



Main Investigation Report

at
Worcester Close, Gravesend, Kent, DA13 9LB

for
Frankham Projects Limited

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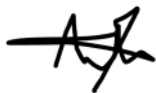
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Current regulations and good practice were used in the preparation of this report. The recommendations given in this report must be reviewed by an appropriately qualified person at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.



Commission

Frankham Projects Limited commissioned Soils Limited to undertake an intrusive ground investigation and prepare a Main Investigation Report on land at Worcester Close, Gravesend, Kent, DA13 9LB. The scope of the investigation was outlined in the Soils Limited quotation reference Q26587, dated 18th July 2022.

This document comprises the Main Investigation Report (MIR) and incorporates the results, discussion, and conclusions to this intrusive works.

This MIR must be read in conjunction with the Preliminary Investigation Report (PIR) undertaken on the above site by Soils Limited, Report ref: 20374/PIR, dated September 2022.

This revised document (Rev 1.2) supersedes all previous revisions of the MIR produced by Soils Limited.

Limitations and Disclaimers

This Main Investigation Report relates to the site located at Worcester Close, Gravesend, Kent, DA13 9LB and was prepared for the sole benefit of Frankham Projects Limited (The "Client"). The report was prepared solely for the brief described in Section 1.1 of this report.

The contents, recommendations and advice given in the report are subject to the Terms and Conditions given in Quotation Q26587, dated 18/07/2022 accepted by the Client in their Purchase Order 30521, dated 03/08/2022.

Soils Limited disclaims any responsibility to the Client and others in respect of any matters outside the scope of the above.

This report has been prepared by Soils Limited, with all reasonable skill, care and diligence within the terms of the Contract with the Client, incorporation of our General Conditions of Contract of Business and taking into account the resources devoted to us by agreement with the Client.

The report is personal and confidential to the Client and Soils Limited accept no responsibility of whatever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report wholly at its own risk.

The Client may not assign the benefit of the report or any part to any third party without the written consent of Soils Limited.

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the Client in accordance with their brief. As such these do not necessarily address all aspects of ground behaviour at the site.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

If the term “competent person” is used in this report or any Soils Limited document, it means an engineering geologist or civil engineer with a minimum of three years post graduate experience in the understanding and application of the appropriate codes of practice.

Unless the site investigation works have been designed and specified in accordance with EC7, this report is a Geotechnical Investigation Report and is not necessarily a Ground Investigation Report as defined by EC7 (Eurocode 7 Part 1, §3.4, Part 2, §6.1) or a Geotechnical Design Report (Eurocode 7 Part 1, §2.8) as defined by Eurocode 7 and as such may not characterise the ground conditions and additional works may be required to comply with the requirements of EC7.

Within the report reference to ground level relates to the site level at the time of the investigation, unless otherwise stated.

Exploratory hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sample borehole implies the specific technique used to produce an exploratory hole.

The depth to roots and/or of desiccation may vary from that found during the investigation. The Client is responsible for establishing the depth to roots and/or of desiccation on a plot by plot basis prior to the construction of foundations. Supplied site surveys may not include substantial shrubs or bushes and is also unlikely to have data or any trees, bushes or shrubs removed prior to or following the site survey.

Where trees are mentioned in the text this means existing trees, substantial bushes or shrubs, recently removed trees (approximately 20 years to full recovery on cohesive soils) and those planned as part of the site landscaping).

The geotechnical laboratory testing was performed by GEO Site & Testing Services Ltd (GSTL) in accordance with the methods given in BS 1377:1990 Parts 1 to 8 and their UKAS accredited test methods.

For the preparation of this report, the relevant BS code of practice were adopted for the geotechnical laboratory testing technical specifications, in the absence of the relevant Eurocode specifications (ref: ISO TS 17892).

The chemical analyses were undertaken by Derwentside Environmental Testing Services (DETS) in accordance with their UKAS and MCERTS accredited test methods or their documented in-house testing procedures. This investigation did not comprise an environmental audit of the site or its environs.

Ownership of land brings with it onerous legal liabilities in respect of harm to the environment. "Contaminated Land" is defined in Section 57 of the Environment Act 1995 (as updated 2021) as:

"Land which is in such a condition by reason of substances in, on or under the land that significant harm is being caused or that there is a significant possibility of such harm being caused or that pollution of controlled waters is being, or is likely to be caused".

It must be noted that a detailed survey of the possible presence or absence of invasive species, such as Japanese Knotweed, is outside of the scope of investigation.

Deleterious materials may be present in any Made Ground that pose a potential risk to site workers, end users and adjacent vulnerable receptors. These could include a range of contaminants, including asbestos, especially if the material includes large fractions of demolition derived materials.

The investigation, analysis or recommendations in respect of contamination are made solely in respect of the prevention of harm to vulnerable receptors, using where possible best practice at the date of preparation of the report. The investigation and report do not address, define or make recommendations in respect of environmental liabilities. A separate environmental audit and liaison with statutory authorities is required to address these issues.

All environmental works are undertaken in the context of, and in compliance with, BS10175+A2 2017 and LCRM (EA 2021) and all other pertinent planning, standards, documentation and guidance appropriate to the site at the time of production which may include, but are not necessarily limited to, documents provided by BS/CEN/ISO, NHBC, AGS, CIEH, CIRIA, SoBRA and CLAIRE.

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Section I Introduction

1.1 Objective of Investigation

Frankham Projects Limited commissioned Soils Limited to undertake an intrusive ground investigation and to prepare a Main Investigation Report to supply the Client and their designers with information regarding ground conditions, to assist in preparing a foundation scheme for development that was appropriate to the settings present on the site.

The investigation was to be undertaken to provide comment on appropriate foundation options for the proposed residential development. The investigation was to be made by means of in-situ testing and geotechnical laboratory testing undertaken on soil samples taken from the exploratory holes.

Soil samples were taken for chemical laboratory testing to enable recommendations for the safe redevelopment of the site and the protection of site workers, end-users and the public from any contamination identified as dictated by the Conceptual Site Model (CSM) in the Preliminary Investigation Report undertaken for the site by Soils Limited (Report ref: 20374/PIR, September 2022) and/or the Revised Conceptual Site Model presented in Appendix D.1.

1.2 Location

The site was located at Worcester Close, Gravesend, Kent, DA13 9LB and had an approximate O.S Land Ranger Grid Reference of TQ 636 702.

The site location plan is given in Figure 1.

1.3 Site Description

At the time of the siteworks, the site area was an open green space. The site was predominantly grass vegetated with numerous large mature trees scattered across the site area, and a hardstanding footpath was seen from the south of the site extending along the western boundary. The site topography was undulating, gently sloping easterly $<3^\circ$ predominantly. The wider topography also was undulating and sloping easterly $<3^\circ$.

An aerial photograph of the site and its close environs has been included in Figure 2.

1.4 Proposed Development

The proposal comprised the erection of 2-storey residential apartments with eight homes consisting of a mixture of 1-bed and 2-bed homes. The homes will be situated in generous soft-landscaped public open space areas, with areas of hard-landscaping to include permeable paving and block paving. Car park and access will be located south of the site.

In compiling this report reliance was placed on drawings within the document of 20-102 –

Worcester Close, Gravesend, Kent, DA13 9LB Pre-application Meeting 02 dated June 2022 prepared by BPTW. The recommendations provided within this report are made exclusively in relation to the scheme outlined above and must not be applied to any other scheme without further consultation with Soils Limited. Soils Limited must be notified about any change or deviation from the scheme outlined.

Development plans provided by the Client are presented in Appendix E.

1.5 Anticipated Geology

The 1:50,000 BGS map showed the site to be located directly upon the bedrock Lewes Nodular Chalk Formation, Seaford Chalk Formation, and Newhaven Chalk Formation (Undifferentiated) with no overlying superficial deposits. Head deposits were indicated as close as ~210m east of the site, and deemed likely to be encountered within the site area.

1.5.1 Head

Head are drifts produced by solifluxion, the downslope movement of debris outwash during the periglacial period, and characteristically comprise poorly sorted sands gravels and chalk of local derivation.

1.5.2 Lewes Nodular, Seaford, and Newhaven Chalk Formations (Undifferentiated)

Lewes Nodular Chalk Formation comprises hard to very hard nodular chalks and hardgrounds (which resist scratching by finger-nail) with interbedded soft to medium hard chalks (some grainy) and marls; some griotte chalks. The softer chalks become more abundant towards the top. Nodular chalks are typically lumpy and iron-stained (usually marking sponges). Brash is rough and flaggy or rubbly and tends to be dirty. First regular seams of nodular flint, some large, commence near the base and continue throughout.

Seaford Chalk Formation can be described as firm white chalk with conspicuous semi-continuous nodular and tabular flint seams. Hardgrounds and thin marls are known from the lowest beds. Some flint nodules are large to very large.

The Newhaven Chalk Formation is a soft white friable microporous limestone composed of coccolith biomicrites with a varying proportion of larger shell fragments. At various levels clay sized material occurs as marl seams and partings. Close to the surface the upper few metres are invariably discoloured brown, due to leaching from the overlying strata. The interface with any overlying stratum is invariably extremely irregular as a result of localised weathering and general solution. Weathering by frost action may extend to a depth of several metres.

Chalk is a weak rock and as such it should be noted that the drilling, excavating, and sampling process is detrimental to its fabric and structure.

Chalk samples that have been machine sampled will therefore appear to be of a lower descriptive grade, as given in CIRIA C574, than the in-situ chalk. Soil sampling and visual observations from open excavations i.e. trial pits would allow chalk description and classification in accordance with CIRIA 574 including commenting for any aperture and discontinuities in the chalk structure.

Erosional features, such as pipes, swallow holes and solution cavities, usually in-filled with drift deposits, are occasionally found in the chalk, sometimes manifesting themselves at the surface as shallow circular depressions. Solution features may be reactivated by the concentrated ingress of water from leaking drains or soakaways. Reactivation may lead to surface collapse.

Section 2 Site Works

2.1 Proposed Project Works

The proposed intrusive investigation was designed to provide information on the ground conditions and to aid the design of foundations for the proposed residential development. The intended investigation, as outlined within the Soils Limited quotation (Q26587, dated 18th July 2022), was to comprise the following items:

- Service Clearance via C.A.T and Genny
- UXO Specialist on-site support (rate only)
- 4no. (up to) 4.00m deep windowless sampler boreholes
- 4no. (up to) 6.00m deep dynamic probe DPSH
- 1no. monitoring well installation
- 3no. in-situ CBRs via DCP
- Geotechnical testing
- Contamination testing

2.1.1 Actual Project Works

The actual project works were undertaken on 12th August 2022, with subsequent sample logging, laboratory testing, and reporting. The actual works comprised:

- Service Clearance via C.A.T and Genny
- UXO Specialist on-site support
- 4no. 4.00m deep windowless sampler boreholes
- 4no. (up to) 6.00m deep dynamic probe DPSH
- 1no. monitoring well installation
- 3no. in-situ CBRs via DCP
- Geotechnical testing
- Contamination testing

One windowless sampler borehole (WS3) was backfilled with gravel and bentonite following the installation of monitoring wells, and three boreholes (WS1, WS2, and WS4) was backfilled with arising's.

All exploratory hole locations have been presented in Figure 3.

Following completion of site works, soil cores were logged and sub sampled so that samples could be sent to the laboratory for both contamination and geotechnical testing.

2.2 Ground Conditions

On 12th August 2022 four windowless sampler boreholes (WS1 – WS4) were drilled, using a Premier 110 rig, each to a depth of 4.00m below ground level (bgl) at locations selected by Soils Limited using a development plan provided by the Client.

One standpipe was installed within one window sample borehole location (WS3) to allow for continued monitoring of both groundwater and ground gas.

Four super heavy dynamic probes, (DP1 – DP4) were driven prior and adjacent to their corresponding windowless sampler borehole to depths ranging between 5.00 and 6.00m bgl.

The maximum depths of exploratory holes have been included in Table 2.1.

All exploratory holes were scanned with a Cable Avoidance Tool (C.A.T.) and GENNY prior to excavation to ensure the health and safety of the operatives.

Table 2.1 Final Depth of Exploratory Holes

Exploratory Hole	Depth (m bgl)
WS1 / DP1	4.00 / 6.00
WS2 / DP2	4.00 / 6.00
WS3 ^w / DP3	4.00 / 6.00
WS4 / DP4	4.00 / 5.00

Note(s): ^w - well installation. The depths given in this table are taken from the ground level on-site at the time of investigation.

The approximate exploratory hole locations are shown on Figure 3.

The soil conditions encountered were recorded and soil sampling commensurate with the purposes of the investigation was carried out. The depths given on the exploratory hole logs and quoted in this report were measured from ground level.

The soils encountered from immediately below ground surface have been described in the following manner. Where the soil incorporated an organic content such as either decomposing leaf litter or roots or has been identified as part of the in-situ weathering profile, it has been described as Topsoil both on the logs and within this report. Where man has clearly either placed the soil, or the composition altered, with say greater than an estimated 5% of a non-natural constituent, it has been referred to as Made Ground both on the log and within this report.

For more complete information about the soils encountered within the general area of the site reference must be made to the detailed records given within Appendix B, but for the purposes of discussion, the succession of conditions encountered in the exploratory holes in descending order can be summarised as:

Made Ground (MG)
Head (HD)
Lewes Nodular, Seaford, and Newhaven Chalk Formations (LSNCK)

The ground conditions encountered in the exploratory holes are summarised in Table 2.2.

Table 2.2 Ground Conditions

Strata	Epoch	Depth Encountered (m bgl)		Typical Thickness (m)	Typical Description
		Top	Bottom		
MG	Anthropocene	0.00	1.20	1.20	Stiff greyish brown mottled dark brown slightly sandy slightly gravelly CLAY, with chalk, brick, and clinker and rare metallic fragments.
HD	Holocene	0.00–1.20	0.75–1.70	0.95	Firm to stiff dark brown/orangish brown slightly silty slightly sandy slightly gravelly CLAY.
LSNCK	Cretaceous	0.75–1.70	4.00 ¹ /6.00 ²	Not proven ³	Structureless CHALK recovered as silty slightly sandy angular GRAVEL/slightly sandy SILT.

Note(s): ¹ Final depth of exploratory hole. ² Inferred depths. ³ Base of strata not encountered. The depths given in this table are taken from the ground level on-site at the time of investigation.

