SOAKAWAY INVESTIGATION REPORT

Proposed Mixed Use Development
Land to the North of Nuttall Farm, Much Marcle

Prepared for: Boultbee Brooks Real Estate Ltd

Date: May 2020

Report No: 6176/SA

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REPORT TITLE : **Soakaway Investigation Report:**

Proposed Mixed Use Development

Land to the North of Nuttall Farm, Much Marcle

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EXECUTIVE SUMMARY

Proposals		Boultbee Brooks Real Estate Ltd is proposing the construction of a new mixed-use development within land to the North of Nuttall Farm, Much Marcle. The proposed development will comprise two sheds for livestock, a dwelling for temporary workers and an access road.
Geology		The British Geological Survey's (BGS) 1:50, 000 scale geological map (Sheet 215) of the area shows that the site is underlain by the Upper Ludlow Shales Group of Silurian Age. The BGS describe the Upper Ludlow Shales group as calcareous siltstones, silty mudstones and mudstones. No superficial deposits are indicated to be present within the site.
Field Investigation		The site works were scoped by Vectos Ltd and comprised the following: • 1No. Machine excavated trial pits (TP01), • 2No. Hand excavated pits (DP1 and DP2), and • 3No. In-situ soakaway tests (TP01, DP1 and DP2). The site works were carried out at the site the 12th of May 2020. No groundwater was encountered within any of the exploratory location.
Engineering Recommendations	***Storm Drainage***	1No. in-situ soakaway test was undertaken at TP01 in accordance with the requirements of BRE 365. TP01 completed one test within the time permitted although with additional time over three days it is likely this locality could complete three complete fills in accordance with BRE365. Therefore, based on the above it is considered there is potential for soakaways to be viable at the site for discharging surface waters.
	Field Drainage	2No. in-situ infiltration tests were undertaken at DP1 and DP2 broadly in accordance with the requirements of BS 5930:1999+A2:2010 (Section 4). Vp values ranged between 120 and 182 with an average result of 151. It is generally accepted that values >100 may not be deemed suitable. Therefore, it is likely that drainage field infiltration may not be a viable option at the proposed development.

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SECTION 1 Introduction and Proposed Development

Boultbee Brooks Real Estate Ltd is proposing the construction of a new mixed-use development within land to the North of Nuttall Farm, Much Marcle. The proposed development will comprise two sheds for livestock, a dwelling for temporary workers and an access road.

Vectos Ltd are the consulting drainage engineers for the proposed development.

Terra Firma (South) have been commissioned as Geotechnical and Geo-Environmental Engineers to carry out a Soakaway Investigation of the site.

The main objectives of the Soakaway Investigation were to:

- Establish the ground conditions of the site, including logging of the holes and undertaking of in-situ testing.

The Ground Investigation has been undertaken in accordance with the following advisory guidance:

- Code of Practice for Site Investigations - (BS 5930): 2015
- Investigation of Potentially Contaminated Sites - CoP (BS 10175): 2011 + A2 2017
- Methods of test for soils for civil engineering purposes - In-situ tests (BS 1377-9): 1999

In order to achieve the above objectives, Terra Firma (South) carried out an assessment programme including a review of existing data, followed by a field investigation to determine the prevailing ground conditions at the site.

The scope of the works including the schedule for in-situ testing was determined by Vectos Ltd.

1.1 Limitations and Exceptions of Investigation

Boultbee Brooks Real Estate Ltd has requested that a Soakaway Investigation Report be performed in order to establish the ground conditions at the site and collect representative samples for laboratory analysis.

The Soakaway Investigation was conducted and this report has been prepared for the sole internal reliance of Boultbee Brooks Real Estate Ltd and their design and construction team. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Terra Firma (South). If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

The report represents the findings and opinions of experienced geo-environmental and geo-technical consultants. Terra Firma (South) does not provide legal advice and the advice of lawyers may also be required.

The subsurface geological profiles, any contamination and other plots are generalised by necessity and have been based on the information found at the locations of the exploratory holes and depths sampled and tested.

