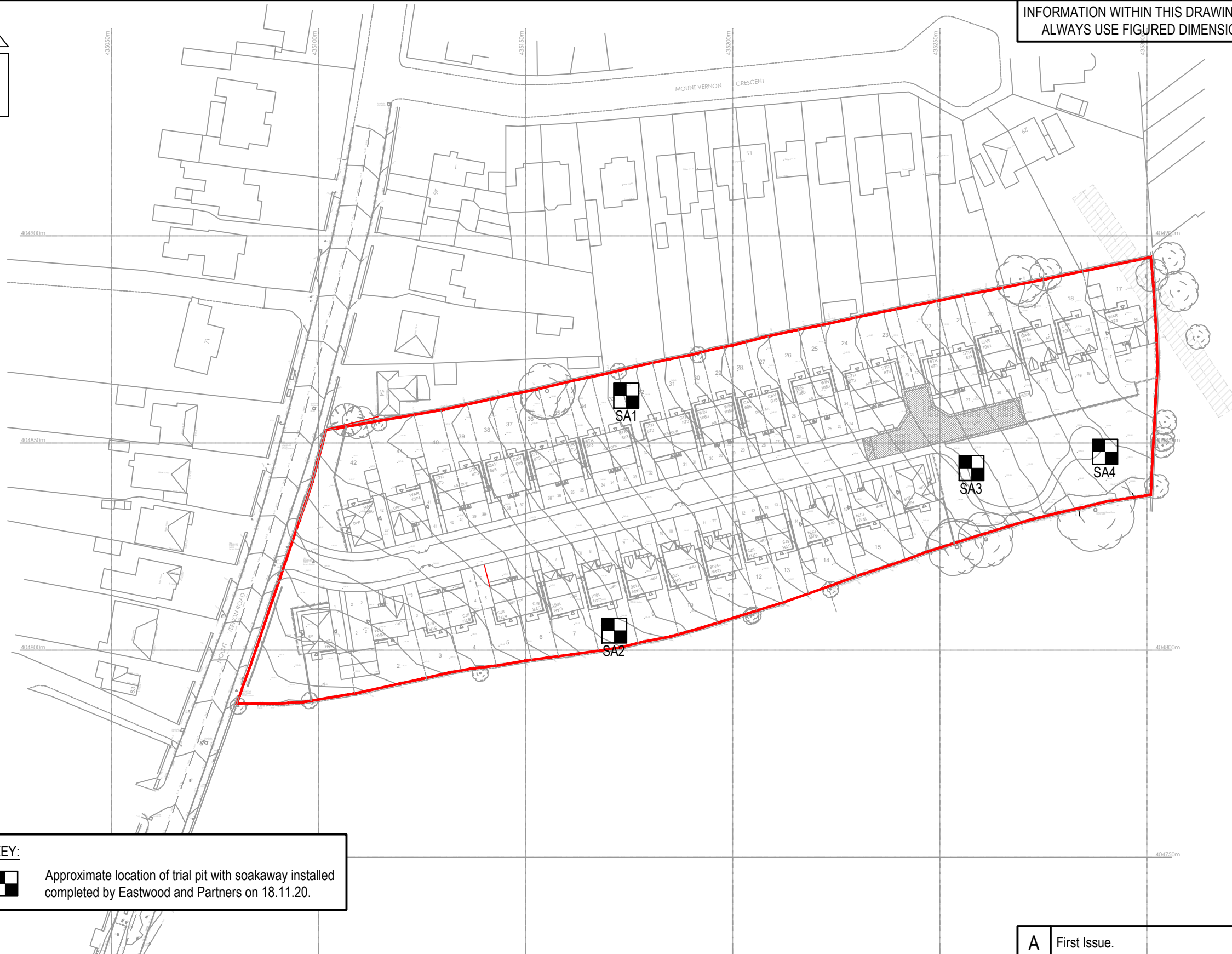
SA04



SA04 Arisings



INFORMATION WITHIN THIS DRAWING IS NOT NECESSARILY PRODUCED TO SCALE.
ALWAYS USE FIGURED DIMENSIONS AND CO-ORDINATES - IF IN DOUBT, ASK.



