



Geo-Environmental

GROUND APPRAISAL REPORT
for the site at
HORNDEAN ROAD, EMSWORTH
HAMPSHIRE, PO10 7PU
on behalf of
METIS HOMES

**Ground Appraisal Report**

Report:	GROUND APPRAISAL REPORT
Site:	HORNDEAN ROAD, EMSWORTH, HAMPSHIRE, PO10 7PU
Client:	METIS HOMES
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AMENDMENT RECORD

Revision ref.	Date	Reasons for amendment	Author	Reviewed By	Authorised By
1.0	17/07/2019	First issue	VB	LL	GR



EXECUTIVE SUMMARY	
Site Address	Horndean Road, Emsworth, Hampshire PO10 7PU
National Grid Ref	474510, 106830
Site Size	0.93 Ha (approx.)
Scope of Works	To undertake a combined geotechnical and environmental ground investigation with associated interpretation and assessment.
Form of Development	It is understood that the site is proposed to be developed with houses, private gardens, access roads and associated development infrastructure.
Ground Conditions	Head Deposits and River Terrace Deposits overlying the London Clay. It was not possible during the investigation to distinguish between the Head Deposits and River Terrace Deposits, all superficial deposits have therefore been identified as Head Deposits.
Groundwater	Groundwater was encountered within all the intrusive positions at depths ranging between 2.33m bgl and 3.70m bgl. A further monitoring visit undertaken on the 5 th July 2019 encountered water between 1.13m bgl and 2.06m bgl.
Traditional Foundations	Conventional foundations may be appropriate for a low-rise development in areas remote from desiccation and where groundwater is sufficiently deep so as not to hinder or prevent construction. Piled foundations may be necessary for areas where deeper foundations are required due to tree influence, desiccation or the presence of groundwater could cause constructability issues. See Section 4.1 for further details.
Excavations	Shallow excavations within the Head Deposits are likely to remain stable in the short term. Deeper excavations within these strata are likely to be prone to instability in the short term, particularly where more granular soils are encountered. All excavations transecting the groundwater table will become highly unstable and will require support and dewatering. Dewatering trials may be required to confirm the scope and capacity of any dewatering system. It is recommended that further investigation comprising trial pitting is undertaken to assess stability.
Sub-Surface Concrete	On the basis of the testing undertaken, buried concrete should be designed in accordance with design class of DS-1. The pH analyses for the Head Deposits and London Clay indicate the ACEC class as being AC-1.
Pavements	Based on the Dynamic Cone Penetrometer (DCP) test results and TRRL LR1132 guidance for estimated suction index, a CBR value of 2% is recommended for the Head Deposits and which should be assumed to be frost susceptible throughout thus a minimum pavement thickness of 450mm would be appropriate.
Soil Contamination	Contaminants of concern have not been identified above appropriate screening criteria for human health for the proposed residential end use.
Buildings & Infrastructure	Potable water supplies are unlikely to require protection on site. This should be confirmed by the allotted service supplier.
Waste Disposal	The results for the tested determinands did not exceed the relevant CatWasteSoil Hazard Class thresholds. The results of the waste acceptance criteria (WAC) analysis indicated the encountered Made Ground to be 'inert' waste. Further testing may be required once specific materials for disposal have been identified. It is recommended that the results of the analysis are forwarded to the proposed facility for confirmation.
Discovery Strategy	A discovery strategy should be employed, so that any evidence of possible unidentified contamination can be dealt with appropriately.
Primary risks identified from the investigation	- Groundwater is present at shallow depth and could hinder or prevent construction of shallow foundations. Groundwater could be shallower during winter or wetter periods. - Possible desiccation was identified in proximity to trees close to the site's perimeter and could require foundations to extend to depths in excess of 2.0-2.5m bgl. - Piled foundations could be required due to risks associated with constructability and control of groundwater in excavations and also due to desiccation and tree influence



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	on foundation depths.
Further Action	• Additional trial pitting to assess the stability of excavations for the construction of conventional foundation. • Continuation of groundwater monitoring to determined longer term trends and implications for construction. • Possible supplementary investigation for piled foundations, subject to further assessment of excavation stability and groundwater monitoring. • If abnormal conditions are encountered, Geotechnical/Geo-Environmental advice should be sought to determine a suitable source of action.
<i>This Executive Summary is intended to provide a brief summary of the main findings and conclusions of the investigation. For detailed information, the reader is referred to the main report ref. GE18313/GIR/JUL19.</i>	



1.0 INTRODUCTION

1.1 General

Geo-Environmental was instructed by Metis Homes to investigate the geotechnical and geo-environmental factors pertaining to the proposed development works at Horndean Road, Emsworth, Hampshire, PO10 7PU (herein referred to as 'the site'). The site's location is presented in Figure 1.

A Phase I Desk Study was previously prepared for the site by Geo-Environmental in April 2018. For details reference should be made to the full report (GE17182-DSR-APR18v1.0).

1.2 Site Description

The site comprised an irregularly shaped parcel of land extending to approximately 0.93 Ha located at NGR 474510, 106830. Ground level over the eastern half of the site appeared to be fairly level and ground level fell gently towards the west over the western portion of the site.

At the time of the site walkover, April 2018, the site comprised a grassed field which appeared to be disused and overgrown in some areas. The south-western portion of the site and ground immediately to the south-west of the site was observed to be wet underfoot and ponded water was observed in low points.

Several trees and mature shrubs were located around the site's boundary. A chain link fence formed the site's southern boundary with a recreation ground beyond. A padlocked gate was located within this fence line.

A derelict building was located within the site and appeared to be heavily overgrown such that only a portion of the roof and ridge were visible. The roof appeared (from some distance) to comprise corrugated sheeting material which might include asbestos.

Residential properties were located to the north and east of the site, with a recreation ground to the south and farmland/meadows located to the west.

Access to the site was gained from Horndean Road to the east via the recreation ground.

1.3 Form of Development

It is understood that the site is proposed to be developed with houses, private gardens, access roads and associated development infrastructure.

1.4 Objectives

Based on the findings of the previous desk study (April 2018), an intrusive investigation was to be undertaken into the geotechnical and geo-environmental conditions pertaining to the site.

The data from the geotechnical investigation was to form the basis of an interpretation with respect to foundation design, concrete specification and excavation stability.

In terms of the environmental investigation, a Preliminary Risk Assessment (PRA) was undertaken as part of the desk study in accordance with CLR11, in order to provide a basis for the scope and rationale of the subsequent Phase II ground investigation. The data from Phase I and Phase II were then to form the basis of a subsequent Generic Quantitative Risk Assessment (GQRA). The objective of the risk assessments was to evaluate the risks posed to the



proposed redevelopment, adjacent land uses, and the wider environment, in the context of the development options, immediate liabilities under the Environment Act 1990, and risks posed to Controlled Waters under the Water Resources Act.

1.5 Standards

Where practicable, the ground investigation and subsequent geotechnical and environmental assessments were undertaken in accordance with the following documents and guidance:

- British Standards Institute - Code of Practice for Site Investigations (BS5930:2015).
- British Standards Institute - Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings (BS8485:2015+A1:2019).
- British Standards Institute - Eurocode 7 – Geotechnical Design - Parts 1 & 2 (BS EN1997-1:2004 & BS EN1997-2:2007).
- British Standards Institute - Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds (VOCs) (BS8576:2013).
- British Standards Institute - Investigation of Potentially Contaminated Sites - Code of Practice (BS10175:2011).
- British Standards Institute - Soils for Civil Engineering Purposes (BS1377:1990).
- Building Research Establishment - The Performance of Building Materials in Contaminated Land (BRE255) (1994).
- Construction Industry Research and Information Association - Assessing risks posed by hazardous ground gases to buildings (C665) (2007).
- Department for Communities and Local Government - National Planning Policy Framework (2012).
- Department for Environment Food and Rural Affairs and CL:AIRE - Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination (SP1010) (2014).
- Department for Environment Food and Rural Affairs and Environment Agency - Model Procedures for the Management of Contaminated Land (CLR11) (2004).
- Department of Environment - Industry Profiles (1995 - 1996).
- Environment Agency - Guidance for waste destined for disposal in landfills (2006).
- Environment Agency - Guidance on Requirements for Land Contamination Reports (2005).
- National House Building Council, Environment Agency & Chartered Institute of Environmental Health - Guidance for the Safe Development of Housing on Land Affected by Contamination (R&D Publication 66) (2008).
- National House Building Council - Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present (10627-R01[04]) (2007).
- National House Building Council - Standards, Chapter 4.1 Land Quality - Managing Ground Conditions (2019).

1.6 Conditions

This report does not purport to be a "Geotechnical Design Report" as defined in Clause 2.8 of Eurocode 7 (Geotechnical Design BS EN 1997-1:2004) and some of the data used to support the geotechnical assessment may not be fully compliant with that design code, due to the access restrictions at the time of the fieldworks and methods of investigation adopted. It is considered possible that further detailed ground investigations could be required to facilitate the detailed geotechnical design process and should be carried out on a structure specific basis if necessary.

The data collected from the investigations have been used to provide an interpretation of the environmental conditions pertaining to the site. The recommendations and opinions expressed in this report are based on the data



obtained. Geo-Environmental takes no responsibility for conditions that either have not been revealed in the available records, or that occurs between or under points of physical investigation. Whilst every effort has been made to interpret the conditions, such information is only indicative and liability cannot be accepted for its accuracy.

It should be noted that in particular the concentrations and levels of mobile liquid and gaseous materials are likely to vary with time. The results obtained may therefore only be representative of the conditions at the time of sampling. This report should not be taken as any guarantee that a site is free of hazardous or potentially contaminative materials.

Information contained in this report is intended for the use of the Client, and Geo-Environmental can take no responsibility for the use of this information by any party for uses other than that described in this report. Geo-Environmental makes no warranty or representation whatsoever express or implied with respect to the use of this information by any third party. Geo-Environmental does not indemnify the Client or any third parties against any dispute or claim arising from any finding or other result of this investigation report or any consequential losses.

Assessment criteria or other parameters developed for the evaluation of contamination on this site are based on a number of assumptions regarding exposure and toxicology, and exposure to contaminants and levels of adverse effects may therefore vary. Whilst every care and expertise has been employed in the development of such criteria, no liability is accepted in this respect. Other criteria or guidance on the development of assessment criteria may be published in the future, and no liability is accepted in this respect.



2.0 DESK STUDY SUMMARY

A Phase I Desk Study was undertaken by Geo-Environmental in April 2018, a summary of the Preliminary Risk Assessment (PRA) is presented in the following section. For full details reference should be made to the Desk Study (ref: GE17182-DSR-APR18v1.0).

Potential Source/ media	Potential Receptors	Potential Pathways	Likelihood	Severity	Risk and Justification
Contaminants of Concern (Made Ground and Shallow Soils)	End users	Direct contact	Unlikely	Minor	Very Low End users are unlikely to come into contact with soils via direct contact as the development will include private and communal soft landscaping areas. The consequence is likely to be very low.
	Soft Landscaping	Root Uptake	Unlikely	Minor	Very Low Private and communal gardens and soft landscaping areas are proposed. The consequence is likely to be very low.
	Adjacent land users	Direct or indirect contact	Unlikely	Minor	Very Low Adjacent site users are unlikely to come into contact with soils. The consequence is likely to be very low.
	Water supply pipes	Direct contact	Likely	Mild	Moderate to Low Water supply pipes could come into contact with impacted soils depending upon depth of installation and extent of soil impact. The consequence is likely to be moderate to low.
	Buildings and infrastructure	Direct contact	Likely	Minor	Low Foundations and utilities will be placed within potentially aggressive soils (e.g. sulphate). However, the consequence is anticipated to be low.
	Groundwater	Vertical migration	Likely	Mild	Moderate to Low Shallow groundwater (<5m bgl) is likely to be present. The superficial stratum beneath the site is classified as a Secondary 'A' Aquifer, overlying Unproductive Strata. The site is located outside a SPZ. Vertical migration is unlikely due to the anticipated bedded nature of the strata beneath the site giving rise to permeability anisotropy, i.e. horizontal permeability is likely to be much higher than vertical permeability. The consequence is likely to be moderate to low.
Off-site sources	End users	Groundwater flow	Unlikely	Minor	Very Low Whilst lateral migration of groundwater is likely, end users are unlikely to come into contact with impacted groundwater due to the absence of any specific plausible source. The consequence is likely to be very low.



Potential Source/ media	Potential Receptors	Potential Pathways	Likelihood	Severity	Risk and Justification
	Groundwater	Groundwater flow	Likely	Mild	Moderate to Low Whilst it is possible that water could be present, it is probable that groundwater flow would generally be from the site towards the west and thus migration from the primary potential off-site sources, which are downgradient of the site, on to the site is unlikely. The consequence is likely to be moderate to low.

Table 2.1 Plausible Pollutant Linkages & Qualitative Risk Assessment

2.1 Scope of Works

In summary, the following scope of works for the intrusive investigation was specified by the Client:

- Commission of preliminary unexploded ordnance (UXO) survey for the site.
- Attendance of a third party utility clearance company to scan the intrusive positions using Ground Penetrating Radar (GPR) and a Cable Avoidance Tool (CAT).
- Attendance of a Geo-Environmental Engineer to set out and supervise the intrusive investigation, undertake sampling, in-situ testing and logging of recovered soils from exploratory holes.
- Construction of 6No. dynamic sampler boreholes (WS01-WS06) to depths between 3.60m and 4.00m below ground level (bgl), depending on drilling conditions, using a self-propelled track mounted rig.
- Dynamic probing at two locations (DP1 and DP2) to depths of 8.0m bgl to obtain Standard Penetration Test (SPT) equivalent values to inform the geotechnical assessment.
- Excavation using hand tools of 3No. shallow pits in the vicinity of the dilapidated property to obtain samples for targeted asbestos screening.
- Dynamic Cone Penetrometer (DCP) California Bearing Ratio (CBR) testing at 30m intervals (DCP1 – DCP5) along the route of the proposed estate road.
- Installation of 4No. groundwater monitoring wells (WS01, WS02, WS05 & WS06) to a depth of 4.0m bgl to facilitate return monitoring on one occasion. The wells would be completed with a lockable cover fitted flush with adjacent ground.
- Geotechnical laboratory testing to support the geotechnical assessment for foundations, ground floor construction and buried concrete design.
- Geochemical laboratory testing of soils and groundwater (where encountered) for a suite of commonly occurring brownfield contaminants, augmented with additional asbestos screening and quantification (where encountered), and organochloride (OCL) pesticide suites.
- Waste Acceptance Criteria (WAC) testing on selected samples representative of soils to be removed from site for disposal as waste.