The soakaway investigation was limited by the following site constraints:

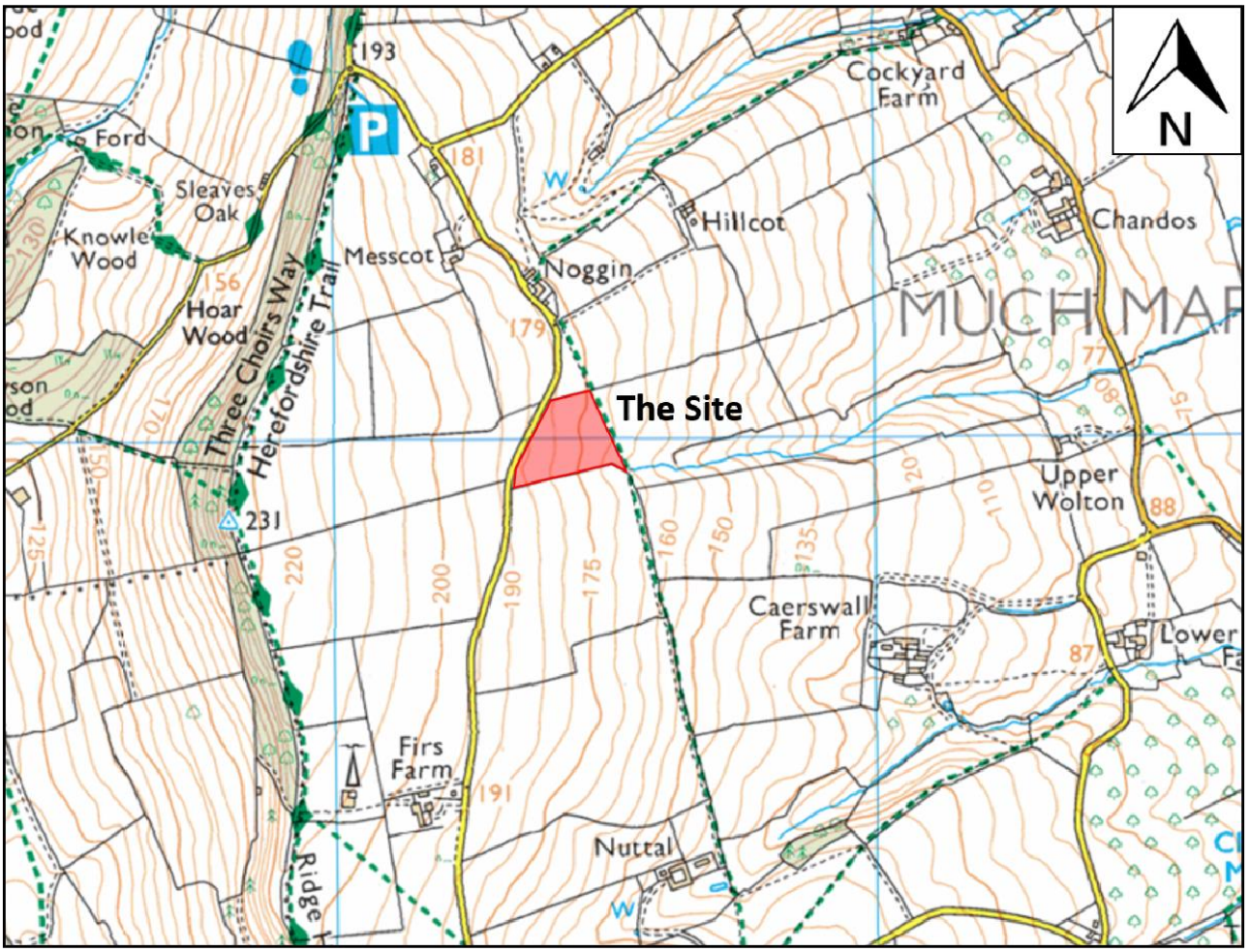
- The presence of time restraints outside of our reasonable control.

SECTION 2 Site Setting

2.1 Physical Setting

The proposed development is to be located within land to the North of Nuttall Farm, Much Marcle, Herefordshire, HR8 2PF

The site is centred on National Grid Reference (NGR) 363300, 234270. The site location is presented in **Drawing 2.1** below.



Drawing 2.1: Site Location Plan

The site is irregular in shape and covers an area of some 1.62 hectares. Ground levels within the site range between 173m and 185m AOD.

The topography of the site and surrounding area slopes to the East.

The site is bound by agricultural fields to the north, east and south and by Cherry Orchard Lane to the west.

2.1.1 Current Use and Site Conditions

A walk-over survey was undertaken on the 12th of May 2020 by a Terra Firma (South) Engineer. The site is accessed via Cherry Orchard Lane to the west. At the time of the walk-over survey the site currently comprises an agricultural field.

2.2 Geological Setting

The British Geological Survey's (BGS) 1:50, 000 scale geological map (Sheet 215) of the area shows that the site is underlain by the Upper Ludlow Shales Group of Silurian Age. The BGS describe the Upper Ludlow Shales group as calcareous siltstones, silty mudstones and mudstones.

