



Factual Soakage Test & Groundwater Monitoring Report

Project Name: Quercus Nursery

Location: Littlehampton Road, Ferring, BN12 6PG

Client: Quercus Nursery Ltd.

Project ID: J14325

Report Date: 07 May 2020

Report Issue: 2

SUMMARY

The site, which extends to approximately 2 acres, comprises a horticultural nursery.

As part of a planning condition, information is required on the soakage potential of soils underlying the site to aid the design of shallow surface water drainage. Information is also required on the depth to the groundwater table during the winter period.

Geological records indicate the site to be underlain by River Terrace Deposits & Head over Upper Chalk (Lewes Nodular Chalk Formation).

No desk study was carried out as part of this investigation. An Unexploded Ordnance (UXO) risk assessment was not included in our brief.

A single phase of intrusive investigation was carried out. All areas of the site were accessible during the fieldwork.

Soakage testing in accordance with BRE 365 was carried out within three trial pits. The results of the soakage testing are appended to this report.

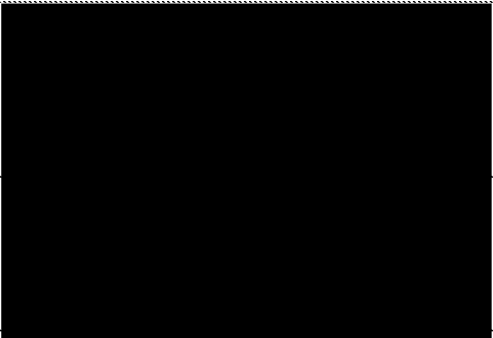
The soils encountered comprised topsoil over firm clay, over Chalk.

Groundwater was encountered at shallow depths during this investigation.

Dataloggers were installed within two groundwater monitoring wells to record the depth to groundwater over a period of three months. This report is a final report issue released upon completion of the monitoring period and supersedes an earlier report containing preliminary groundwater monitoring data.

The investigation was conducted and this report has been prepared for the sole internal use and reliance of Quercus Nursery Ltd. and their appointed Engineers. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Southern Testing Laboratories Ltd. 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 findings and opinions conveyed via this investigation report are based on information obtained from a variety of sources as detailed within this report, and which Southern Testing Laboratories Ltd. believes are reliable. Nevertheless, Southern Testing Laboratories Ltd. cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

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For and on behalf of Southern Testing Laboratories Limited



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A INTRODUCTION

1 Authority

Our authority for carrying out this work is contained in a Southern Testing Project Order form completed by Mr D Baldwin, representing Quercus Nursery Ltd, dated the 20th January 2020.

2 Location

The site is located to the north of the village of Ferring, West Sussex, and approximately 1km north west of Goring-By-Sea railway station.

The National Grid Reference of the site is TQ 09330 03570. The site location is indicated on Figure 1 within Appendix A.

3 Background & Objectives

This is a factual soakage and groundwater monitoring investigation only.

The object of this investigation was to assess the soakage potential of soils on site and to obtain information on the groundwater table during the winter months to aid the design of surface water drainage.

4 Scope

This report presents our exploratory hole logs and test results.

A UXO risk assessment was not requested within our brief for the investigation.

As with any site there may be differences in soil conditions between exploratory hole positions.

This report is not an engineering design and the figures and calculations contained in the report should be used by the Engineer, taking note that variations will apply, according to variations in design loading, in techniques used, and in site conditions. Our figures therefore should not supersede the Engineer's design.

The ground/site investigation has been completed with reference to BS 5930 Ref [1] and BS 10175 Ref [2].

This is a factual soakage investigation only. Contamination and geotechnical issues are not considered in this report.

Waste Classification of soils was not included within our brief for the investigation.

The findings and opinions conveyed via this investigation report are based on information obtained from a variety of sources as detailed within this report, and which Southern Testing Laboratories Ltd. believes are reliable. Nevertheless, Southern Testing Laboratories Ltd. cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

The investigation was conducted and this report has been prepared for the sole internal use and reliance of Quercus Nursery Ltd. and their appointed Engineers. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Southern Testing Laboratories Ltd. 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 recommendations contained in this report may not be appropriate to alternative development schemes.

B GEOLOGY & WALKOVER SURVEY

No Phase 1 Desk Study was included within our brief for this investigation.

4.1 Geology

The British Geological Survey 1:50,000 Map No 317/332 'Chichester & Bognor' indicates that the site geology consists of Aeolian Deposits (Brickearth) & Head over Upper Chalk (Lewes Nodular Chalk Formation).

4.1.1 Brickearth

Brickearth (loess deposit) is a recent deposit which is so called as it is suited to brick manufacture. It is predominantly an aeolian deposit; formed during cold, dry climatic conditions. There is evidence that brickearth has been reworked as part of 'sheet flooding' which helped incorporate flint gravels into the deposit. Brickearth consists mainly of ferruginous silty clay, which is often sandy and may contain some finely divided chalk, scattered flints and gravelly seams, or other locally derived material. It is usually poorly consolidated and may contain numerous hollow root tubes and worm burrows.

4.1.2 Head

Head is a superficial deposit comprising a poorly sorted and poorly stratified material formed mostly by solifluction and/or hillwash and soil creep. This is a polymict deposit of gravel, sand and clay depending on the local upslope geology, from which it is derived.

4.1.3 Lewes Nodular Chalk Formation

The Lewes Nodular Chalk Formation is characterised by bands of orange-stained, hard, medium to very high density chalk interbedded with soft greyer low density chalk. There are some well-developed hardgrounds noted such as the Top Rock and Chalk Rock. A number of persistent marl and flint horizons are included within this formation. Fracturing is variable, although commonly steeply inclined and curvilinear in nature. Horizons of sub-horizontal sheet flints are also present.

The White Chalk outcrop in particular is frequently highly fractured and highly permeable, and usually has good infiltration characteristics. On the other hand, Chalk Head, highly weathered Chalk and Chalk under a low permeability superficial cover may have very poor infiltration characteristics.

4.2 General Site Description

The site comprises a horticultural nursery set on the northern side of Littlehampton Road, north of the village of Ferring, West Sussex. The site is occupied by three polythene greenhouse tunnels, with surrounding planter beds and a number of log cabins/ portacabins/ containers used as offices and storage, together with grassed areas. The site is accessed via a gravel driveway leading from Littlehampton Road to the south of the site to a large gravel parking area. To the north of the greenhouses and buildings is grassed fields, with further planter beds. Between the greenhouses and open field is a 1m high earth bund, with another on the other side of the planter beds.

Site boundaries comprise wooden fencing to the north, south and west, vegetated with hedgerows in places. The eastern boundary comprises a wire fence line. To the north of the site are riding paddocks, to the south is Littlehampton Road, beyond which is housing, whilst to the west is a driveway to nearby properties/ paddocks. To the east of the site is a vineyard.

At the time of our investigation, some areas of grass appeared heavily saturated, with areas of pooled water. The site is predominantly level, with a slight rise in the northern quarter, which further steepens to the north off-site.

4.3 Site Photographs

A series of photographs showing the site and immediate surrounding area is included in Appendix C.

C GROUND INVESTIGATION

5 Strategy and Method

The strategy adopted for the intrusive investigation comprised the following:

Activity / Method	Purpose	Max Depth (mbgl)	Installations / Notes
TP1-3 8T Tracked Excavator	Trial pits to investigate the shallow ground conditions and allow for assessment of soakage potential using the BRE365 method, at locations specified by the client.	1.0/3.0	Pits gravel filled prior to testing to maintain pit stability.
WLS1 & WLS2 Dynamic Windowless Sampling	Boreholes to install shallow groundwater monitoring wells.	5.0	50mm groundwater monitoring wells installed within WLS1 and WLS2. Installation of dataloggers to monitor groundwater levels.

Within trial pit TP1, a 40mm plastic water pipe was encountered at approximately 1.0mbgl. This hole was terminated at this depth and relocated a short distance away (TP1a).

Exploratory hole locations are shown in Figure 2 in Appendix A.

In-situ test and sampling method descriptions employed are given in Appendix B together with the test results.

6 Weather Conditions

The initial fieldwork was carried out between the 29th and 30th January 2020, at which time the weather was generally dry and cold, with the occasional rain shower. During January 2020, rainfall within the south east of England was recorded at approximately 90% of the long-term average. In the South East of England however, the preceding months of October to December were significantly wetter than the long-term average.

The groundwater monitoring period extended from late January until late April. The weather during this time was variable, with rainfall during February recorded as being well above average (237% UK-wide), whilst during March rainfall was recorded as 80% of the long-term average in the south east of England (85% UK-wide). No rainfall data was available for the month of April at the time of publication of this report.

7 Soils as Found

The soils encountered are described in detail in the attached exploratory hole logs (Appendix A), but in general comprised a covering of Topsoil over firm Clay/ Chalk Head, over Chalk. A summary is given below.

