MICHAEL SMITH & ASSOCIATES

PROPOSED NETBALL COURTS

20 WANGARA ROAD

SANDRINGHAM

Report No: 119367

Date: 22 November, 2018

GEOTECHNICAL INVESTIGATION

By

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1. INTRODUCTION

1.01 **Investigation Requested By:** The geotechnical investigation was commissioned Mr Michael Smith of Michael Smith & Associates via email correspondence.

1.02 **Purpose of Investigation:** It is proposed to construct a netball facility at 20 Wangara Road, Sandringham. The site is understood to have previously been used as a quarry and later as a landfill for municipal waste. It is currently used as a golf driving range. Herein, it was required to forecast foundation conditions and recommend design parameters for the proposed structures and associated pavements.

At the time of preparing this report, it is anticipated that the proposed structures include an indoor netball facility, outdoor netball courts and associated car parks. It is also understood that a significant portion of the subject site is underlain by deep uncontrolled fill associated with the backfilling of a former quarry including the above ground placement of fill.

In the absence of any detailed structural drawings it has been assumed for the purpose of this report that no unusual loads or performance specifications apply.

Likely pile loads have been provided as up to 900 kN.

1.03 **Geology:** Other than the variable depths of fill known to be present in the immediate area, the 1:63,360 Geological Survey of Victoria, Ringwood Sheet indicates the subject site to be underlain by sedimentary deposits, which are of the Tertiary age and form part of the Brighton Group. Typically, these deposits comprise shallow surface sands and silt underlain by moderate strength clays, which grade to medium dense to dense clayey and silty sand. The Brighton Group often contains high strength cemented layers, which comprise ferruginous sandstone. These deposits extend to significant depths in the area.

The survey also indicates that Quaternary sand ridges and sand hill deposits are located within the subject site, however it is likely that these have been removed during previous quarrying activity.

The site is understood to have previously been used as a quarry and later as a landfill for municipal waste. It is therefore expected that deep fill will be encountered over most of the site.

1.04 **Field Methods:** As part of the geotechnical investigation the following field methods were incorporated:

i) **Auger Drilling:** The boreholes were drilled using truck mounted Terrington 6.0 and Gemco HP-7 drilling rigs as well as a Dingo K-9 drilling rig, all equipped with continuous flight 110 millimetre diameter augers fitted with tungsten carbide drill bits.

ii) **Standard Penetration Tests:** Standard penetration testing was conducted at regular intervals within the boreholes in accordance with the test procedure outlined in Australian Standard 1289, "Methods of Testing Soils For Engineering Purposes," Test Method 6.3.1, 2004.

iii) **Dynamic Cone Penetrometer Testing:** Dynamic cone penetrometer testing was conducted at selected borehole locations in accordance with the test procedure outlined in Australian Standard 1289, "Methods of Testing Soils For Engineering Purposes," Test Method 6.3.2, 1997.

iv) **Logging of Soil Profiles:** Soil profiles encountered in each of the boreholes were logged in accordance with Australian Standard AS 1726 - 2017, "Geotechnical Site Investigations."

2. RESULTS

2.01 **Site Description:** At the time of the site investigation the following site features were noted:

- The site is currently used as a golf driving range;
- The site exists at an elevated level due to the landfill, with the driving range sitting on the ‘plateau’;
- The height of the embankments appear to be approximately 3-4 metres at the northern sections north and 6-8 metres towards the south of the site;
- There are numerous existing medium to large trees bordering the site;
- Towards the south of the south there is a berm which the ‘BH’ boreholes are located on;
- The site has a moderate cover of grass;
- There is an existing café and golf facilities to the north of the site, as well as a minigolf course and associated car parking to the north-west.

2.02 **Borehole Drilling:** A series of twenty five (25) boreholes were drilled as part of the geotechnical investigation at the approximate locations indicated on Figure 1. The logs of the bores together with the results are given on Figures 2 - 26. The boreholes have been labelled as D1-10, S1-9 and BH1-6 where 'D' represents deep boreholes, 'S' represents shallow boreholes and 'BH1-6' represent the boreholes drilled around the borders of the site for permeability testing.

In BH1-6, slotted standpipes were installed in bores drilled into the fill for falling head permeability analyses.

2.03 **Sub-Surface Soil Profile:** The drilling program indicated the subject site to be underlain by a capping layer comprising of silty sand with gravels. The thickness of the capping layer ranged from 0.4 – 3.1 metres. Underlying the capping layer is fill comprising of silty sands, clayey sands and sandy clays all dark grey in colour. In this fill layer a variety of materials were observed including plastics, rags, metal scraps, tin cans, concrete, wire, brick fragments, glass and wood. The fill extended to depths below the existing surface level ranging from 5.5 to 8.5 metres. All 'S' boreholes were terminated within the fill. Within the 'BH' boreholes (located within the berm), the fill reached depths of 2.5-4.0 metres. Underlying the fill the profile generally revealed a layer of natural stiff sandy clay tending to dense clayey sand at depth. In boreholes D2 and D6 a thin layer (approximately 1 metre) of natural silty sand was encountered overlying the sandy clay. All deep boreholes were terminated within the dense clayey sand/stiff sandy clay at depths ranging between 12.0 to 15.0 metres.

A summary of the sub-soil profile from the boreholes can be seen in Table 1 below.

Borehole	**Fill (m)** Capping layer	**Fill (m)**	**Silty SAND (m)**	**Sandy CLAY (m)**	**Clayey SAND (m)**
D1	*0.0 – 0.6*	*0.6 – 7.6*	-	*7.6 – 9.6*	*9.6 – 12.0*
D2	*0.0 – 0.5*	*0.5 – 5.5*	*5.5 – 6.8*	*6.8 – 7.6*	*7.6 – 13.5*
D3	*0.0 – 0.6*	*0.6 – 8.0*	-	*8.0 – 11.0*	*11.0 – 12.5*
D4	*0.0 – 2.8*	*2.8 – 6.9*	-	*6.9 – 8.9*	*8.9 – 15.0*
D5	*0.0 – 3.1*	*3.1 – 7.0*	-	*7.0 – 8.2*	*8.2 – 12.0*
D6	*0.0 – 1.5*	*1.5 – 7.2*	*7.2 – 8.0*	*8.0 – 9.5*	*9.5 – 12.0*
D7	*0.0 – 1.5*	*1.5 – 6.8*	-	*6.8 – 7.7*	*7.7 – 13.5*
D8	*0.0 – 0.6*	*0.6 – 6.7*	-	*6.7 – 7.7*	*7.7 – 12.0*
D9	*0.0 – 0.4*	*0.4 – 8.5*	-	*8.5 – 12.0*	-

D10	*0.0 – 0.7*	*0.7 – 8.2*	-	*8.2 – 12.5*	-
BH1	*0.0 – 3.0*	-	-	-	-
BH2	*0.0 – 3.0*	-	-	*3.0 – 4.0*	-
BH3	*0.0 – 4.0*	-	-	-	-
BH4	*0.0 – 3.0*	-	-	-	*3.0 – 4.0*
BH5	*0.0 – 3.0*	-	-	-	*3.0 – 4.0*
BH6	*0.0 – 2.5*	-	*2.5 – 3.0*	-	*3.0 – 4.0*
S1	*0.0 – 3.0*	-	-	-	-
S2	*0.0 – 3.0*	-	-	-	-
S3	*0.0 – 1.1*	*1.1 – 2.5*	-	-	-
S4	*0.0 – 1.0*	*1.0 – 2.5*	-	-	-
S5	*0.0 – 0.7*	*0.7 – 2.5*	-	-	-
S6	*0.0 – 0.7*	*0.7 – 2.5*	-	-	-
S7	*0.0 – 1.2*	*1.2 – 2.5*	-	-	-
S8	*0.0 – 0.9*	*0.8 – 2.5*	-	-	-
S9	*0.0 – 1.7*	*1.7 – 2.5*	-	-	-

Table 1: Summary of Sub-Soil Profile

2.04 **Ground Water:** Groundwater was encountered in boreholes D1 and D4 at depths of 11.5 and 14.0 metres respectively. Perched water was also encountered within the fill in boreholes D1 and D10. It should also be noted that, during the winter and spring months, and following prolonged periods of rainfall the fill underlying the site is extremely susceptible to moisture ingress and can even form a temporary perched water table overlying clay lenses.

2.05 **Landfill Gas Analysis:** A landfill gas analysis is to be conducted at a later date. Typically almost all gas is produced within 20 years of placement, however small amounts may continue to be emitted for up to 50 years (Landfill Gas Primer, ATSDR, 2001). Due to a number of factors including low levels of organic/chemical waste encountered, the age of the landfill and the relatively permeable capping layer, we would not expect the results to be within harmful levels at this stage in the life of the landfill. This is to be confirmed by the landfill gas analysis.

2.06 **Permeability:** In-situ permeability testing was carried out within BH1-6 in accordance with BS 5930: 1999, "Code of Practice for Site Investigations" Section 25.4, to determine an average co-efficient of permeability. Ten (10) falling head permeability tests were conducted, to assess the permeability within surface soils and for soils at depth. This assessed by drilling two boreholes at each location, one to four metres in depth and another to two metres in depth. Due to the unstable nature of the fill, all boreholes collapsed to some extent. Accordingly the deep permeability values should be interpreted as from 1.5 metres to 3.5 metres whereas the shallow permeability values should be interpreted as 0.5 metres to 1.5 metres. The deep boreholes at the locations of BH1 and BH5 had collapsed to an extent that would influence the results and were therefore not tested. No groundwater was encountered within any of the boreholes tested for permeability. To diminish the effect of soil suction all boreholes were saturated and allowed to settle prior to testing. The water level in the boreholes was measured initially after filling the bore with water, and at set time intervals thereafter. The permeability was able to be calculated using variable head test calculations after Hvorslev (1951).

Results of the falling head permeability testing carried out in boreholes BH1-6 are shown below:-

Location	Permeability (m/s)	Location	Permeability (m/s)
BH 1 *Shallow*	*K = 7.23 x* 10^{-6} *m/s*	***BH 1*** *Deep*	-
BH 2 *Shallow*	*K = 2.62 x* 10^{-5} *m/s*	***BH 2*** *Deep*	*K = 1.34 x* 10^{-6} *m/s*
BH 3 *Shallow*	*K = 7.20 x* 10^{-6} *m/s*	***BH 3*** *Deep*	*K = 2.48 x* 10^{-6} *m/s*
BH4 *Shallow*	*K = 8.76 x* 10^{-6} *m/s*	***BH4*** *Deep*	*K = 2.23 x* 10^{-6} *m/s*
BH5 *Shallow*	*K = 6.29 x* 10^{-6} *m/s*	***BH5*** *Deep*	-
BH6 *Shallow*	*K = 8.80 x* 10^{-6} *m/s*	***BH6*** *Deep*	*K = 3.17 x* 10^{-6} *m/s*

Taking into account the results of the permeability testing, we would recommend adopting a permeability of **7.66 x** $\mathbf{10^{-6}}$ **m/s** for soils above 1.5 metres and **2.31 x** $\mathbf{10^{-6}}$ **m/s** for soils below 1.5 metres.

Detailed calculations can be found in figures 36 – 45.

In considering the results of the in-situ falling head permeability testing, it should be noted that the method of testing is generally recognised to be accurate to one order of magnitude. It should also be noted that substantial variations in the permeability underlying the subject site are likely to attribute to the variations in the fill, and are highly unlikely to include either the maximum or minimum coefficients of permeability of the fill underlying the subject site.

3. RECOMMENDATIONS

3.1 BUILDING FOUNDATIONS.

3.1.1 **Piled Footings:** In view of the depth of the uncontrolled fill underlying over much of the subject site, the indoor netball court structure should be fully suspended structure on a series of piles.

Provided that adequate protection is provided against the potentially aggressive ground conditions, the use of either driven precast concrete piles or proprietary piles are recommended. Lighter screw piles and timber piles will have significant adverse construction issues.

3.1.2 **Pile Load Capacity:** The load carrying capacities of driven piles will be a combination of side adhesion and end-bearing within the stiff clay or dense clayey sand.

Piling contractors should make their own assessment of piling conditions and load carrying capacities of proprietary pile types, based on the information contained within this report.

From email correspondence with Dale Simpson of Perrett Simpson we understand that preliminary estimates of pile capacities are 650 to 700 kN for the outdoor netball courts and 750 to 900 kN for the indoor netball courts.

As a guide it is estimated that a 450 millimetre square precast concrete pile will achieve the requisite set of 700 kN for piles driven 9.5m below existing surface level founded in the dense sand for the outdoor courts. For the indoor courts it is estimated that the same pile will achieve the required set of 900 kN for piles driven 11.0 metres below existing surface level founded in the dense sand.

Some flexibility should also be introduced to accommodate for pile wastage and damage in fill

3.1.3 **Pile Settlements:** Differential settlements between adjacent piles are not expected to exceed 3 – 7 millimetres.

3.1.4 **Protection of Piles:** Due to the potential aggressive nature of the fill to steel and concrete, particularly at shallow depths, it will be necessary to provide an appropriate level of protection for the proposed precast concrete piles. Such protection should include the use of cement rich, high quality, very dense, impervious concrete, which should be placed with a high degree of vibration. As a guide the concrete should contain not less than 425 kg/m^3 cement and 50 kg/m^3 fly-ash placed with a super-plasticiser at a water cement ratio of 0.30. Care will also need to be taken to ensure that the steel segmental pile joints are not located within the uppermost 8 metres of the piles.