No superficial deposits are indicated to be present within the site.

2.3 Previous Investigation

There has been 1No. previous investigation near the site, as summarised below:

1. Terra Firma (South), 6176, July 2018

   A soakaway report by Terra Firma (South) comprising 4 machine excavated trial pits was undertaken in July 2018 on an area of land approximately 250m to the north of the site within the same geological formation. None of the pits sufficiently drained to provide an infiltration rate for storm drainage design.

SECTION 3 Field Investigation

3.1 General

The site works were scoped by Vectos Ltd and comprised the following:

- 1No. Machine excavated trial pits (TP01),
- 2No. Hand excavated pits (DP1 and DP2), and
- 3No. In-situ soakaway tests (TP01, DP1 and DP2).

The site works were carried out at the site the 12th of May 2020.

Prior to the site works, the following Health and Safety measures were undertaken:

- Risk Assessment & Method Statement (RAMS) was issued and approved beforehand, and
- Before any excavation, all exploratory hole locations were scanned using a Cable Avoidance Tool (CAT).

The exploratory holes were set out at locations provided by Vectos Ltd and adjusted where necessary to take account of any site constraints detailed in Section 1.1.

The site works were supervised by Terra Firma (South), who also logged the exploratory holes to the requirements of BS5930:2015.

The exploratory hole logs and in-situ test results are presented in **Annex A** and **Annex B** respectively, and their locations shown on **Drawing 3.1** below.

Drawing 3.1: Exploratory Hole Location Plan

3.2 Exploratory Holes

3.2.1 Machine Excavated Trial Pits

The trial pits were excavated using a tracked excavator.

Following completion of soil logging, in-situ testing and sampling, the trial pits were backfilled using arisings and re-compacted as best as practicably possible using the excavator backhoe. If necessary, the trial pit was left slightly proud in order to allow for short-term settlement.

3.2.2 Hand Excavated Trial Pits

The hand excavated drainage pits were sunk using conventional digging tools, limited to a maximum investigated depth of 0.30m and used to obtain soakaway infiltration rates for a drainage field design.

Following completion of soil logging, in-situ testing and sampling, the hand excavated trial pits were backfilled using arisings and re-compacted as best as practicably possible using hand tools.

3.3 In-situ Testing

3.3.1 Permeability Testing

During the site investigation, an in-situ permeability test was undertaken within TP01 and where possible were carried out to the requirements of BRE Digest 365. The in-situ permeability test was undertaken within the excavated trial pit in order to provide a soil infiltration rate to be used in soakaway design. A 2000-gallon tractor-towed bowser was used to rapidly fill the pit with water.

Drainage field soakaways were undertaken within DP1 and DP2 and where possible were carried out to the requirements of BS 5930:1999+A2:2010 (Section 4). A 300mm x 300mm x 300mm pit was sunk at the base of the excavation. This small pit was then rapidly filled with water. Despite slight dimensional instability an appropriate volume of water was utilised (27 litres).

The appropriate calculation sheets are presented in **Annex B** and the results given in the table below.

Table 3.1: Infiltration Test Results

Soak away Test	Depth (m)	Type	Soil Type	Infiltration Rate (m/s)
TP01	1.20	Storm Drainage	Very clayey GRAVEL	7.17×10^{-06}
DP1	0.60	Septic Drainage	Slightly sandy gravelly CLAY	$1.72 \times 10^{-06*}$ VP – 182*
DP2	0.75		Mudstone	1.85×10^{-06} VP – 120.4

Notes:

- * Based on extrapolated result

It should be noted that DP2 could only be excavated to 0.75mbgl due to encountering the rock head restricting further excavation.

SECTION 4 Ground Conditions

4.1 Summary

The ground conditions encountered by the exploratory holes were variable across the site and but can in general be summarised as shown in the following table:

Table 4.1: Summary of Ground Conditions

Depth (mbgl)		Thickness (m)		Stratum	
From	To	Min	Max		
0.00	0.30	0.30	0.30	Grass/crop over firm to stiff yellowish brown slightly sandy slightly gravelly clayey SILT	*Topsoil*
0.30	1.20	Unproven		Stiff yellowish brown slightly sandy gravelly CLAY OR Dense light yellowish brown slightly sandy very clayey GRAVEL	*Residual Soils*
0.60	>0.75	Unproven		MUDSTONE recovered as yellowish brown slightly sandy silty GRAVEL	*Bedrock – Upper Ludlow Shales*

Within trial pits, the estimated strength of granular deposits was determined from visual assessment only (ease/difficulty of excavation and pit stability).