2.3 Ground Conditions Encountered in Exploratory Holes

The ground conditions encountered in exploratory holes have been described below in descending order. The engineering logs are presented in Appendix B.1.

2.3.1 Made Ground

Soils described as Made Ground was encountered only in WS1 from ground level to depth of 1.20m bgl. The presence of Made Ground could possibly be from soils excavated during the construction of a possible drainage system underlying the site, as a manhole was seen during the site works. It was also noted that WS1 was undertaken on an area of higher elevation of the site, potentially of mounded reworked material.

The Made Ground typically comprised stiff greyish brown mottled dark brown slightly sandy slightly gravelly CLAY with occasional to frequent rootlets and rare metallic fragments. Gravel was fine to medium flint, chalk, brick, and clinker.

The established depth of Made Ground found at each exploratory hole location have been included in Table 2.3.

Table 2.3 Established Depth of Made Ground

Exploratory Hole	Depth (m bgl)
WS1	1.20
WS2	N/E
WS3	N/E
WS4	N/E
Note(s): N/E not encountered.	

2.3.2 Head

Soils described as LSNCK were found from ground level and directly beneath the Made Ground within WS1 in each of the four exploratory hole locations to depths of between 0.75m (WS2) and 1.70m bgl (WS1).

The soils of the Head comprised firm to stiff dark brown/orangish brown slightly silty slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel was angular to well-rounded fine to coarse of flint, chalk, and clinker.

The established depth of Head found at each exploratory hole location have been included in Table 2.4.

Table 2.4 Established Depth of Head

Exploratory Hole	Depth (m bgl)
WS1	1.70
WS2	0.75
WS3	1.00
WS4	1.55

2.3.3 Lewes Nodular, Seaford, and Newhaven Chalk Formations

Soils described as Lewes Nodular, Seaford, and Newhaven Chalk Formations were encountered underlying the Head in each of the four exploratory hole locations for their full depth of 4.00m bgl and inferred in each of the dynamic probes in an inferred depth of 6.00m bgl. For the purpose of this report, the chalk has been described as LSNCK.

The established depth of LSNCK found at each exploratory hole location have been included in Table 2.5.

Table 2.5 Established Depth of LSNCK

Exploratory Hole	Depth (m bgl)
WS1 / DPI	4.00 ¹ / 6.00 ²
WS2 / DP2	4.00 ¹ / 6.00 ²
WS3 / DP3	4.00 ¹ / 6.00 ²
WS4 / DP4	4.00 ¹ / 5.00 ²
Note(s): ¹ Final depth of exploratory hole. ² Inferred depth.	

It must be noted that Chalk in its unweathered state, is a weak rock, and as such

the drilling and excavating process can disturb both the structure and the fabric of the chalk being sampled. The logged chalk is therefore disturbed by the sampling process.

2.4 Roots

Roots were encountered in each of the four exploratory holes at depths ranging between 1.00 and 2.50m bgl.

The established depth of root penetration found at the exploratory hole locations has been included in Table 2.6.

Table 2.6 Established Depth of Root Penetration

Exploratory Hole	Depth (m bgl)
WS1	2.50
WS2	1.50
WS3	1.00
WS4	1.70

Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs.

It must be emphasised that the probability of determining the maximum depth of roots from a narrow diameter borehole is low. A direct observation such as from within a trial pit is necessary to gain a better indication of the maximum root depth.

The presence of trees can be suggested from the historic maps from the Preliminary Investigation Report undertaken by Soils Limited (ref: 20292/PIR) the site appeared to be part of an orchard from 1938 to 1968. Further indication can be seen from aerial photography shown on Google Earth™, where trees are clearly shown from December 1990, and more trees have been shown within the site area till present day. Foundation design therefore must take this into consideration.

2.5 Groundwater

Groundwater was not encountered within any of the four exploratory holes.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage, tidal effects. The investigation was conducted in August (2022), when groundwater levels should be falling from their annual minimum (lowest) elevation, which typically occurs around September to the annual maximum (highest) which typically occurs around March.

Groundwater equilibrium conditions may only be conclusively established, if a series of observations are made via groundwater monitoring wells.

A monitoring well was installed in WS3, however the monitoring was not part of the scope of the investigation and Soils Limited was not instructed to conduct any monitoring at the time of reporting.

Section 3 Discussion of Geotechnical In-Situ and Laboratory Testing

3.1 Dynamic Probe Tests

Dynamic probing (DPSH) was undertaken at four locations (DP1 to DP4) adjacent and prior to the drilling of WS1 to WS4 to depths ranging between 5.00 and 6.00m bgl. The results were converted to equivalent SPT “N60” values based on dynamic energy using commercial computer software (Geostru). The results were then interpreted based on the classifications outlined in Appendix C.1, Table C.1.1 to Table C.1.3.

The SPT “N60” values presented have been corrected in accordance with BS EN 22476 Part 3, to account for the rig’s trip hammer efficiency, borehole depth, overburden factors etc. Further correction of the ‘N’ values should therefore not be necessary. The energy ratio of the drilling rig was 92.96%. The energy ratio for each location is presented on the individual logs within Appendix B.1.

The Head recorded equivalent SPT “N60” values between 4 and 22 within the cohesive beds and 13 to 31 in granular beds. The cohesive beds were classified as low to high strength and inferred undrained cohesive strength of 20kPa to 110kPa. The relative density of the granular beds, only found within WS4 from 0.90m to 1.55m bgl, were classified as medium dense to dense, generally increasing with depth.

The Lewes Nodular Chalk Formation, Seaford Chalk Formation, and Newhaven Chalk Formation (Undifferentiated) recorded equivalent SPT “N60” values between 9 and >35. Generally, the chalk was inferred to be Structureless (Dc) to Structured chalk (C5 – A1). Structureless (Dm) chalk was inferred in DP2 at a thickness of 0.40m from 5.40m to 5.80m bgl.

A full interpretation of the DPSH tests, are outlined in Appendix C.2, Table C.2.1.

3.2 Dynamic Cone Penetrometer Tests

The Transport Research Laboratory (TRL), Dynamic Cone Penetrometer (DCP) were undertaken at three locations (DCP1 – DCP3). The results were interpreted based on the classification outlined in Appendix C.1.

The results from DCP testing indicated CBR values of between 9% and 45% for the soils encountered in the top 1.00m bgl. The high CBR values encountered were anticipated to be large gravel clasts or Made Ground inclusions struck during the test.

The DCP results are presented in Appendix C.3.

3.3 Atterberg Limit Tests

Atterberg Limit tests were performed on two samples obtained from the Head. The results were classified in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

The Head was classified as medium volume change potential in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

A full interpretation of the Atterberg Limit tests, are outlined in Table C.2.2, Appendix C.2 and the laboratory report in Appendix C.3.

3.4 Saturation Moisture Content Tests

Saturated Moisture Content (SMC) tests were performed on three samples recovered from the Lewes Nodular, Seaford, and Newhaven Chalk Formations (Undifferentiated). The results were classified based on Table 3.2, CIRIA Publication, Engineering in Chalk, C574, 2002.

The SMC tests classified the Lewes Nodular, Seaford, and Newhaven Chalk Formations (Undifferentiated) as low density, with dry density ranging between 1.45Mg/m³ and 1.51Mg/m³.

A full interpretation of the SMC tests, are outlined in Table C.2.3, Appendix C.2 and the laboratory report in Appendix C.3.

3.5 Sulphate and pH Tests

Three samples were taken from the Head and one from the Lewes Nodular, Seaford, and Newhaven Chalk Formations (Undifferentiated) (WS2:2.30m bgl) for water soluble sulphate (2:1) and pH testing in accordance with Building Research Establishment Special Digest 1, 2005, 'Concrete in Aggressive Ground'.

The tests for the Head recorded water soluble sulphate between <10mg/l and 15mg/l with pH values of 8.0 to 8.2.

The test for the Lewes Nodular, Seaford, and Newhaven Chalk Formations (Undifferentiated) recorded water soluble sulphate of <10mg/l with pH value of 8.3.

The significance of the sulphate and pH Test results are discussed in Section 5.22 and the laboratory report in Appendix C.3.

Section 4 Engineering Appraisal

4.1 Established Ground Conditions

An engineering appraisal of the soil types encountered during the site investigation and likely to be encountered during the redevelopment of this site is presented. Soil descriptions are based on analysis of disturbed samples taken from the exploratory holes.

4.1.1 Made Ground and Topsoil

Foundations must not be placed on non-engineered fill unless such use can be justified on the basis of a thorough ground investigation and detailed design. Foundations must be taken through any Topsoil and/or Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

Soils described as Made Ground were encountered in one (WS1) out of the four exploratory holes from ground level to depth of 1.20m bgl.

4.1.2 Head

Soils described as Head were encountered in each of the four exploratory holes from ground level and directly below the Made Ground and persisted to depths ranging between 0.75 and 1.70m bgl.

Peat and organic soils are highly compressible, and even lightly loaded foundations will be subject to considerable settlements over a long period if placed on them. For this reason, these soils are not suitable for carrying the loads for important structures.

The results from DPSH testing inferred that the cohesive soils of the Head were of a **low to high strength**, with undrained cohesions of between **15kPa and 145kPa**. The relative density of the granular beds were classified as **medium dense to dense**, generally increasing with depth.

The results from Atterberg Limits tests confirmed that the soils of the Head had **medium volume change potential** in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

Soils of the Head are normally consolidated, typically of both cohesive or granular soils and as such are expected to display low to moderate bearing capacities with moderate to high settlement characteristics. The soils of the Head were not considered suitable for the proposed development due to root depths of up to 2.50m bgl, presence of trees within the site area, and medium volume change potential.

4.1.3 Lewes Nodular, Seaford, and Newhaven Chalk Formations (Undifferentiated)

Soils described as LSNCK were encountered underlying the Head from 0.75m to

1.70m bgl and persisted to the full investigatory depth of 6.00m bgl.

The results from the dynamic probing inferred that LSNCK was typically **Structureless (Dc) and Structured chalk (C5 – A1)**. DP2 encountered structureless (Dm) chalk between 5.40m to 5.80m bgl. As this was found as a thin soft layer, it is not considered to be of significance and therefore deemed unlikely to impact the proposed development.

Saturated moisture content testing indicated the chalk was of **low density**, with dry density ranging between 1.45 and 1.51 Mg/m³.

It must be noted that Chalk in its unweathered state, is a weak rock, and as such the drilling and excavating process can disturb both the structure and the fabric of the chalk being sampled. The logged chalk is therefore disturbed by the sampling process.

Chalk descriptions from windowless sampler boreholes are not in accordance with CIRIA C574 and are not representative of in-situ chalk. Generally, soils of the LSNCK are Structureless (Dc) chalk and would possess low to moderate bearing and settlement characteristics. The LSNCK would be suitable as a bearing stratum for shallow foundations for the proposed development.

4.1.4 Guidance on Shrinkable Soils

The ground conditions were established as Head, with a typical thickness off 0.95m, overlying the bedrock of LSNCK.

Atterberg Limit testing were classified in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2 to determine the volume change potential.

The volume change potential for each strata was established and presented in Table 4.1.

Table 4.1 Established Volume Change Potential by Strata

Strata	Volume Change Potential		Established Lower Boundary (m bgl)
	BRE	NHBC	
HD	Medium	Medium	1.70

The Head are variable in composition both laterally and vertically and therefore a worst-case volume change potential of medium was recommended. Further testing could allow a reduction in volume change potential within localised areas across the site.

4.1.5 Groundwater

Groundwater was not encountered within any of the four exploratory holes.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in August

(2022), when groundwater levels should be falling from their annual minimum (lowest) elevation, which typically occurs around September to the annual maximum (highest) which typically occurs around March.

Groundwater equilibrium conditions may only be conclusively established, if a series of observations are made via groundwater monitoring wells.

A monitoring well was installed in WS3, however the monitoring was not part of the scope of the investigation and Soils Limited was not instructed to conduct any monitoring at the time of reporting.

Section 5 Foundation Scheme

5.1 Foundation Recommendations

Foundations **must not** be constructed within any Made Ground/Topsoil and Head due to the likely variability and potential for large load induced settlements both total and differential.

Roots were encountered in each of the four exploratory holes at depths ranging between 1.00m bgl and 2.50m bgl. If roots are encountered during the construction phase foundations **must not be placed within any live root penetrated or desiccated cohesive soils or those with a volume change potential**. Should the foundation excavations reveal such materials, the excavations **must** be extended to greater depth in order to bypass these unsuitable soils. Excavations must be checked by a suitable person prior to concrete being poured.

Considering the type of development, a shallow foundation solution taken into the chalk was considered the most suitable. Foundations taken completely into the chalk can be designed without volume potential.

It is noted that numerous large mature trees are seen within the site area, and therefore considered that the foundation design must be undertaken using NHBC Standards Chapter 4.2 to ensure it does not affect the proposed development. In addition, foundations must not be constructed within the Head due to medium volume change potential.

5.1.1 Strip Foundations into the Lewes Nodular, Seaford, and Newhaven Chalk Formations (Undifferentiated)

The dynamic probe undertaken showed the Lewes Nodular, Seaford and Newhaven Chalk Formations as structureless (Dc) to structured (C5 – A1). The dynamic probe blow counts did not indicate the presence of solution features at the test hole location, however the presence of solutions features could not be completely ruled out in other untested areas of the site.

Foundations should be taken into the LSNCK at a minimum depth of 1.70m bgl passing through the Head.

Based on the SMC testing intact chalk fragments were classified as medium density, which was adopted.

When considering an allowable bearing capacity for foundation design in chalk it is the yield strength that dictates the bearing capacity. Exceeding the yield strength will lead to unacceptable settlements. For low density structureless chalk (Dc), CIRIA C574 proposes a yield strength of 225kPa when unweathered.

Therefore, an allowable bearing capacity of up to 175kPa could be adopted for

foundations on structureless (Dc) to structured (C5 – A1) LSNCK. Provided the bearing capacity does not exceed 175kPa settlements will remain below 25mm.

The bearing value given is likely to be significantly higher than that required for the proposed development and the adoption of a lower bearing value would result in a proportionally lower settlement.

The bearing capacities outlined in CIRIA C574 are based on lower bound values, should higher bearing values be required, in-situ plate loading tests must be undertaken to confirm acceptability.

All loose material, loose blocks of chalk and soft spots must be removed from the base of the excavations, these excavations then being either concreted or blinded as soon after excavation as possible. Failure to do so could result in increased settlements. Foundations must not be cast over foundations of former structures and/or other hard spots.

