



Proposed Residential Development, Southleigh Road, Havant

Preliminary Ground Investigation Report and Infiltration Assessment

On behalf of **Bloor Homes Ltd.**

Project Ref: 332310755 | Rev: 00 | Date: July 2024

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Contents

1	Introduction.....	1
1.1	Preamble	1
1.2	Scope and Objective of Work	1
1.3	Limitations	1
2	The Site.....	2
2.1	Site Location and Description	2
2.2	Current Land Use	2
2.3	Site History	2
2.4	Geology	3
	Published Geology	3
2.5	Hydrogeology	4
3	Ground Investigations	6
3.1	Introduction	6
3.2	BGS Historical Records.....	6
3.3	Current Investigation	6
4	Ground Conditions.....	9
4.1	Stratigraphy	9
4.2	Topsoil	10
4.3	Made Ground.....	10
4.4	Aeolian Deposits.....	10
4.5	Head Gravel	11
4.6	Head Deposits	11
4.7	London Clay Formation	12
4.8	Groundwater	12
4.9	Infiltration Testing	13
4.10	Infiltration Assessment	14
5	Geoenvironmental Conditions and Assessment	15
5.1	Introduction	15
5.2	Contamination Assessment Regime	15
5.3	Field and Laboratory Analysis	15
5.4	Visual and Olfactory Evidence of Contamination	16
5.5	Geoenvironmental Assessment	16
5.6	Conclusions	16
	References	17
	Essential Guidance for Report Readers.....	18
	Figures.....	19

Figures

Figure 1	Site Location Plan
Figure 2	Site Layout Plan
Figure 3	Atterberg Limits
Figure 4	Particle Size Distribution

Tables

Table 4.1	Summary of Geological Conditions – 2023 Ground Investigation and BGS Historical Archive Exploratory Holes.....	9
Table 4.2	Summary of Groundwater Monitoring Results	12
Table 4.3	Summary of Infiltration Tests	13

Appendices

Appendix A	Extracts of Relevant BGS Archive Exploratory Holes
Appendix B	Stantec Methodology for Assessment of Land Contamination (England) and Stantec Rationale for Selection of Evaluation Criteria for Generic Quantitative Risk Assessment (England)
Appendix C	Table Summarising Geoenvironmental Laboratory Analysis Results (Soils)

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1 Introduction

1.1 Preamble

- 1.1.1 Stantec UK Ltd (Stantec) has been commissioned by Bloor Homes Ltd. (the Client) to prepare a preliminary Ground Investigation Report (GIR) and infiltration assessment for the proposed residential led development of the parcel of land known as Southleigh Road, Havant (the Site).

1.2 Scope and Objective of Work

- 1.2.1 A preliminary ground investigation was carried out by Endeavour Drilling Ltd (Endeavour) to determine the ground conditions and the infiltration potential of the near surface soils required to assist with the outline design of the surface water drainage strategy for the proposed development of the Site. In addition, some basic geotechnical and geoenvironmental testing were carried out to inform subsequent work that may be required to support a future planning application for the proposed development.
- 1.2.2 The factual results of the investigation including exploratory hole records, infiltration test records and laboratory testing certificates are presented in a separate report prepared by Endeavour (EDL, 2024) which is presented alongside this report. The fieldwork and laboratory testing were carried out under the technical direction of Stantec.
- 1.2.3 This report presents a preliminary assessment of the ground conditions, evaluation of the infiltration test records and commentary on the geotechnical and geoenvironmental testing carried out.

1.3 Limitations

- 1.3.1 Guidance on the context of this report and any general limitations or constraints on its content and usage are given in a separate guidance note included after the text of this report.

2 The Site

2.1 Site Location and Description

- 2.1.1 The Site is situated between the eastern edge of Havant and the western edge of the New Brighton area of Emsworth in Hampshire and is centred at approximate National Grid Reference (NGR) 473785 E, 107155 N, as shown on the Site Location Plan presented as **Figure 1**.
- 2.1.2 The Site occupies an area of approximately 105 ha and predominantly comprises agricultural/open undeveloped land with occasional copses of woodland. The Site can be divided into three parcels, as follows:
- The north-western parcel is irregularly shaped and comprises land between the Site's north-western boundary, Barton Road and Eastleigh Road and is approximately 18 ha in area;
 - The north-eastern parcel is approximately triangular and comprises land between Eastleigh Road in the west, Horndean Road in the east, and Southleigh Road in the south and is approximately 27 ha in area;
 - The southern parcel is irregularly shaped and comprises land between the Site's southern, western and eastern boundaries, and Southleigh Road to the north and is approximately 60 ha in area.

2.2 Current Land Use

- 2.2.1 Current land use within the southern and north-western parcels appears to be agricultural. The land within the north-eastern parcel appears to be parkland associated with Southleigh Park House, a stately home located immediately north of the Site.
- 2.2.2 Current land use surrounding the Site comprises:
- North - woodland, agricultural land, a hospital and Southleigh Park House with associated grounds.
 - East – agricultural land and residential properties forming the New Brighton area of Emsworth.
 - South – agricultural land, the A27 beyond which is open undeveloped land, a railway line (approximately 120 m to the south of the Site) and residential properties on the northern edge of Emsworth.
 - West – agricultural land and residential properties forming the Denvilles area of Havant.
- 2.2.3 The layout of the Site is shown on the Site Layout Plan presented as **Figure 2**.

2.3 Site History

- 2.3.1 This Site history has been compiled with reference to publicly available historical mapping presented on the National Library of Scotland website, alongside historical aerial imagery available within Google Earth and internet searches for relevant historical information.
- 2.3.2 The earliest publicly available historical mapping, dated 1885 – 1900 shows the majority of the Site to be undeveloped (presumed agricultural) land surrounding Leigh Farm. The surrounding land is similarly agricultural, with scattered residential properties, including the properties (possible farm) at

East Leigh adjacent to Eastleigh Road, (off-Site between the north-eastern and north-western parcels). South Leigh, the stately home later named Southleigh Park House, is present to the north of the north-eastern parcel, and the north-eastern parcel appears to be in use as parkland associated with the stately home.