4.2 Stability

The sides of the excavations were typically found to be stable

4.3 Strata Details

4.3.1 Topsoil

The Topsoil layer was encountered within all exploratory locations and comprised grass or crop overlying a firm to stiff SILT with numerous rootlets. The Topsoil material extended to maximum thickness of 0.30m.

4.3.2 Residual Soils

The Residual Soils were encountered within TP01 and DP1 and comprised a stiff gravelly CLAY (DP1) or a very clayey GRAVEL (TP01). The Residual Soils were not fully penetrated at these locations.

4.3.3 Bedrock Geology

The Bedrock Geology was encountered within DP2 only and comprised a mudstone rock recovered as a silty GRAVEL. The nature of the rock prohibited further excavation at the DP2 location.

4.4 Water Strikes

No groundwater was encountered within any of the exploratory location.

SECTION 5 Engineering Recommendations

5.1 Storm Drainage

1No. in-situ soakaway test was undertaken at TP01 in accordance with the requirements of BRE 365.

TP01 completed one test within the time permitted although with additional time over three days it is likely this locality could complete three complete fills in accordance with BRE365.

Therefore, based on the above it is considered there is potential for soakaways to be viable at the site for discharging surface waters.

During drainage design, consideration should be given to the variability encountered across the site.

It should be noted proposed soakaways would only be effective above the level of groundwater. No groundwater was encountered during this investigation but higher groundwater may be encountered during winter months.

Any planned soakaways should be at least 5-10m away from building foundations in accordance with recommendations within guidelines.

5.2 Field Drainage

2No. in-situ infiltration tests were undertaken at DP1 and DP2 broadly in accordance with the requirements of BS 5930:1999+A2:2010 (Section 4).

Vp values ranged between 120 and 182 with an average result of 151. It is generally accepted that values >100 may not be deemed suitable.

Therefore, it is likely that drainage field infiltration may not be a viable option at the proposed development.

Annex A: Exploratory Hole Logs

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Borehole No.
DP1
Sheet 1 of 1

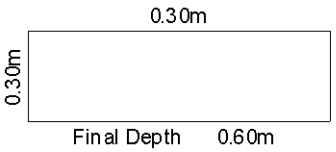
Project Name	Project No.	Date	Hole Type
Land at Noggin Farm, Much Marcle	6176	12/05/2020 to 12/05/2020	TP

Client	Co-ords	Water Strike Details		Logged By
Boultbee Brooks Real Estate Ltd	E:	Depth Strike	Remarks	AS
Contractor / **Plant Used**	N:			Approved By: PS
BBRE / Hand Tools	L:			Scale 1:50

Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend
Results	Type	Depth				
			(0.30)		TOPSOIL: Grass/crop over firm to stiff light yellowish brown slightly gravelly slightly sandy clayey SILT with abundant rootlets.	
			0.30			
			(0.30)		Stiff yellowish brown slightly sandy gravelly CLAY. Gravel is angular to subangular fine to coarse of weak to medium strong mudstone.	
			0.60		End of Trial Pit at 0.60m	
			1			
			2			
			3			
			4			

Trial Pit Photographs

Remarks
0.3m x 0.3m x 0.3m pit excavated between 0.30m and 0.60mgl for septic drainge test



Pit Stability: STABLE

Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.

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Borehole No.
DP2
Sheet 1 of 1

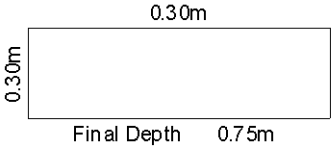
Project Name	Project No.	Date	Hole Type
Land at Noggin Farm, Much Marcle	6176	12/05/2020 to 12/05/2020	TP

Client	Co-ords	Water Strike Details		Logged By
Boultbee Brooks Real Estate Ltd	E:	Depth Strike	Remarks	AS
Contractor / **Plant Used**	N:			Approved By
BBRE / Hand Tools	L:			PS
				Scale 1:50

Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend
Results	Type	Depth				
			(0.30)		TOPSOIL: Grass/crop over firm to stiff light yellowish brown slightly gravelly slightly sandy clayey SILT with abundant rootlets.	
			0.30			
			(0.45)		Weak MUDSTONE recovered as yellowish brown slightly sandy silty GRAVEL. Gravel is angular to subangular fine to coarse of weak to medium strong mudstone.	
			0.75		End of Trial Pit at 0.75m	
			1			
			2			
			3			
			4			

Trial Pit Photographs

Remarks
0.3m x 0.3m x 0.15m pit excavated between 0.60m and 0.75mgl for septic drainge test.
Pit refused at 0.75m on rock head.