KEY:



Approximate location of trial pit with soakaway installed
completed by Eastwood and Partners on 18.11.20.

Eastwood & Partners
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DUCHY HOMES

MOUNT VERNON, WOSBOROUGH

EXPLORATORY HOLE LOCATION PLAN

A	First Issue.					
REV	DESCRIPTION			SIG	CHK	DATE
SCALE WHEN PLOTTED AT A3			DRAWING STATUS			
1:1000			INFORMATION			
DRAWN	CHECKED	DATE	DRAWING NUMBER		REV	
JRB	LW	25.11.20	45521/015		A	

PROJECT:	Mount Vernon Road, Worsbrough	Job No. 45521	Date 18.11.20
SUBJECT:	Infiltration Test Results and Calculation of Infiltration Rates	Prepared LW	Checked AJK

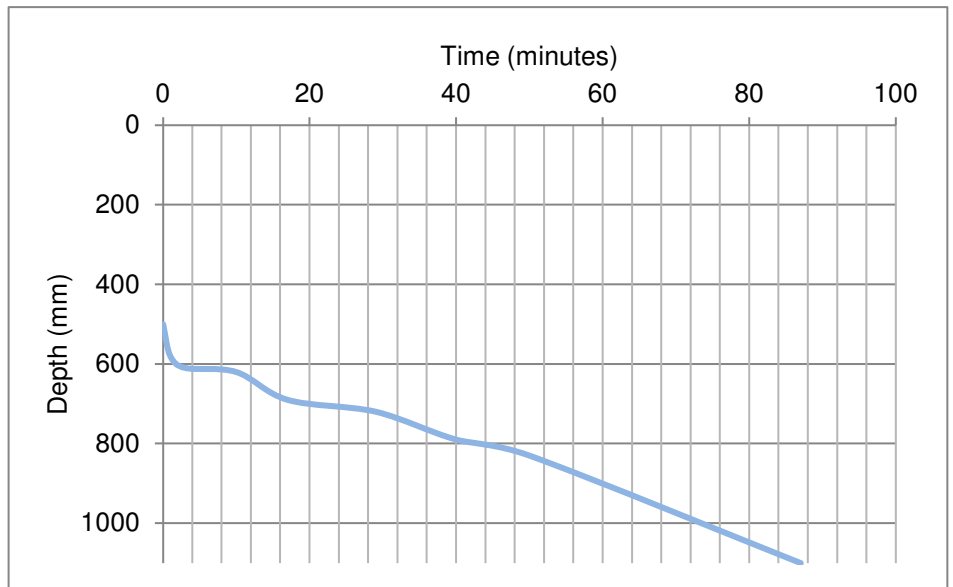
Test No. SA01 - Test 1

Test Pit Dimensions

Length = **1400** mm Plan area = **0.98** m²
Width = **700** mm
Depth = **1100** mm (Total depth)

Approximate time to discharge water into the hole: **20** Seconds
Depth to water after completion of pumping: **500** mm

Time (min)	Depth (mm)
0	500
1	580
3	610
10	620
17	690
29	720
40	790
50	830
87	1100



Test Pit Log

Depth (m)	Description
0.0 - 0.3	Topsoil: slightly sandy silty CLAY
0.3 - 1.1	Slightly clayey gravelly fine to coarse SAND

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Test No. SA01 - Test 1

Soil Infiltration Rate in Accordance with BR365

$$f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Where:

V_{p75-25} is the effective storage volume of water in the trial pit between 75% and 25% effective depth;

a_{p50} is the internal surface area of the trial pit up to 50% effective depth and including the base area

t_{p75-25} is the time for the water level to fall from 75% to 25% effective depth