The Preliminary UXO Risk Assessment (EP9102-00) prepared by 1st Line Defence in June 2019 indicated the risk of potential UXO on the site was of a moderate order. The recommendation for the site was that a further detailed UXO risk assessment be undertaken. Due to time constraints this was not done before site works, and a UXO engineer attended site and scanned all locations prior to and during drilling. For further details reference should be made to the report within Appendix D.



3.0 ENCOUNTERED CONDITIONS

A factual record of the conditions encountered during the physical investigation of the site is presented in the following sections.

For further details of the encountered ground conditions, reference should be made to the engineer's logs presented in Appendix A, the geotechnical testing results in Appendix B and the contamination testing results in Appendix C.

The physical ground investigation works were undertaken on 26th June 2019. The contamination and geotechnical testing were undertaken by UKAS accredited laboratories.

Unless stated otherwise, all depths are reported as metres below ground level (m bgl).

3.1 Ground Conditions

The investigation confirmed the anticipated geology of Head Deposits and River Terrace Deposits overlying the London Clay. It was not possible during the investigation to distinguish between the Head Deposits and River Terrace Deposits, as such all superficial deposits have therefore been recorded as Head Deposits. A generalised summary of the encountered conditions within boreholes is presented in Table 3.1.

Top (m bgl)	Base (m bgl)	Geology	Locations
0.00	0.30	MADE GROUND: Dark brown gravelly sandy silt with nettle cover and frequent rootlets and roots. Gravel is occasional fine sub angular brick and flint.	WS01
0.00	0.40	TOPSOIL: Light brown gravelly sandy silt with frequent rootlets. Gravel is occasional subangular flint fragments.	All except WS01
0.20 - 0.40	0.50 - 1.20	HEAD DEPOSITS: Brown sandy gravelly SILT and clayey silty sandy GRAVEL. Gravel is fine to coarse sub angular to sub rounded flint and occasional rootlets.	WS01, WS02, WS03, WS06
0.50 - 1.20	1.00 – 2.80	HEAD DEPOSITS: Soft to very stiff orangish brown and orangish brown and grey sandy gravelly CLAY with occasional rootlets and roots up to 3mm. Gravel is fine to medium sub angular to sub rounded flint, ferruginous inclusions and mudstone.	WS01, WS02, WS03, WS04, WS05, WS06
1.00 – 2.80	4.00+	LONDON CLAY FORMATION: Stiff to very stiff dark grey sandy CLAY with very fine selenite crystals.	WS01, WS02, WS04, WS05, WS06
3.58	3.60	LONDON CLAY FORMATION: Very stiff grey sandy CLAYSTONE.	WS03

Table 3.1 Summary of Encountered Ground Conditions

For further details of the ground conditions encountered, reference should be made to the information presented in Appendix A.

3.2 Groundwater

Groundwater was encountered within all borehole positions as summarised in Table 3.2.

Position	Strike Depth (m bgl) (26/06/19)	Return monitoring (m bgl) (05/07/19)
WS01	3.70	2.06



Position	Strike Depth (m bgl) (26/06/19)	Return monitoring (m bgl) (05/07/19)
WS02	3.56	1.52
WS03	2.40	-
WS04	2.33	1.34
WS05	2.70	1.13

Table 3.2 Summary of Encountered Groundwater

Four groundwater monitoring standpipes were installed on site (WS01, WS02, WS05 and WS06) all to a depth of 4.00m bgl. One return monitoring visit was undertaken on 5th July 2019. Groundwater was recorded at depths of between 1.13m bgl and 2.06m bgl within the standpipes during the return visit.

Changes in groundwater depth and/or level do occur for a number of reasons including seasonal effects and variations in drainage. Such fluctuations may only be recorded by the measurement of the groundwater level within a standpipe or piezometer.

3.3 Obstructions

An impenetrable obstruction was encountered within WS03 at approximately 3.60m bgl. It was thought this comprised a thick Claystone lense. No other impenetrable obstructions were encountered during the intrusive investigation. However, the presence of artificial or natural obstructions elsewhere on site should not be discounted.

3.4 Geochemical Analysis

In order to assess the general chemical quality of the strata encountered, samples of soils recovered from the exploratory holes were submitted for analysis of a range of potential contaminants selected on the basis of the findings of the Contamination Strategy Report and supported by the joint National House Building Council (NHBC), Environment Agency (EA) and Chartered Institute of Environmental Health (CIEH) publication, '*Guidance for the Safe Development of Housing on Land Affected by Contamination*' (2008).

Soil samples were placed into plastic containers for general inorganic analysis and into amber jars for organic analysis. Samples were stored in temperature controlled conditions from sampling until receipt at the laboratory from which time sample preparation and storage was determined by testing requirements and in line with the laboratory's protocols.

Six soil samples were submitted for analysis of a comprehensive suite of commonly occurring contaminants based upon determinands listed within the above guidance, augmented with speciated hydrocarbon analysis (CWG) and asbestos screening.

In addition, three targeted samples taken from HP01, HP02 and HP03 was submitted for asbestos screening to determine the potential impact of this contaminant in these positions.

Waste acceptance criteria (WAC) analyses were undertaken on one sample, and a pesticides suite was tested on a further two samples.

3.5 Geotechnical Testing

A summary of the laboratory and in situ geotechnical testing results is presented in Table 3.3.



Characteristic/Parameter	Head Deposits	London Clay Formation
Plasticity Index (%)	15 - 52	48
Modified Plasticity Index (%)	3.9 - 52	47.5
Volume Change Potential (NHBC)	Non-shrinkable to high	High
Natural Moisture Content (%)	17 - 35	33
pH	7.29 - 7.43	7.49
Water soluble sulphate (g/l)	0.12 - 0.14	0.21

Table 3.3 Summary of Geotechnical Test Results

In addition to the above testing, two moisture content profiles were completed through WS03 (in close proximity to the trees bounding the site) and WS05 (the most remote location from trees). A potential difference was seen in moisture content profile and a hand penetrometer versus depth graph (Figure 3) indicates potential evidence of desiccation within WS01 and WS02 to between 2.0m and 2.5m bgl again in proximity to the trees bounding the site. Please see plots presented on Figure 3 and Figure 4.

For further details reference should be made to the laboratory results in Appendix B.



4.0 ENGINEERING CONSIDERATIONS

Subsequent to intrusive investigation of the site and receipt of the laboratory results, the following preliminary interpretative assessments have been made with respect to engineering considerations.

4.1 Traditional Foundations

Based on the ground and groundwater conditions encountered, it is considered that conventional shallow foundations might be suitable for low rise lightly loaded structures. However, this would be limited to areas where desiccation has not been identified, where deepening due to proximity to trees/tree influence is not required and where construction will be above the water table. Alternatively, a piled foundation solution would be recommended.

The results of the Atterberg Limit tests in conjunction with the field observations indicated that the more cohesive soils of the Head Deposits (to c.3.5m bgl) should be classified '*en-masse*' as high volume change potential, with the underlying London Clay also classified as high volume change potential as defined by NHBC Standards, Chapter 4.2. Any granular soils (sand and gravel) of the Head Deposits would be considered non-shrinkable. Whilst a minimum founding depth of 1.0m bgl would apply based on the volume change potential of the cohesive Head Deposits, due to the shallow depth of the granular Head Deposits they are not considered suitable as a bearing stratum. It is recommended foundations should be taken below the granular Head Deposits, any Made Ground, root zones, disturbed ground or reworked or desiccated ground and terminate in the cohesive Head Deposits. Foundations within the zone of moisture demand of any existing, recently removed or proposed trees should be derived in accordance with the NHBC Standards. Heave protection measures are likely to be required for any foundations deeper than 1.5m bgl (passing through the granular Head Deposits) should be designed in accordance with the NHBC Standards, Chapter 4.2.

Based on the ground conditions encountered, a net allowable bearing capacity of 100kPa is recommended for strip foundations bearing into or onto the sandy gravelly clay of the Head Deposits. Total settlement should remain within tolerable limits for the proposed structures based on the recommendations above.

It is recommended that foundation excavations be concreted or blinded as soon after excavation as possible. Where concreting could take place the following day it is recommended that excavations are not taken to full depth overnight and that the final 0.5m of cover is only removed immediately prior to concreting.

Water was encountered at between 2.33m bgl and 3.70m bgl within the Head Deposits during the investigation, and between 1.13m bgl and 2.06m bgl within the standpipes during the return visit undertaken on the 5th July. However, it should be noted that changes in groundwater levels do occur for a number of reasons including seasonal effects and variations in drainage. If groundwater is present at or close to the proposed founding depth during construction, it could cause significant constructability problems and allowance for groundwater control and trench support may be required. It is recommended that groundwater depths are confirmed in the short term prior to foundation construction such that appropriate control/mitigation measures can be employed, if required. In addition, it is recommended that trial pitting is carried out to clarify groundwater ingress depths and short term excavation stability across the site.

As noted previously, potential indicators of desiccation were identified to depths of 2.0-2.5m bgl in WS01, WS02 and WS03, seemingly associated with tree influence. Construction of conventional foundations in this scenario is not considered feasible (groundwater present at shallower depth) and thus a piled foundation is considered to be required.

It should be noted that construction of conventional foundations across the site might be hindered or indeed not possible due to the presence of groundwater, which could cause excavations to collapse prior to casting of



foundations. As such, allowance should be made for construction of alternative foundations, such as piled foundations if preliminary design indicates that conventional foundations are likely to extend to depths close to or below groundwater.

Supplementary investigation would be required to inform the design of piled foundations.

4.2 Excavations

Shallow excavations within the Head Deposits are likely to remain stable in the short term. Deeper excavations within these strata are likely to be prone to short term instability, particularly where more granular soils are encountered.

Furthermore, all excavations transecting the groundwater table will become highly unstable and will require support and dewatering. Dewatering trials may be required to determine the suitability and capacity of any dewatering system on this site.

It would be recommended further investigation is undertaken using trial pits to assess fully the stability of the ground and that groundwater monitoring is continued to provide additional information on possible variations in groundwater levels seasonally and/or in response to rainfall events.

The need for man entry into excavations should where possible be designed out. However, where this cannot be achieved it should only be permitted in accordance with an approved risk assessment, method statement and safe system of work.

4.3 Sub-Surface Concrete

The results of the geotechnical laboratory tests undertaken on samples of the natural Head Deposits and London Clay Formation encountered beneath the site correspond to a design class of DS-1 as defined within the BRE Special Digest 1 (2005). The pH analyses for the Head Deposits and London Clay indicate the ACEC class as being AC-1.

It is recommended that the advice of the above publication be taken for the design and specification of all sub-surface concrete within these strata.

4.4 Pavements

In-situ CBR tests were undertaken at 5No. locations as part of the site investigation works on site using a Dynamic Cone Penetrometer (DCP), the results of which suggest a preliminary CBR of between 10-27% is applicable at a formation level of circa 0.3m bgl. However, these results are likely to have been skewed by the presence of variable proportions of gravel in shallow soils.

The Transport and Road Research Laboratory Report (LR1132) entitled '*The Structural Design of Bituminous Roads*' (1984) cites an estimated worst case equilibrium suction index of 2% based on the reported Plasticity Index range for the clays of the Head Deposits, under average construction conditions and low groundwater levels.

Based on the geotechnical results, the near surface Head Deposits should be considered as being frost susceptible for pavement design purposes for which a minimum construction thickness of 450mm is required.

Based on the DCP test results and TRRL LR1332 guidance an estimated suction index, a CBR value of 2% is recommended for the Head Deposits.



Any hard or soft spots in the formation level may induce reflective cracking in the pavement and allowance should be made for removing any slabs or other hard spots etc. that may be present. Furthermore, the sub-grade should be carefully proof rolled and any soft or loose zones replaced with compacted granular engineering fill.



5.0 ENVIRONMENTAL CONSIDERATIONS

A Generic Quantitative Risk Assessment (GQRA) incorporating the results of the ground investigation was undertaken in accordance with CLR11, the findings of which are presented in the following sections.

No sources of ground gas were identified within the desk study and risks associated with ground gases were therefore ruled out.

5.1 Soil Contamination vs. End Users

Six soil samples from depths of between 0.10m bgl and 0.30m bgl were submitted to a UKAS accredited laboratory for general chemical screening including common brownfield contaminants and asbestos screening.

The presence of a possible contaminant does not necessarily imply that a site or area is contaminated or that there is any unacceptable risk to human health. A Preliminary Quantitative Risk Assessment has been undertaken in accordance with CLR11, in order to evaluate any unacceptable risks posed to human health with respect to the proposed redevelopment. It should be noted that this assessment is protective of the chronic long-term effects of contaminants, which is also likely to be protective of any possible immediate acute effects.

A quantitative risk assessment has been undertaken by comparing the results of the laboratory chemical testing of shallow soils against Tier 1 screening criteria in the first instance. These criteria comprise the Atkins ATRISK soil screening values (SSVs), the Suitable for Use Levels (S4ULs) published by LQM (Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3453. All rights reserved) and the Category 4 Screening Levels (C4SLs) published by DEFRA. Although the C4SLs were released for Part 2A use, the associated policy companion document for the C4SLs indicated that they may also be used for planning. Although the C4SLs represent a marginally higher risk level than the SSACs (low risk rather than minimal risk) it is considered that the risk levels remain very low. Therefore, the final C4SLs are considered to be suitable to assess soils under the planning regime.

The laboratory results were compared individually against thresholds for a residential with plant uptake end use (6% SOM). Determinands were all returned as either below the laboratory detection limits or their respective SSV.

In addition two samples were selected and tested for a suite of commonly occurring pesticides, all returned values below the laboratory detection limits.

Furthermore, all soil samples submitted for asbestos screens were returned with no asbestos fibres identified.

5.2 Soil Contamination vs. Soft Landscaping

British Standard BS3882:2015 '*Specification for topsoil and requirements for use*' provides assessment criteria for a number of potentially phytotoxic contaminants in terms of new planting.

The results of the chemical analysis for determinands known to pose a potential phytotoxic risk to plant growth are summarised in Tables 5.1, together with the respective adopted Generic Assessment Criteria (GAC) for plant growth. The compliance criteria set out in BS3882:2015 are pH dependent and thus the GAC used relate to the pH range measured on samples recovered from the site.

Determinand	Phytotoxicity GAC (mg/kg)			GAC Exceedances
	pH <6.0	pH 6.0-7.0	pH >7.0	
Zinc	200	200	300	No



Copper	100	135	200	No
Nickel	60	75	110	No

Table 5.1 Summary of Plant Phytotoxicity Assessment

Based on the results of the laboratory testing, specific remedial action to protect soft landscaping from phytotoxic effects would not be required.