Pit Stability: STABLE

Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.

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Borehole No.
TP01
Sheet 1 of 1

Project Name	Project No.	Date	Hole Type
Land at Noggin Farm, Much Marcle	6176	12/05/2020 to 12/05/2020	TP

Client	Co-ords	Water Strike Details		Logged By
Boultbee Brooks Real Estate Ltd	E:	Depth Strike	Remarks	AS

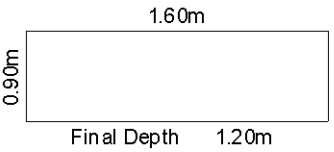
Contractor	Plant Used		Approved By
BBRE	Tracked Excavator	N: L:	PS

Scale 1:50

Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend
Results	Type	Depth				
			(0.30) 0.30		TOPSOIL: Grass/crop over firm to stiff light yellowish brown slightly gravelly slightly sandy clayey SILT with abundant rootlets.	
			(0.90) 1.20		Dense light yellowish brown slightly sandy very clayey GRAVEL with frequent cobbles. Gravel is angular to subangular fine to coarse of limestone and mudstone. Interbedded with very thinly to thickly laminated beds of mudstone/shale (1-5cm) and thinly bedded limestone (5-10cm). Fossilised shell remains present.	
					End of Trial Pit at 1.20m	

Trial Pit Photographs

Remarks



Pit Stability: STABLE

Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.

Annex B: In-situ Test Results

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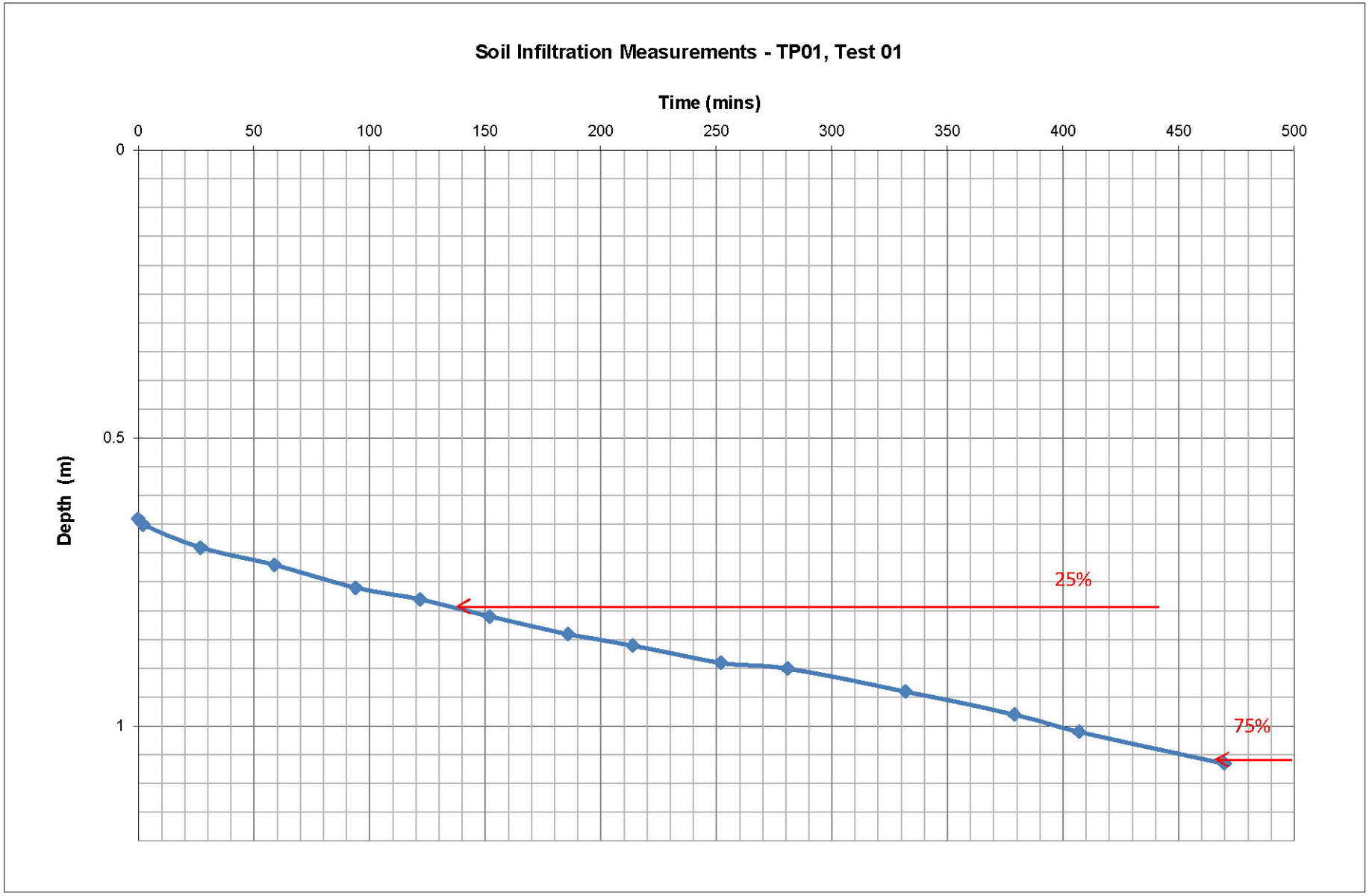
Site Name:	The Noggin, Much Markle	**Job No.:** 6176	**Date Undertaken**: 12/05/2020
Trial Pit No.:	TP01	**Test No.**: 1	