- 2.3.3 Mapping dated 1888 - 1915 and 1892 - 1914 records a small clay pit and brick field adjacent to the south-western corner of the southern parcel and an "old gravel pit" in the north-eastern corner of the north-western parcel. Further gravel pits are recorded off-Site to the north of South Leigh, the nearest being approximately 150 m north of the northern corner of the north-eastern parcel. Several small ponds are recorded within the north-western parcel. The pond on the north-western boundary of the north-western parcel is shown to have a stream flowing southwards from it through the north-western parcel on an approximately north-south alignment, towards East Leigh. A further stream appears to issue from two small ponds adjacent to the woodland in the north-east of the north-western parcel, flowing southwards along the north-western parcel's eastern boundary. Multiple "drains" are recorded within the southern parcel.
- 2.3.4 Subsequent maps do not record any significant changes on-Site, noting that the clay pit and gravel pits are no longer recorded. Modern-day LIDAR imagery indicates that the clay pit does not appear to have been infilled. The gravel pit in the north-eastern corner of the north-western parcel appears to be potentially infilled, possibly during historical re-alignment of Bartons Road.
- 2.3.5 Throughout the second half of the 20th Century and early 21st Century residential developments associated with the neighbouring settlements were constructed in the vicinity of the Site, and the A27 on the Site's southern boundary was constructed in the mid-1980s.
- 2.3.6 In approximately 2017, an area in the south-eastern corner of the southern parcel appears to have been excavated to a lower-level to form a 'water retention area' associated with the adjacent housing development.

2.4 Geology

Published Geology

- 2.4.1 The 1:50 000 scale geological map Sheet 316 Fareham, Solid and Drift (BGS, 1998), and the BGS's archive of historical exploratory hole records have been reviewed for published geological information relevant to the Site and the sheet description (BGS, 2001)

Superficial Deposits

- 2.4.2 The Superficial Deposits are recorded in the area of the site as detailed below starting from the youngest in the geological sequence.

Aeolian Deposits

- 2.4.3 The Aeolian Deposits are the youngest of the Superficial Deposits recorded at the Site, overlying the Head Gravel and Head Deposits across the whole of the southern parcel and the southern thirds of the north-eastern and north-western parcels. According to the BGS the Aeolian Deposits comprise typically fairly homogenous yellow-brown silt or clayey silt locally contains a few flint fragments, particularly near the base and chalk detritus. The deposit is typically recorded between 2.0 and 4.0 m thick.
- 2.4.4 It is noted that the online BGS GeoIndex digital mapping refers to the Aeolian Deposits as River Terrace Deposits. As described below, the nomenclature of the BGS paper map has been adopted in this report.

Head Gravel

- 2.4.5 The Head Gravel overlies the Head Deposits (see below) across the majority of the Site with the exception of the central thirds of the north-eastern and north-western parcels. The Head Gravel is typically described as sheet-like deposit which comprises angular flint gravel in a sandy stiff clay matrix. The deposit is typically recorded between 5 and 7 m thick.
- 2.4.6 The Head Gravel is recorded at the surface along the parts of the northern and eastern boundaries of the southern parcel within minor valley features where the overlying Aeolian Deposits have been eroded.
- 2.4.7 It is noted that the BGS' GeoIndex digital mapping does not differentiate between the Head Gravel and the underlying Head Deposits (see below). As the purpose of this assessment relates principally to the infiltration characteristics of the near-surface soils, which are likely to differ between the Head Deposits and the Head Gravel (differentiated by their gravel content), the nomenclature of the BGS' paper map has been adopted within this report.

Head Deposits

- 2.4.8 The oldest Superficial Deposit at the Site is the Head Deposits. This deposit is covered by the younger Aeolian Deposits and Head Gravel deposits but is understood to have been deposited across the majority of the Site with the exception of the central and northern thirds of the north-eastern and north-western parcels. The Head Deposits are typically described as yellowish-brown, silty, sandy clay with a variable proportion of gravel.

Solid Geology

- 2.4.9 The whole of the Site is shown to be underlain by the London Clay Formation. The London Clay is typically described as blue-grey or grey-brown, silty to very silty clay with occasional layers of sandy clay. The London Clay Formation is typically between approximately 75 m and 120 m thick.
- 2.4.10 The London Clay is indicated to be underlain by approximately 30 m to 35 m thickness of the Lambeth Group, described as "*vertically and laterally variable sequences mainly of clay, some silty or sandy, with some sands and gravels, minor limestones and lignites and occasional sandstone and conglomerate*". Beneath the Lambeth Group, undifferentiated deposits of the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Portsdown Chalk Formation (White Chalk Subgroup) are recorded.

2.5 Hydrogeology

Aquifer Classification

- 2.5.1 DEFRA's Multi Agency Geographic Information for the Countryside (MAGIC) viewer indicates that the superficial River Terrace Deposits are classified by the Environment Agency as a Secondary A Aquifer, described¹ as "*permeable layers that can support local water supplies, and may form an important source of base flow to rivers*".
- 2.5.2 The aquifer designation map appears to be based upon the older BGS paper mapping, with differing aquifer designations for the Head Deposits and Head Gravel:
- The Head Gravel and Aeolian Deposits are classified as Secondary A Aquifers, described by the EA as "*permeable layers that can support local water supplies, and may form an important source of base flow to rivers*"

- The Head Deposits are classified as a Secondary Undifferentiated Aquifer, a classification applied by the EA *“where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type. These have only a minor value”*.

2.5.3 The bedrock geology of the London Clay Formation is classified by the Environment Agency as an Unproductive Stratum (non-aquifer).

Groundwater Source Protection Zones (SPZs)

- 2.5.4 DEFRA's MAGIC viewer indicates that the whole of the north-western parcel and the western edges of the southern and north-eastern parcels are located within a groundwater SPZ Zone 1c. SPZ1c is a sub-class of the SPZ1 defined by the EA as an area within a 50-day travel time between pollutant source and a groundwater abstraction *“where the aquifer is covered by an effective thickness of at least 10m of protective cover and may be affected by deep drilling or other subsurface activities”*.
- 2.5.5 Given the superficial Secondary A Aquifers within the SPZ1c comprise the shallow superficial Aeolian Deposits and Head Gravel, i.e., the aquifer does not benefit from >10 m of effective cover, i.e., cover that is not impacted by features that connect the surface to the aquifer, for example abandoned boreholes, it is assumed that the SPZ1c must relate to a deeper aquifer such as the underlying Lambeth Group or White Chalk Subgroup. In this situation the substantial thickness of London Clay Formation would provide “effective cover”.
- 2.5.6 The EA groundwater protection position statement on sustainable drainage systems (SuDS) (Environment Agency, 2018) states that *“where infiltration SuDS are proposed for anything other than clean roof drainage in a SPZ1, a hydrogeological risk assessment should be undertaken, to ensure that the system does not pose an unacceptable risk to the source of supply”*.
- 2.5.7 Given the intent to utilise infiltration drainage as part of the proposed development it will be necessary to confirm with the Environment Agency whether the above assumption is correct, as if the shallow superficial aquifers are part of the SPZ1c, and the ground conditions are such that infiltration drainage is feasible then additional assessment would be required.