Initial parameters

Depth to water = **500 mm** Average water depth: **300 mm**
 Start time = **0 min** Change in water depth: **600 mm**

Final parameters

Depth to water = **1100 mm** Time interval: **87 min**
 End time = **87 min**

Effective Storage Volume of Water in the Trial Pit = **0.588 m³**
 75% Effective Depth = **650 mm** from ground level
 25% Effective Depth = **950 mm** from ground level
 Time at 75% Effective Depth = **13 minutes**
 Time at 25% Effective Depth = **66 minutes**

V_{p75-25} = **0.29 m³**
 a_{p50} = **2.24 m²**
 t_{p75-25} = **3180 sec**
 f = **4.1E-05 m/sec**

Average Soakaway Rate = **1.1E-04 m³/sec**
 Average soakaway area = **2.24 m²** (sides + base)

BR365 Soil Infiltration Rate = 4.1E-05 m/sec
Average Infiltration Rate = 5.0E-05 m/sec

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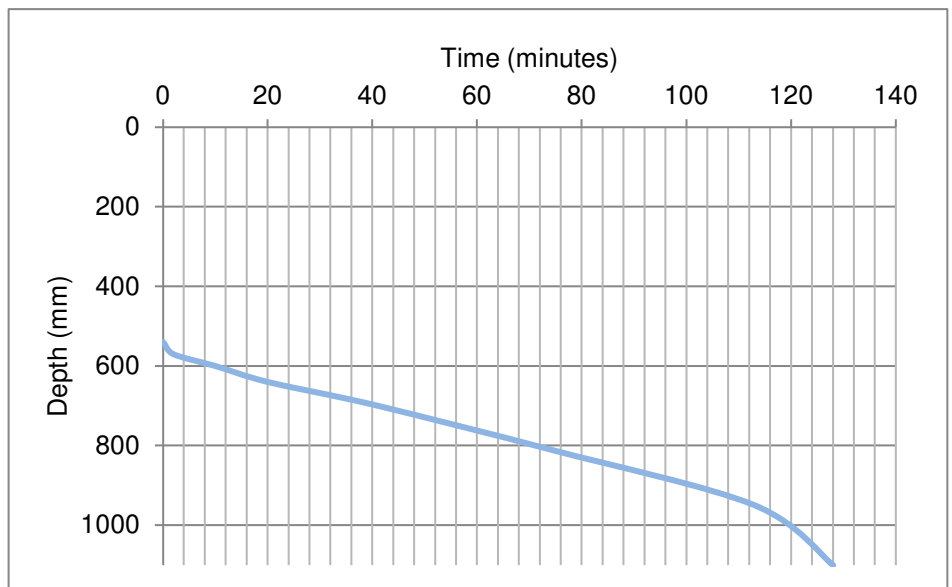
Test No. SA01 - Test 2

Test Pit Dimensions

Length = **1400** mm Plan area = **0.98** m²
Width = **700** mm
Depth = **1100** mm (Total depth)

Approximate time to discharge water into the hole: **20** Seconds
Depth to water after completion of pumping: **540** mm

Time (min)	Depth (mm)
0	540
2	570
10	600
20	640
41	700
74	810
113	950
128	1100



Test Pit Log

Depth (m)	Description
0.0 - 0.3	Topsoil: slightly sandy silty CLAY
0.3 - 1.1	Slightly clayey gravelly fine to coarse SAND

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Test No. SA01 - Test 2

Soil Infiltration Rate in Accordance with BR365

$$f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Where:

V_{p75-25} is the effective storage volume of water in the trial pit between 75% and 25% effective depth;

a_{p50} is the internal surface area of the trial pit up to 50% effective depth and including the base area

t_{p75-25} is the time for the water level to fall from 75% to 25% effective depth

Initial parameters

Depth to water = **540** mm Average water depth: **280** mm
 Start time = **0** min Change in water depth: **560** mm