5.3 Soil Contamination vs. Buildings & Infrastructure

Recommendations with respect to sulphate and buried concrete are made in Section 4.4. For details, reference should be made to the specific section.

The current guidance on selection of materials for water supply pipes to be laid in contaminated land is contained in UK Water Industry Research's (UKWIR) report reference 10/WM/03/21 (re-issued 2010). However, the guidance is not mandatory and there has been concerns raised by various industry technical associations regarding the document and the methodologies proposed.

Although there are concerns regarding the document, in lieu of any further guidance in the first instance the results of this investigation have been compared with the proposed thresholds published in UKWIR Table 3.1. The results of the chemical analysis indicate that there were no exceedances within the shallow soils on the site. Based on the chemical testing results and given that the proposed development would effectively be upon a 'greenfield' site, barrier pipe is unlikely to be required for proposed potable water supplies within the application site. However, the results of chemical testing should be passed to the water company for their sign off.

As a matter of good practice, and to maximise the protection to utilities, it is recommended that clean, gap-graded granular backfill is used in service runs and that marker tapes are used for all buried services.

5.4 Soil Contamination vs. Groundwater

The site overlies a Secondary 'A' Aquifer within the superficial deposits and Unproductive Strata of the London Clay Formation. It is situated outside of any Source Protection Zone.

Given the absence of any significant concentrations of potentially mobile contamination identified as part of the chemical analysis it was considered unlikely that the site poses any significant risk to groundwater chemical quality. Therefore, no remedial measures are considered necessary in this respect.

5.5 Waste

5.5.1 Reuse of Material

In accordance with CL:AIRE Code of Practice (2011) materials are only considered waste if 'they are discarded, intended to be discarded or required to be discarded by the holder'.

The Code of Practice therefore allows soils to be reused on site where the following criteria are met:

- The soils are required to be used
- The soils are suitable both in terms of chemical and geotechnical properties for the intended use
- Only the required volume is used.



In order to comply with the Code of Practice, a material management plan that confirms the above criteria are met has to be prepared. The material management plan must be reviewed by a 'Qualified Person' who then issues a declaration to the Environment Agency. Geo-Environmental can provide this service should it be required.

Where materials do not meet the required criteria, it may be possible to treat them under an environmental permit so that they may be re-used on site.

5.5.2 Reuse of Waste

Where material is discarded as waste, it may still be possible to reuse the waste on site under a standard rules environmental permit or a U1 waste exemption. However, strict limits on the volumes that can be reused apply in these cases.

5.5.3 Disposal to Landfill

Under current legislation, where wastes are to be disposed of to landfill they may, depending on their classification, require pre-treatment. Pre-treatment shall comprise a chemical, physical (including sorting), thermal or biological process. The pre-treatment is required to change the characteristics of the waste, reduce its volume, reduce its hazardous nature, and facilitate its handling and enhance its recovery.

5.5.4 Waste Classification

The following information is provided for preliminary guidance purposes, as different facilities or operators may have differing acceptance criteria and further laboratory analysis may be required to confirm the exact classification.

In the first instance the laboratory results were uploaded to Atkins' waste soils characterisation assessment tool, 'CatWasteSoil' which determines whether a generated waste has any hazardous chemical properties based on standard laboratory analysis. The results for the tested determinands did not exceed the relevant CatWasteSoil Hazard Class thresholds. One WAC sample (WS01, 0.20m bgl) was carried out, this returned a classification of inert. In addition, no asbestos was detected within the samples submitted for analysis.

Uncontaminated natural arisings of the Head Deposits and London Clay Formation are likely to be considered as 'inert' waste, suitable for disposal at an inert waste facility.

However, confirmation of the above assessment should be sought from the receiving landfill facility.

5.6 Discovery Strategy

Whilst the investigation undertaken on the site to date is considered to be thorough, it remains possible that previously unexpected soil conditions may be encountered during the process of site demolition and construction.

Examples may include oily pockets within the soil, pockets of cement boarding or fibrous materials within the soil, black ashy materials, soils exhibiting strong odours, brightly coloured materials, and former structures or brickwork.

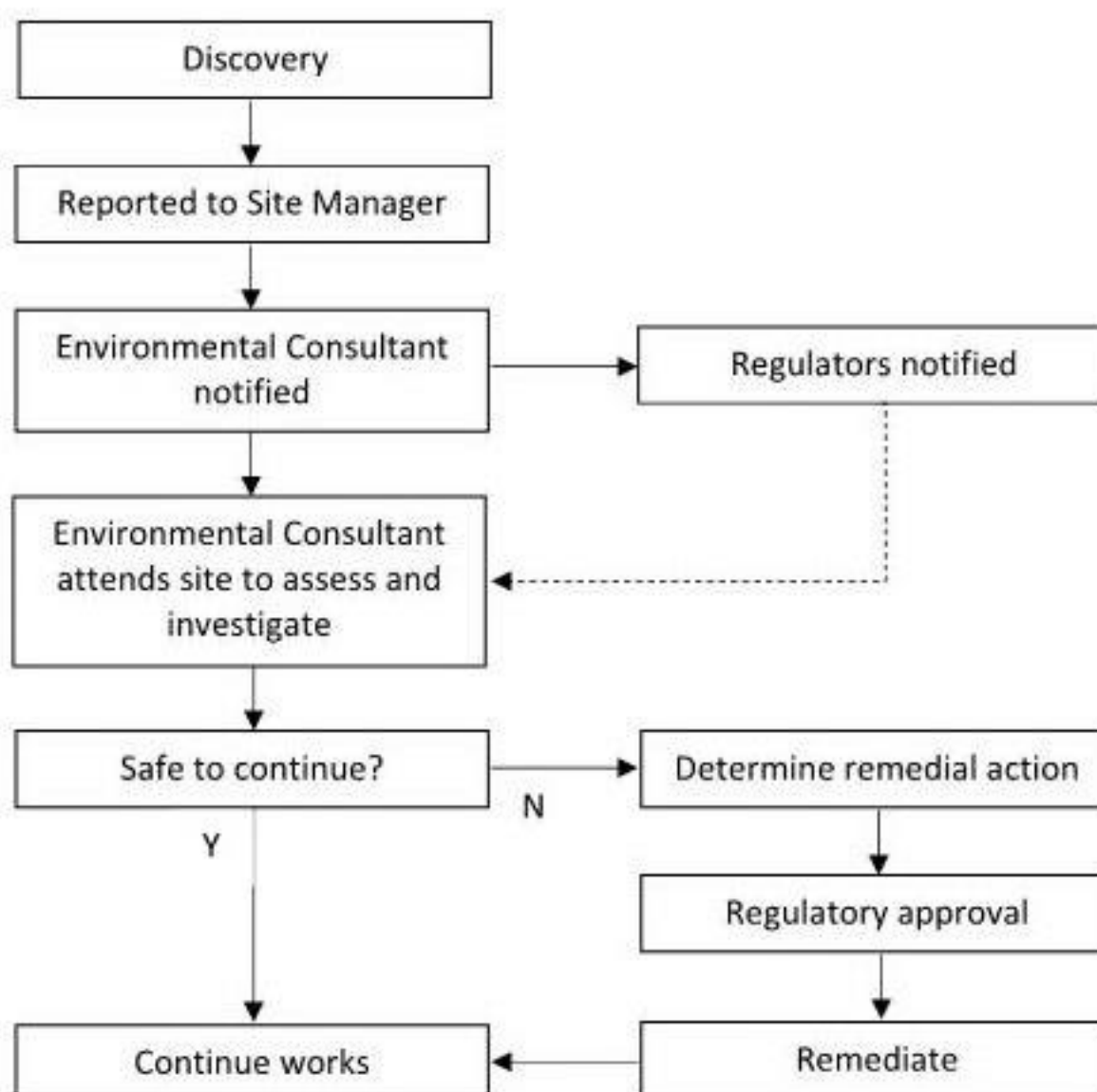
Should previously undiscovered contamination be encountered during the demolition/construction of the new buildings the following course of action should be adhered to:

- Works in the area of the suspected contamination should cease immediately. The ground workers should report any suspected contamination immediately to the Client's site supervisor. The supervisor should contact the Environmental Consultant, who should visit the site to assess the extent of the 'contamination'.



- The Environmental Consultant shall make records of their inspection, and pass details of these to the Local Authority.
- Where the conditions revealed differ from those previously anticipated, the Environmental Consultant shall take samples as deemed appropriate to be dispatched for appropriate chemical testing.
- Depending on the results of the testing either: 1) no further work will be required; 2) a further detailed risk assessment will be required; and/or 3) localised specific remedial measures will be necessary. Appraisal criteria will vary depending on the nature of the assessment.
- The results of any such testing will be sent to the Regulatory Authority for consultation. If remediation is required, the Regulatory Authority will be informed of the date and time of the proposed works.
- Remediation will be undertaken in accordance with a method statement submitted to the Local Authority for approval. The works shall be supervised by the Environmental Consultant who shall provide a Validation Report for the Local Authorities purposes.

The process is summarised overleaf:



Discovery Strategy Process

A copy of this strategy should be lodged on site, and provisions made to ensure that all workers are made aware of their responsibility to observe, report, and act on any potentially suspicious or contaminated materials they may encounter.

**Caveat**

The data collected from the investigations have been used to provide an interpretation of the geo-environmental conditions pertaining to the site. The recommendations and opinions expressed in this report are based on the data obtained.

Geo-Environmental Services Limited takes no responsibility for conditions that either have not been revealed in the available records, or that occurs between or under points of physical investigation. Whilst every effort has been made to interpret the conditions, such information is only indicative and liability cannot be accepted for its accuracy.

Information contained in this report is intended for the use of the client and their agents, and Geo-Environmental Services Limited can take no responsibility for the use of this information by any third party for uses other than that described in this report.

It should be noted that in particular the concentrations and levels of mobile liquid and gaseous materials are likely to vary with time. The results obtained may therefore only be representative of the conditions at the time of sampling. Such reservations have been indicated in the text where such conditions are considered to apply.

Geo-Environmental Services Limited does not indemnify any third parties such as the vendor against any dispute or claim arising from any finding or result of this investigation or any claim or dispute arising as a result of any decisions made thereof.



FIGURES





Project:	Horndean Road, Emsworth	Title:	Site Location Plan		
Address:	Horndean Road, Emsworth PO10 7PX	Date:	19/06/2019	Revision:	v1
		Drawn:	TS	 Geo-Environmental	
Grid Ref:		Scale:	Not to Scale	Ref:	GE18313
Client:	Metis Homes	Figure:	1		

Project Title:	Horndean Road, Emsworth
Location :	Horndean Road, Emsworth
Project No. :	GE18313
Client :	Metis Homes

Title : Figure 2 - Exploratory Hole Location Plan
Scale: 1:1000
Engineer: Jason Kanellis



Geo-Environmental

Legend Key

- Locations By Type - IP
- Locations By Type - WLS
- Locations By Type - DCP



HPEN Vs DEPTH

Project ID: **GE18313**

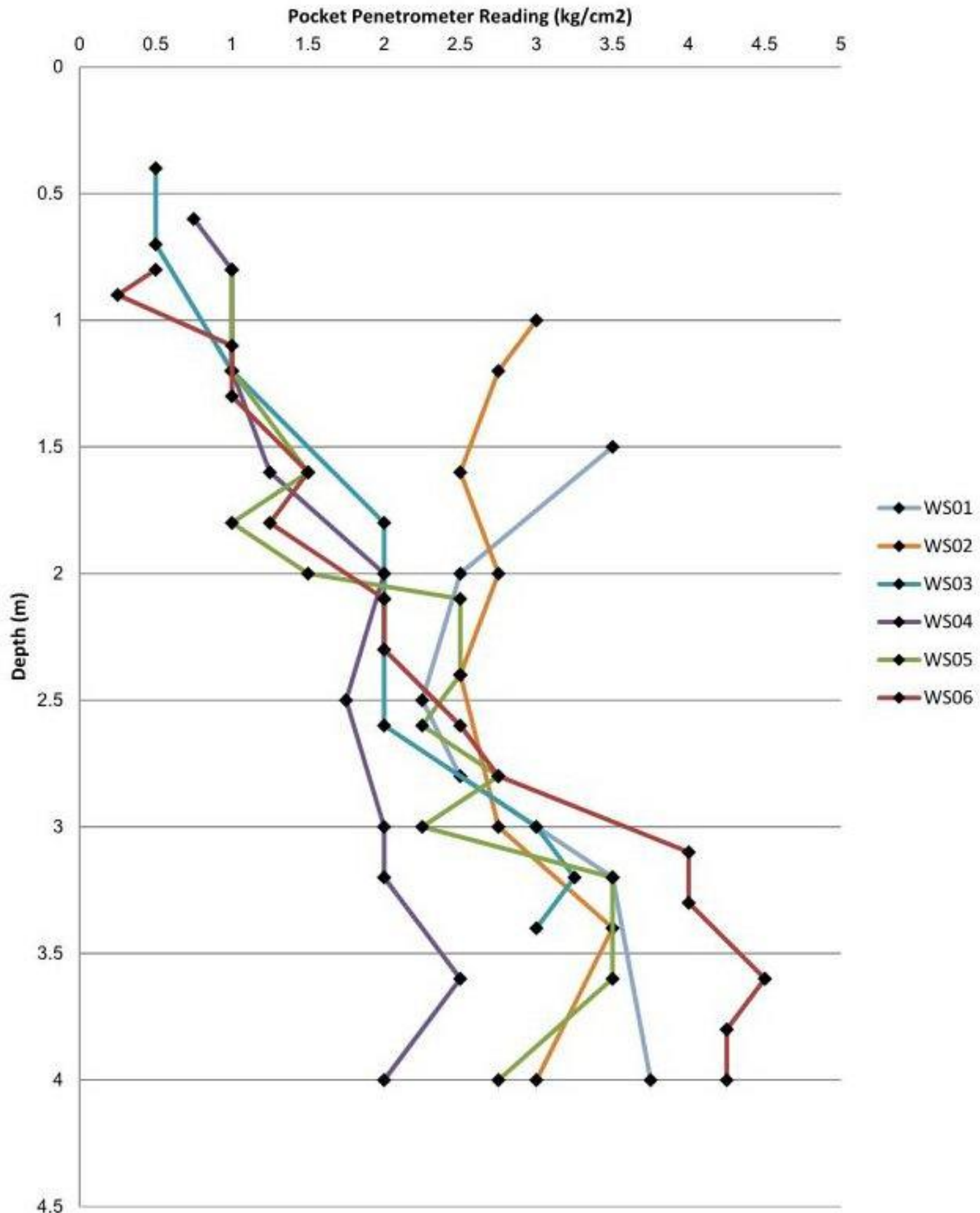
Project Title: **Horndean Road, Emsworth**