3.1.5 **Installation of Piles:** Due to the extent of the rubble content within the fill underlying the subject site, it is possible that some piles will refuse within the fill. This is not considered to represent a suitable founding stratum for the piles. Consequently, pre-boring of the piles through the fill is likely to be necessary over at least part of the subject site or pile wastage accepted.

3.1.6 **Pile Testing:** The use of a Pile Driver Analyser (PDA) or equivalent on a number of piles driven at the commencement of the piling contract should be used to establish driving and set criteria for subsequent piles.

3.1.7 **Shallow Footings:** Where differential movements are not critical in isolated structures such as light poles, it is considered feasible that shallow footings could be placed in adequately prepared fill. Due to the unpredictability of these founding layers they should be designed on a case by case basis. Further advice should be sought from this office if this is opted for.

3.1.8 **Earthquake Provisions:** In accordance with Australian Standard 1170.4-2007, Part 4, "Earthquake Actions in Australia", site sub-soil class of De – Deep or soft soil site and Hazard Factor (Z) of 0.09 should be adopted for the design of the proposed structure at the subject site.

3.2 PAVEMENT AND FLOOR SLAB CONSTRUCTION

3.2.1 **Preparation of Fill Subgrade:** It is considered feasible that the outdoor netball courts may be constructed on a floor slab (as opposed to fully suspended construction). Adequate site preparation is considered to be essential to the performance of a pavement, which is to be founded on fill.

In view of both the variable depth and density of the existing fill underlying the subject site, it is recommended that the existing fill be compacted using an appropriate impact roller. Herein advice should be sought from specialist impact roller operators with regard to the selection of an appropriate impact roller, which is matched to the type and depth of fill. Broms or Landpac should be considered.

Monitoring of settlements on the ground surface during the impact rolling will ultimately determine the number of passes applicable at the subject site, with impact rolling being continued until no appreciable surface settlements are observed.

Any areas of poor quality or saturated fill material identified during the impact rolling process should be excavated and replaced with good quality granular material.

Due to the potential disturbance of the near surface soils caused by the impact roller, it is likely to be necessary to compact the ground surface, upon the completion of the impact rolling, with a conventional heavy weight vibrating roller. Upon completion the fill should be compacted to a dry density not less than 98% of the maximum dry density value determined by the Standard Compaction Test in accordance with Australian Standard AS 1289 5.1.1 - 1993

Significant premiums can be gained by scheduling the preparation of the proposed subgrade during the drier months of the year. If work is carried out following prolonged rain periods it is possible that extensive areas of the subgrade may exist in an unstable condition due to the ingress of surface water.

Due to the age of the fill it is considered that instantaneous and primary settlement would have already occurred in the fill. Accordingly, secondary settlement has been estimated using Sowers Model (Sowers, 1973). **It is thought a reasonable estimate of likely total settlements following impact rolling would be still some 55 - 65 millimetres over the next 50 years with this being all differential settlements. If this settlement is unacceptable a piled approach should be adopted for all external courts.**

It may be necessary to monitor vibrations during impact rolling to ensure vibration waves do not transfer significantly into the any existing services or nearby structures as required. If there is concern to nearby structures or underground assets it may be necessary to construct a cut-off to a depth of some 1.5 metres if sufficient buffers cannot be achieved. The distance impact rolling may effect structures may be as much as 50 – 70m.

3.2.2 **Pavements and Floor Slabs Constructed on Fill:** Ongoing settlements within the significant depths of fill underlying the subject site will result in distortion and maintenance requirements to pavements and floor slabs constructed on the existing ground surface level. Recognising this, any proposed pavements should be constructed on an adequately prepared subgrade with maximum possible grades to minimise future maintenance and ponding of water. Services should be sleeved and flexible and relative movement allowed between the structure and surrounding material.

Flexible pavements constructed on an adequately prepared fill subgrade may be designed using a Design CBR value of 2%. Rigid pavements on the other hand, constructed on a similar subgrade may be designed using a Modulus of Subgrade reaction value of 18 kPa/mm. Alternatively rigid pavements may be designed in accordance with the Cement and Concrete Association of Australia, 1997 publication, "Industrial Pavements - Guidelines for Design, Construction and Specification" using long and short term Young's Moduli of 14 and 20 MPa respectively.

The effects of movements on any proposed rigid pavements and floor slabs can be minimised by incorporation of positive load transfer devices such as dowels.

3.2.3 **Long Term Subgrade Moisture Control:** It is considered essential for the long term performance of any proposed pavements and floor slabs at the subject site that both an effective surface and perimeter cut-off drainage system be provided and maintained to reduce the risk of lateral moisture migration in the pavement and subgrade layers.

Preparation should be as outlined in section 3.2.1.

3.2.4 **Landfill Gas Collection Layer:** If the results of the landfill gas analysis reveal significant amount of methane gas, a gas collection layer should be implemented.

Such a layer should have the capacity to be “forced” if required and we have indicated the following detail being a combination of construction issues that should prove satisfactory.

At this site, there is no requirement for a clean fill layer however, the top of the gas collection layer should be relatively impermeable to gas migration. On this basis, we have proposed a

"Damtuff" proprietary HDPE liner, with on both sides a non-woven geo-textile sufficiently robust to protect the HDPE liner from the underlying screenings and the overlying cement stabilised crushed rock.

The preparation also allows for a non-woven geo-textile as a separation medium at subgrade level for the screenings layer.

On this basis, the composite construction could consist as follows.

- Floor slab
- 200mm layer 3% cement stabilized class 3 crushed rock 20mm maximum particle size
- Non-woven geo-textile 270 GSM (Dux 270 or equivalent proprietary product)
- 0.4mm HDPE plastic liner (Dam tough or equivalent proprietary product)
- Non-woven geo-textile 270 GSM (Dux 270 or equivalent proprietary product)
- 300mm screenings layer with gas collection pipes
- Non-woven geo-textile 270 GSM (Proprietary product Dux 270 GSM or equivalent)
- Prepared subgrade

A schematic of the proposed gas collection layer may be seen in figure 46 if this is eventually required.

3.2.5 **Fully Suspended Construction:** If the anticipated floor slab and pavement settlements cannot be tolerated it will be necessary to fully suspend the proposed pavements and floor slabs on a series of piles as detailed in Section 3.1.1.

3.3 CONSTRUCTION AND MAINTENANCE OF FOOTING SYSTEMS

3.3.1 **Articulation of Masonry Walls:** All brickwork and blockwork should be adequately articulated in accordance with the recommendations outlined by the Cement and Concrete Association of Australia in Technical Note 61, "Articulated Walling."

Articulation Spacings should not exceed the spacings recommended in Table 2 of Technical Note 61 unless structural design of the proposed structure is able to accommodate increased spacings. Articulation joints should also be provided at the transition points where more than one footing type is being used and at all points where the proposed extension connects to the existing structure.

3.3.2 **Site Drainage:** Water shall not be permitted to pond in footing excavations for any length of time. It is essential that no water be allowed to pond against any footings once they have been constructed.

The ground adjacent to the footings should be graded as soon as footing construction has been completed so as to provide a grade of at least 1 in 20 over the first 2.0 metres. Alternatively, all water run-off should be collected and channelled away from the proposed structure, with this situation being maintained throughout the life of the structure.

Service trench excavations located adjacent to footings should be avoided. However, where this cannot be avoided the service trench excavations should be backfilled in such a manner so as to prevent water from seeping beneath the footings.

3.3.3 **Footings Located Adjacent to Easement:** Footings located adjacent to any easements, which may be located on the subject site should be deepened to below the 45^0 angle of repose line extending from the base of the easement.

3.4. GENERAL

3.4.1 **Underground Services:** Ongoing settlements within the significant depths of fill underlying the subject site will result in distortion and maintenance requirements to underground services at the subject site. Recognising this, the following precautions should be taken for any proposed underground services at the subject site:

- All services should be laid with maximum possible grades to minimise future maintenance requirements.

- Flexible joints should be incorporated for all services.

- Services connecting to the proposed structure should be appropriately sleeved at the point of connection to allow for differential settlements where the structure is suspended.

- Where applicable, services should be tied to associated suspended structures.

3.4.2 **General:** Conditions are likely to vary significantly with the seasons for the subject site. In particular, the near surface fill underlying the site may become saturated and unworkable following prolonged periods of rainfall.

The above recommendations are based on the bore and test results together with experience of similar conditions and are expected to be typical of the area or areas being considered. Nevertheless, all excavations should be examined carefully and any unusual feature reported to us in order to determine whether any changes might be advisable.

Under no circumstance shall this report be reproduced unless in full.

Yours faithfully,

PADDY BEASLEY B.Eng. Civil (Hons)
A.S. JAMES PTY LTD

Reviewed by:
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A.S. JAMES PTY LTD

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A.S. JAMES PTY LTD
Geotechnical Engineers

JOB: 20 Wangara Road SANDRINGHAM

JOB No: 119367 **Nov '18**

LEGEND

- Denotes approximate deep borehole location
- Denotes approximate shallow borehole location
- Denotes approximate perimeter borehole location

BORE PLAN

CHECKED: T. Holt
DRAWN: P. Beasley

SOURCE: Google Earth

FIGURE 1

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Location: 20 Wangara Road, SANDRINGHAM — **Borehole** D1
Job No. 119367 — **Date:** Nov '18
Ground Water: 11.5 metres

Soil Type	Description	Depth	Tests	Results
FILL	SAND, with silt and gravels Grey brown Moist, medium dense	0.00 – 0.60		
FILL	SAND, with silt, clay, plastics, rags, metal scraps Black / grey Moist Medium dense Shallow perched water encountered on clay lense	0.60 – 7.60	+	11 / 14 / 16 N = 30
CLAY (CL)	Grey brown Silty, with gravels Moist Stiff to very stiff	7.60 – 9.60	+	19 / 21 for 100mm
SAND (SC)	Grey brown Clayey, silty lenses Moist Dense	9.60 – 12.00	+	40 / -
	BOREHOLE TERMINATED	12.00		

+ Standard Penetration Test - N blows/150mm. incr.
I Undisturbed Sample - Diameter Stated
s Vane Shear Strength
p Pocket Penetrometer Resistance

c Apparent Cohesion
Ø Friction Angle
P Wet Density
w Moisture Content

L.L. Liquid Limit
P.L. Plastic Limit
P.I. Plasticity Index
L.S. Linear Shrinkage

Figure 2

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Location: 20 Wangara Road SANDRINGHAM
Borehole D2
Job No. 119367
Date: Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
FILL	SAND, with silt, gravels and brick fragments	**0.00**		
	Grey brown			
	Moist, medium dense	**0.50**		
FILL	SAND, with silt, clay, plastics, rags, metal scraps			
	Black / grey			
	Moist			
	Medium dense			
	With plastics, wire and concrete			
			+	40 for 90mm
SAND (SM)	Brown / grey brown	**5.50**		
	Silty			
	Moist			
	Medium dense			
		6.80		
CLAY (CL)	Grey brown,			
	Sandy, with silt and gravels			
	Moist, stiff to very stiff	**7.60**	+	41 / -
SAND (SC)	Grey brown			
	Clayey, silty lenses			
	Moist		+	40 / -
	Dense			
	BOREHOLE TERMINATED	**13.50**	+	40 for 100mm

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 3**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

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Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM
Borehole D3
Job No. 119367
Date: Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
FILL	SAND, with silt, gravels and brick fragments Grey brown Moist, medium dense	**0.00** **0.60**		
FILL	Gravels, sand, plastic, Coke cans (numerous) Loose to medium dense	**1.70**		
FILL	SAND, clayey Dark grey With plastic bags, metal scraps		+	5 / 11 / 25 N = 36
	100mm concrete at 6m			
			+	40 for 60mm
		8.00		
CLAY (CL)	Pale grey / grey brown Silty / sandy Moist Stiff to very stiff		+	28 / 12 for 40mm
SAND (SC)	Orange brown Clayey, lightly cemented Moist Medium dense to dense	**11.00**	+	40 for 100mm
	BOREHOLE TERMINATED	**12.50**		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 4**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM **Borehole** D4

Job No. 119367 **Date:** Nov '18

Ground Water: 14.0 metres

Soil Type	Description	Depth	Tests	Results
		0.00		
FILL	SAND, silty with gravels Grey brown Moist Medium dense			
FILL	CLAY, with sand, silt and gravels	2.80		
	Grey brown / black		+	7 / 9 / 13
	Moist			N = 22
	Firm	3.70		
FILL	CLAY, with silt, sand and gravels			
	Grey brown		+	25 / 15 for 100mm
	Moist Firm With rags, plastics and metal scraps			
			+	7 / 7 / 15 for 60mm
CLAY (CL)	Grey	6.90		
	Silty, with gravels and sand Moist Stiff to very stiff			
		8.90		
			+	40 for 120mm
SAND (SC)	Grey / grey brown Clayey Moist Medium dense to dense			
			+	40 for 120mm
		12.80		
SAND (SM)	Yellow / grey brown Very silty Moist Medium dense to dense			
	BOREHOLE TERMINATED	15.00	+	40 for 100mm