Final parameters

Depth to water = **1100** mm Time interval: **128** min
 End time = **128** min

Effective Storage Volume of Water in the Trial Pit = **0.5488** m³
 75% Effective Depth = **680** mm from ground level
 25% Effective Depth = **960** mm from ground level
 Time at 75% Effective Depth = **30** minutes
 Time at 25% Effective Depth = **115** minutes

V_{p75-25} = **0.27** m³
 a_{p50} = **2.16** m²
 t_{p75-25} = **5100** sec
 f = **2.5E-05** m/sec

Average Soakaway Rate = **7.1E-05** m³/sec
 Average soakaway area = **2.16** m² (sides + base)

BR365 Soil Infiltration Rate = 2.5E-05 m/sec
Average Infiltration Rate = 3.3E-05 m/sec

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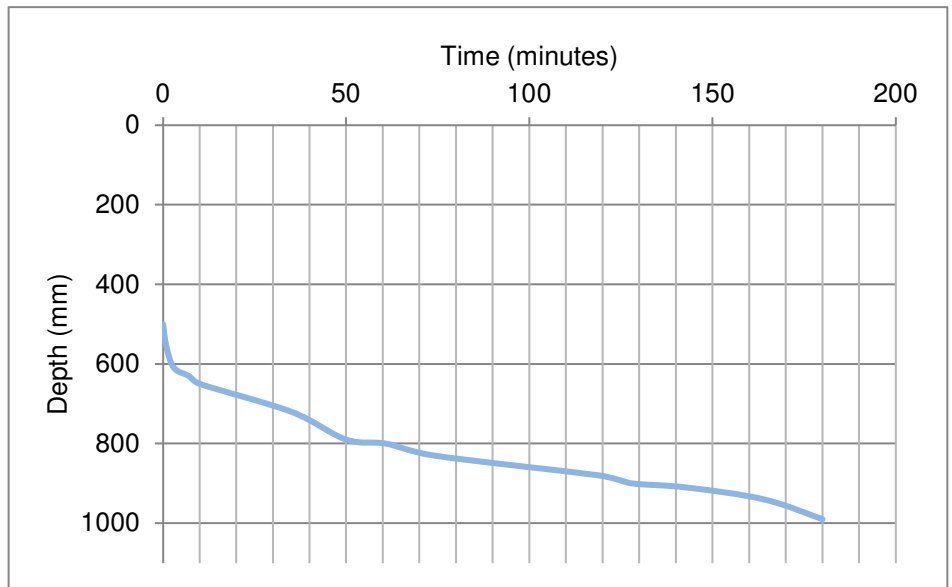
Test No. SA02 - Test 1

Test Pit Dimensions

Length = **1700** mm Plan area = **1.19** m²
Width = **700** mm
Depth = **1100** mm (Total depth)

Approximate time to discharge water into the hole: **20** Seconds
Depth to water after completion of pumping: **500** mm

Time (min)	Depth (mm)
0	500
1	560
3	610
7	630
10	650
35	720
50	790
61	800
74	830
119	880
128	900
143	910
164	940
180	990



Test Pit Log

Depth (m)	Description
0.0 - 0.4	Topsoil: slightly sandy silty CLAY
0.4 - 1.1	Slightly clayey gravelly fine to coarse SAND

PROJECT:	Mount Vernon Road, Worsbrough	Job No. 45521	Date 18.11.20
SUBJECT:	Infiltration Test Results and Calculation of Infiltration Rates	Prepared LW	Checked AJK

Test No. SA02 - Test 1

Soil Infiltration Rate in Accordance with BR365

$$f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Where:

V_{p75-25} is the effective storage volume of water in the trial pit between 75% and 25% effective depth;

a_{p50} is the internal surface area of the trial pit up to 50% effective depth and including the base area

t_{p75-25} is the time for the water level to fall from 75% to 25% effective depth

Initial parameters

Depth to water = **500** mm Average water depth: **355** mm
 Start time = **0** min Change in water depth: **490** mm