For the allowable bearing value given above, settlements should not exceed the presented values, provided that excavation bases are carefully bottomed out and blinded or concreted as soon after excavation as possible and kept dry.

Foundations must not be constructed over former structures and other hard spots. The foundations design must be suitable for the conditions present at the site.

Should a foundation be constructed at a point(s) where a root bowl has been removed the foundation trench will have to be locally deepened, this may result in a local hard spot.

Where isolated pad foundations are adopted, they must be kept at least 1.5 times the width of the largest adjacent pad apart (face to adjacent face) to ensure that their vertical stress “bowls” do not interact. Failure to do so may result in additional settlements.

5.1.2 Ground Floor Slab

NHBC Standards 2022 states ground floors should be constructed as suspended floors where:

- *“the foundation depth dictated by the NHBC Standards 2022, Chapter 4.2.10 would exceed 1.5m bgl;”*
- *“ground floor construction is undertaken when the surface soils are seasonally desiccated;”*
- *“the depth of fill exceeds 600mm;”*
- *“there is shrinkable soil that could be subject to movement, expansive material or other unstable soils;”*
- *“the ground has been subject to vibratory improvement;” or*

- “ground or fill is not suitable to support ground-bearing slabs.”

Due to the presence of numerous large mature trees, roots found up to 2.50m bgl, and medium change volume potential of the shallow soils, suspended ground floors must be adopted.

5.2 Subsurface Concrete

The sulphate and pH tests carried out in accordance with BRE Special Digest 1, 2005, ‘Concrete in Aggressive Ground’, established the site concrete classifications for each stratum as presented in Table 5.1.

Table 5.1 Concrete Classification

Stratum	Design Sulphate Class	ACEC Class
HD	DS-I	AC-I
LSNCK	DS-I	AC-I
Overall Design	DS-I	AC-I

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1 2005, ‘Concrete in Aggressive Ground’ taking into account any possible exposure of potentially pyrite bearing natural ground and the pH of the soils.

5.3 Excavations

Shallow excavations in the Made Ground and Head are likely to be marginally stable in the short term at best. Deeper excavations into the Head are likely to be unstable.

Deeper excavations taken into the Lewes Nodular Chalk Formation, Seaford Chalk Formation, and Newhaven Chalk Formation (Undifferentiated) are likely to be stable in the short term, depending on the thickness of overlying Head. Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions must therefore be taken to ensure that such earth faces are adequately supported or battered back to a safe angle of repose.

Excavations beneath the groundwater table are likely to be unstable and dewatering of foundation trenches may be necessary.

Section 6 Pavements

6.1 Pavements

The Transport Research Laboratory (TRL) Dynamic Cone Penetrometer (DCP) was undertaken at eleven locations on site (DCP101 – DCP110). The results from dynamic cone penetrometer tests indicated **CBR values of between 9% and 45%** for the soils encountered in the top 1.00m bgl. The high CBR values encountered were anticipated to be large gravel clasts and/or Made Ground inclusions struck during the test.

When removing 400mm of Made Ground the worst case CBR value was 13% which was considered suitable for design purposes for the majority of the road layout.

In-situ testing must be undertaken immediately prior to the installation of pavements/roads. Any soft spots at formation level must be dug out and replaced with a suitably compacted granular fill. Prior to construction the formation level must be proof rolled.

The Head had a plasticity index of between 33 – 34%, and can be regarded as non-frost susceptible. Soils of the LSNCK are regarded as frost susceptible.

The overall thickness of the pavement will be dictated by the frost susceptibility of the sub-grade.

Section 7 Determination of Chemical Analysis

7.1 Site Characterisation and Revised Conceptual Site Model

The Preliminary Investigation undertaken by Soils Limited (report ref: 20374/PIR dated September 2022) did not identify a risk of ground contamination from previous usage of the site and offsite sources.

The Main Investigation identified Made Ground to depth of 1.20m bgl within WS1.

There were no significant visual or olfactory indicators of contamination noted within the samples recovered, during logging, or within the boreholes.

Groundwater was not encountered during the intrusive investigation.

7.2 Soil Sampling

Exploratory hole locations were established to provide an overview of ground conditions across the site in relation to the proposed construction, together with enabling the collection of samples to enable chemical characterisation of the underlying strata.

Representative samples for potential environmental testing were obtained from the exploratory holes at depths of between 0.10m and 0.50m to allow appropriate representation of the materials encountered, with additional samples to be obtained, if necessary, where there was visual or olfactory evidence of contamination.

Unless otherwise stated, analytical testing was based initially on a screening suite of commonly identified inorganic and organic contaminants, taking into account the prevailing site conditions and the findings of the initial conceptual site model.

7.3 Determination of Chemical Analysis

The driver for determination of the analysis suite was the information obtained from the Preliminary Investigation Report and Main Investigation Report intrusive investigation.

The chemical analyses were carried out on 2no. samples of Made Ground and 3no. samples of the Head. The nature of the analyses is detailed in Table 7.1.

Table 7.1 Chemical Analyses Suites

No. of Tests	Determinants
5	Metal suites: Arsenic, Boron (Water Soluble), Cadmium, Chromium (total & hexavalent), Copper, Lead, Mercury, Nickel, Selenium, Zinc
5	Polycyclic aromatic hydrocarbons (PAH) – (EPA 16)
5	Extractable petroleum hydrocarbons (EPH) – Texas Banded
5	Phenols – total monohydric
5	pH

No. of Tests	Determinants
5	Organic matter contents
5	Moisture contents
5	Asbestos screens
1	Total petroleum hydrocarbons (TPH) – CWG bandings
1	BTEX & MTBE
1	PCB

The soil testing was carried out in compliance with the MCERTS performance standard, and the results are shown in Appendix D.2, Test Report 22-07348.

Section 8 Qualitative Risk Assessment

8.1 Assessment Criteria

The assessment criteria used to determine risks to human health are derived and explained within Appendix D.3.

8.2 Representative Contamination Criteria - Soil

The proposal comprised the erection of 2-storey residential apartments with eight homes consisting of a mixture of 1-bed and 2-bed homes. The homes will be situated in generous soft-landscaped public open space areas, with areas of hard-landscaping to include permeable paving and block paving. Car park and access will be located south of the site.

In compiling this report reliance was placed on drawings within the document of 20-102 – Worcester Close, Gravesend, Kent, DA13 9LB Pre-application Meeting 02 dated June 2022 prepared by BPTW. The recommendations provided within this report are made exclusively in relation to the scheme outlined above and must not be applied to any other scheme without further consultation with Soils Limited. Soils Limited must be notified about any change or deviation from the scheme outlined.

Based on the proposed development, the results of the chemical analysis have been compared against generic assessment criteria (GAC) for a '**Public Open Space - Residential**' end use, as presented in SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination December 2014 (C4SL), derived for the protection of human health. Where this document has not published screening values for determinants, GACs derived for the same end use have been adopted from the following published guidance; DEFRA Soil Guideline Values (SGV) and LQM/CIEH/Suitable 4 Use Level (S4UL).

To assess the potential toxicity of organic determinants (Petroleum Hydrocarbons and Polyaromatic Hydrocarbons) to the human health, soils samples were analysed for Soil Organic Matter (SOM). The selected samples analysed recorded, SOM values of between 2.2% and 8.1%. For each soil sample tested, the resultant SOM allowed for the correct comparison to be made with the appropriate guideline value for each organic determinants analysed.

8.3 Risk Assessment – Made Ground

Table 8.1 outlines the sample that have exceeded their relevant assessment criteria. The full laboratory report is presented in Appendix D.2.

Table 8.1 Summary of GAC Exceedances – Made Ground

Location	Depth (m bgl)	Contaminant	Concentration	Guidance Level
None				
Note(s): Units mg/kg				

The risk assessment has established there is no potentially significant linkage in relation to human health from the Made Ground.

8.4 Risk Assessment – Head

Table 8.2 outlines the samples that have exceeded their relevant assessment criteria. The full laboratory report is presented in Appendix D.2.

Table 8.2 Summary of GAC Exceedances – Head

Location	Depth (m bgl)	Contaminant	Concentration	Guidance Level
None				
Note(s): Units mg/kg				

The risk assessment has established there is no potentially significant linkage in relation to human health from the Head.

8.5 Asbestos

The test certificate for each sample submitted for contamination analysis during this investigation includes the results of an Asbestos Screen. In each case 'Not detected' was reported.

This finding does not obviate the risk of asbestos being present on the site and the Client must seek advice from qualified and competent asbestos specialist during and prior to undertaking works to ensure compliance with appropriate legislation and guidance.

8.6 Risk to Groundwater

The site is located on a principal aquifer and is within a zone II and zone III groundwater source protection zone and there is one groundwater abstractions within 1km of the site, the closest is located 982m from the site and is for potable water supply.

No groundwater was found during the intrusive investigation, and there was no evidence of any impacted soils at shallow depth which could therefore potentially provide a viable source to impact the groundwater. On this combined basis, the risk to groundwater is considered low to negligible.

The site is currently free draining to the underlying soils, and the proposed development will need to consider the implementation of a new drainage regime on site, as such the proposed development is considered to provide a betterment of site conditions where site drainage would not follow a pathway to impact on third party land or property.

8.7 Risk from Ground Gas Ingression

The Preliminary Investigation and the Main Investigation did not identify any significant source for producing ground gases, therefore ground gas was not considered to be of any significant risk.

8.8 Generic Quantitative Risk Assessment

Quantitative risk assessments are undertaken for the soil, groundwater and ground gas. The CSM has been updated to take account of the assessments below and presented in Appendix D.1. The full laboratory chemical report is presented in Appendix D.2.

8.8.1 Soils

None of the samples had exceedances against “Public Open Space – Residential” land-use from the proposed development.

The Tier 1 Quantitative risk assessment therefore established that there was **no risk to the human health receptors** of construction workers or future end-users.

8.8.2 Groundwater

The Investigations and findings to date have established that the groundwater is not a risk vulnerable receptor on the basis of the ground conditions and the lack of any evidence of a significant source. Therefore, risk to groundwater is considered negligible by default.

8.8.3 Ground Gas

On the basis of the ground conditions and the investigation to date, ground gas risk is considered negligible by default, and therefore no remediation regarding ground gas was considered necessary.

8.9 Conclusions

None of the samples had exceedances against “Public Open Space – Residential” land-use, which is considered the appropriate land use given the nature of the proposed development: Ground gas and water risk are likewise considered low to negligible in context and as such no remediation or mitigation is considered necessary and no significant risk has been identified to the identified vulnerable receptors outlined in the initial Conceptual Site Model.

However, it is a common planning requirement and under CDM that as unknowns always remain, a formalised discovery strategy must be in place during construction and groundworks at a site potentially affected by contamination.

Whilst no remediation or mitigation is considered necessary, comments on possible additional requirements or activities undertaken as part of the proposed development are noted below for reference.

8.10 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site must be kept damp during dry weather and at other times when dust is generated as a result of construction activities. The site must be securely fenced at all times to prevent unauthorised access.

Washing facilities should be provided and eating restricted to mess huts.

8.11 Excavated Material

Excavated material as waste must be defined or classified prior to any disposal, transport, recycling or re-use at or by an appropriately licensed or exempt carrier and/or off-site disposal facility. The requirements inherent in both Duty of Care and Health and Safety must also be complied with. In order to determine what is to happen, what is suitable, appropriate and most effective in the disposal of wastes, especially those subject to CDM waste management plan requirements, several factors must be considered, and competent advice must always be sought.

The amount, type and nature of the material to be removed will in part determine the amount and type of analysis that may be required to comply with current waste guidance, and thereby allow a qualified person to suitably classify the material. Often this data is uncertain or unavailable, especially in the early stages of a project, and therefore further investigation, testing and analysis may be required as additional information regarding the development becomes available.

Wastes must be classified and defined by their solid characteristics to comply with current waste guidance. Existing information and analysis derived for environmental purposes may therefore be suitable for use in this context. Waste Acceptance Criteria (WAC) report the leachability of materials and therefore cannot be used to classify, characterise or define wastes. The only purpose of a WAC analysis is to determine the suitability of a given material for acceptance at one of the three different types of available licenced landfills (inert, stable non-reactive hazardous or hazardous).

Other options are available that may lead to significant savings against disposal to landfill and expert advice must always be sought from a qualified person to advise on their relative costs or benefits and advise on any additional analysis, sampling or investigation that may be required to reduce remaining uncertainties and comply with current guidance. Further consideration of results using HazWasteOnline™ can be undertaken on request to give an indication of potentially hazardous properties in the materials analysed.

8.12 Re-use of Excavated Material On-site

The re-use of on-site soils may be undertaken either under the Environmental Permitting Regulations 2007 (EPR), in which case soils other than uncontaminated soils are classed as waste, or under the CL:AIRE Voluntary Code of Practice (CoP) which was published in September 2008 and is accepted as an alternative regime to the EPR.

Under the EPR, material that is contaminated but otherwise suitable for re-use is also classified as waste and its re-use must be in accordance with the Environmental Permitting Regulations 2007 (EPR). Environmental Permit Exemptions (EPE) are for the re-use of non-hazardous or inert waste only; hazardous waste cannot be re-used under a permit exemption. EPE apply only to imported inert waste materials; inert material arising on site and recovered on site is not classified as waste and does not require an exemption. It is possible that materials arising on-site will be classified as inert and would not need an exemption.

Environmental Permit Exemptions are only allowed for certain activities, placing controls on the quantities that can be stored and re-used. The re-use of waste shall be within areas and levels defined in planning applications and permissions for the development. An EPE requires a site-specific risk assessment for the receptor site to demonstrate that the materials are suitable for use, i.e. that they will not give rise to harm to human health or pollution of the environment.

Under the CL:AIRE voluntary code of practice (CoP) materials excavated on-site are not deemed contaminated if suitable for re-use at specified locations or generally within the site.

Material that may have been classified as hazardous waste under the EPR may be re-used. The CoP regime requires that a 'Qualified Person' as defined under the CoP reviews the development of the Materials Management Plan, including review of Risk Assessments and Remediation Strategy/Design Statement together with documentation relating to Planning and Regulatory issues, and signs a Declaration which is forwarded to the Environment Agency and which confirms compliance with the CoP.