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 5**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

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Location: 20 Wangara Road, SANDRINGHAM
Borehole D5
Job No. 119367
Date: Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
		0.00		
FILL	SAND, silty, with gravels Grey brown / black Moist Loose to medium dense			
FILL	CLAY, sandy, with silt Grey Moist, firm	3.10	+	22 / 18 / -
		3.80		
FILL	CLAY, with silt, sand Grey / black Moist Firm With plastics, rags and metal scraps		+	17 / 4 / 30 for 100mm
		7.00		
CLAY (CL)	Grey brown Sandy, with silt and gravels Moist Stiff to very stiff		+	13 / 25 / -
		8.20		
			+	40 for 120mmm
SAND (SC)	Pale grey / grey brown Clayey Moist Medium dense to dense			
	BOREHOLE TERMINATED	12.00	+	40 for 80mm

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage

Figure 6

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM | **Borehole** D6
Job No. 119367 | **Date:** Nov '18

Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
		0.00		
FILL	SAND, silty, with gravels Grey / black Moist Medium dense			
		1.50		
FILL	SAND, with silt Black / grey brown Moist Medium dense With rags, metal scraps, plastics, wire			
			+	28 / 12 for 40mm
SAND (SM)	Grey / grey brown Silty Moist, medium dense	7.20		
			+	40 for 110mm
		8.00		
CLAY (CL)	Grey brown Sandy, with silt Moist Very stiff			
			+	30 / 10 for 50mm
		9.50		
SAND (SC)	Grey brown Clayey, with silt Moist Medium dense to dense			
	BOREHOLE TERMINATED	12.00	+	40 for 60mm

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 7**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road, SANDRINGHAM — **Borehole** D7

Job No. 119367 — **Date:** Nov '18

Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
		0.00		
FILL	SAND, with silt and gravels Dark grey / black Moist Medium dense			
		1.50		
FILL	CLAY, with sand and silt Black / grey brown Moist Firm With rags, wire, plastics			
			+	20 / 20 for 50mm
		6.80		
CLAY (CL)	Grey brown Sandy, with silt and gravels Moist Stiff to very stiff		+	40 for 80mm
		7.70		
SAND (SC)	Grey brown / yellow Clayey, with gravels and silt Moist Medium dense to dense			
			+	40 for 70mm
	BOREHOLE TERMINATED	13.50	+	40 for 70mm

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage

Figure 8

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road, SANDRINGHAM
Borehole D8
Job No. 119367
Date: Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
FILL	SAND, silty with gravels Brown Moist Medium dense	0.00 – 0.60		
FILL	SAND, with silt and gravels Grey brown / black Moist Medium dense With rags, plastics, metal scraps, wire	0.60 – 6.70	+ +	8 / 9 / 10 N = 19 34 / 6 for 10mm
CLAY (CL)	Pale grey brown Sandy, silty Moist Stiff to very stiff	6.70 – 7.70	+	40 for 60mm
SAND (SC)	Grey / orange brown Clayey Moist Medium dense to dense	7.70 – 12.00	+ +	40 for 100mm 40 for 90mm
	BOREHOLE TERMINATED	12.00		

+ Standard Penetration Test - N blows/150mm. incr.
I Undisturbed Sample - Diameter Stated
s Vane Shear Strength
p Pocket Penetrometer Resistance

c Apparent Cohesion
Ø Friction Angle
P Wet Density
w Moisture Content

L.L. Liquid Limit
P.L. Plastic Limit
P.I. Plasticity Index
L.S. Linear Shrinkage

Figure 9

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road, SANDRINGHAM
Borehole D9
Job No. 119367
Date: Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
FILL	SAND, silty with gravels Brown Moist, medium dense	0.00 0.40		
FILL	CLAY, sandy Dark brown Moist Soft to firm With metal scraps and brick fragments			
			+	3 / 3 / 2 N = 5
			+	2 / 4 / 8 N = 12
		8.50		
CLAY (CL)	Grey Sandy Moist to wet Stiff Tending very sandy		+	11 / 25 / -
	BOREHOLE TERMINATED	12.00	+	8 / 18 / 25 N = 43

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage

Figure 10

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM | **Borehole** D10
Job No. 119367 | **Date:** Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
		0.00		
FILL	SAND, silty, with gravels Grey brown Moist to very moist Medium dense	0.70		
FILL	SAND, with silt, clay, gravels Dark grey Moist Medium dense With metal scraps, glass Perched water at 2.0 metres	8.20		
			+	9 / 23 / 25 N = 48
CLAY (CL)	Grey / grey brown / orange Sandy Moist Stiff Tending very sandy			
	BOREHOLE TERMINATED	12.50	+	30 / -

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage

Figure 11

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM	**Borehole** BH1
Job No. 119367	**Date:** Nov '18
Ground Water: NIL	

Soil Type	Description		Depth	Tests	Results
			0.00		
FILL	SAND, with silt, gravel, brick fragments Brown Dry to moist Medium dense				
	BOREHOLE TERMINATED	REFUSAL	3.00		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 12**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM
Borehole BH2
Job No. 119367
Date: Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
		0.00		
FILL	SAND, with silt, gravel, glass Brown Dry to moist Medium dense			
CLAY (CL)	Orange brown / grey With silt, sand Moist Firm to stiff	**3.00**		
	BOREHOLE TERMINATED	**4.00**		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 13**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM	**Borehole** BH3
Job No. 119367	**Date:** Nov '18
Ground Water: NIL	

Soil Type	Description	Depth	Tests	Results
		0.00		
FILL	SAND, with silt, glass, plastics Brown Dry to moist Medium dense			
	Tending clay fill from 3.3 metres			
	BOREHOLE TERMINATED	**4.00**		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 14**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM
Borehole BH4
Job No. 119367
Date: Nov '18
Ground Water: NIL

Note: Change in Scale

Soil Type	Description	Depth	Tests	Results
		0.00		
FILL	SAND, with silt, gravel, glass, plastics Brown Dry to moist Medium dense			
SAND (SC)	Pale brown Clayey, silty Moist Medium dense to dense	3.00		
	BOREHOLE TERMINATED	4.00		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage

Figure 15

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road
SANDRINGHAM
Borehole BH5
Job No. 119367
Date: Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
		0.00		
FILL	SAND, with silt, gravel, plastics Brown Dry to moist Medium dense			
SAND (SC)	Grey Clayey, silty Moist Medium dense	3.00		
	BOREHOLE TERMINATED	4.00		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	**Figure 16**
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM | **Borehole** BH6
Job No. 119367 | **Date:** Nov '18

Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
FILL	SAND, with silt, gravel Brown Dry to moist Medium dense	**0.00**		
SAND (SM)	Dark grey Silty, with clay Moist Medium dense	**2.50**		
SAND (SC)	Orange brown / grey Clayey, with silt Moist Medium dense	**3.00**		
	BOREHOLE TERMINATED	**4.00**		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 17**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM | **Borehole** S1
Job No. 119367 | **Date:** Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
		0.00		
FILL	SAND, silty, with gravel Grey brown Moist Medium dense			
	BOREHOLE TERMINATED	**3.00**		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 18**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM **Borehole** S2
Job No. 119367 **Date:** Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
		0.00		
FILL	SAND, silty, with gravel, brick fragments Grey brown Moist Medium dense			
	BOREHOLE TERMINATED	**3.00**		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 19**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM | **Borehole** S3
Job No. 119367 | **Date:** Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
FILL	SAND, with silt, clay and gravels	0.00		
	Orange brown			
	Moist			
	Medium dense			
		1.10		
FILL	SAND, with clay, silt, gravels			
	Grey / dark grey			
	Moist, medium dense			
	With plastics, tin cans			
	BOREHOLE TERMINATED	2.50		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 20**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road
SANDRINGHAM
Borehole S4
Job No. 119367
Date: Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
FILL	SAND, with silt, gravels, brick fragements	0.00		
	Grey brown			
	Moist			
	Medium dense	1.00		
FILL	SAND, clayey			
	Dark grey			
	Moist, medium dense			
	With metal, glass, wood, fabric			
	BOREHOLE TERMINATED	2.50		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 21**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM
Borehole S5
Job No. 119367
Date: Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
FILL	SAND, with silt, gravel	**0.00**		
	Grey			
	Moist	**0.70**		
	Medium dense			
FILL	SAND, silty, trace clay			
	Dark grey			
	Moist, medium dense			
	With plastics, fabric, cans, ballast			
	BOREHOLE TERMINATED	**2.50**		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 22**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM **Borehole** S6

Job No. 119367 **Date:** Nov '18

Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
FILL	SAND, with silt, gravel, brick fragments	0.00		
	Grey brown			
	Moist	0.70		
	Medium dense			
FILL	SAND, clayey, with silt			
	Dark grey			
	Moist, medium dense			
	With plastics, wire, metal scraps			
	BOREHOLE TERMINATED	2.50		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 23**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM **Borehole** S7
Job No. 119367 **Date:** Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
FILL	SAND, with silt, gravel Grey brown Moist Medium dense	0.00		
FILL	SAND, clayey, with silt Dark grey Moist, medium dense With plastics, glass, fabric	1.20		
	BOREHOLE TERMINATED	2.50		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 24**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

Location: 20 Wangara Road SANDRINGHAM	**Borehole** S8
Job No. 119367	**Date:** Nov '18
Ground Water: NIL	

Soil Type	Description	Depth	Tests	Results
FILL	SAND, with silt, gravel, brick fragments Grey brown Moist Medium dense	**0.00** **0.90**		
FILL	SAND, clayey, with silt, gravels Dark grey Moist, medium dense With plastics, glass, tin BOREHOLE TERMINATED	 **2.50**		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 25**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S.JAMES PTY. LTD.
Geotechnical Engineers

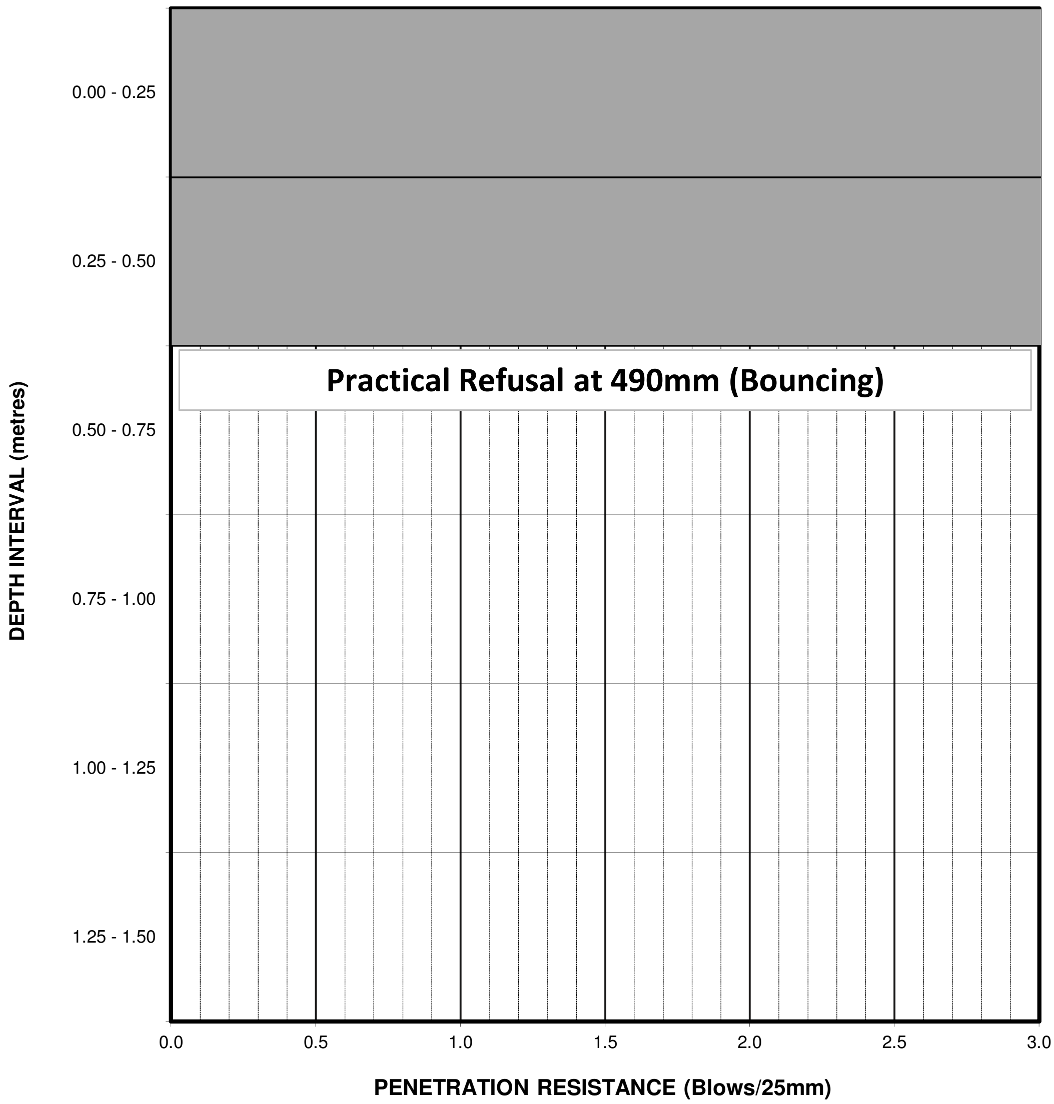
Location: 20 Wangara Road SANDRINGHAM | **Borehole** S9
Job No. 119367 | **Date:** Nov '18
Ground Water: NIL