Final parameters

Depth to water = **990** mm Time interval: **180** min
 End time = **180** min

Effective Storage Volume of Water in the Trial Pit = **0.714** m³
 75% Effective Depth = **650** mm from ground level
 25% Effective Depth = **950** mm from ground level
 Time at 75% Effective Depth = **10** minutes
 Time at 25% Effective Depth = **170** minutes

V_{p75-25} = **0.36** m³
 a_{p50} = **2.63** m²
 t_{p75-25} = **9600** sec
 f = **1.4E-05** m/sec

Average Soakaway Rate = **5.4E-05** m³/sec
 Average soakaway area = **2.89** m² (sides + base)

BR365 Soil Infiltration Rate = 1.4E-05 m/sec
Average Infiltration Rate = 1.9E-05 m/sec

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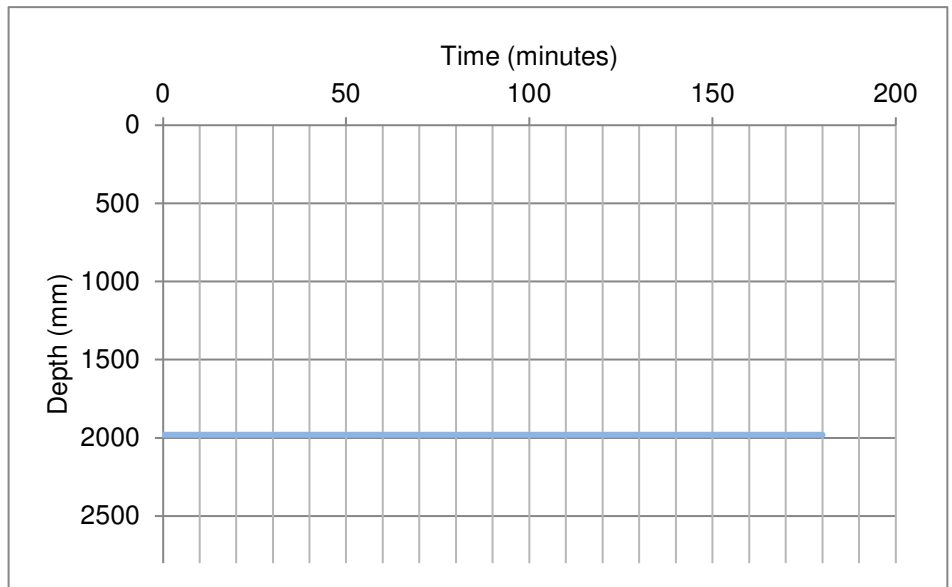
Test No. SA03 - Test 1

Test Pit Dimensions

Length = **2000** mm Plan area = **1.4** m²
 Width = **700** mm
 Depth = **2800** mm (Total depth)

Approximate time to discharge water into the hole: **20** Seconds
 Depth to water after completion of pumping: **1100** mm

Time (min)	Depth (mm)
0	1980
1	1980
2	1980
5	1980
10	1980
38	1980
76	1980
94	1980
124	1980
146	1980
180	1980



Test Pit Log

Depth (m)	Description
0.0 - 0.4	Topsoil: slightly sandy silty CLAY
0.4 - 2.1	Slightly gravelly slightly sandy CLAY
2.1 - 2.8	Thinly bed MUDSTONE

PROJECT:	Mount Vernon Road, Worsbrough	Job No. 45521	Date 18.11.20
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Test No. SA03 - Test 1

Soil Infiltration Rate in Accordance with BR365

$$f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Where: V_{p75-25} is the effective storage volume of water in the trial pit between 75% and 25% effective depth;

a_{p50} is the internal surface area of the trial pit up to 50% effective depth and including the base area

t_{p75-25} is the time for the water level to fall from 75% to 25% effective depth