Final Depth: **0**

Client: **Metis Homes**

Location: **Horndean Road, Emsworth**

Date Drilled:



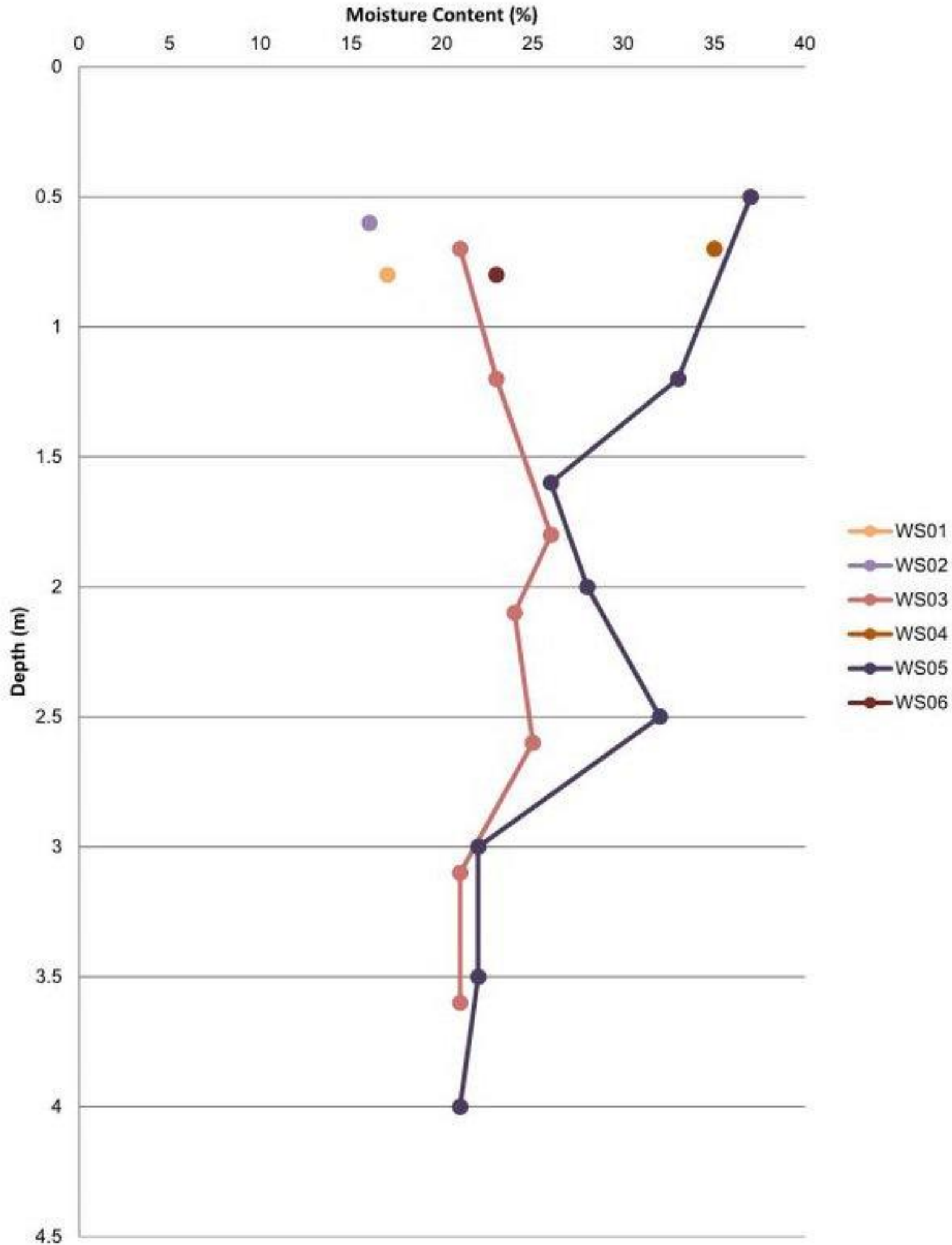
Moisture Content

Project ID: **GE18313**

Project Title: **Horndean Road, Emsworth**

Client: **Metis Homes**

Location: **Horndean Road, Emsworth**





APPENDIX A

Exploratory Hole Logs





Trialpit No

Sheet 1 of 1

Date
26-06-2019

Logged
TS

1

Stability:





Trialpit No

HP02

Sheet 1 of 1

Project Name: Horndean Road, Emsworth

Project No.
GE18313

Co-ords: 474512.74 - 106821.54
Level:

Date
26-06-2019

Location: Horndean Road, Emsworth

Dimensions
(m):

Depth
0.20

Scale
1:10

Logged
TS

Client: Metis Homes

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.20	ES		0.20		 Light brown gravelly sandy silt with frequent rootlets and grass cover. Gravel is occasional subangular flint fragments. TOPSOIL	End of pit at 0.20 m

Remarks:

Stability:





Trialpit No

HP03

Sheet 1 of 1

Date
26-06-2019

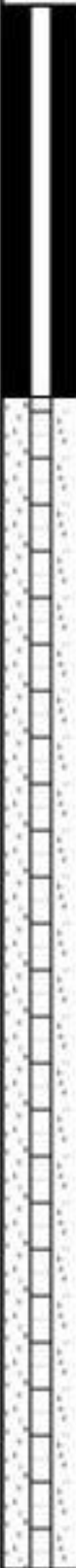
Logged
TS

—

Stability:

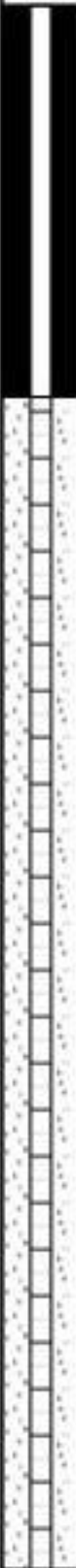


 Unit 7, Danworth Farm Hurstpierpoint BN6 9GL www.gesl.net		Borehole Log				Borehole No. WS01 Sheet 1 of 1	
Project Name: Horndean Road, Emsworth		Project No. GE18313		Co-ords: 474510E - 106886N		Hole Type WLS	
Location: Horndean Road, Emsworth		Level:		Scale 1:25		Logged By TS	
Client: Metis Homes		Dates: 26-06-2019					

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES		0.30		Dark brown gravelly sandy silt with nettle cover and frequent rootlets and roots. Gravel is occasional fine subangular brick and flint. MADE GROUND	1	
		0.80	D		1.20		Brown sandy gravelly SILT with occasional rootlets. Gravel is fine to medium subrounded to subangular flint. HEAD DEPOSITS		
		1.50 1.50	D PP	3.5kg/cm2	2.20		Stiff to very stiff orangish brown sandy CLAY with occasional rootlets up to 1mm. HEAD DEPOSITS		
		2.00 2.00	D PP	2.5kg/cm2	2.20		Stiff orangish brown and grey sandy CLAY with occasional fine subangular flint and mudstone. LONDON CLAY	2	
		2.50 2.60	PP D	2.2kg/cm2	3.00		Very stiff dark grey fine sandy CLAY with frequent very fine selenite crystals. LONDON CLAY		
		2.80	PP	2.5kg/cm2	3.00				
		3.20 3.20	D PP	3.5kg/cm2	4.00			3	
		4.00 4.00	D PP	3.8kg/cm2	4.00				
								End of Borehole at 4.00m	4
								5	

Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks	
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to		
		3.70	3.70				

 Unit 7, Danworth Farm Hurstpierpoint BN6 9GL www.gesl.net		Borehole Log			Borehole No. WS02 Sheet 1 of 1	
Project Name: Horndean Road, Emsworth		Project No. GE18313		Co-ords: 474472E - 106856N		Hole Type WLS
Location: Horndean Road, Emsworth		Level:		Scale 1:25		
Client: Metis Homes		Dates: 26-06-2019		Logged By TS		

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES		0.30		Brown gravelly sandy silt with grass cover and frequent roots and rootlets. Gravel is occasional fine subrounded flint. TOPSOIL		
		0.60	D		0.80		Brown gravelly sandy SILT with occasional rootlets. Gravel is abundant fine to coarse subangular to subrounded flint. HEAD DEPOSITS		
		1.00	D				Stiff orangish brown and grey sandy CLAY with occasional rootlets and roots up to 3mm and reddish brown ferruginous lenses. HEAD DEPOSITS	1	
		1.00	PP	3.0kg/cm2					
		1.20	PP	2.8kg/cm2					
		1.50	D						
		1.60	PP	2.5kg/cm2					
		2.00	D						2
		2.00	PP	2.8kg/cm2					
		2.40	PP	2.5kg/cm2					
		2.50	D						
		2.80							
		3.00	PP	2.8kg/cm2				Stiff to very stiff dark grey fine sandy CLAY with occasional very fine selenite crystals. LONDON CLAY	3
		3.20	D						
		3.40	PP	3.5kg/cm2					
	4.00	D			4.00			4	
	4.00	PP	3.0kg/cm2				----- End of Borehole at 4.00m -----		

Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to	
		3.56	3.56			



 Unit 7, Danworth Farm Hurstpierpoint BN6 9GL www.gesl.net		Borehole Log				Borehole No. WS03 Sheet 1 of 1	
Project Name: Horndean Road, Emsworth		Project No. GE18313		Co-ords: 474505E - 106855N		Hole Type WLS	
Location: Horndean Road, Emsworth		Level:		Scale 1:25		Logged By TS	
Client: Metis Homes		Dates: 26-06-2019					

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES		0.20		Brown sandy gravelly silt with grass cover and rootlets. TOPSOIL		
		0.40 0.40	D PP	0.5kg/cm2	0.50		Brown sandy gravelly SILT. Gravel is abundant fine to medium subrounded flint. HEAD DEPOSITS		
		0.70 0.70	D PP	0.5kg/cm2	1.00		Soft brownish orange and light grey sandy CLAY with occasional rootlets. HEAD DEPOSITS		
		1.20 1.20	D PP	1.0kg/cm2			Firm to stiff orangish brown sandy gravelly CLAY with occasional rootlets and roots up to 3mm. Gravel is occasional fine to medium subangular flint. HEAD DEPOSITS	1	
		1.80 1.80	D PP	2.0kg/cm2				2	
		2.10 2.10	D PP	2.0kg/cm2					
		2.60 2.60	D PP	2.0kg/cm2	2.40		Stiff to very stiff orangish brown and grey sandy gravelly CLAY with occasional very fine selenite crystals. Gravel is occasional fine to medium subangular flint and ferruginous inclusions. LONDON CLAY	3	
		3.00 3.10 3.20	PP D PP	3.0kg/cm2 3.2kg/cm2					
		3.40	PP	3.0kg/cm2					
		3.60	D		3.58 3.60		Dark grey fine sandy CLAYSTONE. Hole terminated due to natural obstruction (Claystone). LONDON CLAY End of Borehole at 3.60m	4	
								5	

Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks	
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to		
		2.40	2.40				

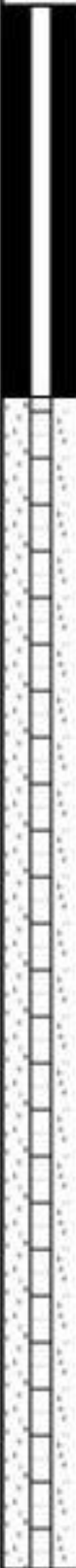
 Unit 7, Danworth Farm Hurstpierpoint BN6 9GL www.gesl.net		Borehole Log				Borehole No. WS04 Sheet 1 of 1	
Project Name: Horndean Road, Emsworth		Project No. GE18313		Co-ords: 474490E - 106807N		Hole Type WLS	
Location: Horndean Road, Emsworth		Level:		Scale 1:25		Logged By TS	
Client: Metis Homes		Dates: 26-06-2019					

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30	ES		0.40		Brown silty sandy gravelly clay with frequent rootlets up to 4 mm. Gravel is frequent fine to medium subangular flint. TOPSOIL		
		0.60	PP	0.8kg/cm2				Soft orangish brown sandy CLAY with rare fine to medium subrounded flint gravel and frequent rootlets up to 3mm. HEAD DEPOSITS	
		0.70	D						
		0.80	PP	1.0kg/cm2					
		1.20	D					Soft to firm orangish brown and grey sandy CLAY with occasional rootlets up to 3mm and fine reddish brown ferruginous inclusions. HEAD DEPOSITS	1
		1.20	PP	1.0kg/cm2					
		1.60	PP	1.2kg/cm2					
		1.90	D						
		2.00	PP	2.0kg/cm2					2
		2.30						Firm orangish brown sandy CLAY with occasional fine reddish brown ferruginous inclusions. HEAD DEPOSITS	
		2.50	D						
		2.50	PP	1.8kg/cm2					
	2.80						Stiff dark grey sandy CLAY with frequent very fine selenite crystals. LONDON CLAY	3	
	3.00	PP	2.0kg/cm2						
	3.20	D							
	3.20	PP	2.0kg/cm2						
	3.60	PP	2.5kg/cm2						
	4.00	D							
	4.00	PP	2.0kg/cm2		4.00		----- End of Borehole at 4.00m -----	4	
								5	

Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to	
		2.33	2.33			



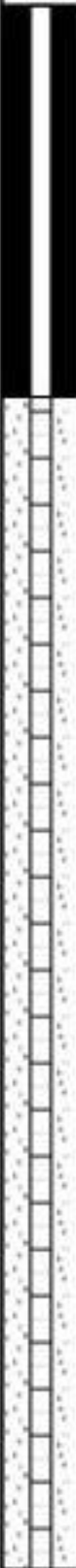
 Unit 7, Danworth Farm Hurstpierpoint BN6 9GL www.gesl.net		Borehole Log			Borehole No. WS05 Sheet 1 of 1	
Project Name: Horndean Road, Emsworth		Project No. GE18313		Co-ords: 474493E - 106766N		Hole Type WLS
Location: Horndean Road, Emsworth		Level:		Scale 1:25		
Client: Metis Homes		Dates: 26-06-2019		Logged By TS		