Soil Type	Description	Depth	Tests	Results
FILL	SAND, with silt, gravel, brick fragments	0.00		
	Grey brown			
	Moist			
	Medium dense			
FILL	SAND, clayey, with silt, gravels	1.70		
	Dark grey			
	Moist, medium dense			
	With plastics, glass, cans			
	BOREHOLE TERMINATED	2.50		

+ Standard Penetration Test - N blows/150mm. incr.	c Apparent Cohesion	L.L. Liquid Limit	**Figure 26**
I Undisturbed Sample - Diameter Stated	Ø Friction Angle	P.L. Plastic Limit	
s Vane Shear Strength	P Wet Density	P.I. Plasticity Index	
p Pocket Penetrometer Resistance	w Moisture Content	L.S. Linear Shrinkage	

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367
		DATE: Nov '18

Depth below ground surface at the commencement of penetration: 0.0 metres

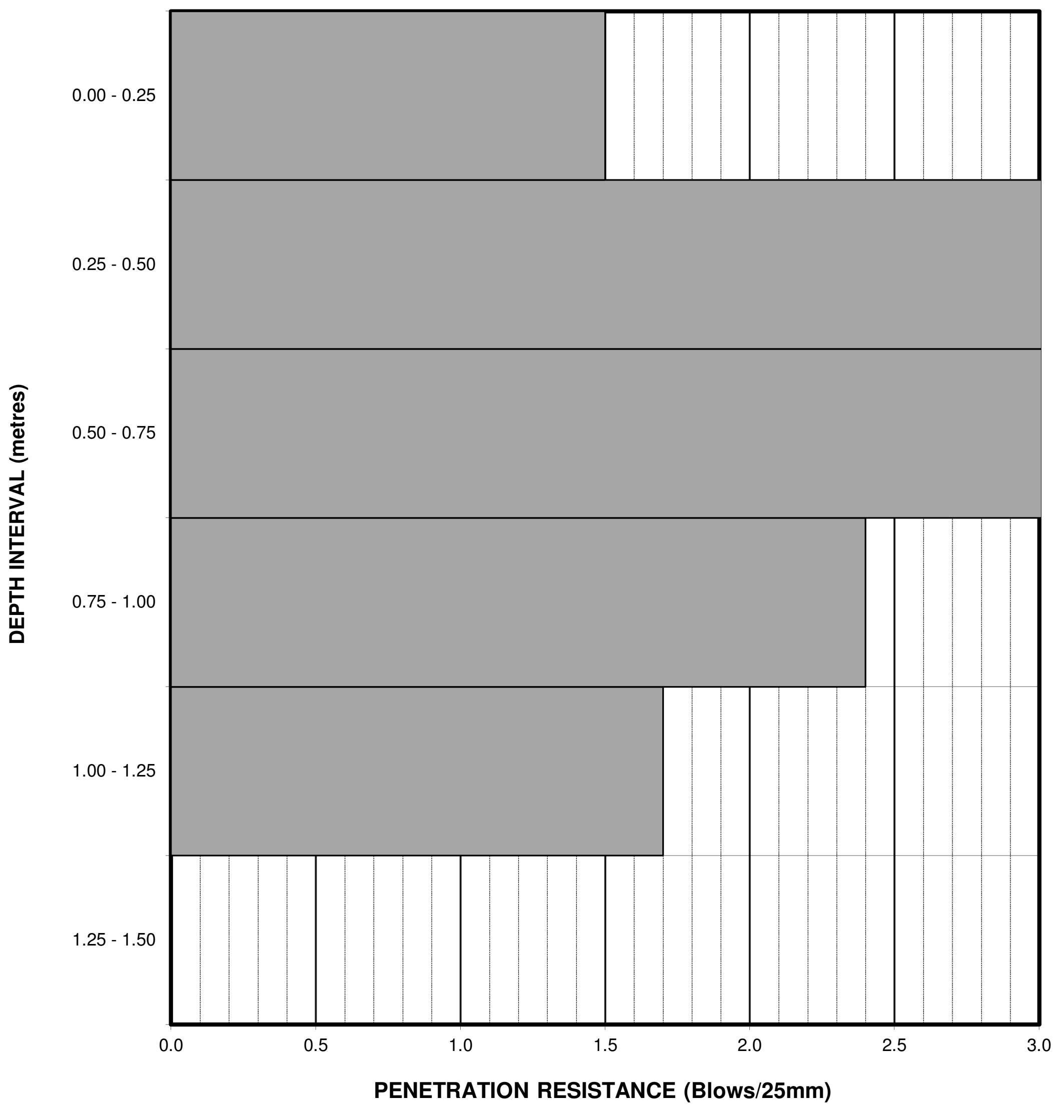


TEST LOCATION:
ADJACENT TO BOREHOLE D1
(REFER TO FIGURE 1)

DYNAMIC CONE PENETROMETER TEST (AS1289, 6.3.2, 1997)	**Drawn / Tested: P. Beasley**	**Figure**
325 sq.mm Cone - 9 kg Weight Falling 510 mm	**Checked: T. Holt**	**27**

A.S. JAMES PTY LTD Geotechnical Engineers	**JOB:** 20 Wangara Road SANDRINGHAM	**JOB No.** 119367
		DATE: Nov '18

Depth below ground surface at the commencement of penetration: 0.0 metres

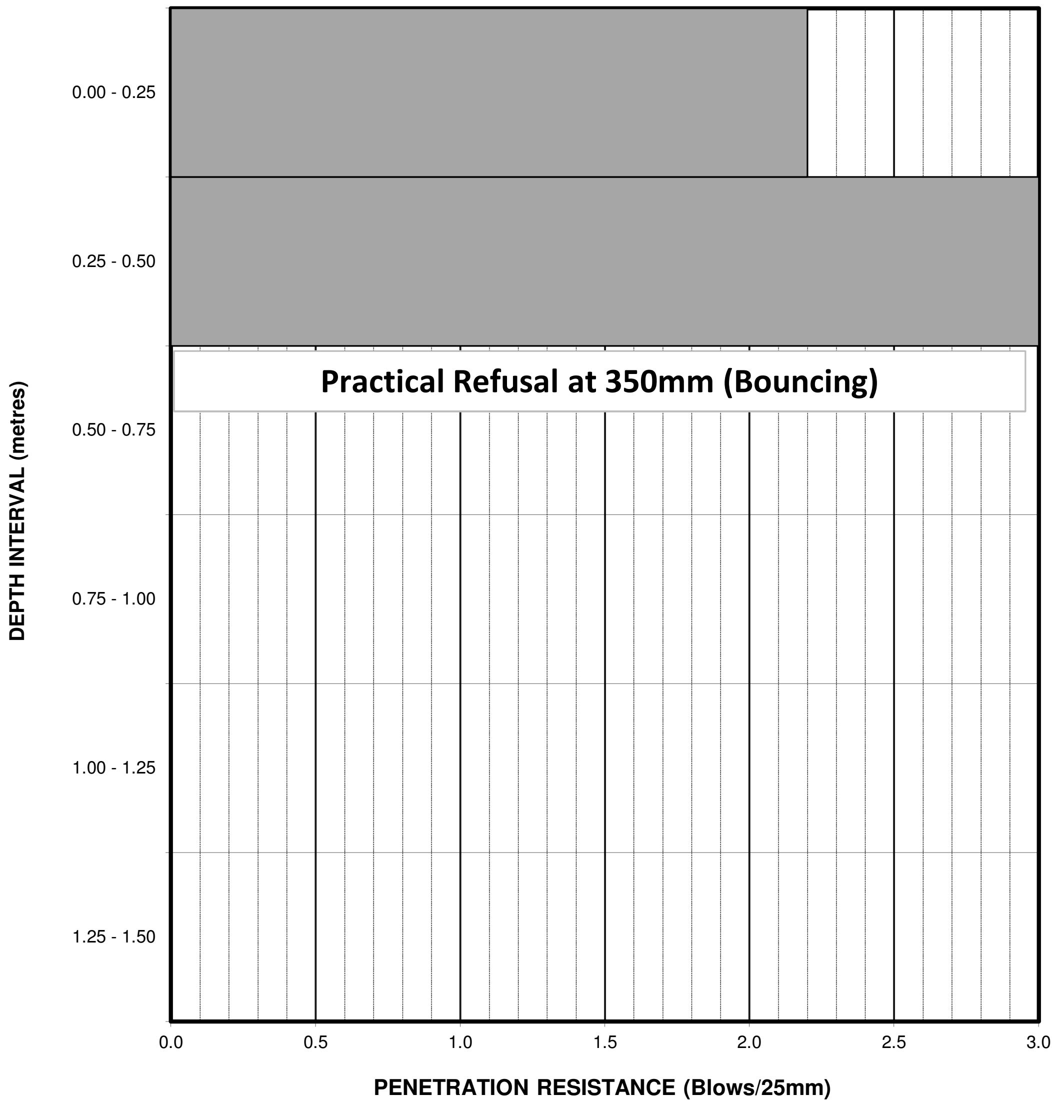


TEST LOCATION:
ADJACENT TO BOREHOLE D2
(REFER TO FIGURE 1)

DYNAMIC CONE PENETROMETER TEST (AS1289, 6.3.2, 1997)	**Drawn / Tested: P. Beasley**	**Figure**
325 sq.mm Cone - 9 kg Weight Falling 510 mm	**Checked: T. Holt**	**28**

A.S. JAMES PTY LTD **Geotechnical Engineers**	**JOB:** 20 Wangara Road SANDRINGHAM	**JOB No.** 119367 **DATE:** Nov '18

Depth below ground surface at the commencement of penetration: 0.0 metres

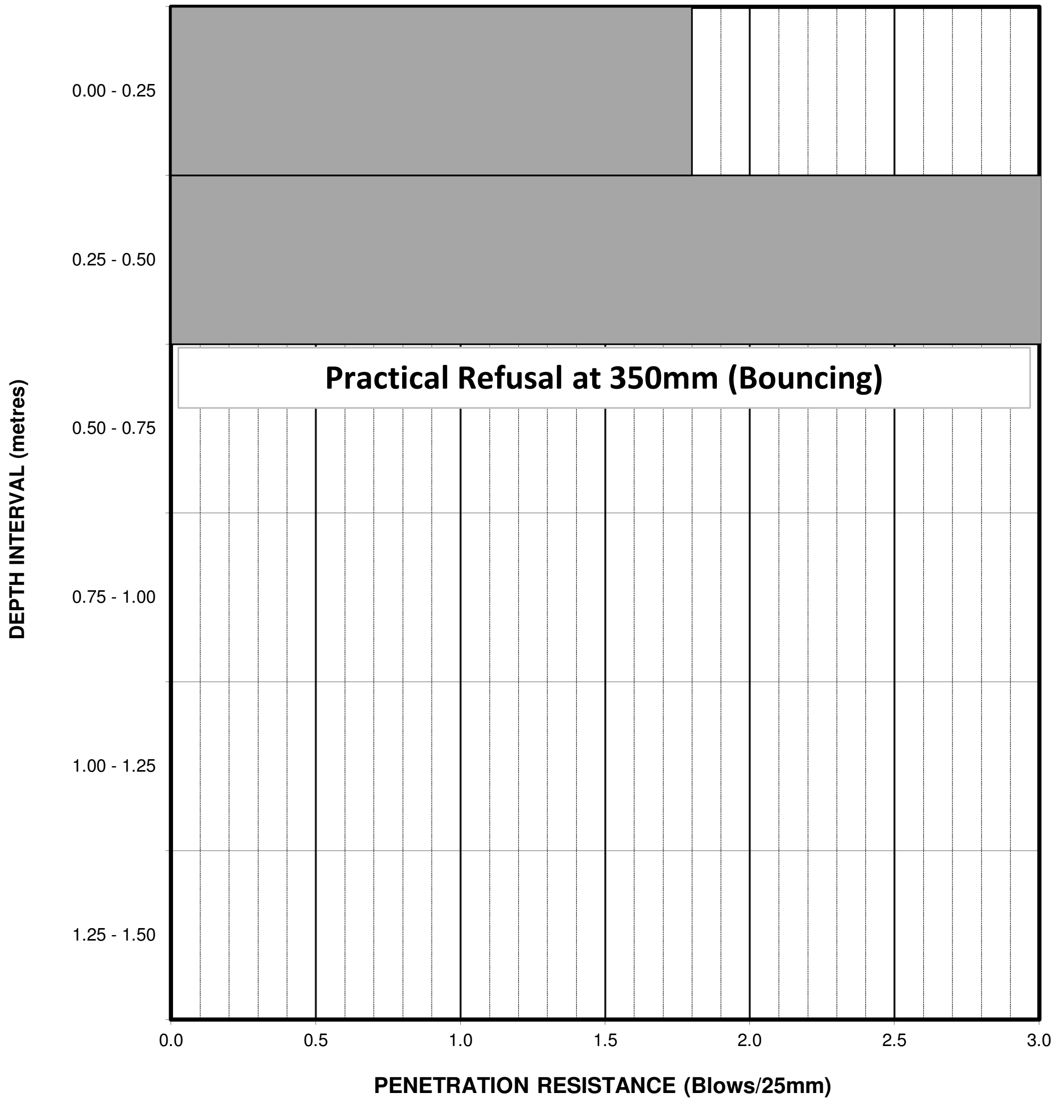


TEST LOCATION:
ADJACENT TO BOREHOLE D3
(REFER TO FIGURE 1)