Initial parameters

Depth to water = **1980** mm Average water depth: **820** mm
 Start time = **0** min Change in water depth: **0** mm

Final parameters

Depth to water = **1980** mm Time interval: **180** min
 End time = **180** min

Effective Storage Volume of Water in the Trial Pit = **1.148** m³
 75% Effective Depth = **2185** mm from ground level
 25% Effective Depth = **2595** mm from ground level
 Time at 75% Effective Depth = **N/A** minutes
 Time at 25% Effective Depth = **N/A** minutes

V_{p75-25} = **0.57** m³
 a_{p50} = **3.61** m²
 t_{p75-25} = **0** sec
 f = **#DIV/0! m/sec**

Average Soakaway Rate = **0.0E+00** m³/sec
 Average soakaway area = **5.83** m² (sides + base)

BR365 Soil Infiltration Rate = 0.0E+00 m/sec
Average Infiltration Rate = 0.0E+00 m/sec

PROJECT:	Mount Vernon Road, Worsbrough	Job No. 45521	Date 18.11.20
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Test No. SA04 - Test 1

Soil Infiltration Rate in Accordance with BR365

$$f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Where:

V_{p75-25} is the effective storage volume of water in the trial pit between 75% and 25% effective depth;

a_{p50} is the internal surface area of the trial pit up to 50% effective depth and including the base area

t_{p75-25} is the time for the water level to fall from 75% to 25% effective depth

Initial parameters

Depth to water = **1150 mm** Average water depth: **275 mm**
 Start time = **0 min** Change in water depth: **550 mm**

Final parameters

Depth to water = **1700 mm** Time interval: **17 min**
 End time = **17 min**

Effective Storage Volume of Water in the Trial Pit = **0.693 m³**
 75% Effective Depth = **1288 mm** from ground level
 25% Effective Depth = **1563 mm** from ground level
 Time at 75% Effective Depth = **1 minutes**
 Time at 25% Effective Depth = **6 minutes**

V_{p75-25} = **0.35 m³**
 a_{p50} = **2.53 m²**
 t_{p75-25} = **315 sec**
 f = **4.4E-04 m/sec**

Average Soakaway Rate = **6.8E-04 m³/sec**
 Average soakaway area = **2.53 m²** (sides + base)

BR365 Soil Infiltration Rate = 4.4E-04 m/sec
Average Infiltration Rate = 2.7E-04 m/sec

PROJECT:	Mount Vernon Road, Worsbrough	Job No. 45521	Date 18.11.20
SUBJECT:	Infiltration Test Results and Calculation of Infiltration Rates	Prepared LW	Checked AJK

Test No. SA04 _ test 2

Soil Infiltration Rate in Accordance with BR365

$$f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Where:

V_{p75-25} is the effective storage volume of water in the trial pit between 75% and 25% effective depth;

a_{p50} is the internal surface area of the trial pit up to 50% effective depth and including the base area

t_{p75-25} is the time for the water level to fall from 75% to 25% effective depth

Initial parameters

Depth to water = **1130 mm** Average water depth: **285 mm**
 Start time = **0 min** Change in water depth: **570 mm**

Final parameters

Depth to water = **1700 mm** Time interval: **18 min**
 End time = **18 min**

Effective Storage Volume of Water in the Trial Pit = **0.7182 m³**
 75% Effective Depth = **1273 mm** from ground level
 25% Effective Depth = **1558 mm** from ground level
 Time at 75% Effective Depth = **1 minutes**
 Time at 25% Effective Depth = **8 minutes**

V_{p75-25} = **0.36 m³**
 a_{p50} = **2.57 m²**
 t_{p75-25} = **435 sec**
 f = **3.2E-04 m/sec**

Average Soakaway Rate = **6.7E-04 m³/sec**
 Average soakaway area = **2.57 m²** (sides + base)

BR365 Soil Infiltration Rate = 3.2E-04 m/sec
Average Infiltration Rate = 2.6E-04 m/sec