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES		0.30		Dark brown gravelly silty clay with frequent rootlets and grass cover. Gravel is occasional fine subangular flint. TOPSOIL		
		0.50	D				Soft brown gravelly CLAY. Gravel is occasional fine to coars subangular to subrounded flint. HEAD DEPOSITS		
		0.80	PP	1.0kg/cm2					
		1.20	D		1.00		Firm to stiff orangish brown and light grey sandy CLAY with rare rootlets up to 1mm. Very fine rare selenite crystals. LONDON CLAY	1	
		1.20	PP	1.0kg/cm2					
		1.60	D						
		1.60	PP	1.5kg/cm2					
		1.80	PP	1.0kg/cm2					
		2.00	D						
		2.00	PP	1.5kg/cm2	2.20				2
		2.10	PP	2.5kg/cm2					
		2.40	PP	2.5kg/cm2			Stiff orangish brown and dark grey sandy CLAY with occasional fine reddish brown ferruginous inclusions and frequent very fine selenite crystals. LONDON CLAY		
		2.50	D						
		2.60	PP	2.2kg/cm2					
		2.80	PP	2.8kg/cm2	2.70		Stiff dark grey silty sandy CLAY with frequent very fine selenite crystals. LONDON CLAY		
		3.00	D						3
	3.00	PP	2.2kg/cm2						
	3.20	PP	3.5kg/cm2						
	3.50	D							
	3.60	PP	3.5kg/cm2						
	4.00	D		4.00				4	
	4.00	PP	2.8kg/cm2				End of Borehole at 4.00m		

Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to	
		3.00	2.70			



 Unit 7, Danworth Farm Hurstpierpoint BN6 9GL www.gesl.net		Borehole Log			Borehole No. WS06 Sheet 1 of 1	
Project Name: Horndean Road, Emsworth		Project No. GE18313		Co-ords: 474538E - 106811N		Hole Type WLS
Location: Horndean Road, Emsworth		Level:		Scale 1:25		
Client: Metis Homes		Dates: 26-06-2019		Logged By TS		

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES		0.20		Light brown gravelly sandy silt with frequent rootlets and grass cover. Gravel is occasional subangular flint fragments. TOPSOIL		
		0.40	D				Light brownish grey clayey silty sandy fine to medium subangular flint GRAVEL with occasional rootlets up to 2mm. HEAD DEPOSITS		
		0.60	ES		0.70				
		0.80	D				Very soft to soft orangish brown CLAY with rare rootlets up to 1mm and occasional fine subrounded reddish brown ferruginous inclusions. HEAD DEPOSITS		
		0.80	PP	0.5kg/cm2					
		0.90	PP	0.2kg/cm2	1.00				
		1.10	PP	1.0kg/cm2			Firm light yellowish brown and orangish brown fine sandy gravelly CLAY. Gravel is frequent fine to coarse subangular flint and occasional fine reddish brown ferruginous inclusions. HEAD DEPOSITS	1	
		1.30	PP	1.0kg/cm2					
		1.50	D						
		1.60	PP	1.5kg/cm2					
		1.80	PP	1.2kg/cm2	2.00				
		2.10	PP	2.0kg/cm2			Stiff brown and orangish brown sandy CLAY. Frequent very fine selenite crystals. LONDON CLAY	2	
		2.30	PP	2.0kg/cm2					
		2.50	D						
		2.60	PP	2.5kg/cm2					
		2.80	PP	2.8kg/cm2	3.00				
		3.10	PP	4.0kg/cm2			Very stiff to very stiff grey CLAY with occasional fine sand lenses. Frequent very fine selenite crystals. LONDON CLAY	3	
		3.30	PP	4.0kg/cm2					
	3.50	D							
	3.60	PP	4.5kg/cm2						
	3.80	PP	4.2kg/cm2						
	4.00	PP	4.2kg/cm2	4.00		----- End of Borehole at 4.00m -----	4		
								5	

Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks	
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to		
		5.00	5.00				

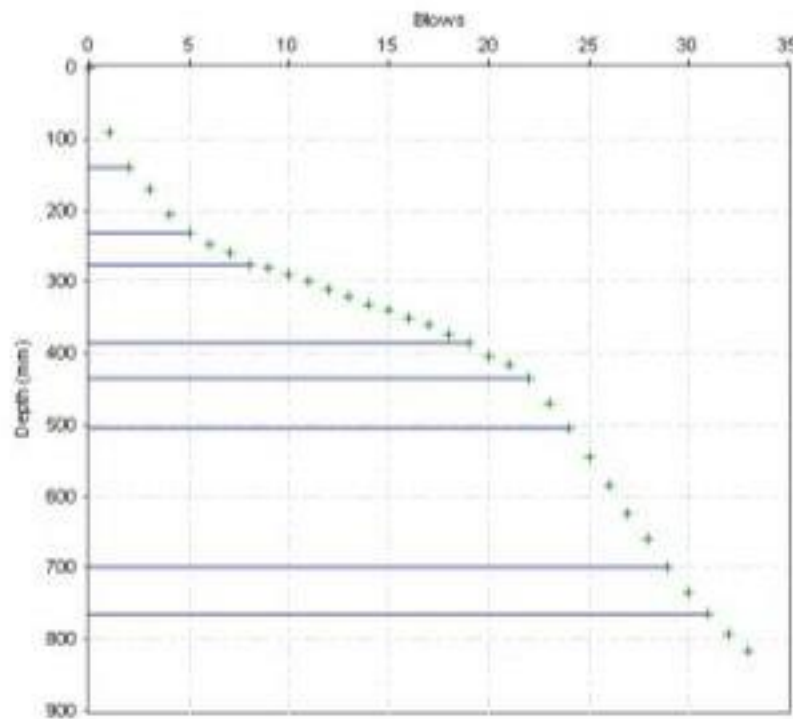
DCP Layer Strength Analysis Report

Project Name: GE18313 Horndean Road - DCP1

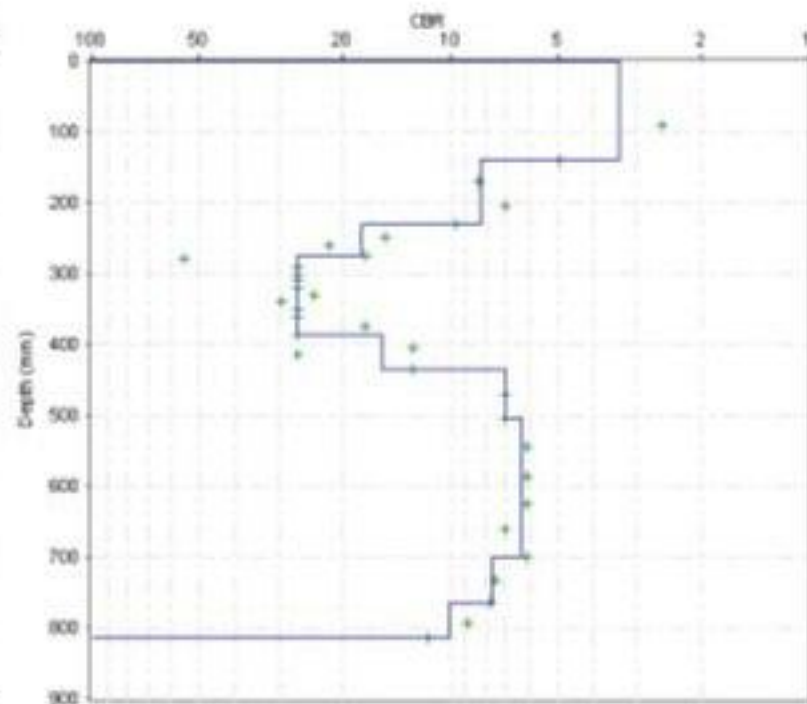
Chainage (km): 0.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 105
 Test Date: 09/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Moderate
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 0.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)
1	70.00	3	140	140
2	30.33	8	91	231
3	14.67	18	44	275
4	10.00	26	110	385
5	16.67	15	50	435
6	35.00	7	70	505
7	39.00	6	195	700
8	32.50	8	65	765
9	25.00	10	50	815

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

Penetration Data Report

Project Name: GE18313 Horndean Road - DCP1

Chainage (km): 0.000

Direction:

Location/Offset: Carriageway

Cone Angle: 60 degrees

Zero Error (mm): 105

Test Date: 09/07/2019

Surface Type:

Unpaved

Thickness (mm):

0

Base Type:

Thickness (mm):

Surface Moisture:

Moderate

Moisture adjustment factor:

Not adjusted

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/blow)	No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/blow)
1	0	0	105	0.00	26	1	25	650	40.00
2	1	1	196	91.00	27	1	26	690	40.00
3	1	2	245	49.00	28	1	27	730	40.00
4	1	3	275	30.00	29	1	28	765	35.00
5	1	4	310	35.00	30	1	29	805	40.00
6	1	5	336	26.00	31	1	30	838	33.00
7	1	6	353	17.00	32	1	31	870	32.00
8	1	7	365	12.00	33	1	32	898	28.00
9	1	8	380	15.00	34	1	33	920	22.00
10	1	9	385	5.00					
11	1	10	395	10.00					
12	1	11	405	10.00					
13	1	12	415	10.00					
14	1	13	425	10.00					
15	1	14	436	11.00					
16	1	15	445	9.00					
17	1	16	455	10.00					
18	1	17	465	10.00					
19	1	18	480	15.00					
20	1	19	490	10.00					
21	1	20	510	20.00					
22	1	21	520	10.00					
23	1	22	540	20.00					
24	1	23	575	35.00					
25	1	24	610	35.00					

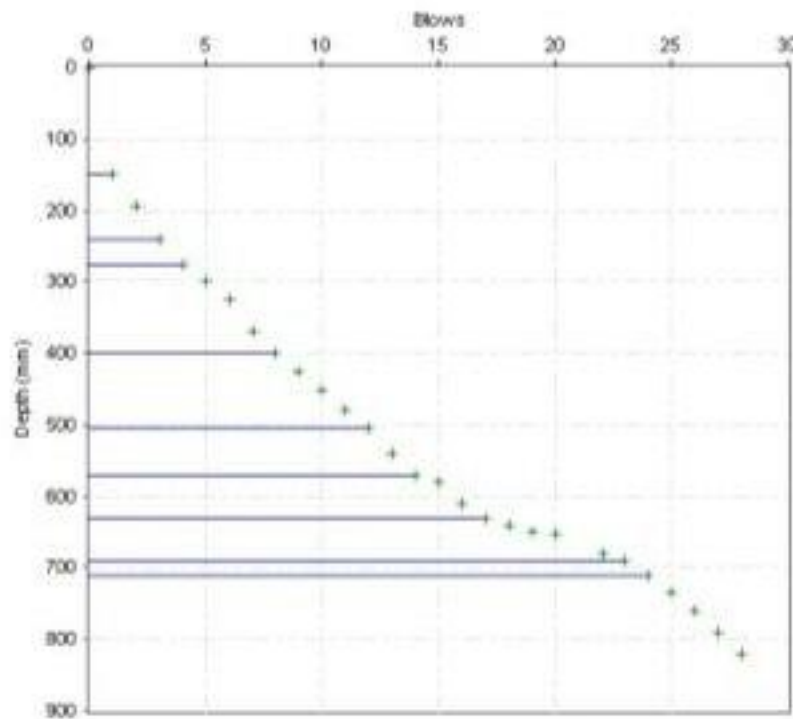
DCP Layer Strength Analysis Report

Project Name: GE18313 Horndean Road - DCP2

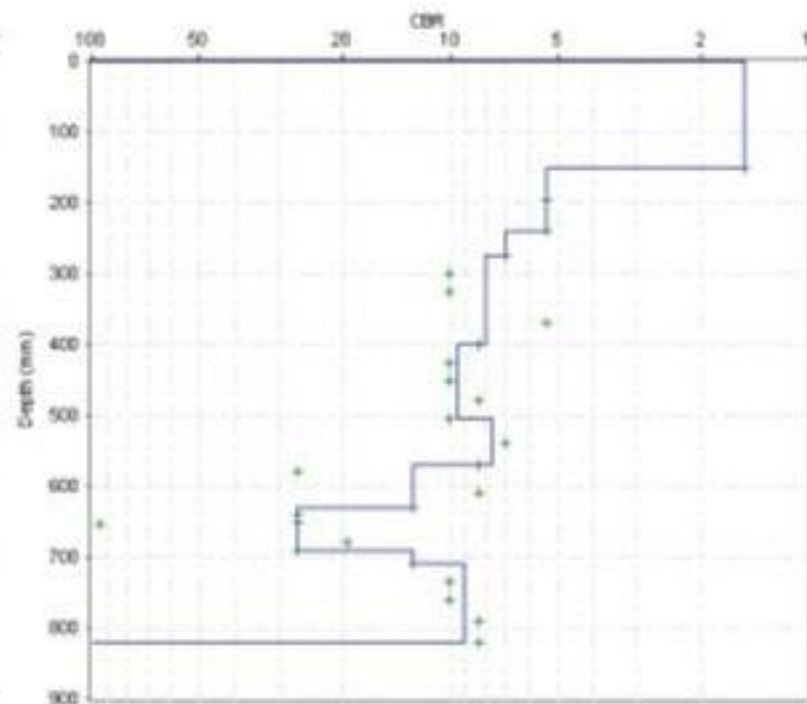
Chainage (km): 0.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 100
 Test Date: 09/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Moderate
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 0.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)
1	150.00	2	150	150
2	45.00	5	90	240
3	35.00	7	35	275
4	31.25	8	125	400
5	26.25	10	105	505
6	32.50	8	65	570
7	20.00	13	60	630
8	10.00	26	60	690
9	20.00	13	20	710
10	27.50	9	110	820

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

Penetration Data Report

Project Name: GE18313 Horndean Road - DCP2

Chainage (km): 0.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 100
 Test Date: 09/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Moderate
 Moisture adjustment factor: Not adjusted

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/blow)	No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/blow)
1	0	0	100	0.00	26	1	26	860	25.00
2	1	1	250	150.00	27	1	27	890	30.00
3	1	2	295	45.00	28	1	28	920	30.00
4	1	3	340	45.00					
5	1	4	375	35.00					
6	1	5	400	25.00					
7	1	6	425	25.00					
8	1	7	470	45.00					
9	1	8	500	30.00					
10	1	9	525	25.00					
11	1	10	550	25.00					
12	1	11	580	30.00					
13	1	12	605	25.00					
14	1	13	640	35.00					
15	1	14	670	30.00					
16	1	15	680	10.00					
17	1	16	710	30.00					
18	1	17	730	20.00					
19	1	18	740	10.00					
20	1	19	750	10.00					
21	1	20	753	3.00					
22	2	22	780	13.50					
23	1	23	790	10.00					
24	1	24	810	20.00					
25	1	25	835	25.00					