3 Ground Investigations

3.1 Introduction

- 3.1.1 The ground conditions at the Site have been investigated by an intrusive ground investigation to provide preliminary information to inform the design of the proposed drainage solution. The scope of works is summarised in the following section and the factual results of the investigation are presented in a separate report prepared by Endeavour Drilling Ltd. (EDL, 2024) which should be read in conjunction with this report.

3.2 BGS Historical Records

- 3.2.1 The BGS archive of historical exploratory hole records contains numerous records both on-Site and in the near vicinity of the Site, e.g., holes associated with the construction of the A27 immediately south of the Site. A selection of these boreholes have been reviewed and the geology encountered is summarised, alongside the data from the Site-specific ground investigation in **Table 4.1**. Copies of the records reviewed are provided in **Appendix A**.

3.3 Current Investigation

Aim of the Investigation

- 3.3.1 The aim of the investigation was to confirm the ground conditions within the area of Site such that informed decisions on the proposed development of the Site's drainage solution can be made. The principal aims of the investigation were to determine:
- The characteristics of the near-surface soils.
 - The presence and depth of any shallow groundwater in the near-surface soils.
 - The infiltration characteristics of the near-surface soils.
 - The nature of any existing contamination in the ground.

Fieldwork

- 3.3.2 The fieldwork was undertaken between 19th June and 31st July 2023, and comprised the following:
- 9 no. Dynamic sampling boreholes to a maximum depth of 6.0 m below existing ground level with standard penetration testing, the recovery of soil samples and the installation of an observation well in each location.
 - 18 no. Trial pits to a maximum depth of 4.0 m with recovery of disturbed soil samples.
 - Infiltration testing in selected trial pit locations in general accordance with BRE Digest 365.
 - Laboratory testing to determine geotechnical properties and concentrations of potential contaminants of the soils.
 - Visits to Site on six occasions at nominal monthly intervals to measure ground water levels in the observation wells.

- 3.3.3 The dynamic sampling boreholes were drilled using a track-mounted rig to depths ranging from 2.45 m bgl to 6.45 m bgl. Boreholes WS102, WS104, WS105, WS106, WS107, WS108 and WS109 were all terminated before reaching the target depth due to either refusal within the River Terrace Deposits, or due to repeated collapses of the borehole during drilling.
- 3.3.4 50mm Diameter HDPE observation wells were installed in boreholes WS101, and WS103 – WS109 to allow the groundwater levels to be monitored. The boreholes were sealed with bentonite pellets below the base of the response zone between the top of the response zone and ground level. A granular filter pack was installed surrounding the response zone.
- 3.3.5 Trial pits were mechanically excavated using a tracked 8-tonne excavator to depths ranging from 1.90 to 3.80 m bgl. Infiltration testing was undertaken in three pits in general accordance with BRE Digest 365 “Soakaway Design” 2016 within trial pits TP103, TP104 and TP106a to determine the infiltration characteristics of the shallow soils.

Laboratory Testing

- 3.3.6 The laboratory testing programme comprised both geotechnical testing and chemical analyses for use in assessing the soil conditions encountered.

Geotechnical Laboratory Testing

- 3.3.7 A programme of geotechnical laboratory soils testing was carried out to verify the visual identification and classification, and to determine the physical properties of selected samples of the materials encountered. The testing was scheduled by Stantec and carried out in general accordance with BS1377-2 (2022) by i2 Analytical Limited, who hold UKAS accreditation for geotechnical soil testing. The testing undertaken comprised.
- 21 no. liquid limit, plastic limit and plasticity index.
 - 21 no. moisture content.
 - 20 no. particle size distribution (PSD) analyses by wet sieving, of which 18No. were extended by sedimentation by pipette.
 - 12 no. BRE SD1 sulphate test suites.

Geoenvironmental Laboratory Testing

- 3.3.8 A programme of geoenvironmental laboratory testing was undertaken on 14 No. samples of the near-surface soils. The geoenvironmental testing was scheduled by Stantec and undertaken by i2 Analytical Limited who hold UKAS / MCERTS accreditation for the analyses specified. The geoenvironmental laboratory testing undertaken comprised:
- 14 no. metals and metalloids (As, Cd, Cr (total and VI), Cu, Pb, Hg, Ni, Se, Zn, Va).
 - 14 no. petroleum hydrocarbons, C5 – C44 aliphatic / aromatic split.
 - 14 no. polycyclic aromatic hydrocarbons, USEPA16.
 - 14 no. asbestos screen and identification, with asbestos quantification undertaken if asbestos was positively identified.
 - 14 no. pH, soil organic matter (SOM), water soluble sulphate.

Monitoring

- 3.3.9 Monitoring of the observation wells installed within the dynamic sampling boreholes was carried out by EDL during six visits to the Site between August 11th, 2023 and January 16th, 2024. The monitoring results are presented in Appendix F of the factual report (EDL, 2024).

4 Ground Conditions

4.1 Stratigraphy

4.1.1 The ground conditions at the Site, as evidenced by the recent ground investigation and the historical investigation information presented in the BGS archive, are summarised in **Table 4.1** below.

Table 4.1 Summary of Geological Conditions – 2023 Ground Investigation and BGS Historical Archive Exploratory Holes

Stratum	Depth to Top of Strata, m bgl	Thickness, m	Typical Description
Topsoil Encountered in 27 locations during recent GI	Ground level	0.15 to 0.85	Brown to “black” silty, variably sandy and gravelly CLAY with occasional rootlets. Gravel is fine to coarse sub-angular to sub-rounded flint.
Made Ground Encountered in eight locations during recent GI	0.15 to 0.30	0.25 to 0.90	Soft to firm greyish or orangish brown to brown sandy, variably gravelly CLAY, with occasional ceramics and rarely with plastic. Gravel is fine to coarse, subrounded to subangular of flint and occasional brick. TP112 encountered 0.6 m thickness of “concrete gravel”.
Aeolian Deposits Encountered in 17 locations during recent GI	Ground level to 0.70	0.20 to 1.50	Very soft to firm and locally stiff light brown to brown, greyish-brown or orangish-brown, occasionally mottled orange silty CLAY and occasionally slightly gravelly.
Head Gravel Encountered in 15 locations during recent GI	0.20 – 3.40	0.2 to 4.0	Medium dense to dense brown to dark brown and orangish-brown clayey, variably silty and sandy GRAVEL. Gravel is fine to coarse of subangular to subrounded flint. Typically becomes looser and less clayey with depth. Soft to firm, locally stiff greyish to orangish-brown sandy, gravelly CLAY. Gravel is fine to coarse, subangular to subrounded flint. Occasionally interbedded with layers of medium dense light brown clayey silty SAND.
Head Deposits Encountered in 15 locations during recent GI	Ground level to 4.60	0.5 to 3.3 (where full thickness proved)	Typically firm to stiff light brown to greyish-brown, rarely dark red silty, gravelly CLAY. Gravel is fine to medium, angular of flint and chalk, occasionally with cobbles of flint. In one location shown to be directly underlain by Head Deposits, the Head contained “ <i>many gypsum crystals</i> ” (possible selenite) and “ <i>occasional black crystals</i> ”.
London Clay Formation Encountered in 15 locations during recent GI	0.50 to 4.95	Proved to a maximum of 29.3 m thick (base not proved)	Upper 0.5 m to 1.5 m is typically weathered and comprises firm to stiff brown to light brown / mottled orangish-brown silty CLAY with occasional laminations of silt and silty sand. Below the weathered margin, the non-weathered London Clay Formation comprises firm to stiff becoming very stiff and hard with depth grey fissured very silty slightly sandy