	Depth to Water (m)	Time (Mins)
(Top of test / effective depth - 100%)	0.64	0
	0.65	2
	0.69	27
	0.72	59
	0.76	94
	0.78	122
	0.81	152
	0.84	186
	0.86	214
	0.89	252
	0.9	281
	0.94	332
	0.98	379
	1.01	407
	1.065	470
(Base of pit / effective depth - 0%)	1.200	

Length of Trial Pit (m)	1.6
Width of Trial Pit (m)	0.9
Depth of Trial Pit (m)	1.2
Effective Storage Depth (m)	0.560
Vp25	0.7800
Vp75	1.0600
Vp75-25	0.403
50% effective depth (m)	0.280
Mean Surface area ap50 (m2)	2.840
Time for 25% **Outflow** (t_{p25})	138
Time for 75% **Outflow** (t_{p75})	468
tp75 - 25	330
Soil Infiltration Rate (m/s)	**7.17E-06**

Soil Infiltration Worksheet: This worksheet has been produced in combination with the document 'BRE Digest 365- September 1991'. This worksheet can be used to determine soil infiltration rates from trial pit field measurements. Worksheet options are identified by a green background


Soil Infiltration Measurements - TP01, Test 01
Time (mins)
0
50
100
150
200
250
300
350
400
450
500
Depth (m)
0
0.5
1
25%
75%