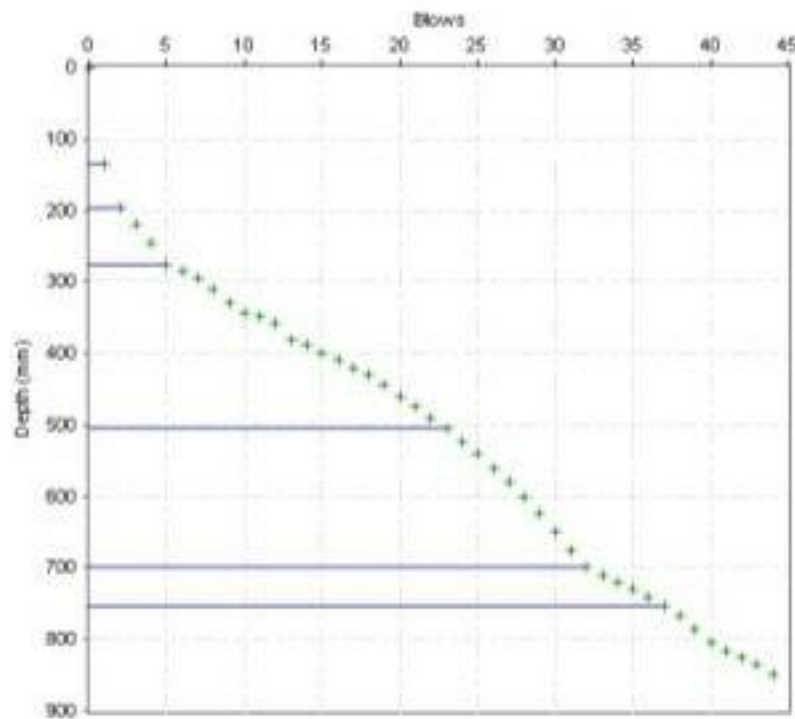
DCP Layer Strength Analysis Report

Project Name: GE18313 Horndean Road - DCP3

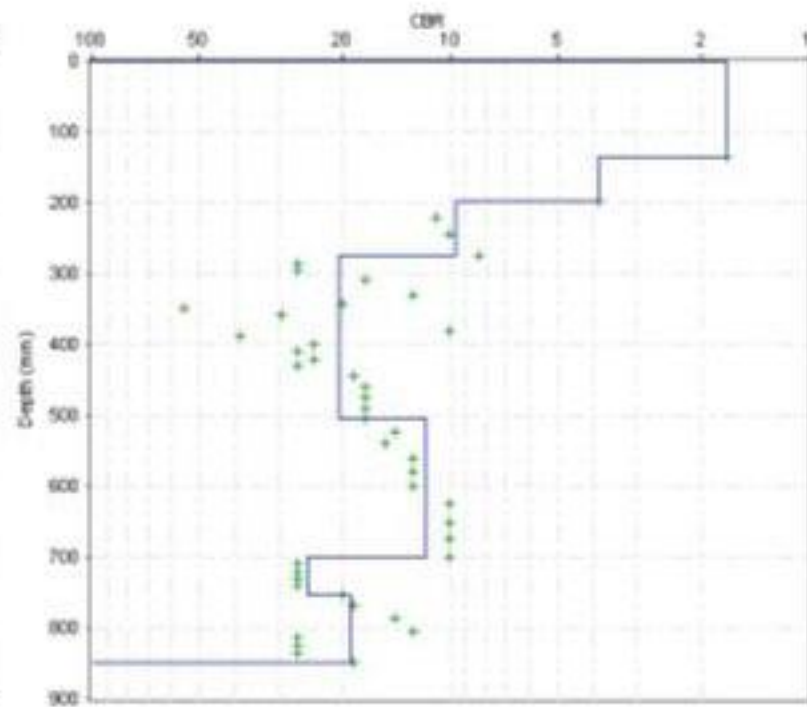
Chainage (km): 0.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 85
 Test Date: 09/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Moderate
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 0.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)
1	135.00	2	135	135
2	62.00	4	62	197
3	26.00	10	78	275
4	12.78	20	230	505
5	21.67	12	195	700
6	10.60	25	53	753
7	13.71	19	96	849

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

Penetration Data Report

Project Name: GE18313 Horndean Road - DCP3

Chainage (km): 0.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 85
 Test Date: 09/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Moderate
 Moisture adjustment factor: Not adjusted

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/blow)	No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/blow)
1	0	0	85	0.00	26	1	25	625	17.00
2	1	1	220	135.00	27	1	26	645	20.00
3	1	2	282	62.00	28	1	27	665	20.00
4	1	3	305	23.00	29	1	28	685	20.00
5	1	4	330	25.00	30	1	29	710	25.00
6	1	5	360	30.00	31	1	30	735	25.00
7	1	6	370	10.00	32	1	31	760	25.00
8	1	7	380	10.00	33	1	32	785	25.00
9	1	8	395	15.00	34	1	33	795	10.00
10	1	9	415	20.00	35	1	34	805	10.00
11	1	10	428	13.00	36	1	35	815	10.00
12	1	11	433	5.00	37	1	36	825	10.00
13	1	12	442	9.00	38	1	37	838	13.00
14	1	13	467	25.00	39	1	38	852	14.00
15	1	14	474	7.00	40	1	39	870	18.00
16	1	15	485	11.00	41	1	40	890	20.00
17	1	16	495	10.00	42	1	41	900	10.00
18	1	17	506	11.00	43	1	42	910	10.00
19	1	18	516	10.00	44	1	43	920	10.00
20	1	19	530	14.00	45	1	44	934	14.00
21	1	20	545	15.00					
22	1	21	560	15.00					
23	1	22	575	15.00					
24	1	23	590	15.00					
25	1	24	608	18.00					

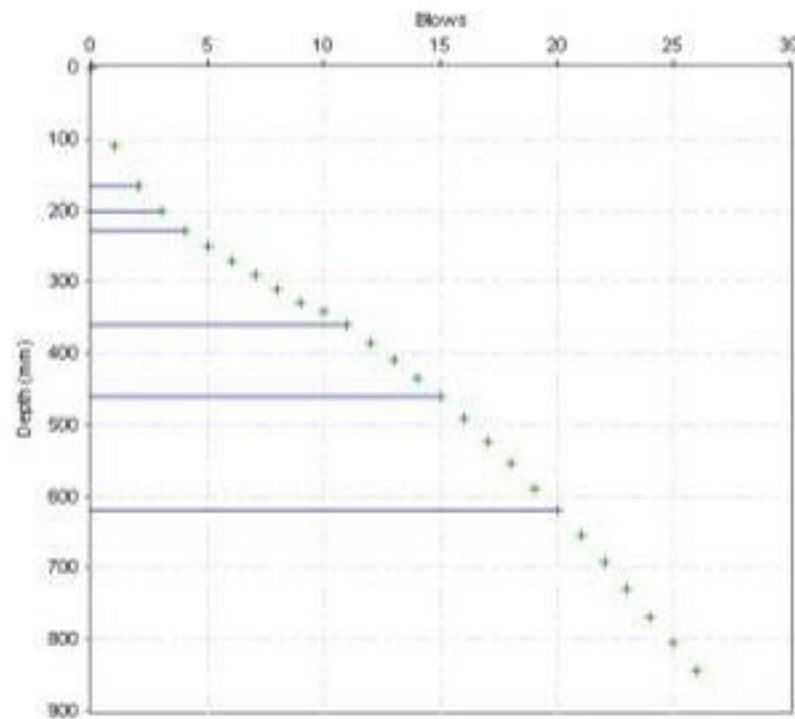
DCP Layer Strength Analysis Report

Project Name: GE18313 Horndean Road - DCP4

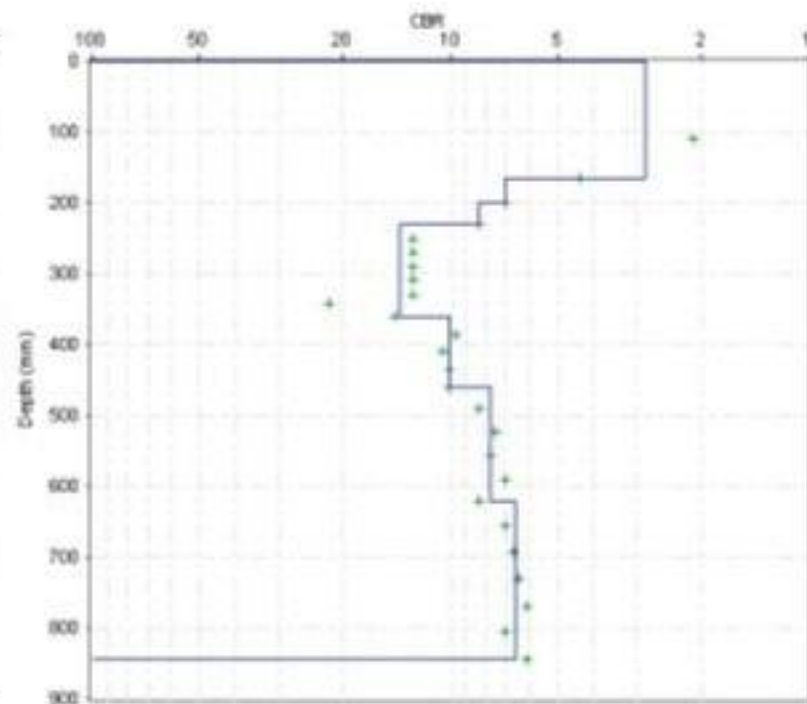
Chainage (km): 0.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 80
 Test Date: 09/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Moderate
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 0.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)
1	82.50	3	165	165
2	35.00	7	35	200
3	30.00	8	30	230
4	18.57	14	130	360
5	25.00	10	100	460
6	32.00	8	160	620
7	37.50	7	225	845

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

Penetration Data Report

Project Name: GE18313 Horndean Road - DCP4

Chainage (km): 0.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 80
 Test Date: 09/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Moderate
 Moisture adjustment factor: Not adjusted

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/blow)	No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/blow)
1	0	0	80	0.00	26	1	25	885	35.00
2	1	1	190	110.00	27	1	26	925	40.00
3	1	2	245	55.00					
4	1	3	280	35.00					
5	1	4	310	30.00					
6	1	5	330	20.00					
7	1	6	350	20.00					
8	1	7	370	20.00					
9	1	8	390	20.00					
10	1	9	410	20.00					
11	1	10	422	12.00					
12	1	11	440	18.00					
13	1	12	466	26.00					
14	1	13	490	24.00					
15	1	14	515	25.00					
16	1	15	540	25.00					
17	1	16	570	30.00					
18	1	17	603	33.00					
19	1	18	635	32.00					
20	1	19	670	35.00					
21	1	20	700	30.00					
22	1	21	735	35.00					
23	1	22	772	37.00					
24	1	23	810	38.00					
25	1	24	850	40.00					

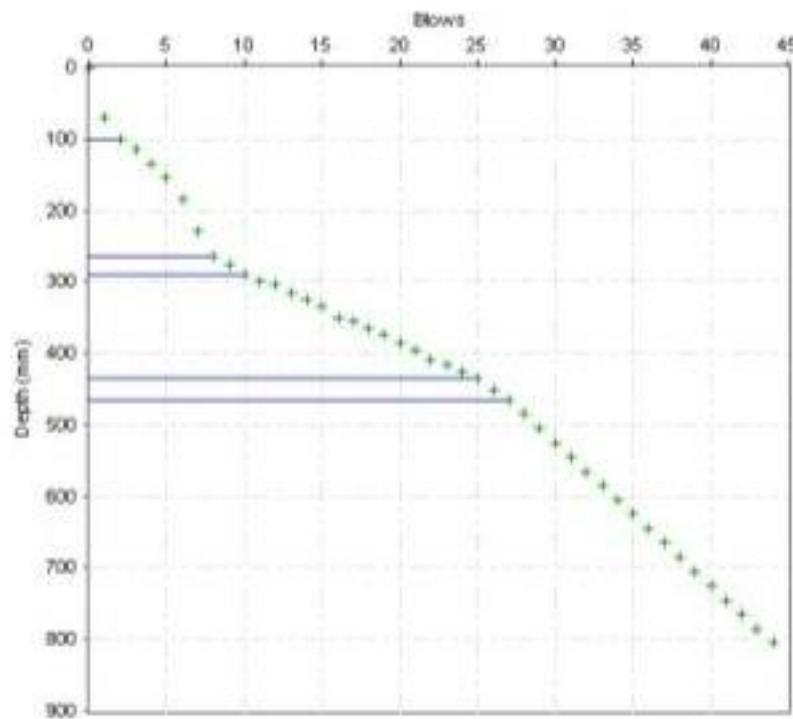
DCP Layer Strength Analysis Report

Project Name: GE18313 Horndean Road - DCP5

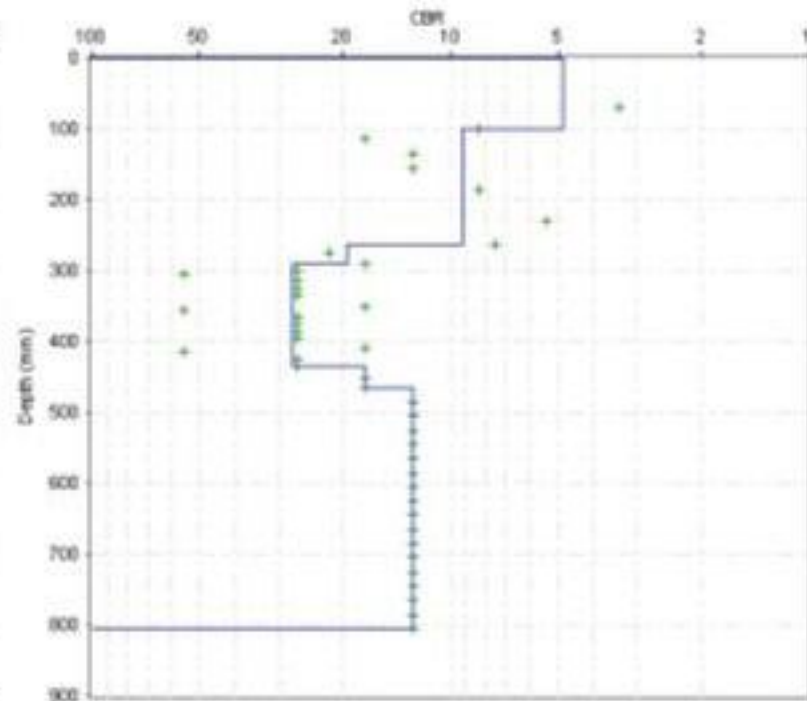
Chainage (km): 0.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 115
 Test Date: 09/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Moderate
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 0.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)
1	50.00	5	100	100
2	27.17	9	163	263
3	13.50	19	27	290
4	9.67	27	145	435
5	15.00	17	30	465
6	20.00	13	340	805

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

Penetration Data Report

Project Name: GE18313 Horndean Road - DCP5

Chainage (km): 0.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 115
 Test Date: 09/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Moderate
 Moisture adjustment factor: Not adjusted