Should it be necessary to import materials from another site where materials are excavated and which is not material from a quarry or produced under a WRAP protocol, then an EPE would be necessary for the imported material whether the work was managed under the CoP or the EPR.

8.13 Imported Material

Any soil, which is to be imported onto the site, must undergo chemical analysis to permit classification prior to its importation and placement in order to ascertain its status with specific regard to contamination, i.e. to prove that it is suitable for the purpose for which it is intended.

8.14 Discovery Strategy

There may be areas of contamination not identified during the course of the investigation. Such occurrences may also be discovered during the demolition and construction phases for the redevelopment of the site.

Care must be taken during excavation works especially to investigate any soils, which appear by eye (e.g. such as fibrous materials, large amounts of ash and unusual discolouration), odour (e.g. fuel, oil and chemical type odours or unusual odours such as sweet odours or fishy odours) or wellbeing (e.g. light headedness and/or nausea, burning of nasal passages and blistering or reddening of skin due to contact with soil) to be contaminated or of unusual and/or different character to standard soils or those analysed.

In the event of any discovery of potentially contaminated soils or materials, this discovery must be quarantined and reported to the most senior member of site staff or the designated responsible person at the site for action. The location, type and quantity must be recorded and the Local Authority, and a competent and appropriate third party Engineer/Environmental consultant notified immediately. An approval from the Local authority must be sought prior to implementing any proposed mitigation action.

The discovery strategy must remain on site at all times and must demonstrate a clear allocation of responsibility for reporting and dealing with contamination. A copy of the strategy must be placed on the health and safety notice board and /or displayed in a prominent area where all site staff are able to take note of and consult the document at any time. Any member of the workforce entering the site to undertake any excavation must be made aware of the potential to discover contamination and the discovery strategy.

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Appendix D Chemical Laboratory Analyses

Appendix D.1 Conceptual Site Model

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Appendix E Information Provided by the Client

Appendix F Trial Hole Photographs



Figure 1 – Site Location Map



Job Number
20374

Project
Worcester Close, Gravesend, Kent, DA13 9LB

Client
Frankham Projects Limited

Date
October 2022



Figure 2 – Aerial Photograph

Project

Worcester Close, Gravesend,
Kent, DA13 9LB

Client

Frankham Projects Limited

Date

October 2022

Job Number

20374



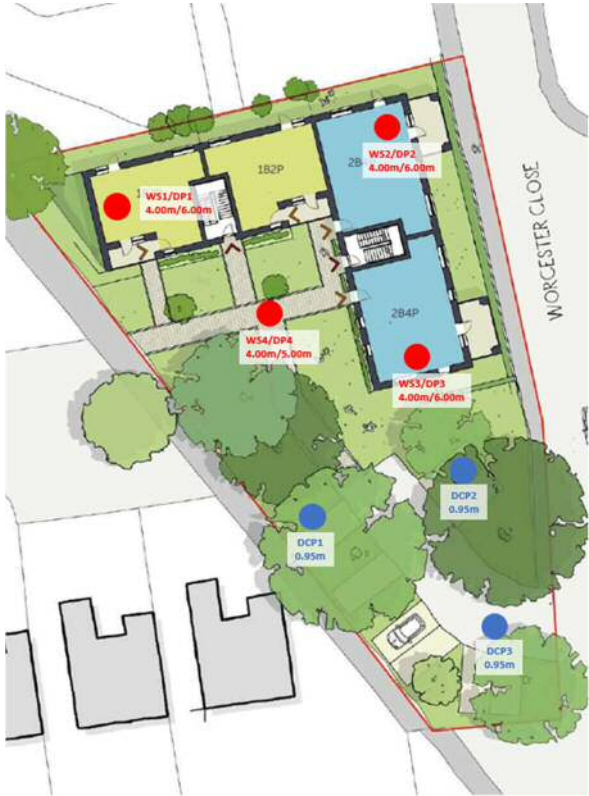
Figure 3 – Exploratory Hole Plan

Project
Worcester Close, Gravesend,
Kent, DA13 9LB

Client
Frankham Projects Limited

Date
October 2022

Job Number
20374



Appendix A Standards and Resources

The site works, soil descriptions and geotechnical testing was undertaken in accordance with the following standards were applicable:

- BS 5930:2015 and BS EN ISO 22476-2 2005+A1:2011
- BS 5930:2015 and BS EN ISO 22476-2&3:2005+A1:2011
- BS 5930:2015 and BS EN ISO 22476-3:2005+A1:2011
- BS EN 1997-1:2004+A1:2013 Eurocode 7. Geotechnical design
- BS EN ISO 14688-1:2018 - Geotechnical investigation and testing - Identification and description
- BS EN ISO 14688-2:2018 - Geotechnical investigation and testing - Principles for a classification
- BS 10175:2011+A2:2017 - Investigation of potentially contaminated sites
- LCRM 2021 Environment Agency
- BS 8004:2015 – Code of practice for foundations
- BS 1377:1990 Parts 1 to 8
- BRE Digest 241 “Low-rise buildings on shrinkable clay soils: Part 2
- BRE Special Digest 1, 2005, ‘Concrete in Aggressive Ground’
- Stroud, M. A. 1974, “The Standard Penetration Test – its application and interpretation”, Proc. ICE Conf. on Penetration Testing in the UK, Birmingham. Thomas Telford, London.
- N.E. Simons, B.K. Menzies, “A Short Course in Foundation Engineering”
- NHBC Standards Chapter 4.2, January 2022.
- SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination December 2014
- CIRIA C733, Asbestos in soil and made ground: a guide to understanding and managing risks and CAR2012 regulations.
- CIRIA C574, Engineering in Chalk; 2002
- Google Earth
- British Geological Survey Website & iGeology App

Appendix B Field Work

Appendix B.1 Engineers Logs

	Contract Name: Worcester Close, Gravesend, DA13 9LB				Client: Frankham Projects Limited				Hole ID: WS1					
	Contract Number: 20374		Start and End Date: 12/08/22		Logged By: EF		Checked By: AY		Status: FINAL		Hole Type: WS			
	Easting:		Northing:		Ground Level:		Plant Used: Premier 1		Print Date: 26/10/2022		Scale: 1:50			
Weather:			Termination: Reached scheduled depth					Sheet 1 of 1						
Samples & In Situ Testing				Strata Details								Groundwater		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/Installation	
0.10 0.20	ES D			(0.40)		Stiff greyish brown mottled dark brown slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is angular to well rounded fine to medium flint and chalk. Frequent rootlets and rare metallic fragments. MADE GROUND.						1		
0.50 0.60	ES D			0.40										
0.80 0.90	D ES			0.80		Stiff dark brown multicoloured mottled slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is fine to medium flint, chalk, brick and clinker. Occasional rootlets. MADE GROUND.						1		
1.20 1.30	D ES			(0.40)										
1.60	D			1.20		Stiff greyish brown mottled orangish brown slightly sandy CLAY. Sand is fine to medium. Occasional rootlets. HEAD						1		
1.30	ES			(0.50)										
1.60	D			1.70		Structureless CHALK. Recovered as slightly black speckled and orange stained, white, angular to sub-angular, fine to medium gravel sized weak to moderately dense chalk clasts in a comminuted silty matrix. Matrix is slightly orange stained, white. Rare angular medium gravel sized rinded flint nodules. Very rare rootlets. LSNCK						2		
2.30	D			(2.30)										
2.80	D					Structureless CHALK. Recovered as slightly black speckled and orange stained, white, angular to sub-angular, fine to medium gravel sized weak to moderately dense chalk clasts in a comminuted silty matrix. Matrix is slightly orange stained, white. Rare angular medium gravel sized rinded flint nodules. Very rare rootlets. LSNCK						3		
3.30	D													
3.80	D			4.00		End of Borehole at 4.00m						4		
														
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:					
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	Rootlets observed to 2.5m bgl.					
Chiselling					Installation				Water Strikes					
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
												0	0.00	No groundwater encountered
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.														

	Contract Name: Worcester Close, Gravesend, DA13 9LB				Client: Frankham Projects Limited				Hole ID: WS2					
	Contract Number: 20374		Start and End Date: 12/08/22		Logged By: EF		Checked By: AY		Status: FINAL		Hole Type: WS			
	Easting:		Northing:		Ground Level:		Plant Used: Premier 1		Print Date: 26/10/2022		Scale: 1:50			
Weather:			Termination: Reached scheduled depth								Sheet 1 of 1			
Samples & In Situ Testing					Strata Details							Groundwater		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/Installation	
0.10	ES					Firm dark brown and mottled white and dark grey slightly silty slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is angular to well rounded fine to medium flint, chalk and clinker. Occasional rootlets. HEAD								
0.30	D			(0.75)										
0.50	D													
0.60	ES			0.75										
0.80	D													
0.90	D			1.00		Structureless CHALK. Recovered as slightly black speckled and orange stained, white, angular to sub-angular, fine to medium gravel sized weak to moderately dense chalk clasts in a comminuted silty matrix. Matrix is slightly orange stained, white. Rare angular gravel sized flint. LSNCK						1		
	ES													
1.30	D					Structureless CHALK composed of slightly sandy silty subangular GRAVEL. Clasts are weak low and medium density white with occasional black speckling and orange staining. Rare rootlets. LSNCK								
1.80	D			(1.60)								2		
2.30	D													
2.80	D			2.60		Structureless CHALK composed of slightly sandy silty subangular GRAVEL. Clasts are weak low and medium density white with occasional black speckling and rare orange staining. LSNCK						3		
3.30	D			(1.40)										
3.80	D			4.00		End of Borehole at 4.00m						4		
												5		
												6		
												7		
												8		
												9		
												10		
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:					
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	Rootlets observed to 1.5m bgl.					
Chiselling					Installation				Water Strikes					
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
												0	0.00	No groundwater encountered
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.														

				Contract Name: Worcester Close, Gravesend, DA13 9LB				Client: Frankham Projects Limited				Hole ID: WS3			
				Contract Number: 20374		Start and End Date: 12/08/22		Logged By: EF		Checked By: AY		Status: FINAL		Hole Type: WS	
				Easting:		Northing:		Ground Level:		Plant Used: Premier 1		Print Date: 26/10/2022		Scale: 1:50	
Weather:				Termination: Reached scheduled depth								Sheet 1 of 1			
Samples & In Situ Testing					Strata Details								Groundwater		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/Installation		
0.10 0.20	ES D			(0.30) 0.30		Firm dark brown slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is angular to well rounded fine to medium flint, chalk and clinker. Frequent rootlets. HEAD									
0.50 0.60 0.80 0.90	D ES D ES			(0.70)		Stiff dark brown multicoloured mottled slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is fine to medium flint. Occasional rootlets and rare bioturbation with 2mm burrows. HEAD									
1.30	D			1.00		Structureless CHALK composed of slightly sandy silty angular to subangular GRAVEL. Clasts are very weak low and medium density white with frequent orange staining and occasional black speckles. Matrix is cream and light brown. LSNCK						1			
1.80	D			(1.00)											
2.30	D			2.00		Sturctureless CHALK composed of slightly sandy SILT. Gravel is angular to subangular weak low density white with frequent black speckling. Occasional orange staining. LSNCK						2			
2.80	D			(2.00)											
3.30	D											3			
3.80	D			4.00											
						End of Borehole at 4.00m						4			
												5			
												6			
												7			
												8			
												9			
												10			
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:						
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	Rootlets observed to 1.0m bgl.						
Chiselling					Installation				Water Strikes						
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	
					0.15 1.00	1.00 4.00	PLAIN SLOTTED	35 35				0	0.00	No groundwater encountered	
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.															

				Contract Name: Worcester Close, Gravesend, DA13 9LB				Client: Frankham Projects Limited				Hole ID: WS4			
				Contract Number: 20374		Start and End Date: 12/08/22		Logged By: EF		Checked By: AY		Status: FINAL		Hole Type: WS	
				Easting:		Northing:		Ground Level:		Plant Used: Premier 1		Print Date: 26/10/2022		Scale: 1:50	
Weather:				Termination: Reached scheduled depth						Sheet 1 of 1					
Samples & In Situ Testing					Strata Details								Groundwater		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/Installation		
0.10	ES			0.20		Stiff dark brown slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is angular to well rounded fine to medium flint, chalk and clinker. Frequent rootlets. HEAD Stiff orangish brown mottled dark grey slightly silty slightly sandy CLAY. Sand is fine to medium. Occasional rootlets. HEAD Stiff brownish grey multicoloured mottled slightly silty slightly sandy CLAY. Sand is fine to medium. Occasional rootlets. HEAD						1			
0.30	D			0.40											
0.60	D			(0.50)											
0.80	ES			0.90		Dark brownish grey multicoloured mottled clayey silty SAND. Sand is fine to medium. Occasional rootlets. HEAD						1			
0.90	D			(0.65)											
1.30	D			1.55		Structureless CHALK composed of slightly sandy silty angular GRAVEL. Gravels are subangular weak low density white with occasional black speckling and occasional orange staining. LSNCK						2			
1.80	D														
2.30	D														
2.80	D			(2.45)											
3.30	D														
3.80	D			4.00											
						End of Borehole at 4.00m						4			
												5			
												6			
												7			
												8			
												9			
												10			
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:						
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	Rootlets observed to 1.7m bgl.						
Chiselling					Installation				Water Strikes						
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	
												0	0.00	No groundwater encountered	
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.															