Depth (m)	Thickness (m)	Soil Type	Description
GL to 0.2/0.5	0.2 to 0.5	Topsoil	TOPSOIL comprising grass over dark brown slightly gravelly sandy CLAY with rootlets. Gravel comprises fine subangular flint and chalk.
0.2 to 0.4 (TP1 & TP1a only)	0.2	Clay/Silt	Dark greyish brown sandy CLAY/ SILT. Sand comprises flint.
0.2/0.5 to 2.8/4.2	1.8 to 3.7	Clay	Firm mid to dark brown/ orange brown slightly gravelly sandy CLAY. Gravel comprises fine to medium subrounded chalk and flint. >1.5/3.1m becoming gravelly. Gravel comprises medium sized chalk and flint.

Depth (m)	Thickness (m)	Soil Type	Description
2.8/4.2 to 5.0+	2.2+	Chalk	Structureless CHALK composed of greyish cream white silty GRAVEL, recovered as putty gravel. Gravel comprises fine to medium subangular chalk with black surface speckling. Some brown infill on chalk clast surfaces.

8 Groundwater Observations

During the fieldwork, groundwater was observed in the exploratory holes as tabulated below. In addition, groundwater monitoring wells were installed in boreholes WLS1 and WLS2 and the results of the subsequent monitoring are included in Section 10 below.

Hole ID	Water Strike Depth (m)	Comment	Stratum
TP1a	2.2	Slow seepage at 2.2m, rising to 1.52m after 1 hour.	Chalk Head
TP2	2.8	Slow seepage at 2.8m, rising to 2.64m after 1 hour	Chalk Head
TP3	3.0	Slow seepage at 3.0m, rising to 2.84m after 1 hour	Chalk Head
WLS1	3.4	Rising to 1.85m after 60 minutes	Chalk Head/ Chalk
WLS2	4.5	Rising to 2.31m after 30 minutes	Chalk Head

D DISCUSSION OF GEOTECHNICAL TEST RESULTS AND RECOMMENDATIONS

9 Soakaways

9.1 Soakage Test Results

The BRE paper DG365, Ref [3] describes a method for site testing to determine soil infiltration rates at the proposed site of a soakaway. The in-situ test method is described in Appendix B.

A total of three soakage tests were carried out across the site, at the locations shown on the attached site plan Figure 2, Appendix A. The full results of the soakage tests are presented within Appendix B.

The DG365 Ref [3], states that each pit should be allowed to drain three times to near empty, with filling on the same or consecutive days.

Given the very poor rate of infiltration obtained during the soakage tests and a high groundwater table encountered, the pits were not drained to near empty during testing. Due to this, only a single soakage test was possible in each pit during the two days of testing.

The infiltration rate from each trial hole is summarised in the table below. The soakage rate in this report is expressed as $\ell/m^2/\text{minute}$, which is a convenient rate to use. The BRE use a unit of m/sec, which is the value in $\ell/m^2/\text{minute}$ divided by 60,000.

Test ID	Test Depth (mbgl)	Design Infiltration Rate		Notes
		$\ell/m^2/\text{minute}$	m/sec	
TP1a	2.2	0.138	2.31×10^{-6}	Groundwater 1.52mbgl at start of test. Pit was not emptied.
TP2	2.8	0.054	8.92×10^{-7}	Groundwater 2.64mbgl at start of test. Pit was not emptied.
TP3	3.0	0.0071	1.18×10^{-7}	Groundwater 2.84mbgl at start of test. Pit was not emptied.

To retain pit stability during testing, two ton bags of gravel were emptied into each pit around 140mm liner pipework to enable water levels to be monitored. The remainder of the pits were infilled with spoil to ground level. Groundwater was noted to rise within the pits during the time period between pit excavation and testing.

Dataloggers were installed within two of the pits (TP1a and TP2) to monitor groundwater levels following the investigation to extend the period of testing. The dataloggers were left within the holes for up to 48 hours.

Given the slow rate of infiltration encountered within all pits during testing, only one filling of each pit was carried out within the time available. Excavation of the trial pits was terminated immediately upon encountering groundwater seepages/ inflows, however, the groundwater levels were noted to subsequently rise gradually over time.

A reduction in the rate of infiltration during the latter stages of testing in TP1a and TP2 likely coincides with the groundwater table at the time of testing. Direct discharge to groundwater would likely be opposed by the Environment Agency.

The calculated results ranged from $1.18 \times 10^{-7} \text{m/s}$ to $2.31 \times 10^{-6} \text{m/s}$ within the test pits. It should be noted that the water level did not fall to the 25% full level during testing within TP3. As only one filling was possible within the pits during this investigation, a reduction factor should be used for design (if applicable).

9.2 General Guidance on Design of Soakaways

Any soakaway scheme may require the approval of the Environment Agency and Building Control.

Soakaways are used to store the immediate surface water run-off from hard surfaced areas, such as roof or car parks, and allow for efficient infiltration into the adjacent soil. They should be designed to discharge their stored water sufficiently quickly to provide the necessary capacity to receive run-off from a subsequent storm. The time taken for discharge depends upon the soakaway shape and size, and the surrounding soil's infiltration characteristics.

Groundwater levels can vary considerably from season to season and year to year, often rising in wet or winter weather, and falling in periods of drought. As such, a high groundwater table may affect the storage capacity of soakaways. In addition, it should be noted that an unsaturated zone may be required between the base of soakaways and the groundwater table, by the Environment Agency. Longer term monitoring may be required to establish actual groundwater levels as part of the planning approval process.

10 Groundwater Monitoring

Groundwater monitoring wells were installed within the two boreholes drilled on the site (WLS1 & WLS2). Dataloggers were installed within the wells to record water levels at intervals of four hours.

Groundwater monitoring data recorded between the installation (31/01/2020) and removal of the dataloggers (30/04/2020) has been tabulated and appended to this report as Figure 3 in Appendix C.

Groundwater monitoring data was downloaded from the dataloggers during an interim visit on 28th February 2020 to enable the production of a preliminary monitoring report (ref. STLJ14325 – Issue 1, 9th March 2020).

Groundwater levels within each borehole/ trial pit at the time of datalogger installation, the interim data download visit and upon removal of the dataloggers are tabulated below.

Hole ID	29 th January 2020 (m bgl)	28 th February 2020 (m bgl)	30 th April 2020 (m bgl)
TP1a	2.2	1.15	2.08
TP2	2.8	1.48	2.58
TP3	3.0	1.40	2.51
WLS1	3.4	1.41	2.17
WLS2	4.5	1.67	2.70

REFERENCES

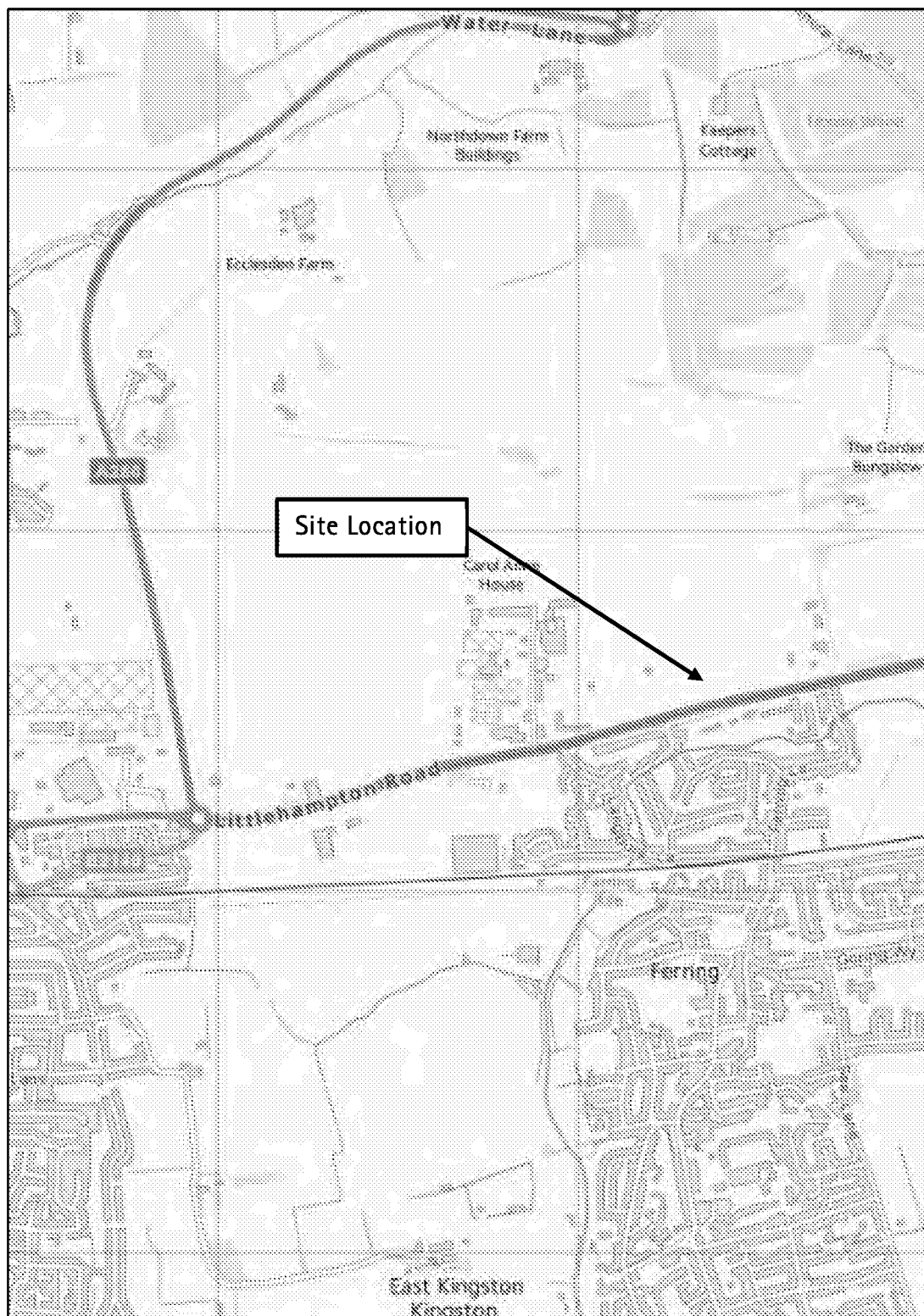
- [1] BSI Standards, "BS 5930 Code of practice for ground investigations," 2015.
- [2] BSI Standards, "BS10175 Investigation of potentially contaminated sites – Code of practice," 2013.
- [3] Building Research Establishment (BRE), "DG365 Soakaway Design," 2016.
- [4] BSI Standards, "BS 3882:2015 Specification for Topsoil," 2015.
- [5] CIRIA, "C574 Engineering in Chalk," 2002.
- [6] R. N. Mortimore, Logging the Chalk, 2014.