Stratum	Depth to Top of Strata, m bgl	Thickness, m	Typical Description
			CLAY with occasional "gypsum" crystals (possible selenite), shell fragments and layers/partings of fine silty sand. Occasional claystones.
Notes: A total of 27 locations were investigated across the site during the 2023 ground investigation			

4.1.2 It should be noted that the Head Deposits and the Head Gravel are derived from the same materials and can be similar in composition. Therefore any separation between the two should be made with caution.

4.1.3 Comments on the properties of the materials encountered are presented in the following sections of this report.

4.2 Topsoil

4.2.1 **Description** Topsoil was encountered in all exploratory holes and extended to depths between 0.15 m and 0.50 m bgl. The topsoil was typically found to comprise greyish brown sandy, occasionally gravelly clay with occasional rootlets.

4.3 Made Ground

4.3.1 **Description** Material described as Made Ground was encountered in TP104, TP105, TP106, TP107, TP109, TP112, WS103 and WS105 as part of the recent investigation. None of the historical on-Site boreholes reviewed encountered Made Ground.

4.3.2 Five of the eight of exploratory holes where Made Ground was encountered were located within the north-eastern parcel. The Made Ground encountered typically comprised material very similar to the natural Head Deposits with limited amounts of anthropogenic material entrained (mostly ceramics) within. TP109 and TP112 both encountered gravel-sized pieces of concrete. The land within this parcel has a long-standing history of use as parkland associated with Southfield Park House, and the Made Ground may therefore relate to historical garden features, paths etc.

4.3.3 Three of the eight exploratory holes where Made Ground was encountered were located within the southern parcel. Similarly to the north-eastern parcel, the Made Ground encountered typically comprised material very similar to the natural Head Deposits with limited amounts of anthropogenic material entrained (mostly ceramics) within. TP105 encountered occasional plastic within the 'Made Ground'. The land within this parcel has a long-standing history of use as agricultural land, and it is considered that the Made Ground represents natural soils within which a limited amount of anthropogenic material which is typical of agricultural soils rather than a discrete layer of Made Ground.

4.3.4 Made Ground was not encountered in the locations investigated in the north-western parcel.

4.4 Aeolian Deposits

4.4.1 **Description** Aeolian deposits were encountered in 17 out of 27 exploratory holes undertaken as part of the recent ground investigation and were also encountered in the majority of historical BGS archive exploratory holes across the Site. These deposits typically comprised very soft to firm and locally stiff light brown to brown, greyish-brown or orangish-brown, occasionally mottled orange silty CLAY and occasionally slightly gravelly.

- 4.4.2 **Classification** Results of the six classification tests undertaken on samples of the Aeolian Deposits are presented on an Atterberg Limits Chart presented as **Figure 3** with measured values of liquid limit and plastic limit between 38 and 47 per cent, and between 18 and 22 per cent respectively, with corresponding values of plasticity index (modified for percentage passing a 425 µm sieve) of between 14 to 28 per cent. This indicates the cohesive material is of medium plasticity. Measured values of moisture content are between 15 and 25 per cent.

4.5 Head Gravel

- 4.5.1 **Description** Head Gravel was encountered in 15 out of 27 exploratory holes undertaken during the recent ground investigation as well as multiple historical BGS archive exploratory holes across the Site, and typically comprised soft to firm, locally stiff greyish to orangish-brown sandy, gravelly CLAY.
- 4.5.2 Within ten exploratory holes as part of the recent ground investigation, and multiple historical BGS archive exploratory holes, layers of typically orangish brown to brown mottled grey, clayey, silty and sandy fine to coarse angular to subrounded GRAVEL of flint were encountered. These layers were encountered at variable depths between 0.4 m and 2.3 m bgl and were between 0.4 m and 1.5 m thick. It is anticipated that these represent individual discrete lenses of gravel, rather than a laterally extensive gravel layer.
- 4.5.3 **Classification** Results of the four classification tests undertaken on samples of the Head Gravel are presented on an Atterberg Limits Chart presented as **Figure 3** with measured values of liquid limit and plastic limit between 48 and 71 per cent, and between 20 and 28 per cent respectively, with corresponding values of plasticity index (modified for percentage passing a 425 µm sieve) of between typically of 8 to 21 per cent. This indicates that the gravelly clay material is of medium to very high plasticity. Measured values of moisture content are between 12 and 18 per cent.
- 4.5.4 **Material Properties** Results of 15 no. particle size distribution analyses show a cobble size fraction between 0 and 15 percent, a gravel size fraction of between 16 and 85 per cent, a sand size fraction of between 1 and 20 per cent and a fines fraction of between 2 and 64 per cent. Where additional particle size distribution analysis was undertaken by hydrometer (13 no. samples) the analyses show a silt fraction between 4 and 31 per cent and a clay fraction of between 8 and 35 per cent. These results are summarised on the PSD chart presented as **Figure 4**.

4.6 Head Deposits

- 4.6.1 **Description** Head Deposits were encountered in 15 out of 27 exploratory holes undertaken during the recent ground investigation as well as multiple historical BGS archive exploratory holes across the Site, and typically comprised firm to stiff light brown to greyish-brown, rarely dark red silty, gravelly CLAY. Gravel is fine to medium, angular of flint and chalk.
- 4.6.2 **Classification** Results of the 7 no. classification tests undertaken on samples of the Head Deposits are presented on an Atterberg Limits Chart presented on **Figure 3** with measured values of liquid limit and plastic limit between 32 and 49 per cent, and between 17 and 21 per cent respectively, with corresponding values of plasticity index (modified for percentage passing a 425 µm sieve) of between typically of 11 to 30 per cent. This indicates the cohesive material is of low to medium plasticity. Measured values of moisture content are between 21 and 32 per cent.
- 4.6.3 **Material Properties** Results of 4 no. particle size distribution analyses show a gravel size fraction of between 2 and 25 per cent, a sand size fraction of between 9 and 24 per cent a silt fraction of between 16 and 37 per cent and a clay fraction of between 34 and 52 per cent. These results are summarised on the PSD chart presented as **Figure 4**.