Project Name:	Worcester Close, Gravesend, DA13 9LB	Project No.	20374	Co-ords:		Hole Type	DP
Location:	Worcester Close, Gravesend, DA13 9LB	Level:	m AOD			Scale	1:50
Client:	Frankham Projects Limited	Dates:	12/08/2022			Logged By	

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
1	1				5
2	2				
3	3				
4	3				
5	3				
6	3				
7	3				
8	3				
9	3				
10	3				
11	3				
12	3				
13	3				
14	3				
15	3				
16	3				
17	3				
18	3				
19	3				
20	3				
21	3				
22	3				
23	3				
24	3				
25	3				
26	3				
27	3				
28	3				
29	3				
30	3				
31	3				
32	3				
33	3				
34	3				
35	3				
36	3				
37	3				
38	3				
39	3				
40	3				
41	3				
42	3				
43	3				
44	3				
45	3				
46	3				
47	3				
48	3				
49	3				
50	3				
51	3				
52	3				
53	3				
54	3				
55	3				
56	3				
57	3				
58	3				
59	3				
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61	3				
62	3				
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64	3				
65	3				
66	3				
67	3				
68	3				
69	3				
70	3				
71	3				
72	3				
73	3				
74	3				
75	3				
76	3				
77	3				
78	3				
79	3				
80	3				
81	3				
82	3				
83	3				
84	3				
85	3				
86	3				
87	3				
88	3				
89	3				
90	3				
91	3				
92	3				
93	3				
94	3				
95	3				
96	3				
97	3				
98	3				
99	3				
100	3				

Remarks	Fall Height	760mm	Cone Base Diameter	52mm
	Hammer Weight	64kg	Final Depth	6m
	Probe Type	DPSH-B	Energy Ratio (Er)	90.53%

Project Name:	Worcester Close, Gravesend, DA13 9LB	Project No.	20374	Co-ords:		Hole Type	DP
Location:	Worcester Close, Gravesend, DA13 9LB	Level:	m AOD			Scale	1:50
Client:	Frankham Projects Limited	Dates:	12/08/2022			Logged By	

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
1	1	4			5
	4				
	4				
	5				
	4				
	3				5
	2				
	5				
	4				
	3				
2	3				5
	3				
	3				
	3				
	3				
	4				5
	3				
	3				
	3				
	3				
3	4				10
	3				
	3				
	3				
	4				
	5				10
	3				
	4				
	5				
	5				
4	4				40
	3				
	4				
	3				
	4				
	5				40
	5				
	4				
	4				
	4				
5	3				40
	1				
	1				
	1				
	2				
6	4				40
	4				
7					40
8					40
9					40
10					40

Remarks	Fall Height	760mm	Cone Base Diameter	52mm
	Hammer Weight	64kg	Final Depth	6m
	Probe Type	DPSH-B	Energy Ratio (Er)	90.53%

Project Name:	Worcester Close, Gravesend, DA13 9LB	Project No.	20374	Co-ords:		Hole Type	DP
Location:	Worcester Close, Gravesend, DA13 9LB	Level:	m AOD			Scale	1:50
Client:	Frankham Projects Limited	Dates:	12/08/2022			Logged By	

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0	2	4			5
0.1	3	4			
0.2	3				5
0.3	2				
0.4	2				5
0.5	2				
0.6	2				5
0.7	2				
0.8	3				5
0.9	4				
1.0	5				10
1.1	4				
1.2	5				5
1.3	4				
1.4	3				5
1.5	4				
1.6	4				5
1.7	4				
1.8	4				5
1.9	4				
2.0	4				5
2.1	4				
2.2	4				5
2.3	4				
2.4	4				5
2.5	4				
2.6	4				5
2.7	4				
2.8	4				5
2.9	4				
3.0	4				5
3.1	4				
3.2	4				5
3.3	4				
3.4	4				5
3.5	4				
3.6	4				5
3.7	4				
3.8	4				5
3.9	4				
4.0	4				5
4.1	4				
4.2	4				5
4.3	4				
4.4	4				5
4.5	4				
4.6	4				5
4.7	4				
4.8	4				5
4.9	4				
5.0	4				5
5.1	4				
5.2	4				5
5.3	4				
5.4	4				5
5.5	4				
5.6	4				5
5.7	4				
5.8	4				5
5.9	4				
6.0	4				5
6.1	4				
6.2	4				5
6.3	4				
6.4	4				5
6.5	4				
6.6	4				5
6.7	4				
6.8	4				5
6.9	4				
7.0	4				5
7.1	4				
7.2	4				5
7.3	4				
7.4	4				5
7.5	4				
7.6	4				5
7.7	4				
7.8	4				5
7.9	4				
8.0	4				5
8.1	4				
8.2	4				5
8.3	4				
8.4	4				5
8.5	4				
8.6	4				5
8.7	4				
8.8	4				5
8.9	4				
9.0	4				5
9.1	4				
9.2	4				5
9.3	4				
9.4	4				5
9.5	4				
9.6	4				5
9.7	4				
9.8	4				5
9.9	4				
10.0	4				5
10.1	4				

Remarks	Fall Height	760mm	Cone Base Diameter	52mm
	Hammer Weight	64kg	Final Depth	6m
	Probe Type	DPSH-B	Energy Ratio (Er)	90.53%

Project Name:	Worcester Close, Gravesend, DA13 9LB	Project No.	20374	Co-ords:		Hole Type	DP
Location:	Worcester Close, Gravesend, DA13 9LB	Level:	m AOD			Scale	1:50
Client:	Frankham Projects Limited	Dates:	12/08/2022			Logged By	

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0.0	2				
0.1	3				
0.2	3				
0.3	2				
0.4	3				
0.5	3				
0.6	2				
0.7	3				
0.8	3				
0.9	4				
1.0	3				10
1.1	3				
1.2	5				
1.3	7				
1.4	4				
1.5	3				
1.6	3				
1.7	3				
1.8	4				
1.9	3				10
2.0	4				
2.1	4				
2.2	4				
2.3	5				
2.4	5				
2.5	6				
2.6	7				
2.7	6				
2.8	6				
2.9	7				10
3.0	8				
3.1	8				
3.2	8				
3.3	10				
3.4	9				
3.5	12				
3.6	14				
3.7	12				
3.8	11				45
3.9	12				
4.0	9				
4.1	9				
4.2	9				
4.3	11				
4.4	16				
4.5	15				
4.6	12				
4.7	10				
4.8	10				35
4.9	10				
5.0					
6.0					
7.0					
8.0					
9.0					
10.0					

Remarks	Fall Height	760mm	Cone Base Diameter	52mm
	Hammer Weight	64kg	Final Depth	5m
	Probe Type	DPSH-B	Energy Ratio (Er)	90.53%

Appendix C Geotechnical In-Situ and Laboratory Testing

Appendix C.1 Classification

Classification based on SPT “N” values:

The inferred undrained strength of the cohesive soils was based on the SPT “N” blow counts, derived from the relationship suggested by Stroud (1974) and classified using Table C.1.1. (Ref: Stroud, M. A. 1974, “The Standard Penetration Test – its application and interpretation”, Proc. ICE Conf. on Penetration Testing in the UK, Birmingham. Thomas Telford, London.).

Table C.1.1 SPT “N” Blow Count Cohesive Classification

Classification	Undrained Cohesive Strength C_u (kPa)
Extremely low	<10
Very low	10 – 20
Low	20 – 40
Medium	40 – 75
High	75 – 150
Very high	150 – 300
Extremely high	> 300

Note(s): (Ref: BS EN ISO 14688-2:2004+A1:2013 Clause 5.3.)

The relative density of granular soils was classified based of the relationship given in Table C.1.2.

The *UK National Annex to Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing*, NA 3.7 SPT test, BS EN 1997-2:2007, Annex F states “Relative density descriptions on borehole records should also be based on uncorrected SPT N values, unless significantly disturbed, using the density classification in BS 5930:2015, Table 7.

Table C.1.2 SPT “N” Blow Count Granular Classification

Classification	SPT “N” blow count (blows/300mm)
Very loose	0 to 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very dense	Greater than 50

Note(s): (Ref: The Standard Penetration Test (SPT): Methods and Use, CIRIA Report 143, 1995)

Chalk samples recovered are disturbed by the sampling process. Therefore, it is difficult to assess an accurate chalk grade for in accordance with CIRIA C574 ‘Engineering in

Chalk'. In the absence of a standardised correlation between SPT "N" values and chalk grade for the most recent chalk classification (CIRIA C574) a broad indication of the in-situ chalk grade can be assessed using a paper by T.R.M. Wakeling from a site in Mundford, Norfolk, which compares SPT "N" values to the old Spink & Norbury chalk classification. From the Spink & Norbury classification it is possible to infer a basic CIRIA Grade (structureless or structured), as outlined in Table C.1.3.

Table C.1.3 Interpretation of SPT "N" Blow Counts in Chalk

SPT "N" Value Range	Spink & Norbury Grade	Inferred CIRIA Grade
<8	VI	Structureless (Dm)
8 – 15	V	Structureless (Dc)
15 – 20	IV	Structured chalk (C5 – A1)
20 - 25	III	Structured chalk (C5 – A1)
25 - 35	II	Structured chalk (C5 – A1)
>35	I	Structured chalk (C5 – A1)

Note(s):

Classification of DCP results to CBR:

The DCP consists of a cone fixed to the bottom of a 575mm vertical rod. An 8kg weight is repeatedly lifted and dropped onto an anvil at the mid-height of the rod to deliver a 'blow'. A vertical scale alongside the rod is used to measure the depth of penetration of the cone. These measurements are then converted to CBR values using the following equation derived from the DTP Interim Advice Note 73/06 – Design Guidance for Road Pavement Foundations:

Appendix C.2 Interpretation**Table C.2.1 Interpretation of DPSH Blow Counts**

DP	Strata	Equivalent SPT N60 Blow Counts	Inferred Cohesive Strength/Granular Density/Approximate CIRIA Chalk Grade
DPI	HD 1.20 – 1.70 CLAY	9 – 13	Medium strength ($C_u = 45 - 65\text{kPa}$)
	LSNCK 1.70 – 4.00 CHALK	13 – >35	Structureless (Dc) to structured chalk (C5 – A1) Grade I
	LSNCK ¹ 4.00 – 6.00 CHALK	>35	Structured chalk (C5 – A1) Grade I
DP2	HD 0.00 – 0.75 CLAY	4 – 22	Low to high strength ($C_u = 20 - 110\text{kPa}$)
	LSNCK 0.75 – 4.00 Chalk	9 - 22	Structureless (Dc) to structured chalk (C5 – A1) Grade III
	LSNCK ¹ 4.00 – 5.40 CHALK	13 – 22	Structureless (Dc) to structured chalk (C5 – A1) Grade III
	LSNCK ¹ 5.40 – 5.80 CHALK	4 – 9	Structureless (Dm) to structureless (Dc)
	LSNCK ¹ 5.80 – 6.00 CHALK	18	Structured chalk (C5 – A1) Grade IV
DP3	HD 0.00 – 1.00 CLAY	9 – 18	Medium to high strength ($C_u = 45 - 90\text{kPa}$)
	LSNCK 1.00 – 4.00 Chalk	9 – 27	Structureless (Dc) to structured chalk (C5 – A1) Grade II
	LSNCK ¹ 4.00 – 6.00 CHALK	9 – 18	Structureless (Dc) to structured chalk (C5 – A1) Grade IV
DP4	HD 0.00 – 0.90 CLAY	9 – 13	Medium strength ($C_u = 45 - 65\text{kPa}$)
	HD 0.90 – 1.55 SAND	13 – 31	Medium dense to dense
	LSNCK 1.55 – 2.00 Chalk	13 - 18	Structureless (Dc) to structured chalk (C5 – A1) Grade IV
	LSNCK 2.00 – 4.00 Chalk	18 - >35	Structured chalk (C5 – A1) Grade I

DP	Strata	Equivalent SPT N60 Blow Counts	Inferred Cohesive Strength/Granular Density/Approximate CIRIA Chalk Grade
	LSNCK ¹ 4.00 – 5.00 CHALK	>35	Structured chalk (C5 – A1)

Note(s): ¹ Ground conditions inferred past the base of windowless sampler boreholes.

Table C.2.2 Interpretation of Atterberg Limit Tests

Stratum	Moisture Content (%)	Plasticity Index (%)	Passing 425µm Sieve (%)	Modified Plasticity Index (%)	Soil Classification	Volume Change Potential	
						BRE	NHBC
HD	23 – 24	33 – 34	90 – 100	22 – 23	CH	Medium	Medium

Note(s): BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)

NHBC Volume Change Potential refers to NHBC Standards Chapter 4.2

Soils Classification based on British Soil Classification System

The most common use of the term clay is to describe a soil that contains enough clay-sized material or clay minerals to exhibit cohesive properties. The fraction of clay-sized material required varies, but can be as low as 15%. Unless stated otherwise, this is the sense used in Digest 240. The term can be used to denote the clay minerals. These are specific, naturally occurring chemical compounds, predominately silicates. The term is often used as a particle size descriptor. Soil particles that have a nominal diameter of less than 2 µm are normally considered to be of clay size, but they are not necessarily clay minerals. Some clay minerals are larger than 2 µm and some particles, 'rock flour' for example, can be finer than 2 µm but are not clay minerals.