APPENDIX A

Site Plans and Exploratory Hole Logs

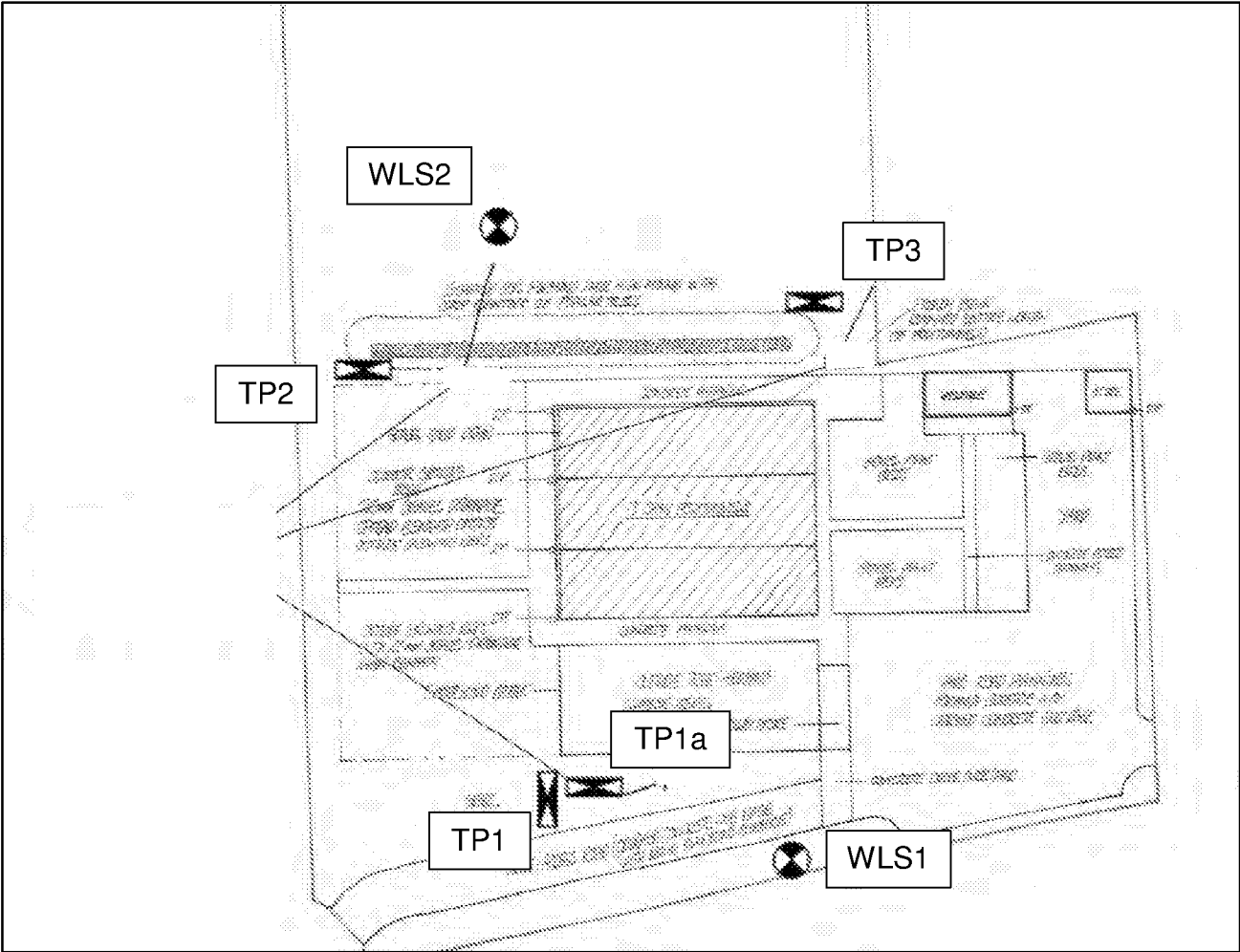




Contains Ordnance Survey Data © Crown Copyright and Database Right 2020

Site:	Quercus Nursery, Littlehampton Road, Ferring, Worthing, BN12 6PG	Project ID	J14325
Figure 1	Site Location Plan	Date:	05/03/2020

NB: Positions of exploratory holes / test positions are only indicative unless dimensioned



Site:	Quercus Nursery, Littlehampton Road, Ferring, Worthing, BN12 6PG	Project ID	J14325
Figure 2	Site Investigation Layout Plan	Date:	05/03/2020



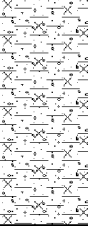
Key to Exploratory Hole Logs, Plans and Sections

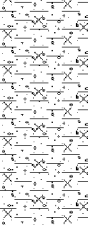
Backfill Symbols	Pipe Symbols	Principal Soil Types	Principal Rock Types	Drilling Records
Arisings	Plain Pipe	Topsoil	Mudstone	Water Strike
Concrete	Slotted Pipe	Made Ground	Claystone	Depth Water Rose
Blacktop	Piezometer	Clay	Siltstone	Total Core Recovery (%) [TCR]
Bentonite	Piezometer Tip	Silt	Sandstone	Solid Core Recovery (%) [SCR]
Gravel Filter	Filter Tip	Sand	Limestone	Rock Quality Index (%) [RQI]
Sand Filter	Extensometer	Gravel	Chalk	Fracture Index (fractures / m) [FI]
	Inclinometers	Peat		

All soil and rock descriptions are in general accordance with BS5930 2015, BS EN ISO 14688-1:2002+A1:2013 and BS EN ISO 14689-1:2003. Chalk descriptions are also based on CIRIA C574 and "Logging the Chalk – R.N. Mortimer 2015". The Geology Code is only provided where a positive identification of the sample strata has been made.

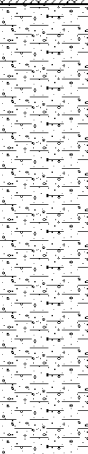
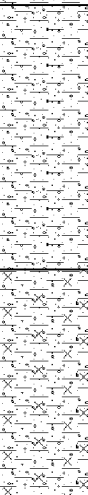
Location / Method Identifiers		In-situ Test Location / Method	
BH	Borehole (undefined)	DP	Dynamic Probe
CP	Cable Percussive	CPT	Cone Penetration Test
RC	Rotary Core	CBR	In-situ CBR Test
RO	Rotary Open Hole	DCP	CBR using Dynamic Cone Penetrometer
ODC	Rotary Odex/Symmetrix drilling cased	CBRT	CBR using TRL Probe
CP+RC	Cable Percussive to Rotary Core	PB	Plate Bearing Test
SNC	Sonic	SPT (S)	Standard Penetration Test (Split Barrel Sampler)
CFA	Continuous Flight Auger	SPT (C)	Standard Penetration Test (Solid Cone)
FA	Flight Auger	N	SPT Result
VC	Vibro Core	-/-	Blows/Penetration (mm) after seating drive
WLS+RC	Windowless (Dynamic) Sampler to Rotary Core	-*/-	Total Blows / Penetration (mm)
WLS	Windowless Sampler	()	Extrapolated Value
WS	Window Sampler	PPT	Perth Penetration (In-House Method - Equivalent N Value)
HA	Hand Auger	HP / UCS	Strength from Hand Penetrometer (kN/m ²)
C	Road / Pavement Core	IVN	Strength from Hand Vane ((kN/m ²) P = peak, R = residual)
IP	Inspection Pit (Hand Excavation)	PID	Photo Ionisation Detector (ppm)
TP	Trial Pit (Machine Excavated)	MEXE	Mexi-Cone CBR (%)
OP	Observation Pit (Supported Excavation Hand or Machine)		