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/blow)	No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/blow)
1	0	0	115	0.00	26	1	25	550	10.00
2	1	1	185	70.00	27	1	26	565	15.00
3	1	2	215	30.00	28	1	27	580	15.00
4	1	3	230	15.00	29	1	28	600	20.00
5	1	4	250	20.00	30	1	29	620	20.00
6	1	5	270	20.00	31	1	30	640	20.00
7	1	6	300	30.00	32	1	31	660	20.00
8	1	7	345	45.00	33	1	32	680	20.00
9	1	8	378	33.00	34	1	33	700	20.00
10	1	9	390	12.00	35	1	34	720	20.00
11	1	10	405	15.00	36	1	35	740	20.00
12	1	11	415	10.00	37	1	36	760	20.00
13	1	12	420	5.00	38	1	37	780	20.00
14	1	13	430	10.00	39	1	38	800	20.00
15	1	14	440	10.00	40	1	39	820	20.00
16	1	15	450	10.00	41	1	40	840	20.00
17	1	16	465	15.00	42	1	41	860	20.00
18	1	17	470	5.00	43	1	42	880	20.00
19	1	18	480	10.00	44	1	43	900	20.00
20	1	19	490	10.00	45	1	44	920	20.00
21	1	20	500	10.00					
22	1	21	510	10.00					
23	1	22	525	15.00					
24	1	23	530	5.00					
25	1	24	540	10.00					



APPENDIX B

Geotechnical Laboratory

Results





Summary of Natural Moisture Content, Liquid Limit and Plastic Limit Results

Job No.	Project Name	Programme	
26742	Horndean Road, Emsworth	Samples received	25/06/2019
Project No.	Client	Schedule received	08/06/2019
GE18313	GESL	Project started	01/07/2019
		Testing Started	11/07/2019

Hole No.	Sample				Soil Description	NMC %	Passing 425µm %	LL %	PL %	PI %	Remarks
	Ref	Top m	Base m	Type							
WS01	2	0.80	-	D	Brown slightly sandy gravelly silty CLAY with occasional rootlets (gravel is fm and sub-angular to sub-rounded)	17	58	37	22	15	
WS02	2	0.60	-	D	Brown slightly sandy silty very gravelly CLAY (gravel is fmc and sub-angular)	16	22	41	23	18	
WS03	3	0.70	-	D	Orangish brown and bluish grey slightly sandy silty CLAY with traces of rootlets	21	100	43	21	22	
WS03	4	1.20	-	D	Orangish brown and bluish grey fine sandy silty CLAY	23					
WS03	5	1.80	-	D	Orangish brown slightly mottled brown and bluish grey slightly gravelly slightly sandy silty CLAY with black flecks (gravel is fm and sub-angular)	26					
WS03	6	2.10	-	D	Orangish brown and brown slightly gravelly slightly sandy silty CLAY (gravel is fm and sub-angular)	24					
WS03	7	2.60	-	D	Orangish brown and brown slightly sandy silty CLAY with dark grey stains	25					
WS03	8	3.10	-	D	Grey slightly orangish brown slightly sandy silty CLAY	21					
WS03	9	3.60	-	D	Grey slightly sandy silty CLAY with pockets of orangish brown silty SAND with mudstone fragments	21					
WS04	2	0.70	-	D	Brown slightly mottled grey slightly sandy silty CLAY with occasional rootlets	35	100	81	29	52	
WS05	2	0.50	-	D	Brown slightly orangish brown slightly sandy silty CLAY with traces of rootlets	37					
WS05	3	1.20	-	D	Brown and bluish grey slightly sandy silty CLAY with chalk nodules and deposits and occasional rootlets	33	99	77	29	48	

 UKAS TESTING 2519	Test Methods: BS1377: Part 2: 1990: Natural Moisture Content : clause 3.2 Atterberg Limits: clause 4.3 and 5.0	Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU Tel: 01923 711 288 Email: James@k4soils.com	Checked and Approved Initials J.P Date: 12/07/2019
	Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R1(b)		



Summary of Natural Moisture Content, Liquid Limit and Plastic Limit Results

Job No. 26742	Project Name Horndean Road, Emsworth	Programme	
		Samples received	25/06/2019
		Schedule received	08/06/2019
Project No. GE18313	Client GESL	Project started	01/07/2019
		Testing Started	11/07/2019

Hole No.	Sample				Soil Description	NMC %	Passing 425µm %	LL %	PL %	PI %	Remarks
	Ref	Top m	Base m	Type							
WS05	4	1.60	-	D	Orangish brown mottled greyish brown and bluish grey slightly sandy silty CLAY	26					
WS05	5	2.00	-	D	Orangish brown mottled greyish brown and bluish grey slightly sandy silty CLAY	28					
WS05	6	2.50	-	D	Orangish brown mottled greyish brown and bluish grey slightly sandy silty CLAY	32					
WS05	7	3.00	-	D	Dark grey slightly sandy silty CLAY	22					
WS05	8	3.50	-	D	Grey slightly sandy silty CLAY with light grey sand pockets	22					
WS05	9	4.00	-	D	Grey slightly sandy silty CLAY with light grey sand pockets	21					
WS06	3	0.80	-	D	Orangish brown and bluish grey slightly sandy silty CLAY with traces of rootlets	23	100	45	21	24	

 UKAS TESTING	Test Methods: BS1377: Part 2: 1990: Natural Moisture Content : clause 3.2 Atterberg Limits: clause 4.3 and 5.0	Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU Tel: 01923 711 288 Email: James@k4soils.com	Checked and Approved Initials J.P Date: 12/07/2019
	2519	Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)	



Sulphate Content (Gravimetric Method) for 2:1 Soil: Water Extract and pH Value - Summary of Results
Tested in accordance with BS1377 : Part 3 : 1990, clause 5.3 and clause 9

Job No.	Project Name	Programme	
26742	Horndean Road, Emsworth	Samples received	25/06/2019
		Schedule received	28/06/2019
Project No.	Client	Project started	01/07/2019
GE18313	GESL	Testing Started	08/07/2019

[illegible]

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved	
Initials	J.P
Date:	12/07/2019

2519

Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

MSF-5-R29



APPENDIX C

Geochemical Laboratory

Results



THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 19-23687

Issue: 1

Date of Issue: 01/07/2019

Contact: Tobias Smith

Customer Details: GESL
Unit 7
Danworth Farm
Hurstpierpoint
West Sussex BN6 9GL

Quotation No: Q19-01488

Order No: 1704

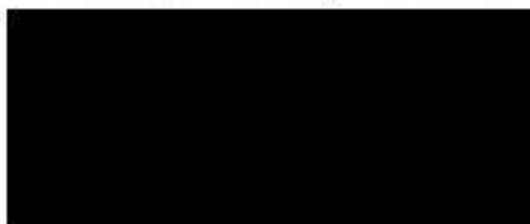
Customer Reference: GE18313

Date Received: 24/06/2019

Date Approved: 01/07/2019

Details: Horndean Road, Emsworth

Approved by:



Mike Varley, Technical Manager

Sample Summary

Report No.: 19-23687, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
177140	WS01 0.20	21/06/2019	26/06/2019	Silty loam	
177141	WS02 0.20	21/06/2019	26/06/2019	Silty loam	
177142	WS03 0.10	21/06/2019	26/06/2019	Silty loam	
177143	WS04 0.30	21/06/2019	26/06/2019	Silty loam	
177144	WS05 0.20	21/06/2019	26/06/2019	Silty loam	
177145	WS06 0.10	21/06/2019	26/06/2019	Silty loam	
177146	HP01 0.20	21/06/2019	26/06/2019		
177147	HP02 0.20	21/06/2019	26/06/2019		
177148	HP03 0.20	21/06/2019	26/06/2019		
177149	WS06 0.60	21/06/2019	26/06/2019		

Results Summary

Report No.: 19-23687, issue number 1

ELAB Reference	177140	177141	177142	177143	177144	177145
Customer Reference						
Sample ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sample Location	WS01	WS02	WS03	WS04	WS05	WS06
Sample Depth (m)	0.20	0.20	0.10	0.30	0.20	0.10
Sampling Date	21/06/2019	21/06/2019	21/06/2019	21/06/2019	21/06/2019	21/06/2019

Determinand	Codes	Units	LOD						
Soil sample preparation parameters									
Material removed	N	%	0.1	24.3	9.8	33.9	< 0.1	< 0.1	< 0.1
Description of Inert material removed	N		0	Stones	Stones	Stones	None	None	None
Metals									
Arsenic	M	mg/kg	1	4.4	5.4	5.8	6.1	11.7	5.5
Barium	U	mg/kg	10	65.3	41.4	38.3	42.9	88.8	36.6
Beryllium	U	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cadmium	M	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Chromium	M	mg/kg	5	15.9	16.7	15.5	17.8	28.0	11.7
Copper	M	mg/kg	5	23.6	9.9	10.6	10.9	15.2	11.2
Lead	M	mg/kg	5	86.3	32.3	24.3	25.5	27.8	26.7
Mercury	M	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Nickel	M	mg/kg	5	8.6	9.1	7.4	9.6	16.8	6.2
Selenium	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium	M	mg/kg	5	17.8	24.1	22.0	26.6	48.5	17.2
Zinc	M	mg/kg	5	126	45.1	32.3	83.7	56.5	30.6
Anions									
Water Soluble Chloride	M	mg/kg	40	< 40	< 40	47	< 40	41	40
Water Soluble Sulphate	M	g/l	0.02	0.02	< 0.02	< 0.02	< 0.02	0.02	< 0.02
Inorganics									
Elemental Sulphur	M	mg/kg	20	< 20	< 20	< 20	< 20	< 20	< 20
Hexavalent Chromium	N	mg/kg	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Total Sulphide	N	mg/kg	2	< 2	< 2	< 2	< 2	< 2	< 2
Total Cyanide	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Acid Soluble Sulphate (SO4)	U	%	0.02	0.04	0.03	0.02	0.03	0.03	0.04
Water Soluble Boron	N	mg/kg	0.5	2.2	0.9	0.6	1.3	1.1	0.7
Miscellaneous									
Acid Neutralisation Capacity	N	mol/kg	0.1	< 0.1	n/t	n/t	n/t	n/t	n/t
Loss On Ignition (450°C)	M	%	0.01	10.7	n/t	n/t	n/t	n/t	n/t
pH	M	pH units	0.1	7.4	5.9	6.0	6.1	6.5	5.6
Total Organic Carbon	N	%	0.01	4.5	2.4	1.5	2.7	1.6	2.5
Phenols									
Total Phenols	N	mg/kg	6	< 6	< 6	< 6	< 6	< 6	< 6
Polyaromatic hydrocarbons									
Naphthalene	M	mg/kg	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	M	mg/kg	0.1	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	M	mg/kg	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	M	mg/kg	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	M	mg/kg	0.1	0.8	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Anthracene	M	mg/kg	0.1	0.4	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	M	mg/kg	0.1	2.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1
Pyrene	M	mg/kg	0.1	1.9	< 0.1	< 0.1	< 0.1	< 0.1	0.1
Benzo(a)anthracene	M	mg/kg	0.1	1.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Chrysene	M	mg/kg	0.1	1.4	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(b)fluoranthene	M	mg/kg	0.1	1.3	< 0.1	< 0.1	< 0.1	< 0.1	0.2
Benzo(k)fluoranthene	M	mg/kg	0.1	1.6	< 0.1	< 0.1	< 0.1	< 0.1	0.2
Benzo(a)pyrene	M	mg/kg	0.1	1.5	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-cd)pyrene	M	mg/kg	0.1	1.0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dibenzo(a,h)anthracene	M	mg/kg	0.1	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo[g,h,i]perylene	M	mg/kg	0.1	0.9	< 0.1	< 0.1	< 0.1	< 0.1	0.2
Total PAH(16)	M	mg/kg	0.4	14.6	< 0.4	0.5	0.5	< 0.4	1.2
Total PAH (Including Coronene)	N	mg/kg	2	15	n/t	n/t	n/t	n/t	n/t

Tests marked N are not UKAS accredited.

Results Summary

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ELAB Reference				177140	177141	177142	177143	177144	177145
Customer Reference									
Sample ID									
Sample Type				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sample Location				WS01	WS02	WS03	WS04	WS05	WS06
Sample Depth (m)				0.20	0.20	0.10	0.30	0.20	0.10
Sampling Date				21/06/2019	21/06/2019	21/06/2019	21/06/2019	21/06/2019	21/06/2019
Determinand	Codes	Units	LOD						
BTEX									
Benzene	M	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Toluene	M	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Ethylbenzene	M	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Xylenes	M	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
MTBE	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Total BTEX	M	mg/kg	0.01	< 0.01	n/t	n/t	n/t	n/t	n/t
TPH CWG									
>C5-C6 Aliphatic	N	mg/kg	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
>C6-C8 Aliphatic	N	mg/kg	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
>C8-C10 Aliphatic	N	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
>C10-C12 Aliphatic	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
>C12-C16 Aliphatic	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
>C16-C21 Aliphatic	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
>C21-C35 Aliphatic	M	mg/kg	1	1.3	1.7	< 1.0	< 1.0	< 1.0	< 1.0
>C35-C40 Aliphatic	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total aliphatic hydrocarbons (>C5 - C40)	N	mg/kg	1	1.3	2.1	< 1.0	< 1.0	< 1.0	< 1.0
>C5-C7 Aromatic	N	mg/kg	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
>C7-C8 Aromatic	N	mg/kg	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
>C8-C10 Aromatic	N	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
>C10-C12 Aromatic	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
>C12-C16 Aromatic	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
>C16-C21 Aromatic	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
>C21-C35 Aromatic	M	mg/kg	1	1.8	3.9	6.1	4.2	< 1.0	3.0
>C35-C40 Aromatic	M	mg/kg	1	1.1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total aromatic hydrocarbons (>C5 - C40)	N	mg/kg	1	3.3	4.7	6.4	4.6	1.0	4.1
Total petroleum hydrocarbons (>C5 - C40)	N	mg/kg	1	4.6	6.8	7.2	4.6	1.0	4.5
Total Petroleum Hydrocarbons									
Mineral Oil	M	mg/kg	5	^ 9	n/t	n/t	n/t	n/t	n/t
PCB (ICES 7 congeners)									
PCB (Total of 7 Congeners)	M	mg/kg	0.03	< 0.03	n/t	n/t	n/t	n/t	n/t
OrganoChlorine Pesticides									
alpha-HCH	M	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
beta_HCH	M	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
gamma-HCH	M	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
delta-HCH	N	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
Heptachlor	N	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
Aldrin	M	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
Heptachlor epoxide	N	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
trans-Chlordane	N	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
alpha cis-Chlordane	N	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
p,p-DDE	M	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
Dieldrin	M	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
Endrin	N	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
p,p-DDD	M	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
Endosulfan II	N	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
Endrin aldehyde	N	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
p,p-DDT	M	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
Endosulphan sulphate	M	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
Methoxychlor	N	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10
Endrin ketone	N	ug/kg	10	n/t	n/t	n/t	< 10	n/t	< 10