4.7 London Clay Formation

- 4.7.1 **Description** The London Clay Formation was encountered in all exploratory holes where the full thickness of the superficial deposits was proved during the recent and historical investigations and was typically found to comprise an upper 0.5 m to 1.5 m thick weathered margin of firm to stiff brown to light brown / mottled orangish-brown silty CLAY with occasional laminations of silt and silty sand. Beneath the weathered margin, the non-weathered London Clay Formation comprises firm to stiff becoming very stiff and hard with depth grey fissured very silty slightly sandy CLAY.
- 4.7.2 **Classification** Results of the four classification tests undertaken on samples of the London Clay Formation are presented on an Atterberg Limits Chart presented on **Figure 3** with measured values of liquid limit and plastic limit between 34 to 67 per cent, and between 20 to 27 per cent respectively, with corresponding values of plasticity index (modified for percentage passing a 425 µm sieve) of 13.6 to 44 per cent. This indicates the London Clay Formation is typically a high plasticity clay, with one result indicating a low plasticity. Measured values of moisture content are between 24 and 30 per cent.
- 4.7.3 **Material Properties** Results of a single particle size distribution analysis record a sand size fraction of 6 per cent, a silt size fraction of 46 per cent and a clay size fraction of 48 per cent. These results are summarised on the PSD chart presented as **Figure 4**.

4.8 Groundwater

- 4.8.1 **Groundwater Entries** During the recent ground investigation, groundwater was struck between 2.0 and 4.0 m bgl, rising to between 1.0 and 3.7 m bgl. Groundwater strikes occurred within the Head Deposits as well as within predominantly granular Head Gravel. Two water strikes were recorded within the London Clay Formation.
- 4.8.2 **Groundwater Levels** Following completion of the ground investigation groundwater levels were measured in the standpipes installed on six occasions at approximately monthly intervals between August 2023 and January 2024. A summary of groundwater levels is presented in the table below.

Table 4.2 Summary of Groundwater Monitoring Results

Borehole ID	Ground Level m OD	Base of Installation, m bgl (m OD)	Screened Within	Groundwater Level, m bgl (mAOD)		Comments
				Minimum	Maximum	
WS101	25.92	6.00 (19.92)	London Clay Formation	0.72 (25.20)	4.00 (21.92)	Between Nov '23 and Jan '24 groundwater appears to have settled between 0.72 and 0.84 m bgl.
WS103	14.56	4.00 (10.56)	Head Gravel and Head Deposits	0.38 (14.18)	2.30 (12.26)	Between Nov '23 and Jan '24 groundwater appears to have settled between 0.38 and 0.43 m bgl.
WS104	12.20	3.00 (9.20)	Head Gravel and Head Deposits	0.02	Dry	Between Nov '23 and Jan '24 groundwater appears to have settled between 0.16 and 0.02 m bgl. Possible seal failure leading to borehole filling up.
WS105	12.91	1.80 (11.11)	Aeolian Deposits and Head Deposits	0.16 (12.75)	1.05 (11.86)	Between Nov '23 and Jan '24 groundwater appears to

Borehole ID	Ground Level m OD	Base of Installation, m bgl (m OD)	Screened Within	Groundwater Level, m bgl (mAOD)		Comments
				Minimum	Maximum	
						have settled between 0.16 and 0.35 m bgl.
WS106	12.28	4.00 (8.28)	Aeolian Deposits, Head Gravel and Head Deposits	1.33 (10.95)	2.70 (9.58)	Between Nov '23 and Jan '24 groundwater appears to have settled between 1.33 and 1.59 m bgl.
WS107	13.36	3.50 (9.86)	Aeolian Deposits and Head Gravel	0.30 (13.06)	2.00 (11.36)	Water level remains variable
WS108	10.16	3.30 (6.86)	Head Deposits and London Clay Formation	0.70 (9.46)	2.61 (7.55)	Between Nov '23 and Jan '24 groundwater appears to have settled between 0.70 and 0.94 m bgl.
WS109	10.82	2.50 (8.32)	Head Gravel and Head Deposits	0.41 (10.42)	2.18 (8.64)	Between Nov '23 and Jan '24 groundwater appears to have settled between 0.41 and 0.51 m bgl.

- 4.8.3 A review of the table above, and the groundwater strikes during drilling suggests that the groundwater level beneath the Site varies seasonally between approximately 3.0 m and 2.0 m bgl in the summer months, rising to within 0.5 m bgl in winter months.

4.9 Infiltration Testing

- 4.9.1 Infiltration tests were carried out in three selected trial pits where the ground conditions were observed to be more favourable for shallow infiltration comprising sand and or gravel. A summary of the infiltration testing is summarised in the table below:

Table 4.1 Summary of Infiltration Tests

Exploratory Hole	Test Section (m)	Strata Tested	Infiltration Rate (m/s)	Comments
TP103	1.80 to 1.90	Head Gravel (clayey, slightly sandy GRAVEL).	$> 1 \times 10^{-4}$ (estimate)	Infiltration rate was very fast – unable to maintain head of water to complete test. Approximately 1,100 L bowser was emptied over approximately 180 seconds.
TP104	2.80 to 1.74	Head Gravel Deposits (sandy GRAVEL and slightly sandy, slightly gravelly CLAY).	$< 1 \times 10^{-9}$ (estimate)	Infiltration rate was very low. Water level dropped by only 0.01 m over 4-hour period.

Exploratory Hole	Test Section (m)	Strata Tested	Infiltration Rate (m/s)	Comments
TP106	2.30 to 1.15	Head Deposits (stiff slightly sandy to sandy CLAY)	$< 1 \times 10^{-9}$ (estimate)	Infiltration rate was very low. Water level dropped by only 0.04 m over 1.5 hours period.

- 4.9.2 The infiltration rates provided in the table above are conservative estimates based upon professional judgement as none of the three tests undertaken were able to be completed. In TP103 the infiltration rate was too fast to allow a test to be undertaken, whereas in TP104 and TP106 the infiltration rate was too slow for the test to be concluded.