DYNAMIC CONE PENETROMETER TEST (AS1289, 6.3.2, 1997) 325 sq.mm Cone - 9 kg Weight Falling 510 mm	**Drawn / Tested: P. Beasley** **Checked: T. Holt**	**Figure** **29**

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

Depth below ground surface at the commencement of penetration: 0.0 metres



TEST LOCATION:

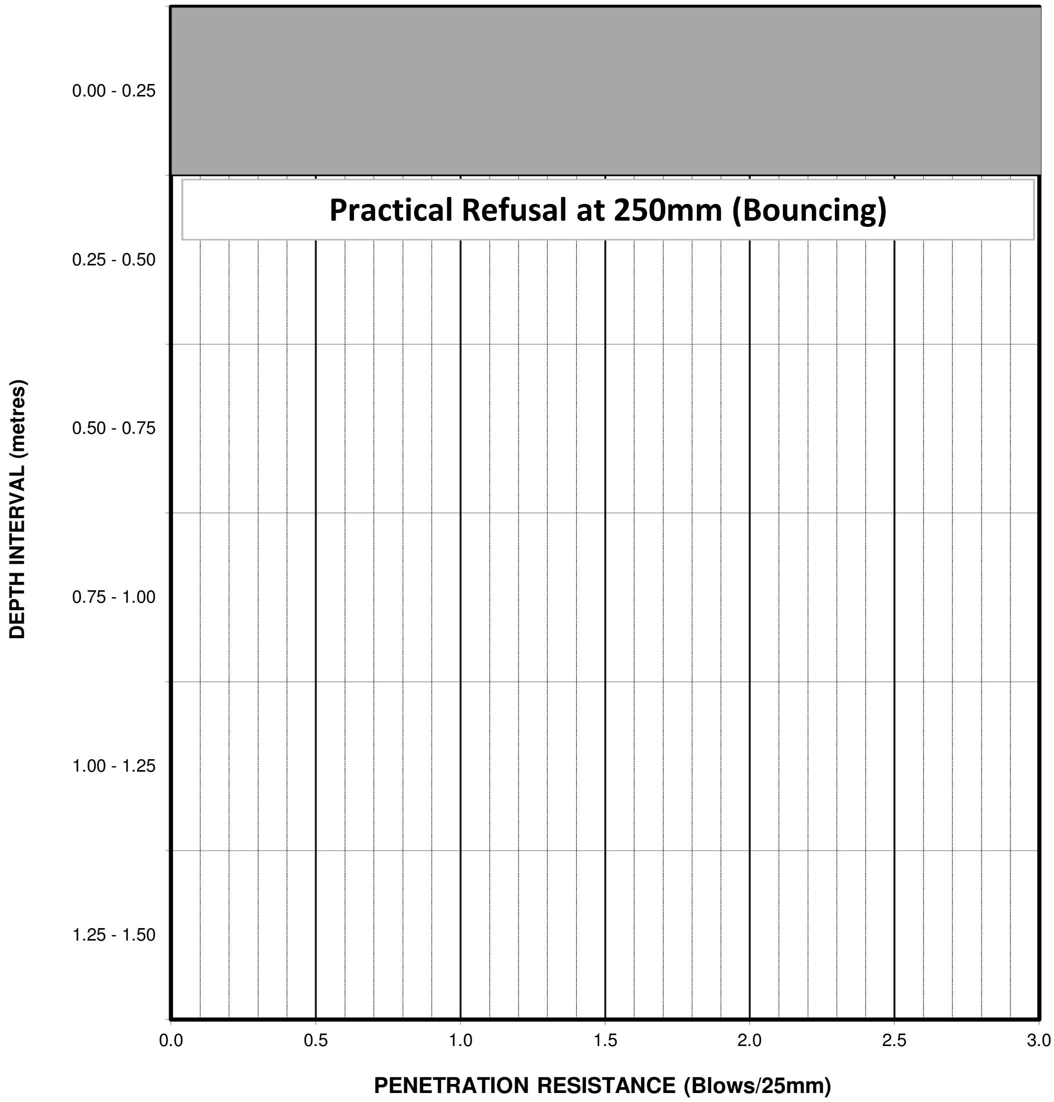
ADJACENT TO BOREHOLE D4

(REFER TO FIGURE 1)

DYNAMIC CONE PENETROMETER TEST (AS1289, 6.3.2, 1997)	Drawn / Tested: P. Beasley	Figure
325 sq.mm Cone - 9 kg Weight Falling 510 mm	Checked: T. Holt	30

A.S. JAMES PTY LTD **Geotechnical Engineers**	**JOB:** 20 Wangara Road SANDRINGHAM	**JOB No.**	119367
		DATE:	Nov '18

Depth below ground surface at the commencement of penetration: 0.0 metres



TEST LOCATION:

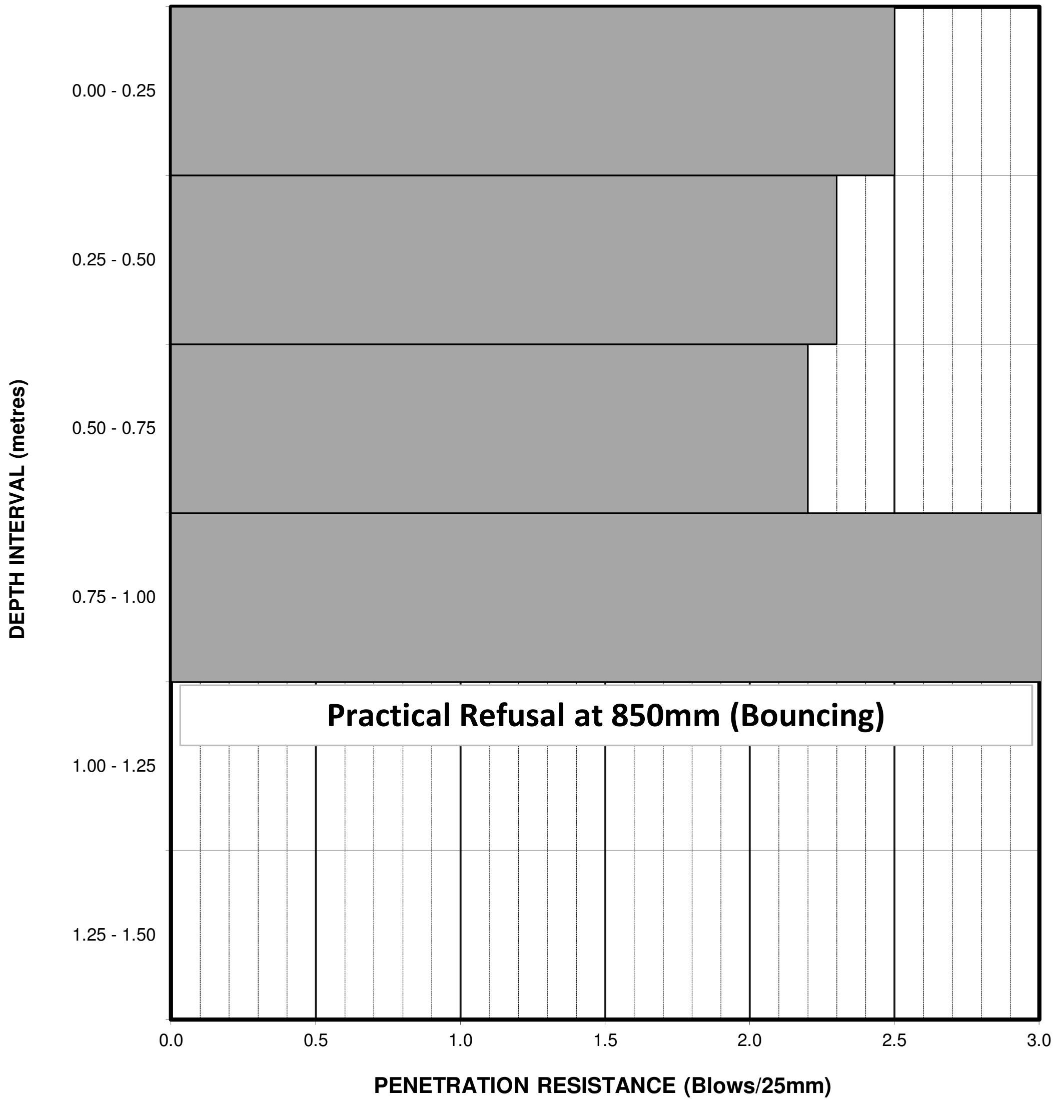
ADJACENT TO BOREHOLE D5

(REFER TO FIGURE 1)

DYNAMIC CONE PENETROMETER TEST (AS1289, 6.3.2, 1997)	**Drawn / Tested:**	**P. Beasley**	**Figure**
325 sq.mm Cone - 9 kg Weight Falling 510 mm	**Checked:**	**T. Holt**	**31**

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

Depth below ground surface at the commencement of penetration: 0.0 metres

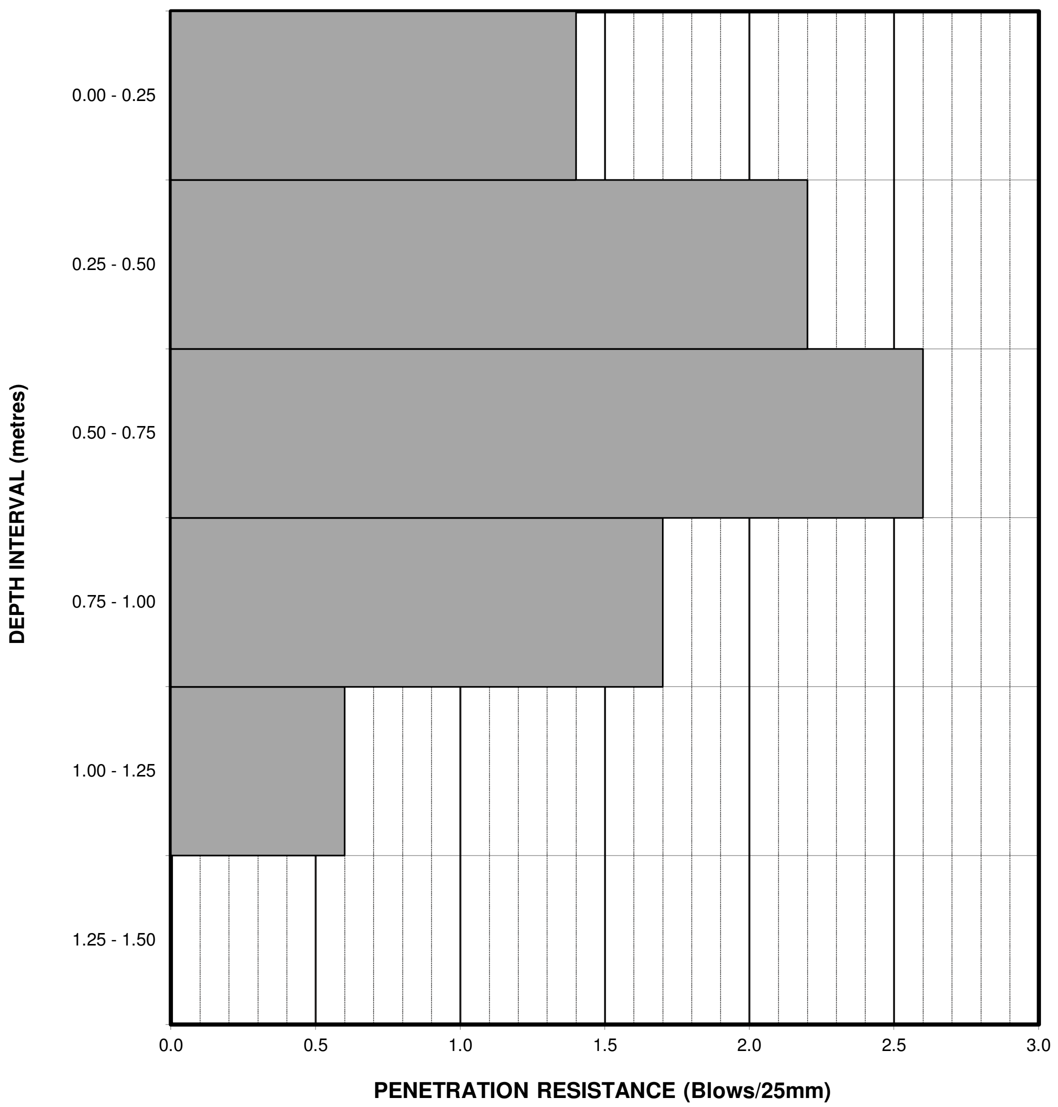


TEST LOCATION:
ADJACENT TO BOREHOLE D6
(REFER TO FIGURE 1)

DYNAMIC CONE PENETROMETER TEST	(AS1289, 6.3.2, 1997)	**Drawn / Tested: P. Beasley**	**Figure**
325 sq.mm Cone - 9 kg Weight Falling 510 mm		**Checked: T. Holt**	**32**