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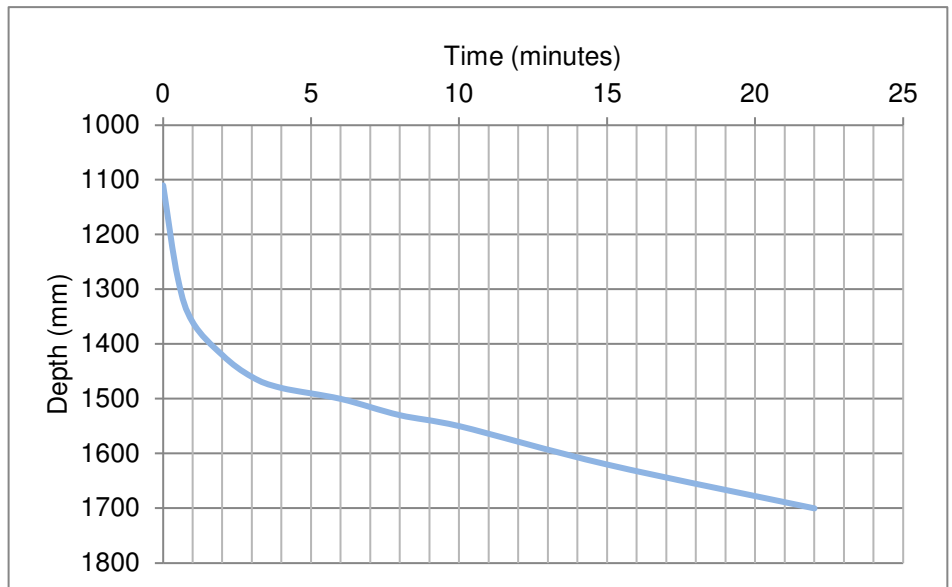
Test No. SA04 - Test 3

Test Pit Dimensions

Length = **1400** mm Plan area = **1.26** m²
Width = **900** mm
Depth = **1700** mm (Total depth)

Approximate time to discharge water into the hole: **20** Seconds
Depth to water after completion of pumping: **1110** mm

Time (min)	Depth (mm)
0	1110
0.5	1280
1	1360
2	1420
3	1460
4	1480
6	1500
8	1530
10	1550
15	1620
22	1700



Test Pit Log

Depth (m)	Description
0.0 - 0.5	Topsoil: slightly sandy silty CLAY
0.5- 1.7	Slightly clayey gravelly fine to coarse SAND

PROJECT:	Mount Vernon Road, Worsbrough	Job No. 45521	Date 18.11.20
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Test No. SA04 - Test 3

Soil Infiltration Rate in Accordance with BR365

$$f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Where:

V_{p75-25} is the effective storage volume of water in the trial pit between 75% and 25% effective depth;

a_{p50} is the internal surface area of the trial pit up to 50% effective depth and including the base area

t_{p75-25} is the time for the water level to fall from 75% to 25% effective depth

Initial parameters

Depth to water = **1110 mm** Average water depth: **295 mm**
 Start time = **0 min** Change in water depth: **590 mm**

Final parameters

Depth to water = **1700 mm** Time interval: **22 min**
 End time = **22 min**

Effective Storage Volume of Water in the Trial Pit = **0.7434 m³**
 75% Effective Depth = **1258 mm** from ground level
 25% Effective Depth = **1553 mm** from ground level
 Time at 75% Effective Depth = **1 minutes**
 Time at 25% Effective Depth = **11 minutes**

V_{p75-25} = **0.37 m³**
 a_{p50} = **2.62 m²**
 t_{p75-25} = **600 sec**
 f = **2.4E-04 m/sec**

Average Soakaway Rate = **5.6E-04 m³/sec**
 Average soakaway area = **2.62 m²** (sides + base)

BR365 Soil Infiltration Rate = 2.4E-04 m/sec
Average Infiltration Rate = 2.2E-04 m/sec