4.10 Infiltration Assessment

- 4.10.1 The ground conditions encountered comprise a typically less than 0.5 m thickness of topsoil and subsoil overlying (where present) up to 1.5 m thickness of predominantly cohesive Aeolian Deposits. Beneath the Aeolian Deposits a variable thickness (where present) of between 0.2 m and 4.0 m of predominantly granular Head Gravel Deposits were encountered, overlying between 0.5 m and 3.3 m of predominantly cohesive Head Deposits. Beneath the Head Deposits, bedrock of the London Clay Formation is present.
- 4.10.2 It is evident that the ground conditions at the Site are predominantly cohesive, with the exception of the Head Gravel, which is of variable thickness and was encountered in only approximately half of the exploratory holes during the recent investigation.
- 4.10.3 Infiltration testing was carried out in the selected locations and indicated that in general the ground conditions are not favourable for the used of shallow infiltration testing.
- 4.10.4 Furthermore, CIRIA report 735 (C735) "The SuDS Manual" provides guidance relating to the design of infiltration drainage systems and states that for discharges to groundwater "*there should be a minimum depth of 1 m of unsaturated aquifer material between the base of any infiltration system and the maximum likely groundwater level (taking account of potential shifts in groundwater level resulting from extended periods of wet weather)*". The winter (maximum likely) groundwater level recorded at the Site is within 0.5 m of the surface meaning that there is not 1.0 m of unsaturated aquifer into which infiltration drainage could drain. On this basis, it is anticipated that the use of infiltration drainage will not be possible.
- 4.10.5 Overall it is considered that shallow infiltration is not suitable for the ground and groundwater conditions at the site.

5 Geoenvironmental Conditions and Assessment

5.1 Introduction

- 5.1.1 The results of the geoenvironmental laboratory testing undertaken on the samples of soil recovered during the recent ground investigation have been compared to current published generic assessment criteria (GAC) to screen the data in accordance with guidance given in the Environment Agency's Land Contamination Risk Management (LCRM) guidance, which refers to this as Tier 2 of the Stage 1 Risk Assessment and identify potential hazards to the plausible receptors.
- 5.1.2 If the concentration of a given parameter is below the criterion for the specified end-use the parameter is not deemed to be a hazard. Exceedance of the criterion indicates that the parameter is a possible hazard but does not indicate that a site is statutorily contaminated and/or unsuitable for a particular use in a planning context. These criteria are used to identify situations where further assessment and/or action may be required.
- 5.1.3 Our guide entitled Rationale for Selection of Criteria Used in Tier 2 (Generic) Risk Assessment (England) that includes further details of the evaluation criteria is presented in **Appendix B**.

5.2 Contamination Assessment Regime

- 5.2.1 The Generic Assessment Criteria (GAC) for a residential (with home-grown produce), residential (without home-grown produce) and public open space in the near vicinity of residential properties were selected, as these land-uses are considered the most representative given the proposed residential use of the Site.
- 5.2.2 Where the GAC are dependent upon Soil Organic Matter (SOM) the GAC for 1% SOM have been used on the basis that the SOM of the on-Site soils varies between 0.4 % and 3.6%. A lower SOM is considered to be more conservative.
- 5.2.3 The GAC selected were the Category 4 Screening Levels (C4SL) for a commercial / industrial end use, prepared under the auspices of Defra (CL:AIRE, 2014, 2021, 2024). Where a C4SL is not available, the Suitable for Use Values (S4ULs) (Nathanail et al, 2015) have been used. There are no S4UL or C4SL for total and free cyanide, therefore the GAC published by the Society of Brownfield Risk Assessment (SoBRA) for free cyanide (SoBRA, 2020) has been utilised as the screening value noting that only the SOBRA GAC (SoBRA, 2020) are for short term exposure where short term is defined as exposure that is (1) irregular (not repeated) and (2) of less than 24-hours duration.
- 5.2.4 The additive effect of the hydrocarbon fractions is considered by calculating a hazard quotient for each carbon banding which is the concentration divided by the fraction S4UL criterion for the selected land use. The hazard quotients are added together to give a Hazard Index for each sample assessed. A Hazard Index that exceeds unity can be indicative of a potentially significant human health hazard.

5.3 Field and Laboratory Analysis

Geoenvironmental Laboratory Testing

- 5.3.1 Geoenvironmental laboratory testing was carried out on 14 no. samples of soil for a range of metals, metalloids and inorganic compounds, together with speciated determination of carbon banding carbon banding of petroleum hydrocarbons (TPH) and speciated determination of polynuclear aromatic hydrocarbons (PAH). All 14 no. soil samples were submitted for an asbestos screen and identification, with asbestos quantification to be undertaken should asbestos be positively identified.

- 5.3.2 Full results of the geoenvironmental laboratory analyses are presented in the factual report of the ground investigation (EDL, 2024)

5.4 Visual and Olfactory Evidence of Contamination

- 5.4.1 Visual and olfactory evidence of contamination was not encountered during the recent ground investigation.

5.5 Geoenvironmental Assessment

- 5.5.1 A table summarising the results of the geoenvironmental laboratory analyses and highlighting exceedances of the chosen assessment criteria is presented in **Appendix C**.
- 5.5.2 **Comparison with Generic Assessment Criteria** The measured concentrations of potential contaminants, as summarised in **Appendix C**, are all below the selected assessment values appropriate for residential (with and without home-grown produce) and residential public open space end-uses with the exception of a single sample of topsoil in TP107 at 0.1 m bgl within which slightly elevated (versus the residential, with and without home-grown produce thresholds) concentrations of benzo(b)fluoranthene, benzo(a)pyrene and dibenzo(a,h)anthracene were recorded. Asbestos was not detected in any of the 14 samples analysed.
- 5.5.3 A review of the exploratory hole log for TP107 indicates that the topsoil comprises “*soft to firm brown slightly sandy slightly gravelly silty clay... gravel is fine to coarse flint and brick*”. Hydrocarbon odours or evidence of hydrocarbon staining were not encountered at this location.

5.6 Conclusions

- 5.6.1 The preliminary assessment undertaken indicates that the on-Site soils are generally suitable for use in a residential end-use.
- 5.6.2 Slightly elevated concentrations of PAHs were encountered within the topsoil in TP107, in the centre of the southern parcel. Given this parcel’s longstanding history of agricultural use and the absence of any obvious source of PAHs there is potential that these marginally elevated PAHs could relate to naturally occurring humic material in the topsoil. It is recommended that as part of future ground investigation to inform the detailed design of the scheme, additional soil sampling and laboratory analysis including a florisil (or similar) cleanup to remove natural humic material prior to analysis should be undertaken to delineate the presence / extent of any potential localised PAH hotspot.