Samples / Test Type		Samples / Test Type	
B	Bulk Sample	SPTLS	Standard Penetration Test Split Barrel Sample
BLK	Block Sample	TW	Thin Wall Push In Sample (e.g. Shelby Sampler)
C	Core Sample	U	Undisturbed Open Drive Sample (blows to take)
CBRS	CBR Mould Sample	UT	Thin Wall Undisturbed Open Drive Sample (blows to take)
D	Small Disturbed Sample	W	Water Sample (Geotechnical)
ES	Environmental Sample (Soil)	SP	Sample from Stockpile
EW	Environmental Sample (Water)	P	Piston Sample
GS	Environmental Sample (Gas)	AMAL	Amalgamated Sample

 Southern Testing ST Consult www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020				Start - End Date: 29/01/2020		Project ID: J14325		Machine Type: 8T		TP1 Sheet 1 of 1	
Project Name: Quercus Nursery Ltd				Remarks:		Co-ordinates:		Level (m AOD):		Logger: JMW	
Location: Littlehampton Road, Ferring, Worthing, BN12 6PG				Water pipe struck at 1mbgl. Trial pit abandoned.							
Client: Quercus Nursery											
Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description				
Depth (m)	Type	Results									
				(0.20)		0.20	TOPSOIL comprising grass over dark brown silty CLAY.		1 2 3 4		
				(0.20)		0.40	Dark greyish brown sandy CLAY/SILT. Sand is fine to coarse grained flint (Possible Made Ground).				
				(0.60)		1.00	Firm mid to dark brown slightly gravelly sandy silty CLAY. Gravel comprises fine to medium subrounded chalk.				
							Pit terminated at 1.00m.				
Pit Dimension (m)			Pit Stability:					Water Strikes:			
Width:	0.60		Stable					Pit dry.			
Length:	1.00										
Depth:	1.00										

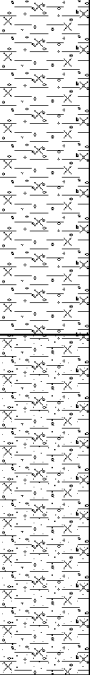
				Start - End Date: 29/01/2020		Project ID: J14325		Machine Type: 8T		TP1a Sheet 1 of 1	
Project Name: Quercus Nursery Ltd				Remarks:		Co-ordinates:		Level (m AOD):		Logger: JMW	
Location: Littlehampton Road, Ferring, Worthing, BN12 6PG				Soakage tested conducted within pit in accordance with BRE365. Pit gravel filled prior to testing.							
Client: Quercus Nursery											
Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description				
Depth (m)	Type	Results									
0.30	HP	UCS(kPa)=200		(0.20)		0.20	TOPSOIL comprising grass over dark brown silty CLAY.		1		
0.50	HP	UCS(kPa)=240		(0.20)		0.40	Dark greyish brown sandy CLAY/SILT. Sand is fine to coarse grained flint (Possible Made Ground).				
0.80	HP	UCS(kPa)=280		(1.20)		1.60	Firm mid to dark brown slightly gravelly sandy silty CLAY. Gravel comprises fine to medium subrounded chalk.				
1.00	PPT	N=11(450)					(0.60)				
							Pit terminated at 2.20m.		2		
									3		
									4		
Pit Dimension (m)			Pit Stability:				Water Strikes:				
Width:	0.60		Stable				Slow seepage from 2.2m, rising to 1.52m after 1 hour.				
Length:	2.00										
Depth:	2.20										

				Start - End Date: 29/01/2020		Project ID: J14325		Machine Type: 8T		TP2 Sheet 1 of 1	
Project Name: Quercus Nursery Ltd				Remarks:		Co-ordinates:		Level (m AOD):		Logger:	
Location: Littlehampton Road, Ferring, Worthing, BN12 6PG				Soakage tested conducted within pit in accordance with BRE365. Pit gravel filled prior to testing.							
Client: Quercus Nursery											

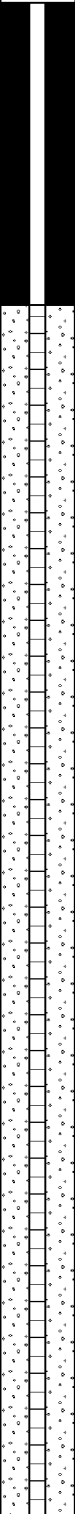
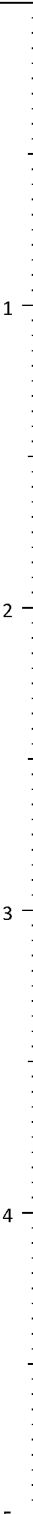
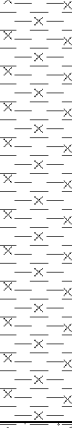
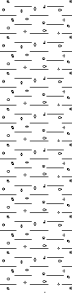
Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description		
Depth (m)	Type	Results							
0.40	HP	UCS(kPa)=190		(0.30)		0.30	TOPSOIL comprising grass over dark brown slightly gravelly sandy CLAY with rootlets. Gravel comprises fine to medium subangular to angular flint.	1	
0.60	HP	UCS(kPa)=280							Firm orange brown slightly gravelly sandy CLAY. Gravel comprises fine to medium subangular to angular flint.
0.90	HP	UCS(kPa)=220							
1.00	PPT	N=15(450)		(1.20)		1.50	Stiff beige and white slightly gravelly very sandy CLAY. Gravel comprises fine to medium subangular to angular flint and chalk.	2	
1.70	PPT	N=19(450)							
2.50	HP	UCS(kPa)=250							
				(0.70)		2.20	Stiff greenish grey and light to orange brown slightly gravelly very sandy silty CLAY. Gravel comprises fine to coarse subrounded to rounded flint.	3	
				(0.60)		2.80	Pit terminated at 2.80m.	4	

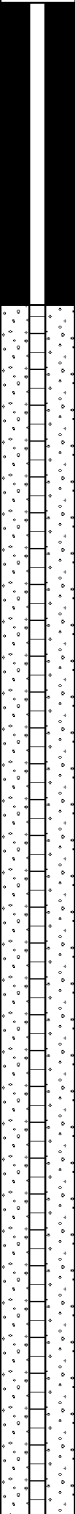
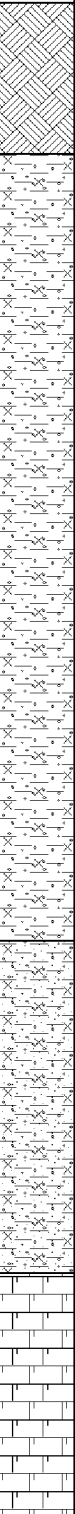
Pit Dimension (m)		Pit Stability:		Water Strikes:	
Width:	0.45	Stable		Slow seepage from 2.8m, rising to 2.64m after 1 hour.	
Length:	2.20				
Depth:	2.80				

 Southern Testing ST Consult				Start - End Date: 29/01/2020		Project ID: J14325		Machine Type: 		TP3 Sheet 1 of 1	
Project Name: Quercus Nursery Ltd				Remarks:		Co-ordinates:		Level (m AOD):		Logger:	
Location: Littlehampton Road, Ferring, Worthing, BN12 6PG				Soakage tested conducted within pit in accordance with BRE365. Pit gravel filled prior to testing.							
Client: Quercus Nursery											

Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description	
Depth (m)	Type	Results						
0.60	HP	UCS(kPa)=270		(0.40)		0.40	TOPSOIL comprising grass over dark brown slightly gravelly sandy silty CLAY with frequent rootlets. Gravel comprises fine to medium subangular to rounded flint.	
1.00	PPT	N=15(450)		(1.70)			Firm brown slightly gravelly slightly sandy CLAY. Gravel comprises fine angular flint.	1
1.60	PPT	N=19(450)				2.10	Firm to stiff light brown and beige very gravelly sandy silty CLAY, with pockets of mid brown slightly gravelly clay. Gravel comprises medium chalk and flint. Sand is medium to coarse chalk.	2
				(0.90)		3.00	Pit terminated at 3.00m.	3
								4

Pit Dimension (m)		Pit Stability:		Water Strikes:	
Width:				Slow seepage at base, rising to 2.84m after 1 hour.	
Length:					
Depth:					

 Southern Testing ST Consult				Start - End Date 29/01/2020		Project ID: J14325		Hole Type: WLS		WLS1 Sheet 1 of 1			
Project Name: Quercus Nursery Ltd				Remarks:		Co-ordinates:		Level:		Logger: JMW			
Location: Littlehampton Road, Ferring, Worthing, BN12 6PG				Groundwater struck at 3.5mbgl, rising to 1.85mbgl after 60 minutes.									
Client: Quercus Nursery													
Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description				
		Depth (m bgl)	Type	Results									
	 												