(The Atterberg Limit Tests were undertaken in accordance with BS 1377:Part 2:1990 Clauses 3.2, 4.3 and 5)

Table C.2.3 Interpretation of SMC Tests

Location	Depth (m bgl)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Moisture Content (%)	Saturation Moisture Content (%)	Density Classification (CIRIA)
WS1	2.80 – 3.30	1.62	1.45	11	32	Low
WS2	1.30 – 1.80	1.87	1.48	26	31	Low
WS3	3.30 – 3.80	1.92	1.51	27	29	Low

Note(s): (The Determination of Saturation Moisture Content of Chalk Tests were made in accordance with BS 1377: Part 2: 1990 Clauses 3.3)

Appendix C.3 Geotechnical In-Situ and Laboratory Results

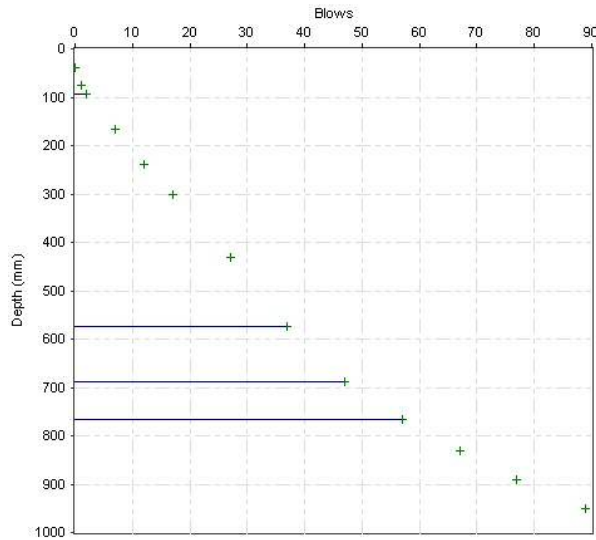
DCP Layer Strength Analysis Report

Project Name: 20374_Worcester Close_DCP 1-3

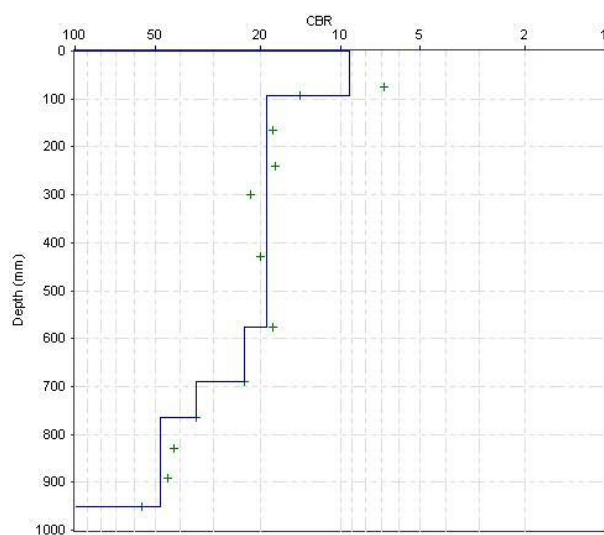
Chainage (km): 1.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 12/08/2022

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

Layer Boundaries: Chainage 1.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	27.00	9	94	94	Base	0.03	0.09	0.09	0.09
2	13.74	19	481	575	Base	0.05	0.92	0.92	0.92
3	11.40	23	114	689	Base	0.06	0.26	0.26	0.26
4	7.70	35	77	766	Base	0.08	0.24	0.24	0.24
5	5.75	48	184	950	Base	0.10	0.71	0.71	0.71

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	2.22	2.22	2.22
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	2.22	2.22	2.22

CBR Relationship:

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

Report produced by

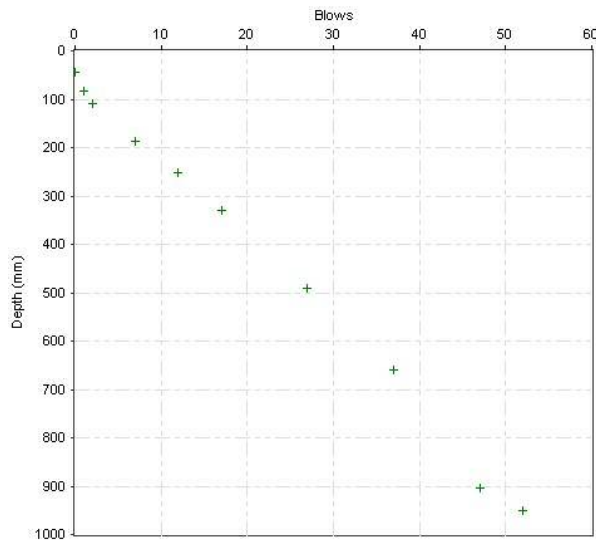
DCP Layer Strength Analysis Report

Project Name: 20374_Worcester Close_DCP 1-3

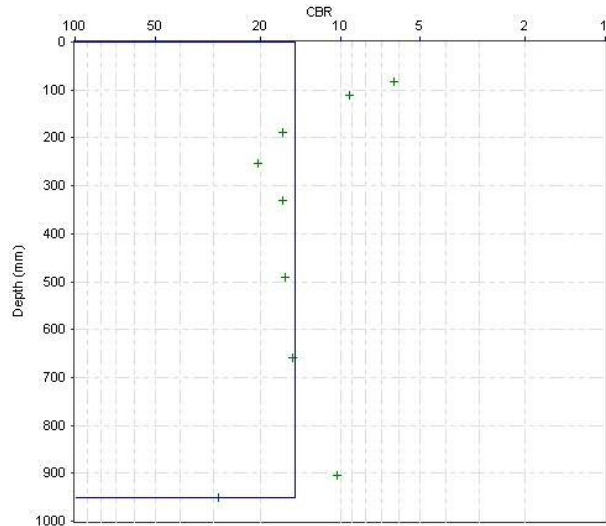
Chainage (km): 2.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 12/08/2022

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

Layer Boundaries: Chainage 2.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	17.42	15	950	950	Base	0.04	1.45	1.45	1.45

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	1.45	1.45	1.45
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	1.45	1.45	1.45

CBR Relationship:

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

Report produced by

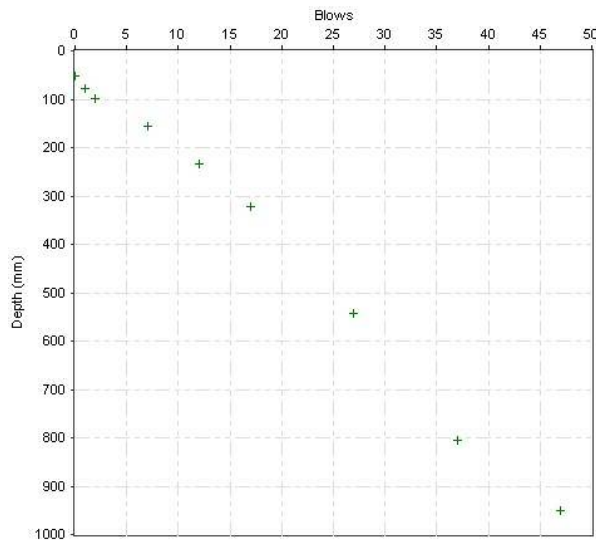
DCP Layer Strength Analysis Report

Project Name: 20374_Worcester Close_DCP 1-3

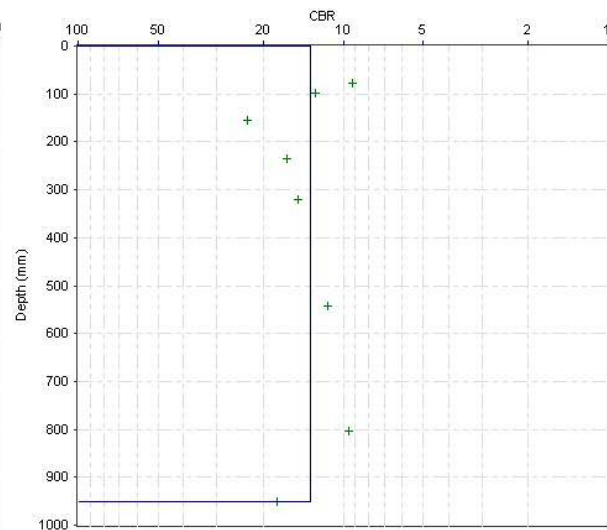
Chainage (km): 3.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 12/08/2022

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

Layer Boundaries: Chainage 3.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	19.13	13	950	950	Base	0.04	1.33	1.33	1.33

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	1.33	1.33	1.33
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	1.33	1.33	1.33

CBR Relationship:

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

Report produced by



Laboratory Report



Contract Number: 61140

Client Ref: **20374/AY**

Client PO: **20374**

Date Received: **02-09-2022**

Date Completed: **20-09-2022**

Report Date: **20-09-2022**

Client: **Soils Limited**
Newton House
Cross Road
Tadworth
Surrey
KT20 5SR

This report has been checked and approved by:

Paul Evans
Director

Contract Title: **Worcester Close, Gravesend, DA13 9LB.**

For the attention of: **Andrew Yuen**

Test Description	Qty
Moisture Content of Soil BS1377 : Part 2 : Clause 3.2 : 1990 - * UKAS	2
1 Point Liquid & Plastic Limit BS 1377:1990 - Part 2 : 4.4 & 5.3 - * UKAS	2
Saturated moisture content of chalk BS1377 : Part 2 : Clause 3.3 : 1990 - * UKAS	3
Disposal of samples for job	1

Notes: Observations and Interpretations are outside the UKAS Accreditation

* - denotes test included in laboratory scope of accreditation

- denotes test carried out by approved contractor

@ - denotes non accredited tests

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Approved Signatories:

Brendan Evans (Office Administrator) - Paul Evans (Director) - Richard John (Quality/Technical Manager)

Shaun Jones (Laboratory manager) - Shaun Thomas (Site Manager) - Wayne Honey (Human Resources/ Health and Safety Coordinator)

**NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND
PLASTICITY INDEX
(BS 1377:1990 - Part 2 : 4.4 & 5.3)**

Contract Number	61140	
Site Name	Worcester Close, Gravesend, DA13 9LB.	
Date Tested	14/09/2022	
	DESCRIPTIONS	

[illegible]

Operators
Darcy Etheridge

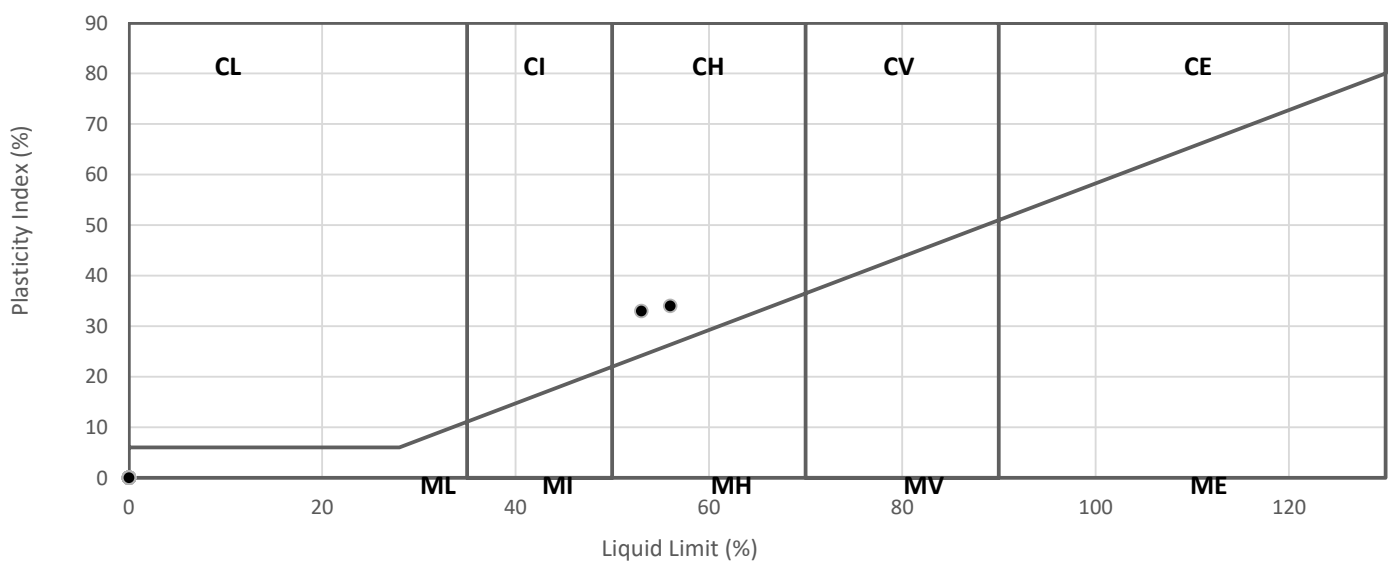
**NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND
PLASTICITY INDEX
(BS 1377:1990 - Part 2 : 4.4 & 5.3)**

Contract Number	61140	
Project Location	Worcester Close, Gravesend, DA13 9LB.	
Date Tested	14/09/2022	

[illegible]

Symbols: NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION BS 5930:1999+A2:2010



Operators
Darcy Etheridge



Andrew Yuen
Soils Ltd
Newton House
Cross Road
Tadworth
Surrey
KT20 5SR

Derwentside Environmental Testing Services Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410

DETS Report No: 22-07349

Site Reference: Worcester Close, Gravesend, DA13 9LB

Project / Job Ref: 20374

Order No: 20374/BRE/AY

Sample Receipt Date: 01/09/2022

Sample Scheduled Date: 01/09/2022

Report Issue Number: 1

Reporting Date: 07/09/2022

Authorised by:

Dave Ashworth
Technical Manager

Dates of laboratory activities for each tested analyte are available upon request.

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Soil Analysis Certificate						
DETS Report No: 22-07349	Date Sampled	23/08/22	23/08/22	23/08/22	23/08/22	
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	
Site Reference: Worcester Close, Gravesend, DA13 9LB	TP / BH No	WS1	WS2	WS2	WS3	
Project / Job Ref: 20374	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	
Order No: 20374/BRE/AY	Depth (m)	1.60	0.50	2.30	0.80	
Reporting Date: 07/09/2022	DETS Sample No	611049	611050	611051	611052	

Determinand	Unit	RL	Accreditation	(n)			
pH	pH Units	N/a	MCERTS	8.2	8.1	8.3	8.0
Total Sulphate as SO ₄	mg/kg	< 200	MCERTS	< 200	476		
Total Sulphate as SO ₄	%	< 0.02	MCERTS	< 0.02	0.05		
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	15	< 10	< 10	< 10
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.01	< 0.01	< 0.01	< 0.01
Total Sulphur	%	< 0.02	NONE	< 0.02	< 0.02		
Ammonium as NH ₄	mg/kg	< 0.5	ISO17025	1.1	0.8		
Ammonium as NH ₄	mg/l	< 0.05	ISO17025	0.11	0.08		
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	25	6		
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	12.3	3		
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	< 3	MCERTS	< 3	22		
Water Soluble Nitrate (2:1) as NO ₃	mg/l	< 1.5	MCERTS	< 1.5	10.8		
W/S Magnesium	mg/l	< 0.1	NONE	1.2	2.1		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Method Description page describes if the test is performed on the dried or as-received portion

Subcontracted analysis (S)

(n) Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation



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Soil Analysis Certificate - Sample Descriptions

DETS Report No: 22-07349	
Soils Ltd	
Site Reference: Worcester Close, Gravesend, DA13 9LB	
Project / Job Ref: 20374	
Order No: 20374/BRE/AY	
Reporting Date: 07/09/2022	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
611049	WS1	None Supplied	1.60	8.9	Brown sandy clay
611050	WS2	None Supplied	0.50	11	Brown sandy clay with chalk
611051	WS2	None Supplied	2.30	21.9	White chalk
611052	WS3	None Supplied	0.80	14.3	Brown sandy clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample ^{1/s}

Unsuitable Sample ^{u/s}



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 22-07349

Soils Ltd

Site Reference: Worcester Close, Gravesend, DA13 9LB

Project / Job Ref: 20374

Order No: 20374/BRE/AY

Reporting Date: 07/09/2022

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 - C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	Fraction Organic Carbon (FOC)	Determination of TOC by combustion analyser.	E027
Soil	D	Organic Matter (SOM)	Determination of TOC by combustion analyser.	E027
Soil	D	TOC (Total Organic Carbon)	Determination of TOC by combustion analyser.	E027
Soil	AR	Exchangeable Ammonium	Determination of ammonium by discrete analyser.	E029
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCS	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received