References

BGS (1999) Geology of the Fareham and Portsmouth district. Sheet description for the British Geological Survey 1:50 000 Series Sheet 316 and the mainland portion of Sheet 331 (England and Wales)

BGS (1998) 1:50,000 scale Solid and Drift Sheet 316: Fareham

BGS (2001) Geology of the Fareham and Portsmouth district: sheet description for the British Geological Survey 1:50000 series sheet 316 and the mainland portion of sheet 331 (England and Wales).

BSI (2007) BS EN 1997-2 Eurocode 7 - Geotechnical design - Part 2: Ground investigation and testing

BSI (2022) BS 1377-2:2022 Methods of test for soils for civil engineering purposes - Classification tests and determination of geotechnical properties

Endeavour Drilling (2024) Factual Report on Ground Investigation. Report Ref: END23-058, version 2
January 2024

Buildings Research Establishment (2003) BRE Digest 365 – Soakaway Design

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Figures



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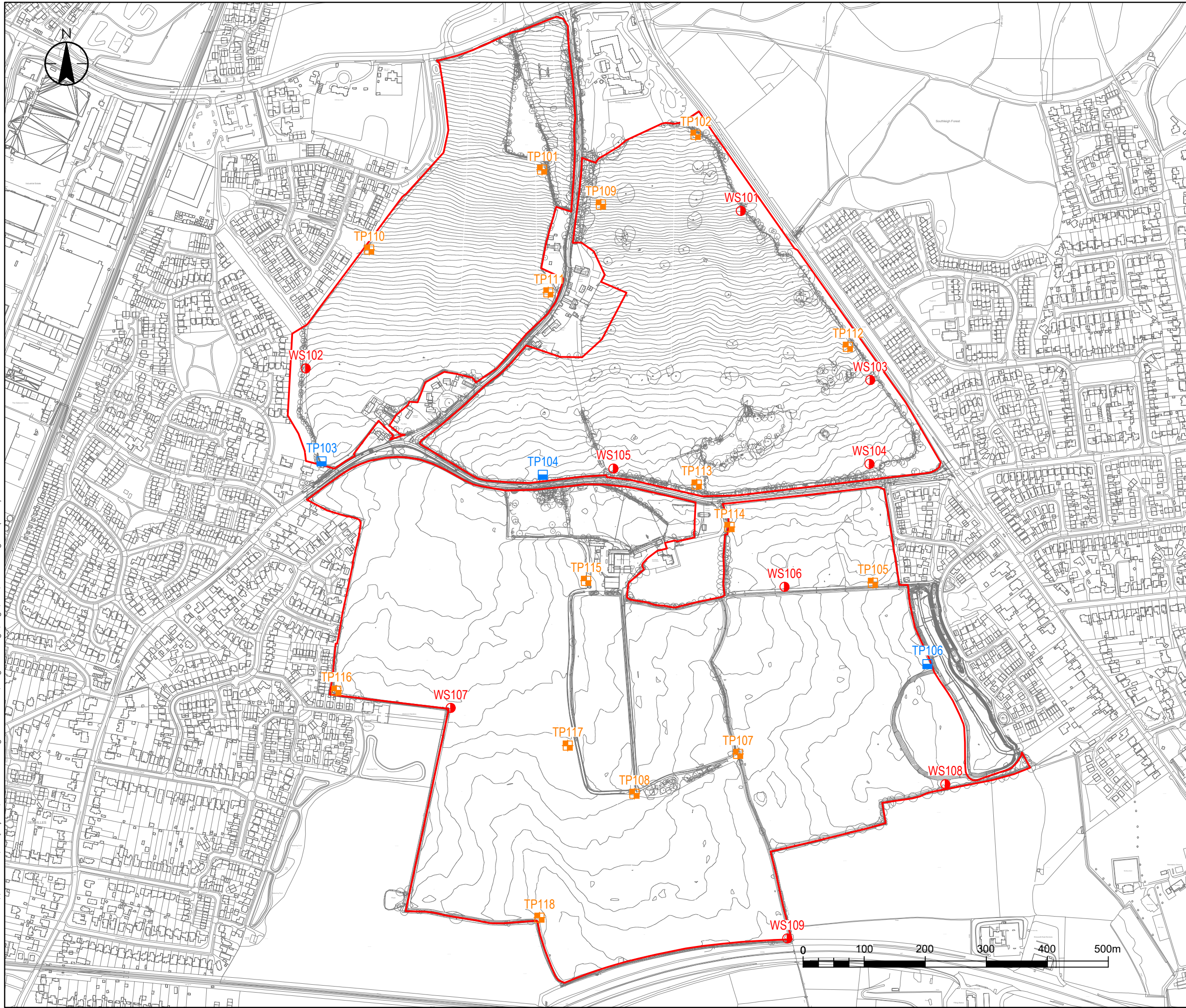
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 2023.04.13

Title
Site Location Plan

Revision:
 0

Figure

Plotted: 23.04.2024 04.23:37:35 PM By: Cotton, David
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Key

- Approximate Site Boundary
- Window Sample Borehole Location
- Trial Pit Location
- Trial Pit and Soakaway Testing

Base mapping source:
Topographical survey conducted by
Siteline, Drawing no 01SQ01, dated Mar
- June 2023 with note that OS mapping
data was supplied by client.