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367
		DATE: Nov '18

Depth below ground surface at the commencement of penetration: 0.0 metres

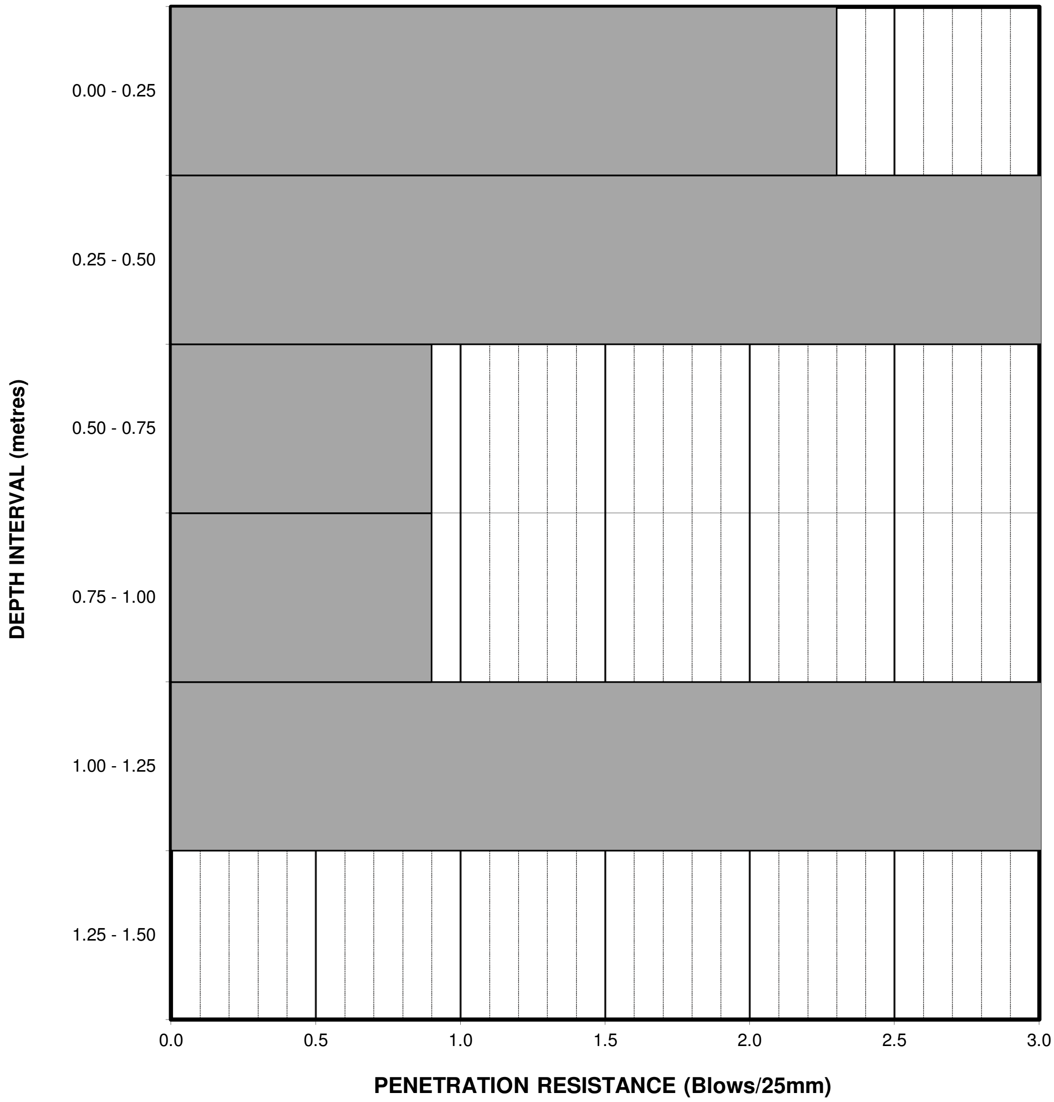


TEST LOCATION:
ADJACENT TO BOREHOLE D7
(REFER TO FIGURE 1)

DYNAMIC CONE PENETROMETER TEST (AS1289, 6.3.2, 1997)	Drawn / Tested: P. Beasley	Figure
325 sq.mm Cone - 9 kg Weight Falling 510 mm	Checked: T. Holt	33

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

Depth below ground surface at the commencement of penetration: 0.0 metres



TEST LOCATION:

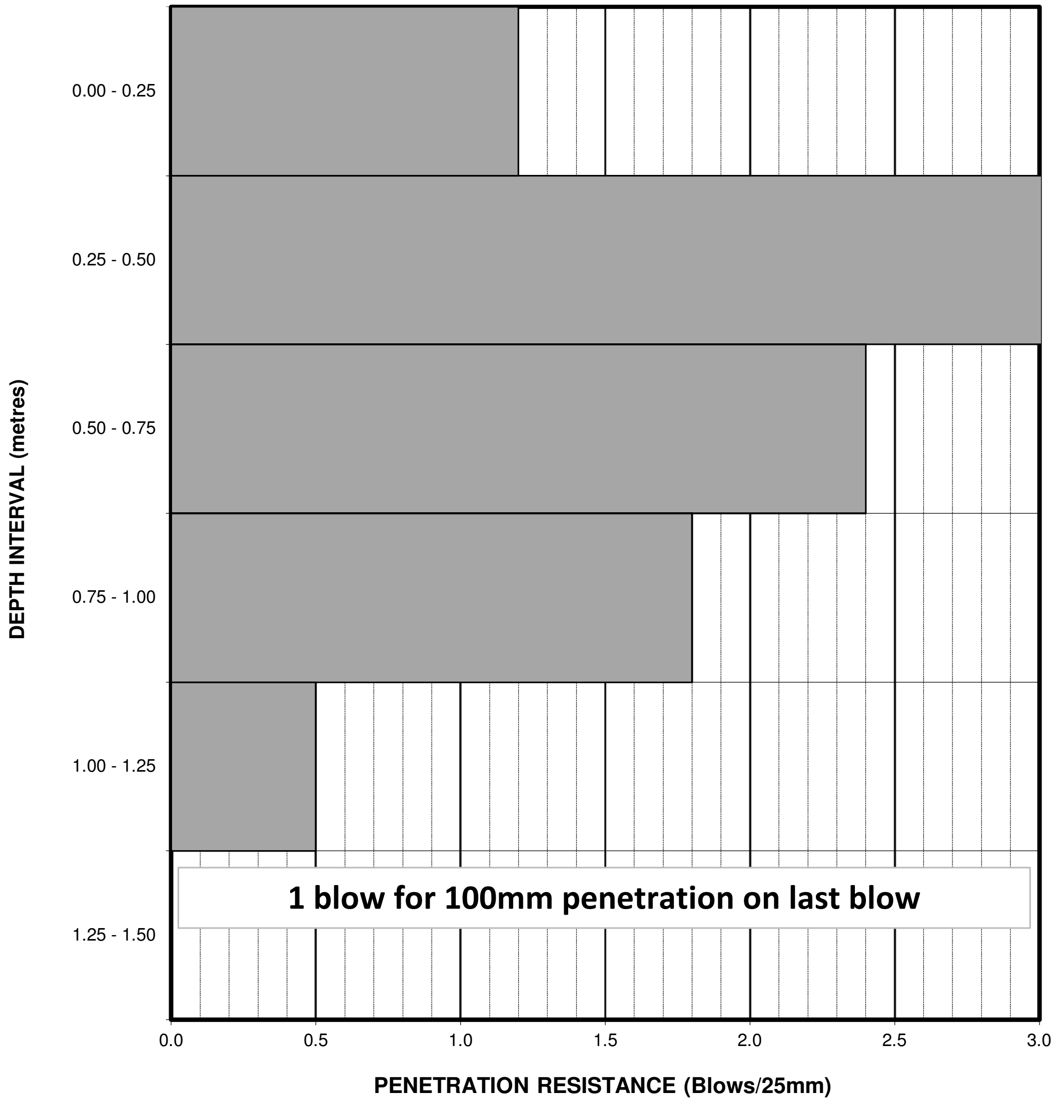
ADJACENT TO BOREHOLE D10

(REFER TO FIGURE 1)

DYNAMIC CONE PENETROMETER TEST (AS1289, 6.3.2, 1997) 325 sq.mm Cone - 9 kg Weight Falling 510 mm	**Drawn / Tested: P. Beasley** **Checked: T. Holt**	**Figure** **34**

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

Depth below ground surface at the commencement of penetration: 0.0 metres



TEST LOCATION:
ADJACENT TO BOREHOLE S3
(REFER TO FIGURE 1)

DYNAMIC CONE PENETROMETER TEST	(AS1289, 6.3.2, 1997)	**Drawn / Tested: P. Beasley**	**Figure**
325 sq.mm Cone - 9 kg Weight Falling 510 mm		**Checked: T. Holt**	**35**

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

FALLING HEAD TEST COMPUTATIONS

Location: **BH1 (Shallow)**

Depth of borehole 1.2 metres below surface

	Time (min)	Top of piezo to GW (m)	H (m)	H/Ho
1	0.17	0.19	0.82	1
2	1	0.25	0.76	0.92683
3	2	0.35	0.66	0.80488
4	3	0.4	0.61	0.74390
5	4	0.46	0.55	0.67073
6	5	0.51	0.5	0.60976
7	7	0.56	0.45	0.54878
8	10	0.64	0.37	0.45122
9	15	0.71	0.3	0.36585
10	20	0.94	0.07	0.08537
11	25	1.01	0	0
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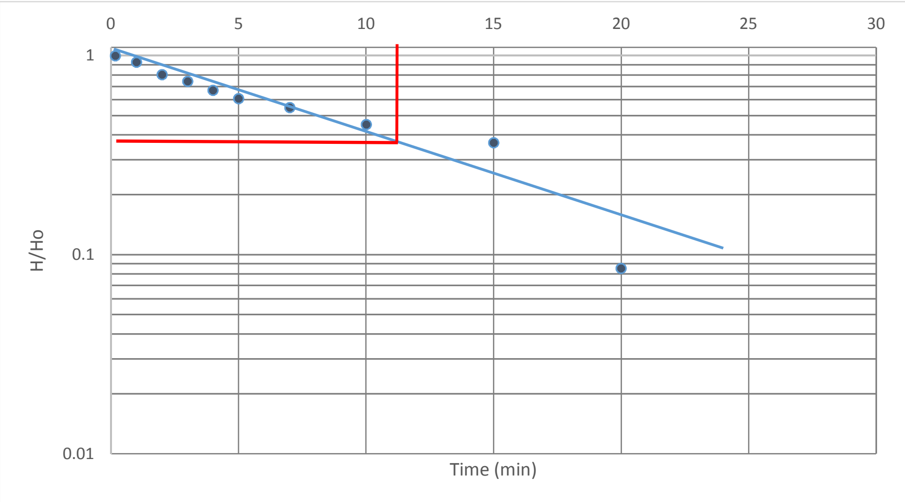
Array size	11	
Borehole Diameter	0.11	m
Height of Test	0.82	m
Cross Sectional Area	9.50E-03	m2
F	1.90E+00	
Input time at 0.37	11.5	**min**
Time	690	sec

Permeability 7.23E-06 m/s



FALLING HEAD PERMEABILITY TESTING (Hvorslev, 1951) BS 5930: 1999, "Code of Practice for Site Investigations" - Section 25.4	Tested: P. Beasley Checked: T. Holt	Figure 36

A.S. JAMES PTY LTD Geotechnical Engineers	**JOB:** 20 Wangara Road SANDRINGHAM	**JOB No.** 119367
		DATE: Nov '18

FALLING HEAD TEST COMPUTATIONS

Location: **BH2 (Deep)**

Depth of borehole 3.5 metres below surface

	Time (min)	Top of piezo to GW (m)	H (m)	H/Ho
1	0.33	2.05	0.84	1
2	1	2.16	0.73	0.86905
3	2	2.2	0.69	0.82143
4	3	2.23	0.66	0.78571
5	5	2.25	0.64	0.76190
6	10	2.31	0.58	0.69048
7	15	2.34	0.55	0.65476
8	20	2.36	0.53	0.63095
9	30	2.41	0.48	0.57143
10	45	2.44	0.45	0.53571
11	60	2.46	0.43	0.511905
12	75	2.62	0.27	0.321429
13	90	2.73	0.16	0.190476
14	105	2.79	0.1	0.119048
15	120	2.82	0.07	0.083333
16	135	2.87	0.02	0.02381
17	150	2.89	0	0
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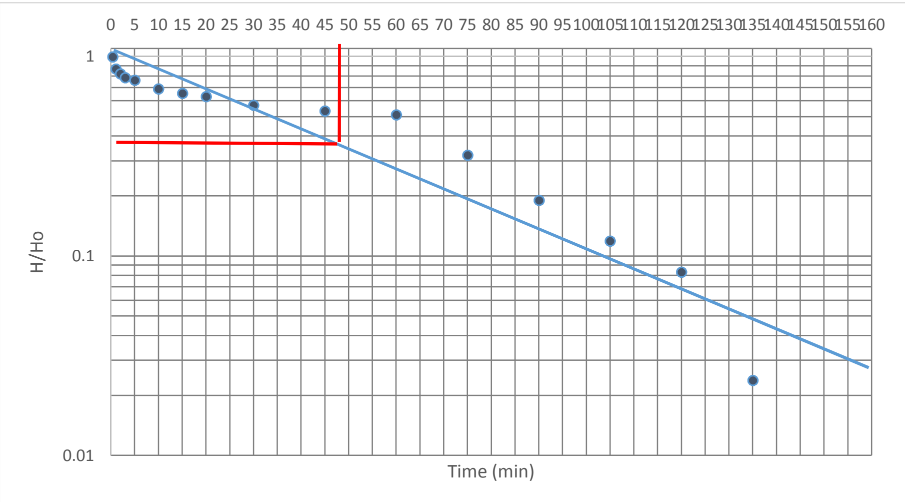
Array size	17	
Borehole Diameter	0.11	m
Height of Test	1.25	m
Cross Sectional Area	9.50E-03	m2
F	2.51E+00	
Input time at 0.37	**47**	**min**
Time	2820	sec