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List of HWOL Acronyms and Operators	
DETS Report No: 22-07349	
Soils Ltd	
Site Reference: Worcester Close, Gravesend, DA13 9LB	
Project / Job Ref: 20374	
Order No: 20374/BRE/AY	
Reporting Date: 07/09/2022	

Acronym	Description
HS	Headspace analysis
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent
CU	Clean-up - e.g. by florisil, silica gel
1D	GC - Single coil gas chromatography
2D	GC-GC - Double coil gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics only
AR	Aromatics only
#1	EH_2D_Total but with humics mathematically subtracted
#2	EH_2D_Total but with fatty acids mathematically subtracted
	Operator - underscore to separate acronyms (exception for +)
+	Operator to indicate cumulative eg. EH+HS_Total or EH_CU+HS_Total
Det - Acronym	

Appendix D Chemical Laboratory Analyses

Appendix D.1 Conceptual Site Model

Table D.I.1 CSM Revised Pre-Chemical Analyses

Source	Potential Contaminant	Exposure Pathway	Receptor	Initial Assessment from Desk Study and Main Investigation Report Information			Comments	Proposed Investigation
				Severity	Probability	Risk		
Made Ground Onsite historic and current site usage	Metals, Semi-metals and non-metals, PAHs, Asbestos	Inhalation of dust	Site Workers/Site Maintenance	Medium	Low	Moderate/Low	Made Ground was found during the Phase II ground investigation.	Chemical testing prior to undertaking a generic qualitative risk assessment.
			End Users	Mild	Unlikely	Very low		
			Off-site Users	Mild	Unlikely	Very low		
	PAHs	Inhalation of Vapour/gases (including Radon)	Site Workers/Site Maintenance	Mild	Unlikely	Very low		
			End Users					
			Off-site Users					
	Metals, Semi-metals and non-metals, PAHs	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	Medium	Low	Moderate/Low		
			End Users	Medium	Unlikely	Low		
	Metals, Semi-metals and non-metals, PAHs	Migration via surface runoff	Surface Water	Mild	Unlikely	Very low		
		Migration in solution via groundwater	Surface Water	Mild	Unlikely	Very low		
			Shallow Aquifer	Medium	Unlikely	Low		
			Deep Aquifer	Medium	Unlikely	Low		
		Direct contact with construction material	Buried structures	Mild	Low	Low		
			Buried Services					

Table D.I.2 CSM Revised Post-Chemical Analyses

Source	Potential Contaminant	Exposure Pathway	Receptor	Initial Assessment from Desk Study and Main Investigation Report Information			Comments	Proposed Investigation
				Severity	Probability	Risk		
Made Ground Onsite historic and current site usage	None	Inhalation of dust	Site Workers/Site Maintenance					None of the samples had exceedances against commercial land-use, that being considered the appropriate land-use given the nature of the proposed development: Ground gas and water risk are likewise considered low to negligible in context and as such no remediation or mitigation is considered necessary and no significant risk has been identified to the identified vulnerable receptors outlined in the initial Conceptual Site Model. However, it is a common planning requirement and under CDM that as unknowns always remain, a formalised discovery strategy must be in place during construction and groundworks at a site potentially affected by contamination.
			End Users					
			Off-site Users					
	None	Inhalation of Vapour/gases (including Radon)	Site Workers/Site Maintenance					
			End Users					
			Off-site Users					
	None	Ingestion and absorption via direct contact	Site Workers/Site Maintenance					
			End Users					
	None	Migration via surface runoff	Surface Water					
		Migration in solution via groundwater	Surface Water					
			Shallow Aquifer					
			Deep Aquifer					
		Direct contact with construction material	Buried structures					
			Buried Services					

Appendix D.2 Chemical Laboratory Results



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t: 01622 850410

DETS Report No: 22-07348

Site Reference: Worcester Close, Gravesend, DA13 9LB

Project / Job Ref: 20374

Order No: 20374/AY

Sample Receipt Date: 01/09/2022

Sample Scheduled Date: 01/09/2022

Report Issue Number: 1

Reporting Date: 06/09/2022

Authorised by:

Dave Ashworth
Technical Manager

Dates of laboratory activities for each tested analyte are available upon request.

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Soil Analysis Certificate						
DETS Report No: 22-07348	Date Sampled	23/08/22	23/08/22	23/08/22	23/08/22	23/08/22
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Worcester Close, Gravesend, DA13 9LB	TP / BH No	WS1	WS1	WS2	WS3	WS4
Project / Job Ref: 20374	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: 20374/AY	Depth (m)	0.10	0.50	0.10	0.10	0.10
Reporting Date: 06/09/2022	DETS Sample No	611044	611045	611046	611047	611048

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
pH	pH Units	N/a	MCERTS	7.3	7.8	7.9	7.6	7.6
Total Cyanide	mg/kg	< 2	NONE	< 2				
Free Cyanide	mg/kg	< 2	NONE	< 2				
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	20				
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.02				
Organic Matter (SOM)	%	< 0.1	MCERTS	8.1	2.2	2.2	4.8	6.4
Arsenic (As)	mg/kg	< 2	MCERTS	16	18	18	29	48
W/S Boron	mg/kg	< 1	NONE	1.1	1	1.2	1.1	1.2
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	0.3	< 0.2	0.4	0.5	0.6
Chromium (Cr)	mg/kg	< 2	MCERTS	45	56	51	47	46
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	20	20	20	20	30
Lead (Pb)	mg/kg	< 3	MCERTS	60	69	63	90	148
Mercury (Hg)	mg/kg	< 1	MCERTS	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	22	23	22	21	23
Selenium (Se)	mg/kg	< 2	MCERTS	< 3	< 3	< 3	< 3	< 3
Vanadium (V)	mg/kg	< 1	MCERTS	41	47	46	42	45
Zinc (Zn)	mg/kg	< 3	MCERTS	79	73	67	75	92
Total Phenols (monohydric)	mg/kg	< 2	NONE	2.6	< 2	< 2	< 2	< 2

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Method Description page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)



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Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 22-07348	Date Sampled	23/08/22	23/08/22	23/08/22	23/08/22	23/08/22
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Worcester Close, Gravesend, DA13 9LB	TP / BH No	WS1	WS1	WS2	WS3	WS4
Project / Job Ref: 20374	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: 20374/AY	Depth (m)	0.10	0.50	0.10	0.10	0.10
Reporting Date: 06/09/2022	DETS Sample No	611044	611045	611046	611047	611048

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6



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Soil Analysis Certificate - EPH Texas Banded						
DETS Report No: 22-07348	Date Sampled	23/08/22	23/08/22	23/08/22	23/08/22	
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	
Site Reference: Worcester Close, Gravesend, DA13 9LB	TP / BH No	WS1	WS2	WS3	WS4	
Project / Job Ref: 20374	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	
Order No: 20374/AY	Depth (m)	0.50	0.10	0.10	0.10	
Reporting Date: 06/09/2022	DETS Sample No	611045	611046	611047	611048	

Determinand	Unit	RL	Accreditation					
EPH Texas (C6 - C8) : HS 1D MS Total	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	
EPH Texas (>C8 - C10) : EH 1D Total	mg/kg	< 1	MCERTS	< 1	< 1	< 1	< 1	
EPH Texas (>C10 - C12) : EH 1D Total	mg/kg	< 1	MCERTS	< 1	< 1	< 1	< 1	
EPH Texas (>C12 - C16) : EH 1D Total	mg/kg	< 1	MCERTS	< 1	< 1	< 1	2	
EPH Texas (>C16 - C21) : EH 1D Total	mg/kg	< 1	MCERTS	< 1	< 1	< 1	2	
EPH Texas (>C21 - C40) : EH 1D Total	mg/kg	< 6	MCERTS	< 6	< 6	11	15	
EPH Texas (C6 - C40) : HS 1D MS+EH 1D Total	mg/kg	< 6	NONE	< 6	< 6	11	19	



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Soil Analysis Certificate - TPH CWG Banded

DETS Report No: 22-07348	Date Sampled	23/08/22				
Soils Ltd	Time Sampled	None Supplied				
Site Reference: Worcester Close, Gravesend, DA13 9LB	TP / BH No	WS1				
Project / Job Ref: 20374	Additional Refs	None Supplied				
Order No: 20374/AY	Depth (m)	0.10				
Reporting Date: 06/09/2022	DETS Sample No	611044				

Determinand	Unit	RL	Accreditation				
Aliphatic >C5 - C6 : HS_1D_MS_AL	mg/kg	< 0.01	NONE	< 0.01			
Aliphatic >C6 - C8 : HS_1D_MS_AL	mg/kg	< 0.05	NONE	< 0.05			
Aliphatic >C8 - C10 : EH_CU_1D_AL	mg/kg	< 2	MCERTS	< 2			
Aliphatic >C10 - C12 : EH_CU_1D_AL	mg/kg	< 2	MCERTS	< 2			
Aliphatic >C12 - C16 : EH_CU_1D_AL	mg/kg	< 3	MCERTS	< 3			
Aliphatic >C16 - C21 : EH_CU_1D_AL	mg/kg	< 3	MCERTS	< 3			
Aliphatic >C21 - C34 : EH_CU_1D_AL	mg/kg	< 10	MCERTS	< 10			
Aliphatic (C5 - C34) : HS_1D_MS+EH_CU_1D_AL	mg/kg	< 21	NONE	< 21			
Aromatic >C5 - C7 : HS_1D_MS_AR	mg/kg	< 0.01	NONE	< 0.01			
Aromatic >C7 - C8 : HS_1D_MS_AR	mg/kg	< 0.05	NONE	< 0.05			
Aromatic >C8 - C10 : EH_CU_1D_AR	mg/kg	< 2	MCERTS	< 2			
Aromatic >C10 - C12 : EH_CU_1D_AR	mg/kg	< 2	MCERTS	< 2			
Aromatic >C12 - C16 : EH_CU_1D_AR	mg/kg	< 2	MCERTS	< 2			
Aromatic >C16 - C21 : EH_CU_1D_AR	mg/kg	< 3	MCERTS	< 3			
Aromatic >C21 - C35 : EH_CU_1D_AR	mg/kg	< 10	MCERTS	< 10			
Aromatic (C5 - C35) : HS_1D_MS+EH_CU_1D_AR	mg/kg	< 21	NONE	< 21			
Total >C5 - C35 : HS_1D_MS+EH_CU_1D_Tot al	mg/kg	< 42	NONE	< 42			



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Soil Analysis Certificate - BTEX / MTBE						
DETS Report No: 22-07348	Date Sampled	23/08/22				
Soils Ltd	Time Sampled	None Supplied				
Site Reference: Worcester Close, Gravesend, DA13 9LB	TP / BH No	WS1				
Project / Job Ref: 20374	Additional Refs	None Supplied				
Order No: 20374/AY	Depth (m)	0.10				
Reporting Date: 06/09/2022	DETS Sample No	611044				

Determinand	Unit	RL	Accreditation				
Benzene : HS_1D_MS	ug/kg	< 2	MCERTS	< 2			
Toluene : HS_1D_MS	ug/kg	< 5	MCERTS	< 5			
Ethylbenzene : HS_1D_MS	ug/kg	< 2	MCERTS	< 2			
p & m-xylene : HS_1D_MS	ug/kg	< 2	MCERTS	< 2			
o-xylene : HS_1D_MS	ug/kg	< 2	MCERTS	< 2			
MTBE : HS_1D_MS	ug/kg	< 5	MCERTS	< 5			



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Soil Analysis Certificate - PCB (7 Congeners)						
DETS Report No: 22-07348	Date Sampled	23/08/22				
Soils Ltd	Time Sampled	None Supplied				
Site Reference: Worcester Close, Gravesend, DA13 9LB	TP / BH No	WS1				
Project / Job Ref: 20374	Additional Refs	None Supplied				
Order No: 20374/AY	Depth (m)	0.10				
Reporting Date: 06/09/2022	DETS Sample No	611044				

Determinand	Unit	RL	Accreditation				
PCB Congener 28	mg/kg	0.008	NONE	< 0.008			
PCB Congener 52	mg/kg	0.008	NONE	< 0.008			
PCB Congener 101	mg/kg	0.008	NONE	< 0.008			
PCB Congener 118	mg/kg	0.008	NONE	< 0.008			
PCB Congener 138	mg/kg	0.008	NONE	< 0.008			
PCB Congener 153	mg/kg	0.008	NONE	< 0.008			
PCB Congener 180	mg/kg	0.008	NONE	< 0.008			
Total PCB (7 Congeners)	mg/kg	< 0.1	NONE	< 0.1			



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Soil Analysis Certificate - Sample Descriptions

DETS Report No: 22-07348	
Soils Ltd	
Site Reference: Worcester Close, Gravesend, DA13 9LB	
Project / Job Ref: 20374	
Order No: 20374/AY	
Reporting Date: 06/09/2022	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
611044	WS1	None Supplied	0.10	10	Brown sandy clay with stones and vegetation
611045	WS1	None Supplied	0.50	12.3	Brown sandy clay
611046	WS2	None Supplied	0.10	9.6	Brown sandy clay with stones
611047	WS3	None Supplied	0.10	11.9	Brown sandy clay with vegetation
611048	WS4	None Supplied	0.10	12.2	Brown sandy clay with vegetation

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample ^{u/s}

Unsuitable Sample ^{u/s}



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 22-07348

Soils Ltd

Site Reference: Worcester Close, Gravesend, DA13 9LB

Project / Job Ref: 20374

Order No: 20374/AY

Reporting Date: 06/09/2022

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 - C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	Fraction Organic Carbon (FOC)	Determination of TOC by combustion analyser.	E027
Soil	D	Organic Matter (SOM)	Determination of TOC by combustion analyser.	E027
Soil	D	TOC (Total Organic Carbon)	Determination of TOC by combustion analyser.	E027
Soil	AR	Exchangeable Ammonium	Determination of ammonium by discrete analyser.	E029
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCS	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received



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List of HWOL Acronyms and Operators	
DETS Report No: 22-07348	
Soils Ltd	
Site Reference: Worcester Close, Gravesend, DA13 9LB	
Project / Job Ref: 20374	
Order No: 20374/AY	
Reporting Date: 06/09/2022	