		1.30	HP	UCS(kPa)=270		(0.40)		0.40	TOPSOIL comprising grass over dark brown slightly gravelly sandy CLAY. Gravel comprises fine subangular flint and chalk.				
		1.60	HP	UCS(kPa)=250		(1.40)			Mid to orange brown black ironstained speckled slightly sandy silty CLAY.				
						(1.00)		1.80	Stiff to very stiff brown and cream white very gravelly CLAY.				
								2.80	2.5m to 2.8m; becoming very clayey GRAVEL.				
						(2.20)			Possible structureless CHALK composed of greyish cream white silty GRAVEL, recovered as putty gravel. Gravel comprises fine to medium subangular chalk, with black surface speckling. Some brown clay infill on clast surfaces.				
								5.00	3.5m to 5.0m; brown clay infill absent.				
End of Borehole at 5.00m													
Hole Details		Casing Details		Waterstrike (m bgl)						Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks
				29-01-2020	3.40			1.85	60				

 Southern Testing ST Consult				Start - End Date 29/01/2020		Project ID: J14325		Hole Type: WLS		WLS2 Sheet 1 of 1			
www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020													
Project Name: Quercus Nursery Ltd				Remarks:		Co-ordinates:		Level:		Logger: JMW			
Location: Littlehampton Road, Ferring, Worthing, BN12 6PG				Groundwater struck at 4.5mbgl, rising to 2.31mbgl after 30 minutes.									
Client: Quercus Nursery													
Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description				
		Depth (m bgl)	Type	Results									
						(0.50)		0.50	TOPSOIL comprising grass over dark brown and dark grey slightly gravelly slightly sandy silty CLAY with abundant rootlets.				
										Firm to stiff mid to orange brown slightly gravelly silty CLAY. Gravel comprises fine to medium angular flint.			
		1.20	HP	UCS(kPa)=300						1.5m to 1.6m; with fine angular flint.			
		1.40	HP	UCS(kPa)=250						1.9m; with occasional coarse sand to fine gravel flint and chalk.			
		1.70	HP	UCS(kPa)=220						2.4m; sand becoming frequent.			
		2.50	HP	UCS(kPa)=150						Stiff brown and white very gravelly slightly sandy silty CLAY. Gravel comprises fine to coarse subrounded to angular chalk. Chalk gravels are extremely weak, black speckled, slightly polished (Chalk Head).			
										Possible structureless CHALK composed of greyish cream white silty GRAVEL, recovered as putty gravel. Gravel comprises fine to medium subangular chalk, with black surface speckling.			
End of Borehole at 5.00m													
Hole Details		Casing Details		Waterstrike (m bgl)						Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks
				29-01-2020	4.50			2.31	30				



APPENDIX B

Field Sampling and In-Situ Test Methods and Results

B

Soil and Rock Descriptions

All soil and rock descriptions are in general accordance with BS5930 Ref [1].

Anthropogenic soils ('made ground' or 'fill') describe materials which have been placed by man and can be divided into those composed of reworked natural soils and those composed of or containing man-made materials. 'Fill' is used to describe material placed in a controlled manner and 'made ground' is used to describe materials placed without strict engineering control.

The classification of materials such as topsoil is based on visual description only and should not be interpreted to mean that the material complies with criteria used in BS 3882 Ref [4].

Chalk descriptions are based on CIRIA C574 Ref [5] and Mortimore Ref [6].

The geology code is only provided on logs where a positive identification of the sample strata has been made.

Inspection Pit

Inspection pits are hand excavated from the surface (maximum depth 1.2 – 1.5m) using appropriate tools to locate and avoid existing buried services at exploratory hole positions. They are also regularly used as part of investigations on existing structures to expose and determine foundation detail.

Trial Pits and Trenches

Trial pits and trenches are unsupported excavations, mechanically excavated by machine to the required depth to enable visual examination, in situ testing and sampling as required from outside the excavation.

Dynamic Sampling - Window or Windowless

Window sampling is carried out by driving hollow steel tubes incorporating a longitudinal access slot (window) and a cutting shoe into the ground using a percussive 'breaker'. This enables recovery of a continuous soil sample for examination and sub-sampling.

Windowless samplers are designed for taking disturbed, continuous soil samples to depths up to 10 metres (depending on ground conditions). The samplers comprise steel tubes of about 50-100mm diameter with a rigid plastic liner (no window) and are driven into the ground with a sliding hammer mounted on a tracked purpose-designed soil sampling rig. After driving and extracting the sampler from the ground, the plastic liner is extracted together with the enclosed soil sample. The sample can then either be extracted, split and sub-sampled or plastic end caps may be fitted, the tube labelled and transported for future examination and sub-sampling.

Soil samples are disturbed by the driving process with both techniques and can be regarded as being between Class 5 up to Class 3 samples at best (in favourable ground).

The major advantage of using windowless samplers is that the plastic liner greatly reduces the possibility of cross-contamination between successive samples.

An equivalent in-situ test to the Standard Penetration Test can be carried out with the windowless sampler rig.

Perth Penetrometer Test

The Perth Penetrometer is a non-standard test used for assessing the relative density of sands. It consists of a 16 mm diameter hardened steel probe, which is driven into the soil by successive blows of a 9.09 kg weight, which freely falls over a distance of 600 mm. The number of blows required for each 50 mm of penetration is recorded, and the test is continued for a total depth of 450 mm, according to soil type.

The energy input is roughly the same as that from the Standard Penetration Test (SPT), and experience by this laboratory indicate that in sand the Perth Penetrometer readings correlate fairly well with SPT blow counts (this relationship does not hold for coarse or cohesive soils). A classification of relative density descriptions as used on trial pit logs is given below.

Perth Correlation with uncorrected SPT N Value	Term
0 - 4	Very Loose

4 - 10	Loose
10 – 30	Medium Dense
30 – 50	Dense
Over 50	Very Dense

Hand Penetrometer Test

The handheld soil penetrometer consists of a spring loaded and calibrated plunger which is forced into cohesive soil. A reading of unconfined compression strength (equal to twice cohesion) is given on a calibrated scale. The average of a set of three readings shall be recorded.

In common with other hand methods of strength assessment it does not give an accurate indication of bearing capacity in stiff or fissured soils, because of the small test area.

Monitoring Well

A groundwater and/or ground gas monitoring well consists of a perforated pipe, which is installed in the ground. The standpipe is typically 50mm nominal in diameter and is installed in a lined borehole. It is perforated from the base with a sand/gravel surround through the soil horizon of interest to an appropriate depth below ground level. Above this there is a bentonite seal with solid pipework and is provided with an end cap or a gas valve at the top as appropriate.

Gas monitoring is carried out via the gas tap. Water sampling/purging can be undertaken by removing the gas tap and bung.

The well is usually completed at the surface with a flush cast iron cover or raised lockable cover.

Groundwater Monitoring – Dip Meter

The dip meter is used to measure standing water levels within boreholes. The probe is lowered into the borehole until the meter detects the groundwater with an audible 'beep'. The level is then read from the tape.

Groundwater Monitoring – Digital Level Loggers

Digital loggers placed within borehole standpipes measuring water pressure, barometric pressure and temperature were used to record data over the monitoring period. The data was processed, using proprietary software, to determine temperature and barometric pressure compensated water levels.

The equipment can record parameters at pre-determined time intervals and has a capacity of many thousands of readings and is therefore suitable for monitoring over extended periods of time.

Soakage Tests (after BRE DG365 2016)

The BRE DG365 Ref [3] paper on soakaway design allows for the design of trench soakaways as well as traditional square and circular soakaways.

The test to measure the soil infiltration rate is carried out in pits which are excavated to the full depth of the proposed soakaway. The trial pits are filled and allowed to drain to empty or near empty, three times, on the same day or on consecutive days. Water levels are recorded against time. Where the sides are unstable the pit should be filled with granular material to provide stability during the test.

Calculated soakage rates are expressed as l/m²/minute, which is a convenient rate to use. The BRE use a unit of m/sec, which is the value in l/m²/minute divided by 60,000.