Results Summary

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WAC Analysis

Elab Ref:	177140					Landfill Waste Acceptance Criteria Limits*		
Sample Date:	21/06/2019					Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID:	WS01							
Depth (m)	0.2							
Site:	Horndean Road, Emsworth							
Determinand		Code	Units					
Total Organic Carbon		N	%		4.50	3	5	6
Loss on Ignition		M	%		10.7	--	--	10
Total BTEX		M	mg/kg		< 0.01	6	--	--
Total PCBs (7 congeners)		M	mg/kg		< 0.03	1	--	--
TPH Total WAC		M	mg/kg		9	500	--	--
Total (of 17) PAHs		N	mg/kg		15.0	100	--	--
pH		M			7.4	--	>6	--
Acid Neutralisation Capacity		N	mol/kg		< 0.1	--	To evaluate	To evaluate

Eluate Analysis

			10:1	10:1	Limit values for compliance leaching test using BS EN 12457-2 at L/S 10 l/kg		
			mg/l	mg/kg			
Arsenic	N	< 0.005	< 0.05	0.5	2	25	
Barium	N	0.009	0.09	20	100	300	
Cadmium	N	< 0.001	< 0.01	0.04	1	5	
Chromium	N	< 0.005	< 0.05	0.5	10	70	
Copper	N	0.007	0.07	2	50	100	
Mercury	N	< 0.005	< 0.01	0.01	0.2	2	
Molybdenum	N	< 0.005	< 0.05	0.5	10	30	
Nickel	N	0.001	< 0.05	0.4	10	40	
Lead	N	< 0.001	< 0.05	0.5	10	50	
Antimony	N	< 0.005	< 0.05	0.06	0.7	5	
Selenium	N	< 0.005	< 0.05	0.1	0.5	7	
Zinc	N	0.009	0.09	4	50	200	
Chloride	N	< 5	< 50	800	15000	25000	
Fluoride	N	< 5	< 10	10	150	500	
Sulphate	N	3	33.20	1000	20000	50000	
Total Dissolved Solids	N	145	1450.00	4000	60000	100000	
Phenol Index	N	< 0.01	< 0.10	1	-	-	
Dissolved Organic Carbon	N	16.300	163.00	500	800	1000	

Leach Test Information

pH	N	8.1					
Conductivity (uS/cm)	N	216					
Dry mass of test portion (g)		104.000					
Dry Matter (%)		78					
Moisture (%)		28					
Eluent Volume (ml)		972					

Results are expressed on a dry weight basis, after correction for moisture content where applicable

* Stated limits are for guidance only, and not for conformity assessment.

Results Summary

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Asbestos Results

Analytical result only applies to the sample as submitted by the client. Any comments, opinions or interpretations (marked #) in this report are outside UKAS accreditation (Accreditation No2583). They are subjective comments only which must be verified by the client.

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
177140	0.20	WS01	Brown soil with stones,brick,clinker	No asbestos detected	n/t	n/t	n/t	n/t
177141	0.20	WS02	Brown soil with stones	No asbestos detected	n/t	n/t	n/t	n/t
177142	0.10	WS03	Brown soil with stones	No asbestos detected	n/t	n/t	n/t	n/t
177143	0.30	WS04	Brown soil with stones	No asbestos detected	n/t	n/t	n/t	n/t
177144	0.20	WS05	Brown soil with stones	No asbestos detected	n/t	n/t	n/t	n/t
177145	0.10	WS06	Brown soil with stones	No asbestos detected	n/t	n/t	n/t	n/t
177146	0.20	HP01	Brown soil with stones and	No asbestos detected	n/t	n/t	n/t	n/t
177147	0.20	HP02	Brown soil with stones	No asbestos detected	n/t	n/t	n/t	n/t
177148	0.20	HP03	Brown soil with stones	No asbestos detected	n/t	n/t	n/t	n/t

Method Summary

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Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
Sulphide	N	As submitted sample	27/06/2019	109	Colorimetry
Hexavalent chromium	N	As submitted sample	27/06/2019	110	Colorimetry
Acid Soluble Sulphate	U	Air dried sample	28/06/2019	115	Ion Chromatography
Aqua regia extractable metals	M	Air dried sample	27/06/2019	118	ICPMS
Phenols in solids	N	As submitted sample	27/06/2019	121	HPLC
Elemental Sulphur	M	Air dried sample	27/06/2019	122	HPLC
PAH (GC-FID)	M	As submitted sample	27/06/2019	133	GC-FID
Water soluble anions	M	Air dried sample	27/06/2019	172	Ion Chromatography
Organochlorine Pesticides in solids	M	As submitted sample	27/06/2019	173	GC-MS
Low range Aliphatic hydrocarbons soil	N	As submitted sample	27/06/2019	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	27/06/2019	181	GC-MS
Water soluble boron	N	Air dried sample	27/06/2019	202	Colorimetry
Total cyanide	M	As submitted sample	27/06/2019	204	Colorimetry
TPH CWG soil by gc-gc	M	As submitted sample	27/06/2019	214	
Asbestos identification	U	Air dried sample	28/06/2019	PMAN	Microscopy
Leachate					
Arsenic	N		01/07/2019	101	ICPMS
Cadmium	N		01/07/2019	101	ICPMS
Chromium	N		01/07/2019	101	ICPMS
Lead	N		01/07/2019	101	ICPMS
Nickel	N		01/07/2019	101	ICPMS
Copper	N		01/07/2019	101	ICPMS
Zinc	N		01/07/2019	101	ICPMS
Mercury	N		01/07/2019	101	ICPMS
Selenium	N		01/07/2019	101	ICPMS
Antimony	N		01/07/2019	101	ICPMS
Barium	N		01/07/2019	101	ICPMS
Molybdenum	N		01/07/2019	101	ICPMS
pH Value	N		01/07/2019	113	Electrometric
Electrical Conductivity	N		01/07/2019	136	Probe
Dissolved Organic Carbon	N		01/07/2019	102	TOC analyser
Chloride	N		01/07/2019	131	Ion Chromatography
Fluoride	N		01/07/2019	131	Ion Chromatography
Sulphate	N		01/07/2019	131	Ion Chromatography
Total Dissolved Solids	N		01/07/2019	144	Gravimetric
Phenol index	N		01/07/2019	121	HPLC
WAC Solids analysis	N				
pH Value	M	Air dried sample	28/06/2019	113	Electrometric
Total Organic Carbon	N	Air dried sample	28/06/2019	210	IR
Loss on Ignition	M	Air dried sample	01/07/2019	129	Gravimetric
Acid Neutralization Capacity to pH 7	N	Air dried sample	28/06/2019	NEN 737	Electrometric
Total BTEX	M	As submitted sample	27/06/2019	181	GCMS
Mineral Oil	M	As submitted sample	27/06/2019	117	GCFID
Total PCBs (7 congeners)	M	Air dried sample	28/06/2019	120	GCMS
Total PAH (17)	N	As submitted sample	01/07/2019	133	GCFID

Tests marked N are not UKAS accredited

Report Information

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Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis (dried at < 30°C), and are uncorrected for inert material removed.

ELAB are unable to provide an interpretation or opinion on the content of this report.

The results relate only to the sample received.

PCB congener results may include any coeluting PCBs

Uncertainty of measurement for the determinands tested are available upon request

Unless otherwise stated, sample information has been provided by the client

Deviation Codes

a	No date of sampling supplied
b	No time of sampling supplied (Waters Only)
c	Sample not received in appropriate containers
d	Sample not received in cooled condition
e	The container has been incorrectly filled
f	Sample age exceeds stability time (sampling to receipt)
g	Sample age exceeds stability time (sampling to analysis)

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month

All water samples will be retained for 7 days following the date of the test report

Charges may apply to extended sample storage



APPENDIX D

Preliminary UXO Report



Express Preliminary UXO Risk Assessment

Client	Geo-Environmental Services Ltd.
Project	Land at Horndean Road, Emsworth
Site Address	Horndean Road, Emsworth, Hampshire, PO10 7PU
Report Reference	EP9102-00
Date	19/06/19
Originator	OG

Assessment Objective

This preliminary risk assessment is a qualitative screening exercise to assess the likely potential of encountering unexploded ordnance (UXO) at the Land at Horndean Road, Emsworth site. The assessment involves the consideration of the basic factors that affect the potential for UXO to be present at a site as outlined in Stage One of the UXO risk management process.

Background

This assessment uses the sources of information available in-house to 1st Line Defence Ltd to enable the placement of a development site in context with events that may have led to the presence of German air-delivered or Allied military UXO. The report will identify any immediate necessity for risk mitigation or additional research in the form of a Detailed UXO Risk Assessment. It makes use of 1st Line Defence's extensive historical archives, library and unique geo-databases, as well as internet resources, and is researched and compiled by UXO specialists and graduate researchers.

The assessment directly follows CIRIA C681 guidelines "Unexploded Ordnance, a Guide for the Construction Industry". The document will therefore assess the following factors:

- Basic Site Data
- Previous Military Use
- Indicators of potential aerial delivered UXO threat
- Consideration of any Mitigating Factors
- Extent of Proposed Intrusive Works
- Any requirement for Further Work

It should be noted that the vast majority of construction sites in the UK will have a low or negligible risk of encountering UXO and should be able to be screened out at this preliminary stage. The report is meant as a common sense 'first step' in the UXO risk management process. The content of the report and conclusions drawn are based on basic, preliminary research using the information available to 1st Line Defence at the time this report was produced. It should be noted that the only way to entirely negate risk from UXO to a project would be to support the works proposed with appropriate UXO risk mitigation measures. It is rarely possible to state that there is absolutely 'no' risk from UXO to a project.





Risk Assessment Considerations

Site location and description/current use	The site is located in the town of Emsworth, within Hampshire. According to recent aerial photography, it is currently occupied by an area of vegetation, including grassland and trees. A single dilapidated building is present within the site. It is bordered by residential structures facing Horndean Road to the north and east. Additional open vegetated ground is present to the south and west. The site is approximately centred on the OS grid reference: SU 7451006819.	
Are there any indicators of current/historical military activity on/close to the site?	In-house records do not indicate that the site footprint had any former military use. No features such as WWII defensive positions, encampments or firing ranges are recorded to have been located at or in the immediate vicinity of the site. In addition, no information of ordnance being stored, produced, or disposed of within the proposed site boundary could be found. A pillbox is recorded approximately 650m south-east of the site, with The Oaks Camp located approximately 800m north-east. These are not thought likely to have affected the site. The closest recorded Heavy Anti-Aircraft (HAA) battery was situated approximately 2.8km to the north-west of the site. The conditions in which unexploded anti-aircraft ordnance may have fallen unrecorded within the proposed site are analogous to that of aerially delivered Luftwaffe bombs. For a discussion on these conditions, see the relevant sections below.	
What was the pre- and post-WWII history of the site?	According to pre-WWII OS mapping dated 1932, the site was largely occupied by open ground. A small structure is evident within its northern section, along with a small building immediately bordering. Residential structures are evident to the north and north-east of the site adjoining Horndean Road, with a structure labelled <i>Lindens</i> to the east. Post-WWII OS mapping dated 1952-53 suggests little change within the site, as it remains occupied by open ground. The small structure within its northern section is no longer present on this map edition.	
Was the area subject to bombing during WWII?	During WWII, the site was situated within the Havant & Waterloo Urban District. According to Home Office statistics, this borough sustained a low-moderate density of bombing with an average of 35.4 items dropped per 1,000 acres. This consisted of 375 high explosive (HE) bombs, 39 parachute mines, 9 oil bombs, 4 phosphorous bombs, and 1 V-1 pilotless aircraft, culminating in 428 incidents in total. 1st Line Defence does not currently hold any bombing records for the district. As such, it has not been possible to discern whether bombing incidents were recorded within the site boundary or in its immediate area. Online reference has been found to four HE bombs and several incendiaries at Horndean Road and Southleigh Road.¹ As the site was open ground situated immediately adjacent to Horndean Road and to the south of Southleigh Road, the possibility that the site was affected by these incidents cannot be discounted at this stage.	

¹ <http://thespring.co.uk/media/3005/33-childhood-memories-of-havant-in-the-second-world-war-2.pdf>





Is there any evidence of bomb damage on/close to the site?	As the site was predominantly occupied by open ground on pre-WWII OS mapping, signs of change indicative of damage are not possible to discern. However, a small structure within the northern section of the site does appear to be cleared between pre- and post-WWII mapping editions. Due to the size of the structure, it is possible this was due to general development. High-resolution WWII-era aerial photography would be needed in order to assess the wartime composition and condition of the site.
To what degree would the site have been subject to access?	As the majority of the site was occupied by open ground, it is anticipated that access would have been relatively infrequent. The roadway to the east and the adjoining residential structures are considered likely to have increased general monitor of the area, however.
To what degree has the site been developed post-WWII?	Little development has occurred on site post-WWII.
What is the nature and extent of the intrusive works proposed?	The proposed works are understood to include 6No. small diameter window sample boreholes to a maximum depth of 4m below ground level (bgl). The area is understood to be used for residential development.

Summary and Conclusions

During WWII, the site was situated within the Havant & Waterloo Urban District, which was subject to an overall low-moderate density of bombing. 1st Line Defence does not currently hold bombing records for the area in-house, and as such it has not been possible to locate recorded bomb strikes. Anecdotal information suggests four HE bombs and a number of incendiaries fell at Horndean Road and Southleigh Road; the site is situated to the east of Horndean Road and to the south of Southleigh Road.

Due to the nature of the site, it has not been possible to assess signs of change indicative of bomb damage on OS mapping, although a small structure does appear to have been cleared within the northern section of the site between mapping editions. Similarly, it is anticipated that access within the site would have been limited due to the lack of prominent structures, and therefore post-raid checks for evidence of UXO may not have been carried out.

Therefore, whilst the risk on site does not seem to be inherently high at this stage, further research is considered prudent in order to account for the bombing incidents in the vicinity and to understand the wartime composition of the site.

Recommendations

Given the findings of this preliminary report, it is recommended that **further research** be undertaken in the form of a **Detailed UXO Risk Assessment**. This would allow for the acquisition of additional resources such as any local bomb mapping, written incident records and high-resolution WWII-era aerial photography.

Prior to or in lieu of a Detailed Assessment, it is recommended that appropriate UXO Risk Mitigation Measures are provided for intrusive works proposed.

If the client has any anecdotal or empirical evidence of UXO risk on site, please contact 1st Line Defence.