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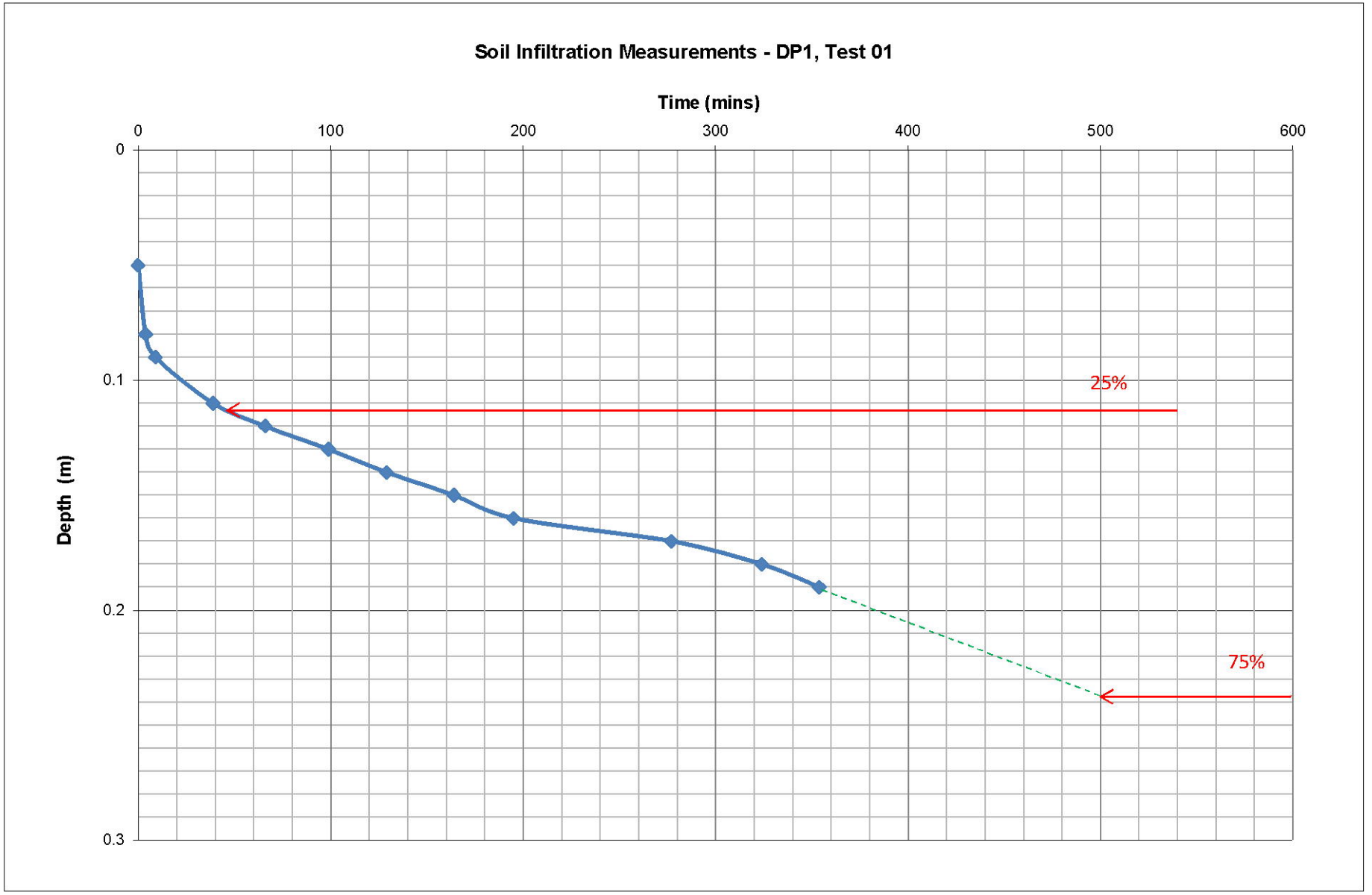
Site Name:	The Noggin, Much Markle	**Job No.:** 6176	**Date Undertaken**: 12/05/2020
Trial Pit No.:	DP1	**Test No.**: 1	

	Depth to Water (m)	Time (Mins)
(Top of test / effective depth - 100%)	0.05	0
	0.08	4
	0.09	9
	0.11	39
	0.12	66
	0.13	99
	0.14	129
	0.15	164
	0.16	195
	0.17	277
	0.18	324
	0.19	354
(Base of pit / effective depth - 0%)	0.300	

Length of Trial Pit (m)	0.3	
Width of Trial Pit (m)	0.3	
Depth of Trial Pit (m)	0.3	Excavated from 0.30m to 0.60m bgl
Effective Storage Depth (m)	0.250	
Vp25	0.1125	
Vp75	0.2375	
Vp75-25	0.011	
50% effective depth (m)	0.125	
Mean Surface area ap50 (m2)	0.240	
Time for 25% **Outflow** (t_{p25})	45	
Time for 75% **Outflow** (t_{p75})	500	
tp75 - 25	455	
Soil Infiltration Rate (m/s)	**1.72E-06**	
Vp	182	Based on extrapolated result

Soil Infiltration Worksheet: This worksheet has been produced in combination with the document 'BRE Digest 365- September 1991'. This worksheet can be used to determine soil infiltration rates from trial pit field measurements. Worksheet options are identified by a green background


Soil Infiltration Measurements - DP1, Test 01
Time (mins)
0
100
200
300
400
500
600
Depth (m)
0
0.1
0.2
0.3
25%
75%