Permeability 1.34E-06 m/s



FALLING HEAD PERMEABILITY TESTING (Hvorslev, 1951)	Tested: P. Beasley	Figure
BS 5930: 1999, "Code of Practice for Site Investigations" - Section 25.4	Checked: T. Holt	37

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

FALLING HEAD TEST COMPUTATIONS Location: **BH2 (Shallow)**

Depth of borehole 0.9 metres below surface

	Time (min)	Top of piezo to GW (m)	H (m)	H/Ho
1	0.33	0	0.62	1
2	1	0.15	0.47	0.75806
3	2	0.28	0.34	0.54839
4	3	0.35	0.27	0.43548
5	4	0.43	0.19	0.30645
6	5	0.46	0.16	0.25806
7	7	0.52	0.1	0.16129
8	10	0.6	0.02	0.03226
9	13	0.62	0	0.00000
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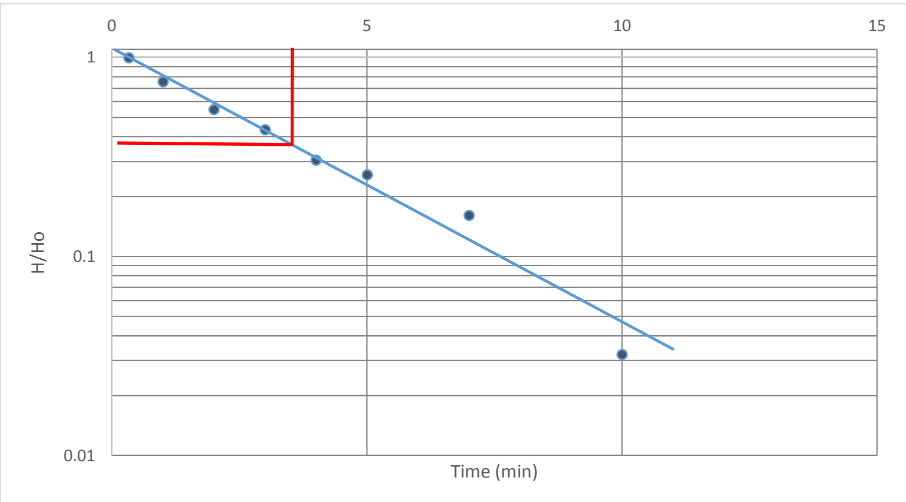
Array size	9	
Borehole Diameter	0.11	m
Height of Test	0.7	m
Cross Sectional Area	9.50E-03	m2
F	1.72E+00	
Input time at 0.37	**3.5**	**min**
Time	210	sec

Permeability 2.62E-05 m/s



FALLING HEAD PERMEABILITY TESTING (Hvorslev, 1951) BS 5930: 1999, "Code of Practice for Site Investigations" - Section 25.4	Tested: P. Beasley Checked: T. Holt	Figure 38

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

FALLING HEAD TEST COMPUTATIONS Location: **BH3 (Deep)**

Depth of borehole 3.3 metres below surface

	Time (min)	Top of piezo to GW (m)	H (m)	H/Ho
1	0.5	2.4	0.55	1
2	1	2.5	0.45	0.81818
3	3	2.53	0.42	0.76364
4	4	2.56	0.39	0.70909
5	5	2.59	0.36	0.65455
6	7	2.6	0.35	0.63636
7	10	2.61	0.34	0.61818
8	20	2.64	0.31	0.56364
9	30	2.68	0.27	0.49091
10	45	2.7	0.25	0.45455
11	60	2.8	0.15	0.272727
12	75	2.9	0.05	0.090909
13	90	2.95	0	0
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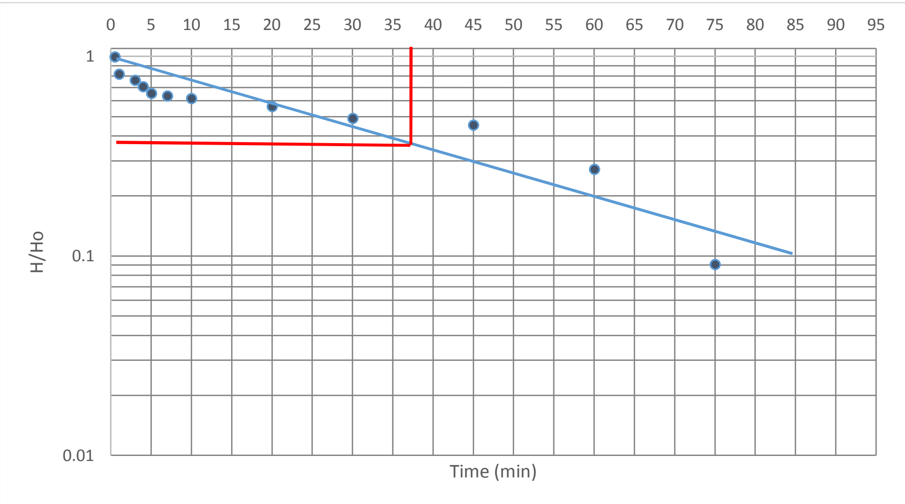
Array size	13	
Borehole Diameter	0.11	m
Height of Test	0.7	m
Cross Sectional Area	9.50E-03	m2
F	1.72E+00	
Input time at 0.37	**37**	**min**
Time	2220	sec

Permeability 2.48E-06 m/s



FALLING HEAD PERMEABILITY TESTING (Hvorslev, 1951)	Tested: P. Beasley	Figure
BS 5930: 1999, "Code of Practice for Site Investigations" - Section 25.4	Checked: T. Holt	39

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

FALLING HEAD TEST COMPUTATIONS Location: **BH3 (Shallow)**

Depth of borehole 1.4 metres below surface

	Time (min)	Top of piezo to GW (m)	H (m)	H/Ho
1	0.17	0	0.96	1
2	1	0.2	0.76	0.79167
3	2	0.41	0.55	0.57292
4	3	0.45	0.51	0.53125
5	4	0.52	0.44	0.45833
6	5	0.57	0.39	0.40625
7	7	0.69	0.27	0.28125
8	11	0.77	0.19	0.19792
9	15	0.8	0.16	0.16667
10	20	0.82	0.14	0.14583
11	30	0.93	0.03	0.03125
12	40	0.96	0	0
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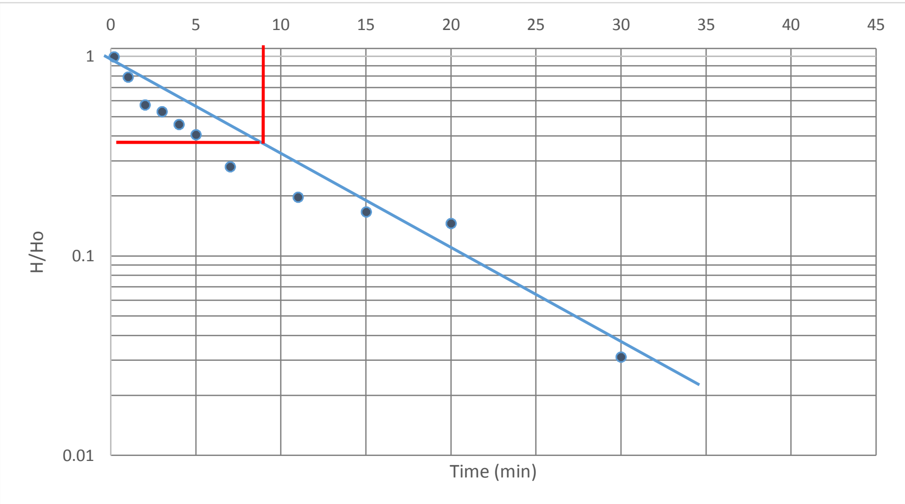
Array size	12	
Borehole Diameter	0.11	m
Height of Test	1.2	m
Cross Sectional Area	9.50E-03	m2
F	2.44E+00	
Input time at 0.37	**9**	**min**
Time	540	sec

Permeability 7.20E-06 m/s



FALLING HEAD PERMEABILITY TESTING (Hvorslev, 1951)	Tested: P. Beasley	Figure
BS 5930: 1999, "Code of Practice for Site Investigations" - Section 25.4	Checked: T. Holt	40

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

FALLING HEAD TEST COMPUTATIONS Location: **BH4 (Deep)**

Depth of borehole 3 metres below surface

	Time (min)	Top of piezo to GW (m)	H (m)	H/Ho
1	0.5	1.6	0.3	1
2	1	1.65	0.25	0.83333
3	2	1.72	0.18	0.60000
4	3	1.72	0.18	0.60000
5	4	1.72	0.18	0.60000
6	5	1.72	0.18	0.60000
7	7	1.72	0.18	0.60000
8	9	1.75	0.15	0.50000
9	11	1.75	0.15	0.50000
10	15	1.76	0.14	0.46667
11	20	1.76	0.14	0.466667
12	25	1.78	0.12	0.4
13	30	1.8	0.1	0.333333
14	35	1.8	0.1	0.333333
15	40	1.9	0	0
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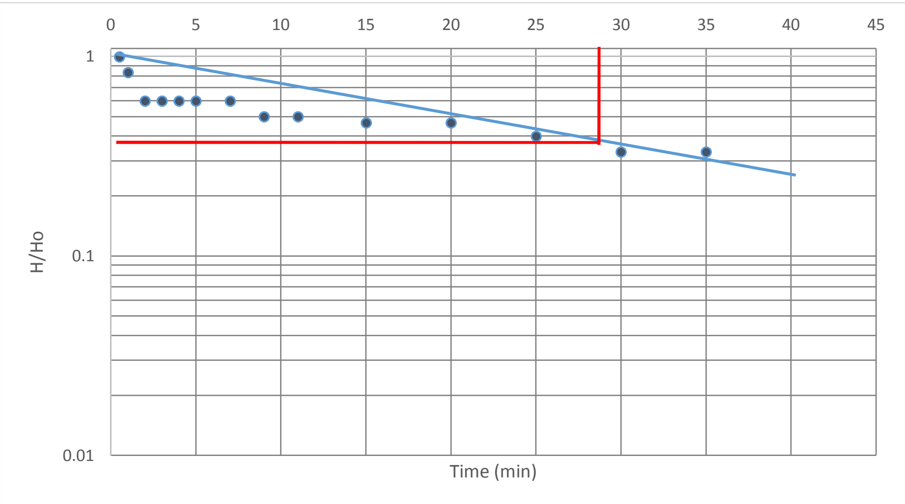
Array size	15	
Borehole Diameter	0.11	m
Height of Test	1.2	m
Cross Sectional Area	9.50E-03	m2
F	2.44E+00	
Input time at 0.37	**29**	**min**
Time	1740	sec

Permeability 2.23E-06 m/s



FALLING HEAD PERMEABILITY TESTING (Hvorslev, 1951)	Tested: P. Beasley	Figure
BS 5930: 1999, "Code of Practice for Site Investigations" - Section 25.4	Checked: T. Holt	41

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

FALLING HEAD TEST COMPUTATIONS Location: **BH4 (Shallow)**

Depth of borehole 1 metres below surface

	Time (min)	Top of piezo to GW (m)	H (m)	H/Ho
1	0.5	0.2	0.65	1
2	1	0.25	0.6	0.92308
3	2	0.35	0.5	0.76923
4	3	0.35	0.5	0.76923
5	4	0.4	0.45	0.69231
6	5	0.45	0.4	0.61538
7	7	0.55	0.3	0.46154
8	9	0.6	0.25	0.38462
9	11	0.7	0.15	0.23077
10	15	0.7	0.15	0.23077
11	20	0.75	0.1	0.153846
12	25	0.75	0.1	0.153846
13	30	0.8	0.05	0.076923
14	35	0.82	0.03	0.046154
15	40	0.85	0	0
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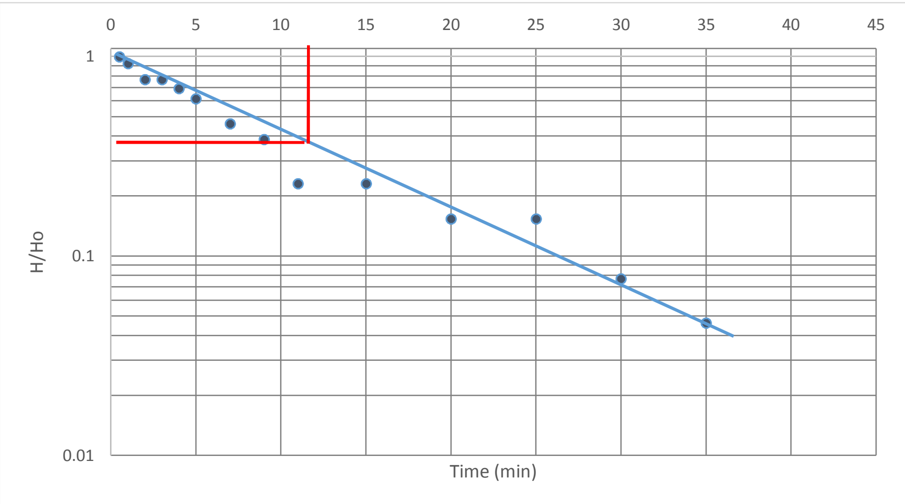
Array size	15	
Borehole Diameter	0.11	m
Height of Test	0.6	m
Cross Sectional Area	9.50E-03	m2
F	1.57E+00	
Input time at 0.37	**11.5**	**min**
Time	690	sec