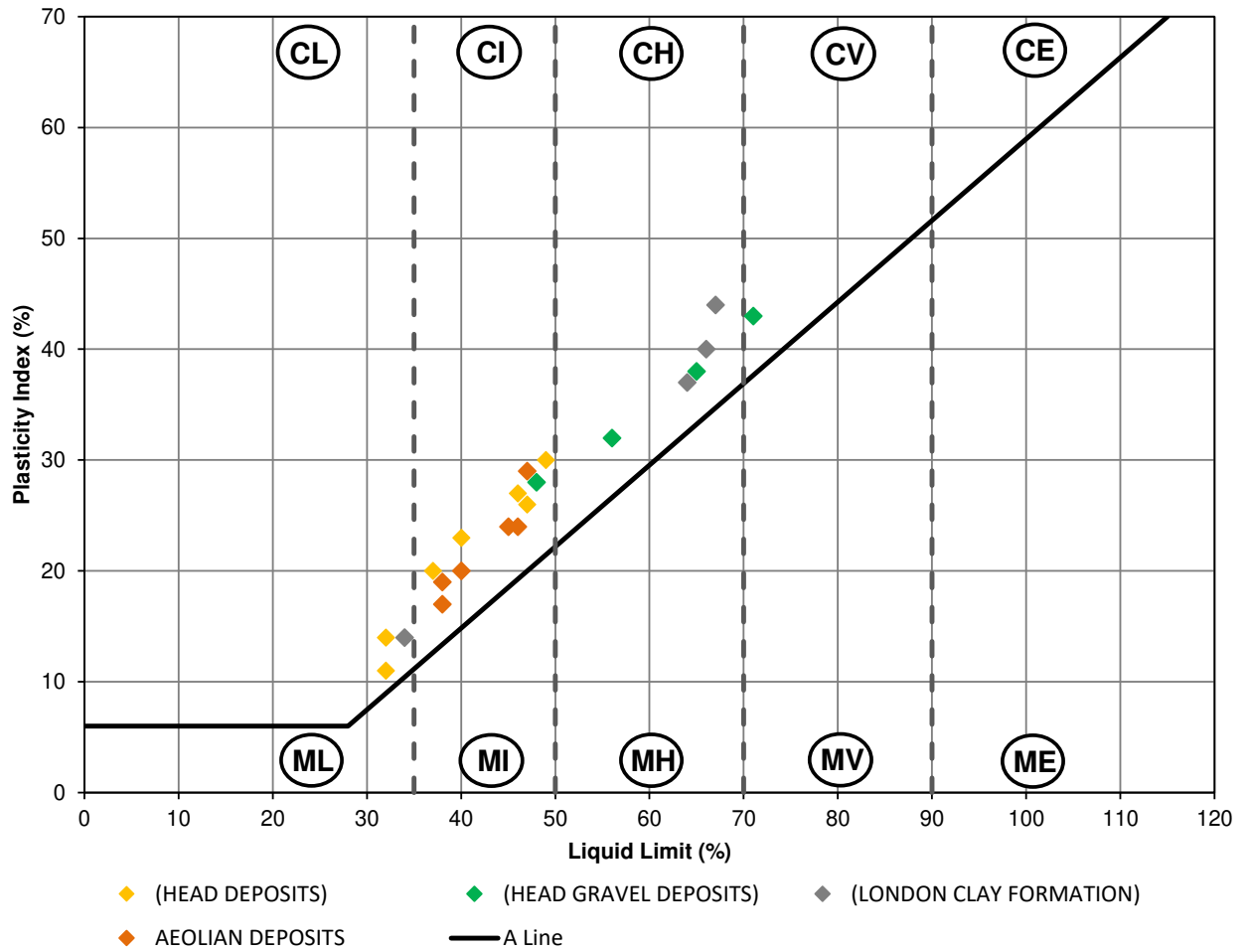
Client/Project:
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Havant

Prepared:	Checked:	Date:
davco	ZM	2023.12.15

Title
Site Layout Plan

Revision:	Figure
0	2



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Date:
May 2021

Title

Atterberg Limits

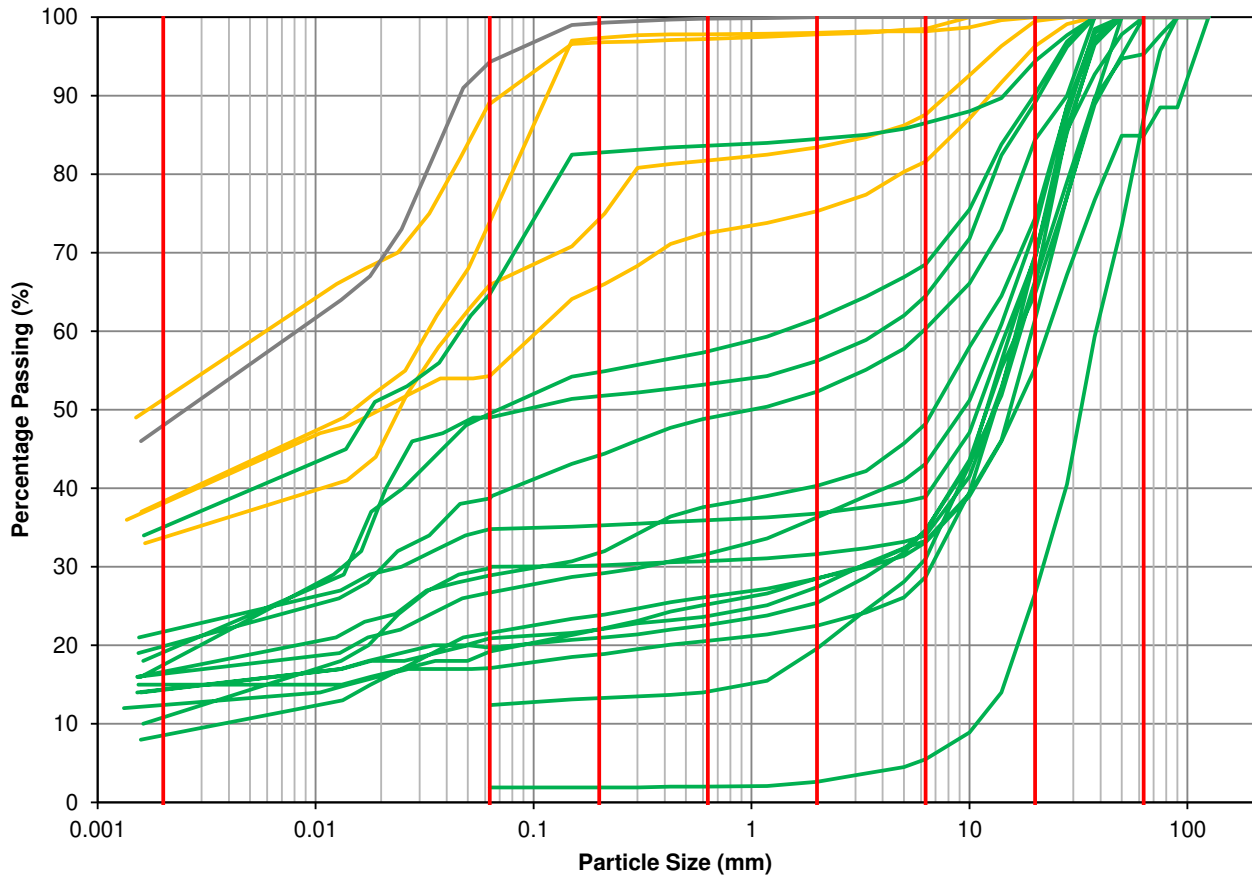
Revision:

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Figure

3

Clay	Silt	Fine	Med	Coarse	Fine	Med	Coarse	Cobbles
		Sand			Gravel			



— (HEAD DEPOSITS)
 — (HEAD GRAVEL DEPOSITS)
 — (LONDON CLAY FORMATION)



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Date:
May 2021

Title

Particle Size Distribution

Summary

Revision: 00

Figure

4a

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