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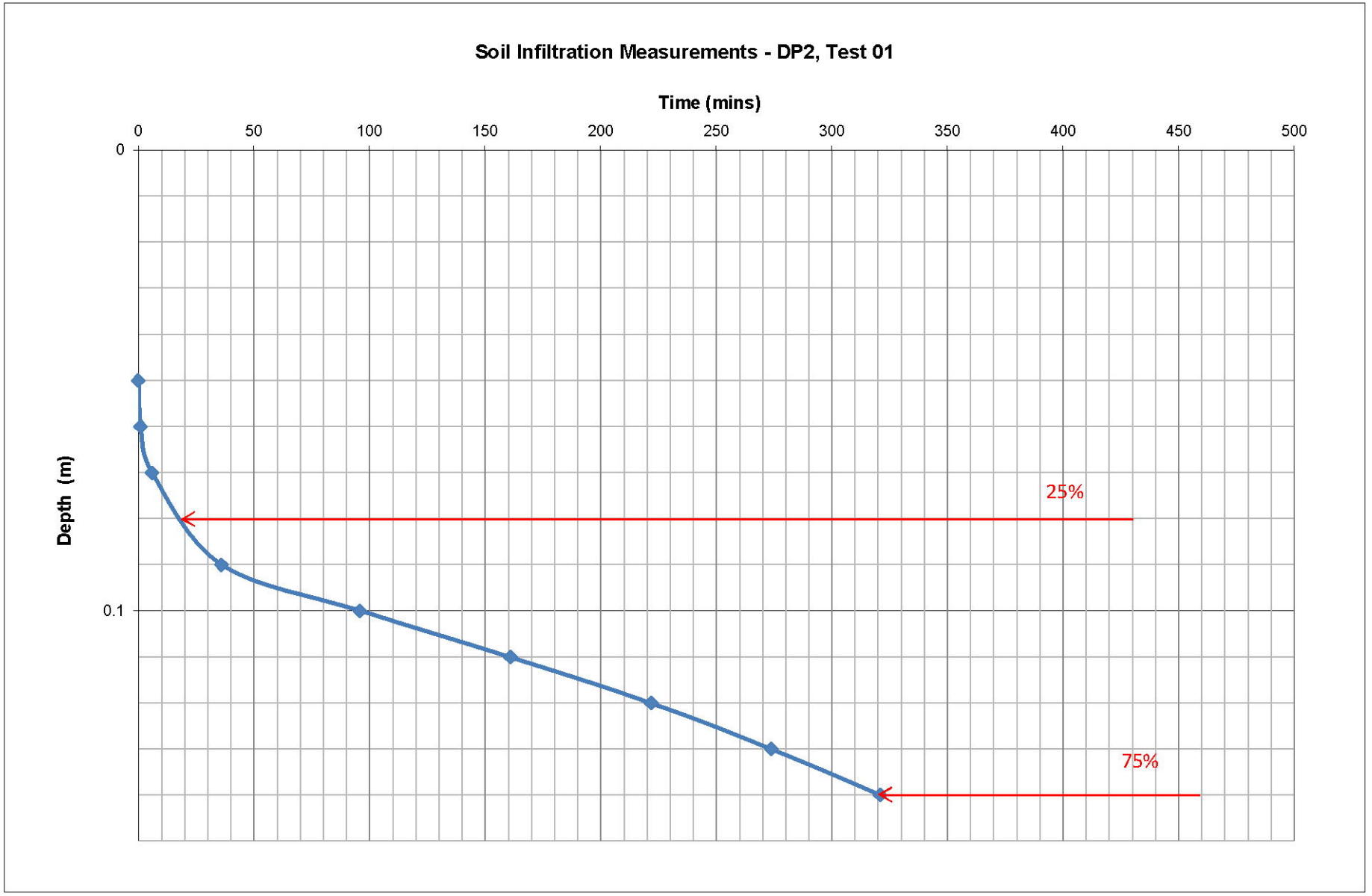
Site Name:	The Noggin, Much Markle	**Job No.:** 6176	**Date Undertaken**: 12/05/2020
Trial Pit No.:	DP2	**Test No.**: 1	

	Depth to Water (m)	Time (Mins)
(Top of test / effective depth - 100%)	0.05	0
	0.06	1
	0.07	6
	0.09	36
	0.1	96
	0.11	161
	0.12	222
	0.13	274
	0.14	321
(Base of pit / effective depth - 0%)	0.170	

Length of Trial Pit (m)	0.3	
Width of Trial Pit (m)	0.3	
Depth of Trial Pit (m)	0.17	Excavated from 0.60m to 0.75m bgl
Effective Storage Depth (m)	0.120	
Vp25	0.0800	
Vp75	0.1400	
Vp75-25	0.005	
50% effective depth (m)	0.060	
Mean Surface area ap50 (m2)	0.162	
Time for 25% **Outflow** (t_{p25})	19	
Time for 75% **Outflow** (t_{p75})	320	
tp75 - 25	301	
Soil Infiltration Rate (m/s)	**1.85E-06**	
Vp	120.4	

Soil Infiltration Worksheet: This worksheet has been produced in combination with the document 'BRE Digest 365- September 1991'. This worksheet can be used to determine soil infiltration rates from trial pit field measurements. Worksheet options are identified by a green background


Soil Infiltration Measurements - DP2, Test 01
Time (mins)
0
50
100
150
200
250
300
350
400
450
500
Depth (m)
0
0.1
25%
75%