Permeability 8.76E-06 m/s



FALLING HEAD PERMEABILITY TESTING (Hvorslev, 1951)	Tested: P. Beasley	Figure
BS 5930: 1999, "Code of Practice for Site Investigations" - Section 25.4	Checked: T. Holt	42

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

FALLING HEAD TEST COMPUTATIONS Location: **BH5 (Shallow)**

Depth of borehole 1.5 metres below surface

	Time (min)	Top of piezo to GW (m)	H (m)	H/Ho
1	0.5	0.55	0.65	1
2	1	0.65	0.55	0.84615
3	2	0.7	0.5	0.76923
4	3	0.75	0.45	0.69231
5	4	0.8	0.4	0.61538
6	5	0.84	0.36	0.55385
7	7	0.9	0.3	0.46154
8	9	0.95	0.25	0.38462
9	11	0.95	0.25	0.38462
10	15	0.97	0.23	0.35385
11	20	1	0.2	0.307692
12	25	1.2	0	0
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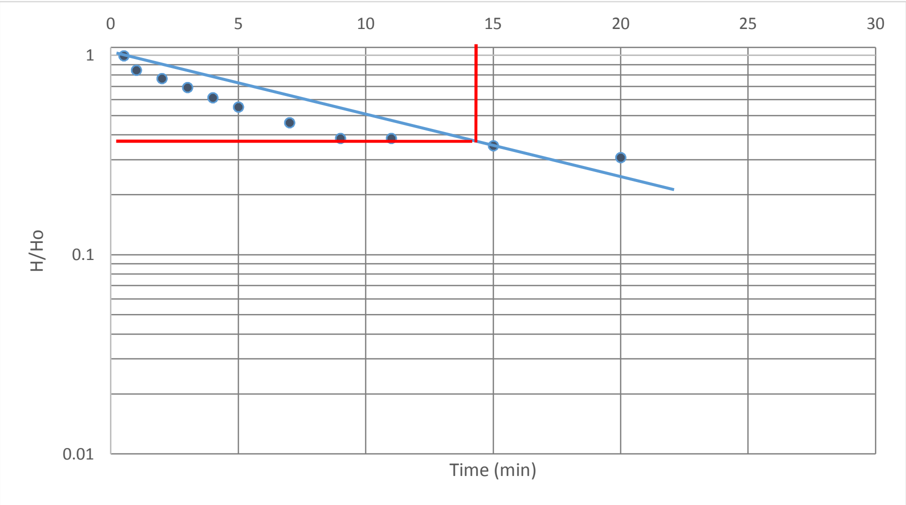
Array size	12	
Borehole Diameter	0.11	m
Height of Test	0.75	m
Cross Sectional Area	9.50E-03	m2
F	1.80E+00	
Input time at 0.37	**14**	**min**
Time	840	sec

Permeability 6.29E-06 m/s



FALLING HEAD PERMEABILITY TESTING (Hvorslev, 1951)	Tested: P. Beasley	Figure
BS 5930: 1999, "Code of Practice for Site Investigations" - Section 25.4	Checked: T. Holt	43

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

FALLING HEAD TEST COMPUTATIONS Location: **BH6 (Deep)**

Depth of borehole 3.6 metres below surface

	Time (min)	Top of piezo to GW (m)	H (m)	H/Ho
1	0.5	1	0.79	1
2	1	1.1	0.69	0.87342
3	2	1.2	0.59	0.74684
4	3	1.3	0.49	0.62025
5	4	1.3	0.49	0.62025
6	5	1.35	0.44	0.55696
7	7	1.38	0.41	0.51899
8	9	1.4	0.39	0.49367
9	11	1.44	0.35	0.44304
10	15	1.5	0.29	0.36709
11	20	1.6	0.19	0.240506
12	25	1.67	0.12	0.151899
13	30	1.72	0.07	0.088608
14	35	1.75	0.04	0.050633
15	40	1.79	0	0
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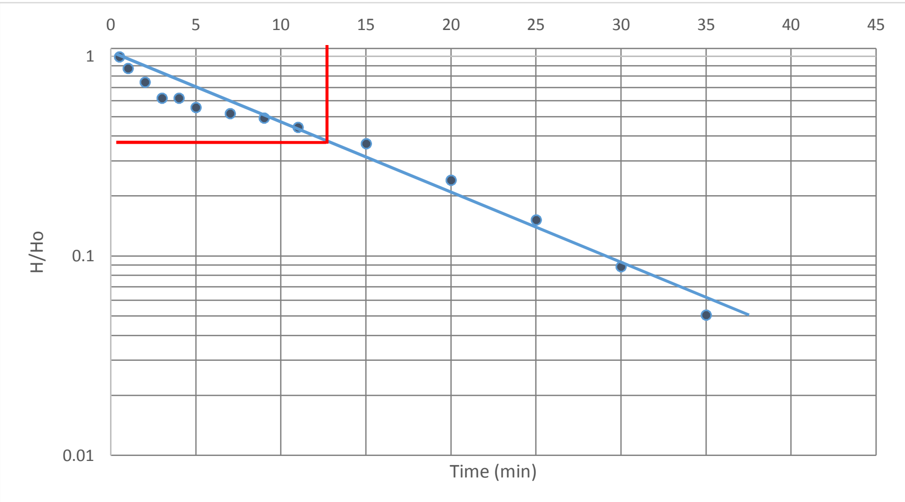
Array size	15	
Borehole Diameter	0.11	m
Height of Test	2.4	m
Cross Sectional Area	9.50E-03	m2
F	3.99E+00	
Input time at 0.37	**12.5**	**min**
Time	750	sec

Permeability 3.17E-06 m/s



FALLING HEAD PERMEABILITY TESTING (Hvorslev, 1951)	Tested: P. Beasley	Figure
BS 5930: 1999, "Code of Practice for Site Investigations" - Section 25.4	Checked: T. Holt	44

A.S. JAMES PTY LTD Geotechnical Engineers	JOB: 20 Wangara Road SANDRINGHAM	JOB No. 119367 DATE: Nov '18

FALLING HEAD TEST COMPUTATIONS Location: **BH6 (Shallow)**

Depth of borehole 1.3 metres below surface

	Time (min)	Top of piezo to GW (m)	H (m)	H/Ho
1	0.5	0.35	0.89	1
2	1	0.5	0.74	0.83146
3	2	0.6	0.64	0.71910
4	3	0.68	0.56	0.62921
5	4	0.7	0.54	0.60674
6	5	0.71	0.53	0.59551
7	7	0.8	0.44	0.49438
8	9	0.84	0.4	0.44944
9	11	0.9	0.34	0.38202
10	15	0.95	0.29	0.32584
11	20	1	0.24	0.269663
12	25	1.2	0.04	0.044944
13	30	1.21	0.03	0.033708
14	35	1.21	0.03	0.033708
15	40	1.24	0	0
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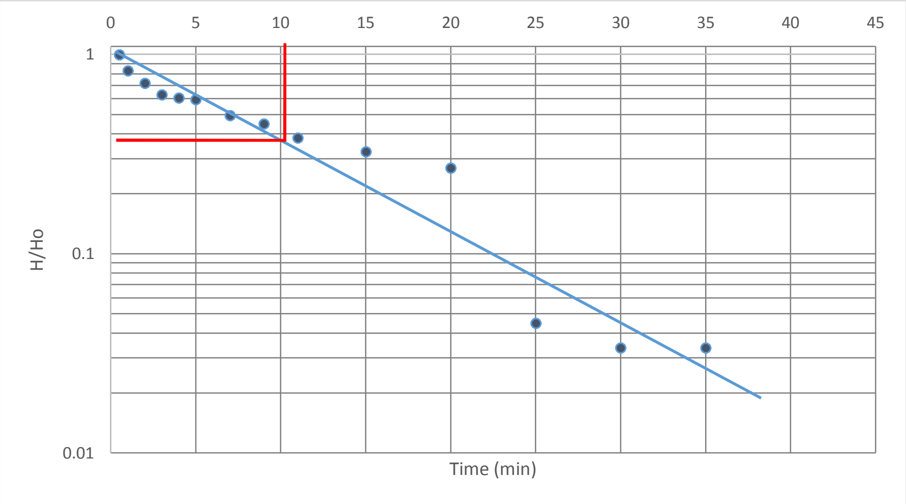
Array size	15	
Borehole Diameter	0.11	m
Height of Test	0.75	m
Cross Sectional Area	9.50E-03	m2
F	1.80E+00	
Input time at 0.37	**10**	**min**
Time	600	sec

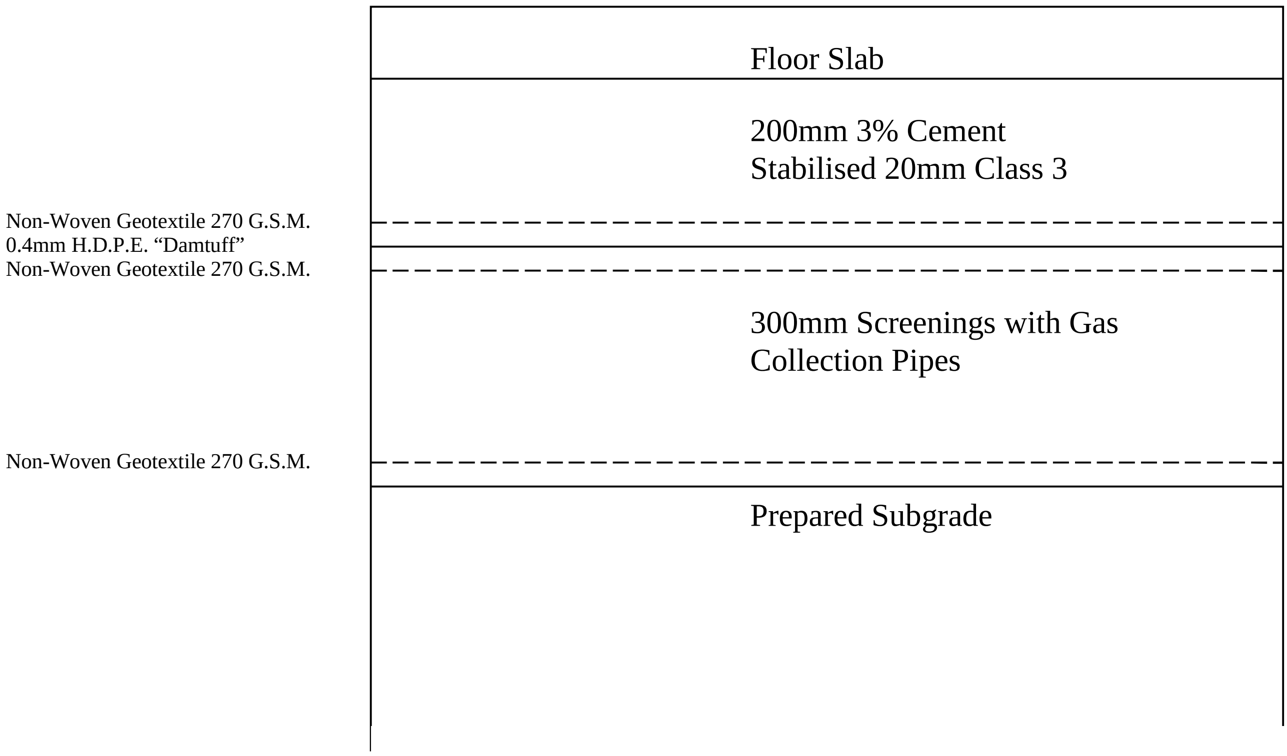
Permeability 8.80E-06 m/s



FALLING HEAD PERMEABILITY TESTING (Hvorslev, 1951)	Tested: P. Beasley	Figure
BS 5930: 1999, "Code of Practice for Site Investigations" - Section 25.4	Checked: T. Holt	45

A.S. JAMES PTY LTD
Geotechnical Engineers

A.S. JAMES PTY LTD Geotechnical Engineers	**JOB:** 20 Wangara Road SANDRINGHAM	**JOB No.** 119367
		DATE: Nov '18



METHANE COLLECTION LAYER	**Tested:**	**Figure 46**
	Checked: T. Holt	