Summary Sheet

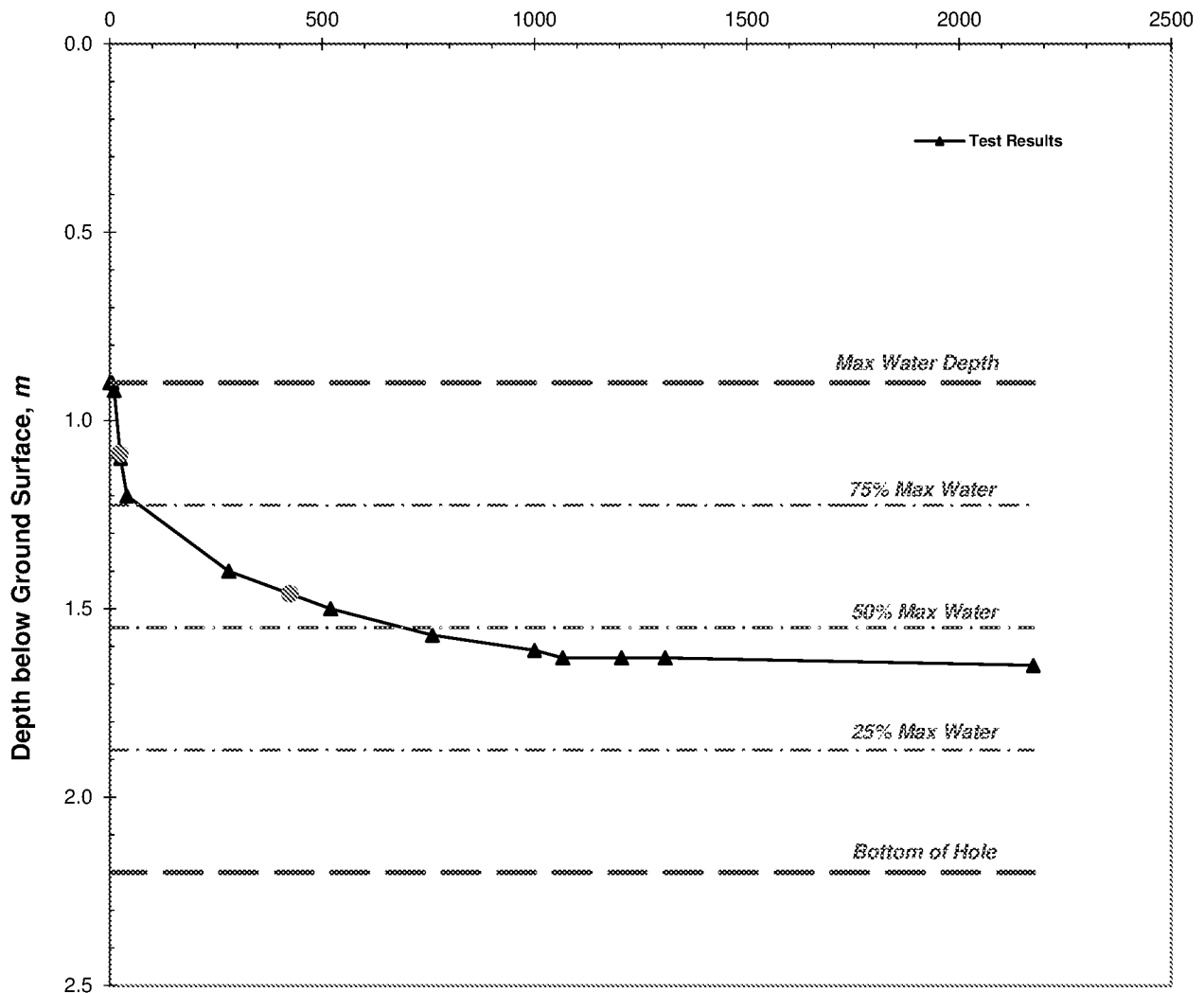
Results of BRE Digest DG365 Soakage Tests

Site : Quercus Nursery, Worthing					Job No : J14325		
Client : Quercus Nursery Ltd					O S Reference :		
Tested By : AA				Engineer: JMW		Test Date : 29/Jan/2020	
Hole No	Test No	Hole Depth <i>m</i>	Soakage Rate for Each Test <i>litre/m²/min</i>	Soakage Rate for Each Hole <i>litre/m²/min m/sec</i>		Water Level at Finish of Test	Remarks
TP1a	No 1	2.20	0.138	0.138	2.31E-6	Pit was not emptied; Non compliant value was calculated.	Depth to existing ground water level was 1.63m.
TP2	No 1	2.80	0.054	0.054	8.92E-7	Pit was not emptied; Non compliant value was calculated.	Depth to existing ground water level was 1.9m.
TP3	No 1	3.00	0.0071	0.0071	1.18E-7	Pit was not emptied; Non compliant value was calculated.	Depth to existing ground water level was 2.84m.
Mean Value of All Calculated Soakage Rates :				0.066 <i>litre/m²/min</i>	1.11E-6 <i>m/sec</i>		

BRE Digest DG365 Soakage Test

Test Hole No: TP1a
Test No: Test No 1 (Initial)

Time from Filling to Maximum Water Depth, *minute*



Pit Length, m	2.000	Depth to Water at Start of Test, m	0.900
Pit Width, m	0.600	Max Water Dropdown during Test, m	0.750
Depth to Pit Base, m	2.200	Total Soakage Test Time, min	2175.0
Depth to Top of Permeable Soils, m		Mean Internal Discharge Area, m ²	6.015
Depth to Groundwater Surface, m	1.630	Discharge Rate, litre/min	0.832
Depth to Top of Granular Fill, m	1.400	Soakage Rate, litre/m ² /min	0.138
Voids Assumed for Granular Fill, %	35%	BRE Soil Infiltration Rate, m/sec	2.31E-06

Comments:

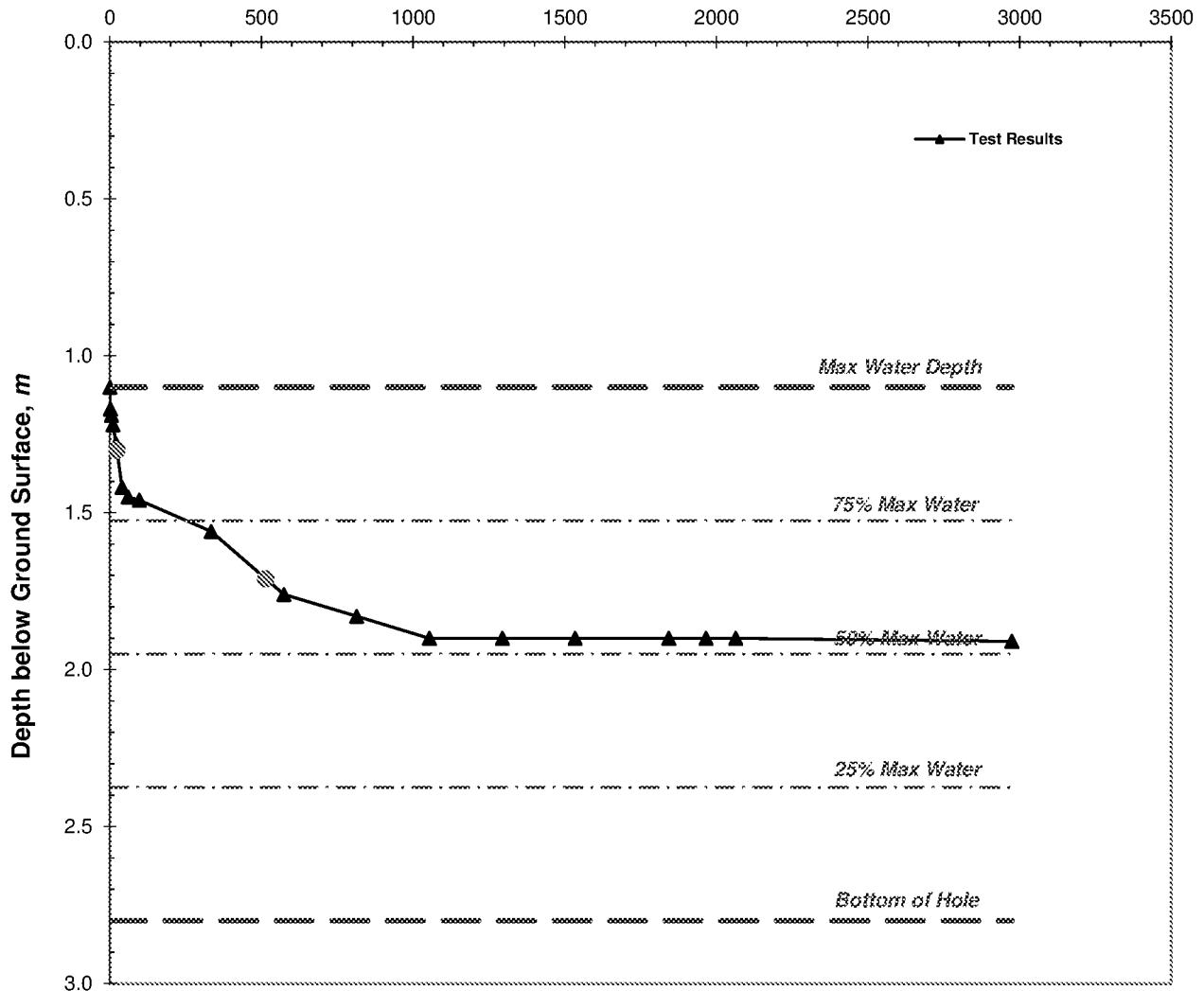
Water level fell to 50% -- 25% max water depth, calculations were based on actual fall of water level achieved.
Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: Quercus Nursery Ltd	Job No: J14325	Test Date: 29/Jan/2020
Site: Quercus Nursery, Worthing	Tested By: AA	Engineer: JMW Fig. S1

BRE Digest DG365 Soakage Test

Test Hole No: TP2
Test No: Test No 1 (Initial)

Time from Filling to Maximum Water Depth, *minute*



Pit Length, m	2.200	Depth to Water at Start of Test, m	1.100
Pit Width, m	0.450	Max Water Dropdown during Test, m	0.810
Depth to Pit Base, m	2.800	Total Soakage Test Time, min	2974.0
Depth to Top of Permeable Soils, m		Mean Internal Discharge Area, m ²	7.854
Depth to Groundwater Surface, m	1.900	Discharge Rate, litre/min	0.420
Depth to Top of Granular Fill, m	1.400	Soakage Rate, litre/m ² /min	0.054
Voids Assumed for Granular Fill, %	35%	BRE Soil Infiltration Rate, m/sec	8.92E-07

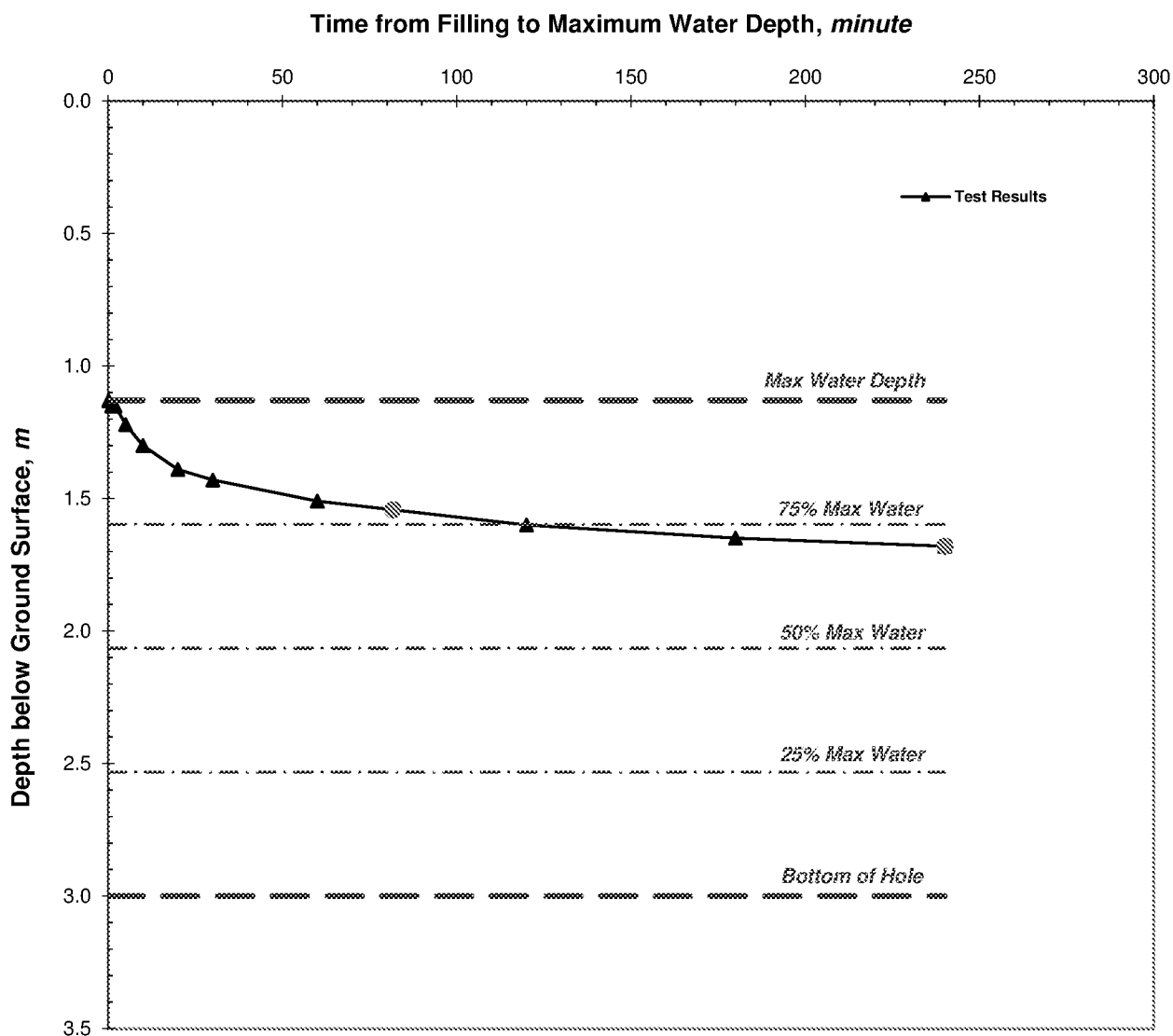
Comments:

Water level fell to 75% -- 50% max water depth, calculations were based on actual fall of water level achieved.
Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: Quercus Nursery Ltd	Job No: J14325	Test Date: 29/Jan/2020
Site: Quercus Nursery, Worthing	Tested By: AA	Engineer: JMW Fig. S2

BRE Digest DG365 Soakage Test

Test Hole No: TP3
Test No: Test No 1 (Initial)



Pit Length, m	2.100	Depth to Water at Start of Test, m	1.130
Pit Width, m	0.450	Max Water Dropdown during Test, m	0.550
Depth to Pit Base, m	3.000	Total Soakage Test Time, min	240.0
Depth to Top of Permeable Soils, m		Mean Internal Discharge Area, m ²	8.028
Depth to Groundwater Surface, m	2.840	Discharge Rate, litre/min	0.057
Depth to Top of Granular Fill, m	1.300	Soakage Rate, litre/m ² /min	0.0071
Voids Assumed for Granular Fill, %	35%	BRE Soil Infiltration Rate, m/sec	1.18E-07

Comments:

Water level fell to 75% -- 50% max water depth, calculations were based on actual fall of water level achieved.
Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: Quercus Nursery Ltd	Job No: J14325	Test Date: 29/Jan/2020
Site: Quercus Nursery, Worthing	Tested By: AA	Engineer: JMW Fig. S3

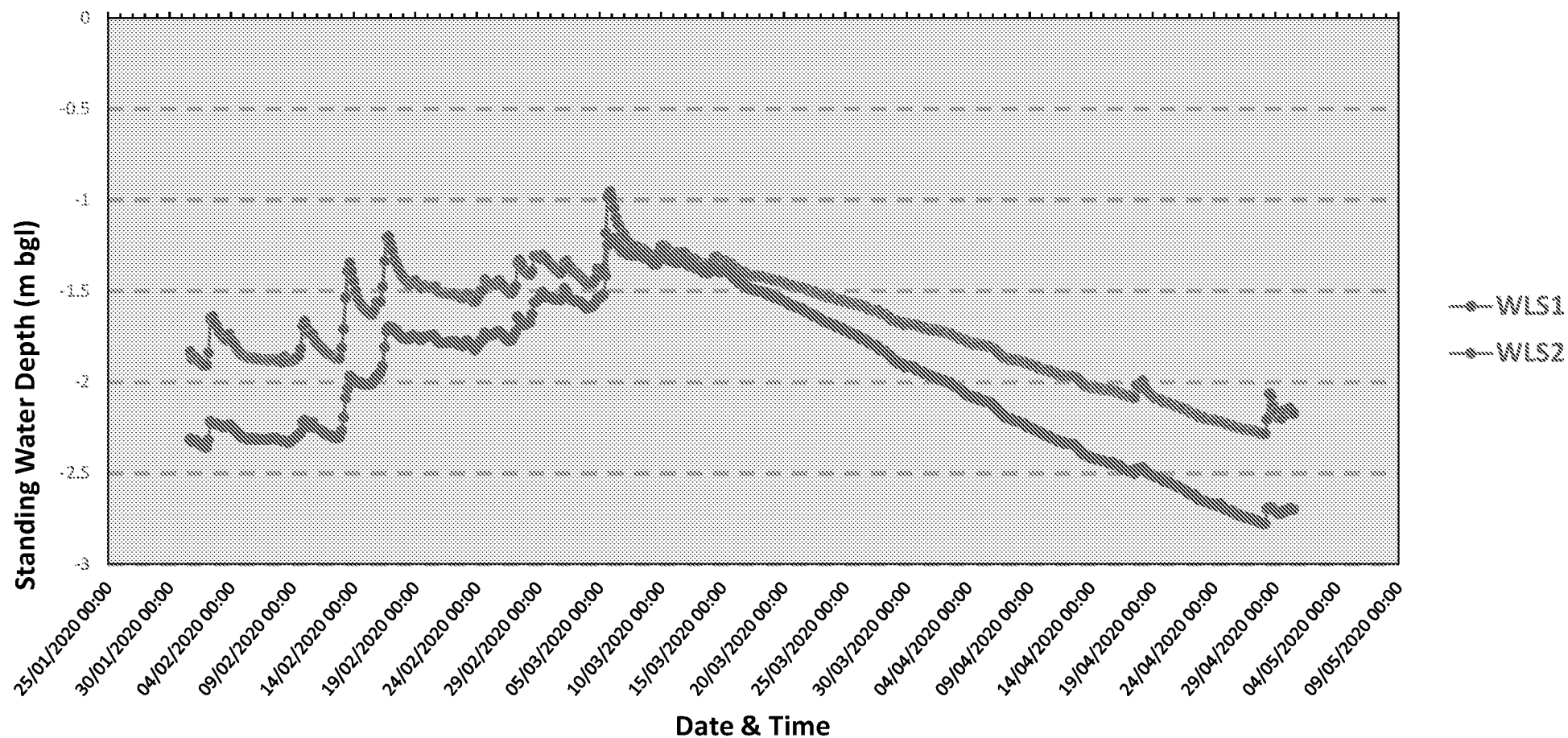


APPENDIX C

Groundwater Monitoring Data



STL J14325 Quercus Nursery, Worthing - Groundwater Monitoring Data



Site: Quercus Nursery, Littlehampton Road, Ferring, Worthing, BN12 6PG

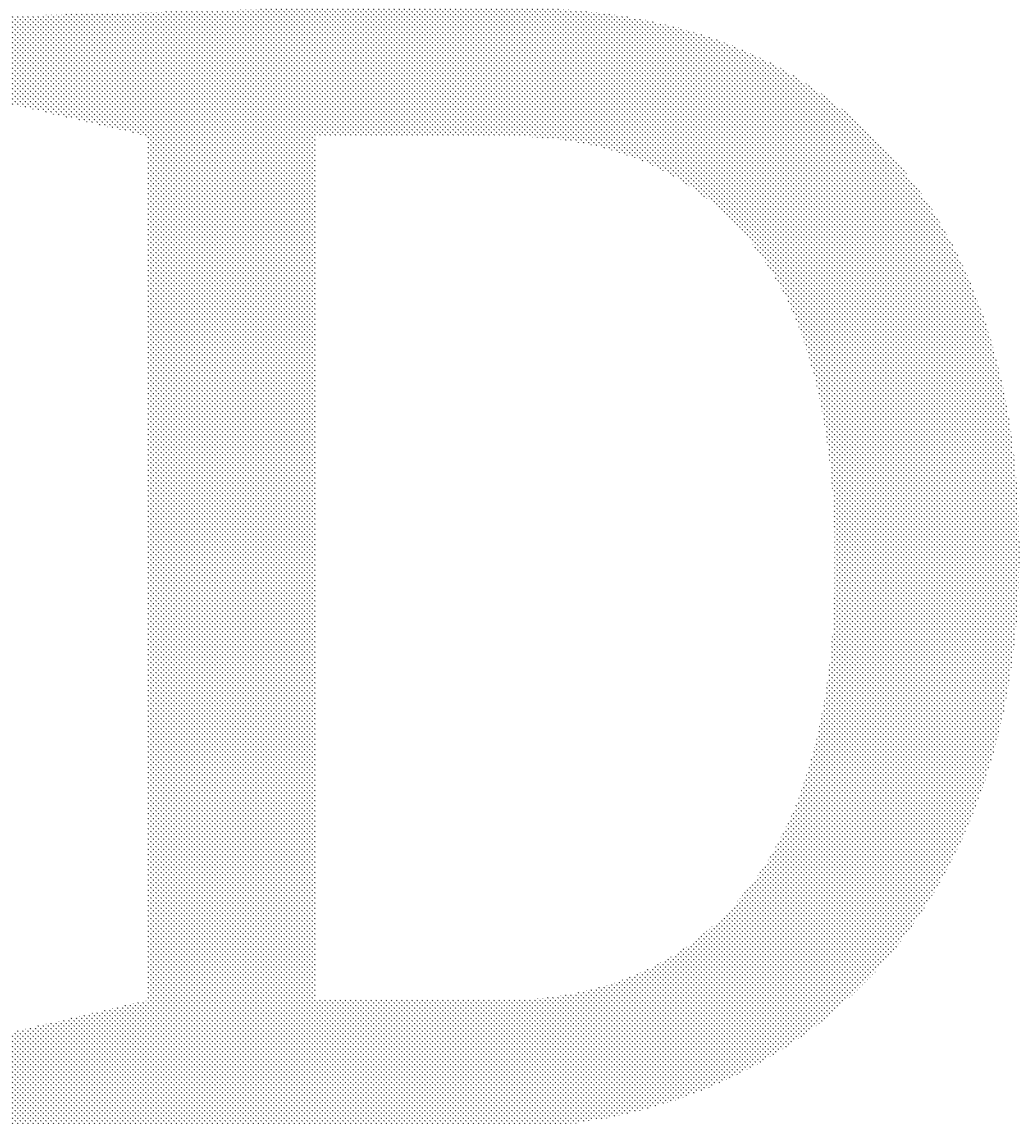
Project Id: J14325

Figure 3 Groundwater Monitoring Data

Date: 04/05/2020

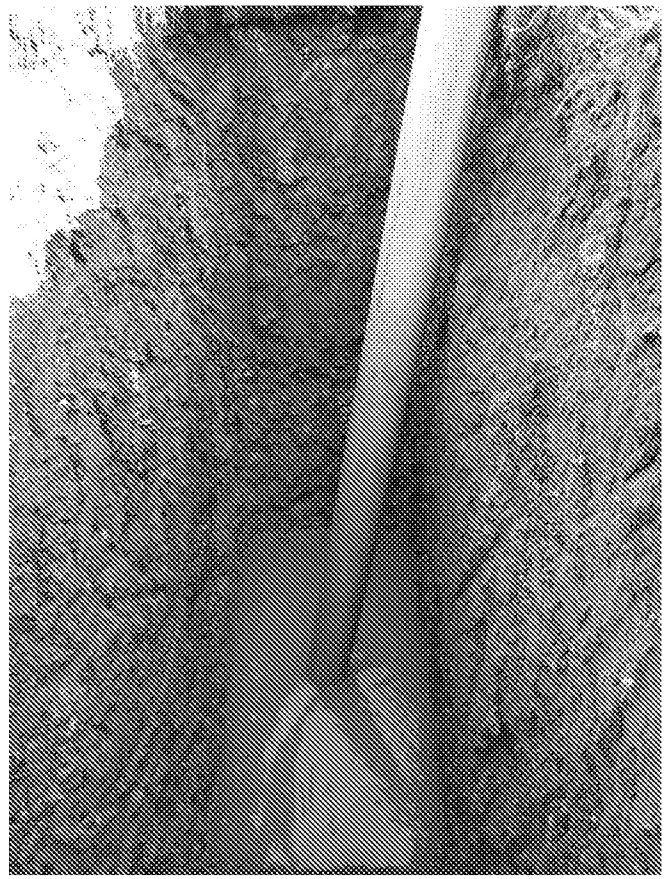
APPENDIX D

Photographs





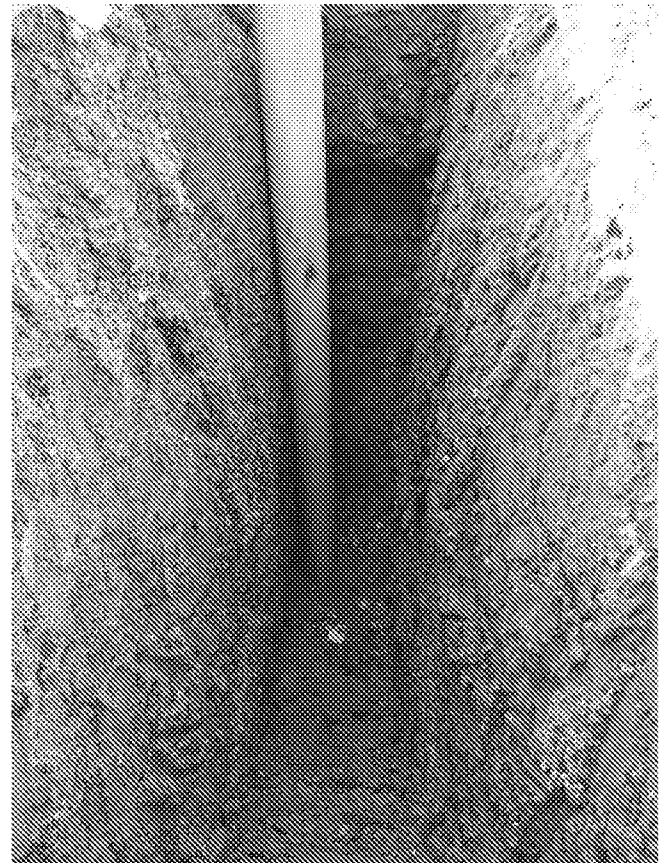
TP1



TP1a



TP2



TP3



Entrance driveway to nursery site – view east



Entrance driveway to nursery site – view west



Planter beds and TP3 – view north



Planter beds and earth bund – view north



Planter beds and nursery buildings – view south east



Planter beds and open field – view north



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