Acronym	Description
HS	Headspace analysis
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent
CU	Clean-up - e.g. by florisil, silica gel
1D	GC - Single coil gas chromatography
2D	GC-GC - Double coil gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics only
AR	Aromatics only
#1	EH_2D_Total but with humics mathematically subtracted
#2	EH_2D_Total but with fatty acids mathematically subtracted
	Operator - underscore to separate acronyms (exception for +)
+	Operator to indicate cumulative eg. EH+HS_Total or EH_CU+HS_Total

Det - Acronym
Benzene - HS_1D_MS
EPH Texas (C10 - C12) - EH_1D_Total
EPH Texas (C12 - C16) - EH_1D_Total
EPH Texas (C16 - C21) - EH_1D_Total
EPH Texas (C21 - C40) - EH_1D_Total
EPH Texas (C6 - C40) - HS_1D_MS+EH_1D_Total
EPH Texas (C6 - C8) - HS_1D_MS_Total
EPH Texas (C8 - C10) - EH_1D_Total
Ethylbenzene - HS_1D_MS
MTBE - HS_1D_MS
TPH CWG - Aliphatic >C10 - C12 - EH_CU_1D_AL
TPH CWG - Aliphatic >C12 - C16 - EH_CU_1D_AL
TPH CWG - Aliphatic >C16 - C21 - EH_CU_1D_AL
TPH CWG - Aliphatic >C21 - C34 - EH_CU_1D_AL
TPH CWG - Aliphatic >C5 - C6 - HS_1D_MS_AL
TPH CWG - Aliphatic >C6 - C8 - HS_1D_MS_AL
TPH CWG - Aliphatic >C8 - C10 - EH_CU_1D_AL
TPH CWG - Aliphatic C5 - C34 - HS_1D_MS+EH_CU_1D_AL
TPH CWG - Aromatic >C10 - C12 - EH_CU_1D_AR
TPH CWG - Aromatic >C12 - C16 - EH_CU_1D_AR
TPH CWG - Aromatic >C16 - C21 - EH_CU_1D_AR
TPH CWG - Aromatic >C21 - C35 - EH_CU_1D_AR
TPH CWG - Aromatic >C5 - C35 - HS_1D_MS+EH_CU_1D_AR
TPH CWG - Aromatic >C5 - C7 - HS_1D_MS_AR
TPH CWG - Aromatic >C7 - C8 - HS_1D_MS_AR
TPH CWG - Aromatic >C8 - C10 - EH_CU_1D_AR
TPH CWG - Total >C5 - C35 - HS_1D_MS+EH_CU_1D_Total
Toluene - HS_1D_MS
m & p-xylene - HS_1D_MS
o-Xylene - HS_1D_MS

Appendix D.3 General Assessment Criteria

HUMAN HEALTH RISK ASSESSMENT

Introduction

The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref. 1.1, which was introduced by the Environment Act 1995, ref. 1.2;

‘Land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

- (a) significant harm is being caused or there is a significant possibility of such harm being caused; or
- (b) pollution of controlled waters is being, or is likely to be, caused.’

The UK guidance on the assessment of contaminated has developed as a direct result of the introduction of these two Acts. The technical guidance supporting the new legislation has been summarised in a number of key documents collectively known as the Contaminated Land Reports (CLRs), a proposed series of twelve documents. Seven were originally published in March 1994, four more were published in April 2002, while the last remaining guidance document, CLR 11, ref 1.3 was published in 2004. In 2008 CLR reports 7 to 10 were withdrawn by DEFRA and the Environment Agency and updated version of CLR 9 and 10 were produced in the form of Science Reports SR2, ref. 1.4 and SR3, ref. 1.5.

In establishing whether a site fulfils the statutory definition of ‘contaminated land’ it is necessary to identify, whether a pollutant linkage exists in respect of the land in question and whether the pollutant linkage:

- is resulting in significant harm being caused to the receptor in the pollutant linkage,
- presents a significant possibility of significant harm being caused to that receptor,
- is resulting in the pollution of the controlled waters which constitute the receptor, or
- is likely to result in such pollution.

A ‘pollutant linkage’ may be defined as the link between a contaminant ‘source’ and a ‘receptor’ by means of a ‘pathway’.

Assessment Methodology

The guidance proposes a four-stage assessment process for identifying potential pollutant linkages on a site. These stages are set out in the table below:

No.	Process	Description
1	Hazard Identification	Establishing contaminant sources, pathways and receptors (the conceptual model).
2	Hazard Assessment	Analysing the potential for unacceptable risks (what linkages could be present, what could be the effects).
3	Risk Estimation	Trying to establish the magnitude and probability of the possible consequences (what degree of harm might result and to what receptors, and how likely is it).
4	Risk Evaluation	Deciding whether the risk is unacceptable.

Stages 1 and 2 develop a '*conceptual model*' based upon information collated from desk based studies, and frequently a walkover of the site. The walkover survey should be conducted in general accordance with CLR 2, ref. 1.6. The formation of a conceptual model is an iterative process and as such, it should be updated and refined throughout each stage of the project to reflect any additional information obtained.

The extent of the desk studies and enquiries to be conducted should be in general accordance with CLR 3, ref. 1.7. The information from these enquiries is presented in a desk study report with recommendations, if necessary, for further work based upon the conceptual model. Specific DoE 'Industry Profiles' provide guidance on the nature of contaminants relating to specific industrial processes.

If potential pollutant linkages are identified within the conceptual model, a Phase 2 site investigation and report will be recommended. The investigation should be planned in general accordance with CLR 4, ref 1.8. The number of exploratory holes and samples collected for analysis should be consistent with the size of the site and the level of risk envisaged. This will enable a contamination risk assessment to be conducted, at which point the conceptual model can be updated and relevant pollutant linkages can be identified.

A two-stage investigation may be more appropriate where time constraints are less of an issue. The first stage investigation being conducted as an initial assessment for the presence of potential sources, a second being a more refined investigation to delineate wherever possible the extent of the identified contamination.

All site works should be in general accordance with the British Standards BS 10175:2011, ref. 1.9. and BS 5930:2015, ref. 1.10.

The generic contamination risk assessment screens the results of the chemical analysis against generic guidance values which are dependent on the proposed end-use of the development.

The end-use may be defined as one of the following ref. 1.15;

- Residential with homegrown produce – domestic low rise and low density housing with gardens where vegetables may be grown for home consumption
- Residential without homegrown produce – domestic low density and low density housing where no gardens are present.
- Allotments – specific areas where vegetables are grown for home consumption.
- Public open space in close proximity to residential housing – includes the predominantly grassed area adjacent to high density housing and the central green area around which houses are developed. This land-use includes the smaller areas commonly incorporated in newer developments as informal grassed areas or more formal landscaped areas with a mixture of open space and covered soil with planting.
- Public open space in use as general parkland – provided for recreational use and may be used for family visits and picnics, children's play area, sports grounds and dog walking.
- Commercial – industrial premises where there is limited exposure to soil.

Standard Land-use Scenarios

The standard land-use scenarios used to develop conceptual exposure models are presented in the following sections:

Residential with homegrown produce

Generic scenario assumes a typical two-storey house built on a ground bearing slab with a private garden having a lawn, flowerbeds and a small fruit and vegetable patch.

- | |
|--|
| • Critical receptor is a young female child (zero to six years old) |
| • Exposure duration is six years. |
| • Exposure pathways include direct soil and indoor dust ingestion, consumption of home-grown produce and any adhering soil, skin contact with soils and indoor dust and inhalation of indoor and outdoor dust and vapours. |
| • Building type is a two-storey small terraced house. |

A sub-set of the Residential land-use is **Residential without Homegrown produce**. The generic scenario assumes low density housing with communal landscaped gardens where the consumption of home grown vegetables will not occur.

Allotments

Provision of open space (about 250sq.m) commonly made available to tenants by the local authority to grow fruit and vegetable for their own consumption. Typically, there are a number of plots to a site which may have a total area of up to 1 hectare. The tenants are assumed to be adults and that young children make occasional accompanied visits.

Although some allotment holders may choose to keep animals including rabbits, hens, and ducks, potential exposure to contaminated meat and eggs is not considered.

-
- Critical receptor is a young female child (zero to six years old)
 - Exposure duration is six years.
 - Exposure pathways include direct soil ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and inhalation of outdoor dust and vapours.
 - There is no building.
-

Commercial

The generic scenario assumes a typical commercial or light industrial property comprising a three-storey building at which employees spend most time indoors and are involved in office-based or relatively light physical work.

-
- Critical receptor is a working female adult (aged 16 to 65 years old).
 - Exposure duration is a working lifetime of 49 years.
 - Exposure pathways include direct soil and indoor dust ingestion, skin contact with soils and dusts and inhalation of dust and vapours.
 - Building type is a three-storey office (pre 1970).
-

Public Open Space within Residential Area

The generic scenario refers to any grassed area 0.05 ha and that is close to Housing.

-
- Grassed area of up to 0.05 ha and a considerable proportion of this (up to 50%) may be bare soil
 - Predominantly used by children for playing and may be used for activities such as a football kick about
 - Sufficiently close proximity to home for tracking back of soil to occur, thus indoor exposure pathways apply
 - older children as the critical receptor on basis that they will use site most frequently (Age class 4-9)
 - ingestion rate 75 mg.day^{-1}
-

Public Open Space Park

This generic scenario refers to any public park that is more than 0.5ha in area:

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- Public park (>0.5 ha), predominantly grassed and may also contain children's play equipment and border areas of soil containing flowers or shrubs (75% cover)
 - Female child age classes 1-6
 - Soil ingestion rate of 50 mg.day^{-1}
 - Occupancy period outdoors = 2 hours.day^{-1}
 - Exposure frequency of 170 days.year⁻¹ for age classes 2-18 and 85
 - days.year⁻¹ for age class 1
 - Outdoor exposure pathways only (no tracking back).
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Human Health Generic Quantitative Risk Assessment (GQRA) involves the comparison of contaminant concentrations measured in soil at the site with Generic Assessment Criteria (GAC).

GAC are conservative values adopted to ensure that they are applicable to the majority of possible contaminated site. These values may be published Contaminated Land Exposure Assessment Model (CLEA) derived GAC derived by a third party or the Environment Agency/ DEFRA. It is imperative to the risk assessor to understand the uncertainties and limitations associated with these GAC to ensure that they are used appropriately. Where the adoption of a GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses, then a Detailed Quantitative Risk Assessment (DQRA) may be undertaken to develop site specific values for relevant soil contaminants based on the site specific conditions.

In 2014, the publication of Category 4 Screening Levels (C4SL) ref 1.15, 1.16, as part of the Defra-funded research project SP1010, included modifications to certain exposure assumptions documented within EA Science Report SC050221/SR3 (herein after referred to as SR3) ref 1.5 used in the generation of SGVs. C4SL were published for six substances (cadmium, arsenic, benzene, benzo(a)pyrene, chromium VI and lead) for a sandy loam soil type with 6% soil organic matter, based on a low level of toxicological concern (LLTC; see Section 2.3 of research project report SP1010 ref 1.16. Where a C4SL has been published, Soils Limited has adopted them as GAC for these six substances.

For all other substances the soils will be compared to Suitable 4 Use Levels (S4ULs) published by LQM ref. 1.12, which were developed for around 85 substances and are intended to enable a screening assessment of the risks posed by soil quality on development sites. The updated LQM/CIEH GAC publication was developed to accommodate recent developments in the understanding of chemical, toxicological and routine exposure to soil-based contaminants.

Where no S4UL or C4SL is available, the assessment criteria (AC) may be generated using the Contaminated Land Exposure Assessment (CLEA) Software Version 1.07, ref. 1.13. Toxicological and physico-chemical/fate and transport data used to generate the AC has been derived from a hierarchy of data sources as follows:

1. Environment Agency or Department of Environment Food and Rural Affairs (DEFRA) documents;
2. Other documents produced by UK Government or state organisations;
3. European institution documents;
4. International organisation documents;
5. Foreign government institutions.

In the case of the majority of contaminants considered, the toxicological data has been drawn from the relevant CLR 9 TOX report, or updated toxicological data published by the Environment Agency (2009), ref. 1.6, where available. Where no TOX report is available reference has been made to the health criteria values, derived for use in Land Quality Press (2006), ref. 1.17, as this is considered to represent a peer reviewed data source. Similarly, fate and transport data has been derived in the first instance from Environment Agency (2003), ref. 1.18 and for contaminants not considered in this document the fate and transport data used in previous versions of the CLEA model has been used.

Chemical laboratory test results are processed as follows. A statistical analysis of the results is conducted, as detailed in CIEH and CL:AIRE 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref. 1.14. Individual concentrations are compared to the selected guideline values to identify concentrations of contaminants that are above the selected screening criteria.

Where the risk estimation identifies significant concentrations of one or more contaminants, a further risk evaluation needs to be undertaken.

References

- 1.1 The Environmental Protection Act, Part IIA, Section 78, DoE 1990.
- 1.2 Environment Act 1995, Section 57, DoE 1995.
- 1.3 CLR 11, '*Model Procedures for the Management of Contaminated Land*', DEFRA and Environment Agency, 2004.
- 1.4 Environment Agency Science Report SC050021/SR2 'Human health toxicological assessment of contaminants in soil'.
- 1.5 Science Report SC050021/SR3 '*Updated technical background to the CLEA model*', Environment Agency, 2008
- 1.6 CLR 2, '*Guidance on preliminary site inspection of contaminated land*', Report by Applied Environmental, DoE 1994.
- 1.7 CLR 3 '*Documentary Research on Industrial Sites*', Report by RPS Consultants Ltd., DOE, 1994
- 1.8 CLR 4, '*Sampling strategies for contaminated land*', Report by The Centre for Research into the Built Environment, the Nottingham Trent University, DoE, 1994
- 1.9 BS 10175: 2011 '*Investigation of potentially contaminated sites. Code of practice*', British Standards Institute, 2011
- 1.10 BS 5930: 2015 '*Code of practice for ground investigations*', British Standards Institute, 2015
- 1.11 Science Report SC050021 '*Contaminants in Soil: Updated Collation of Toxicological Data and Intake Values for Humans*', Environment Agency, 2009
- 1.12 The LQM/S4ULs for Human Health Risk Assessment, Nathanail P, McCaffery C, Gillett A, Ogden R, and Nathanail J, Land Quality Press, Nottingham, published 2015.
- 1.13 CLEA '*Software Version 1.071*' (downloaded from the Environment Agency website, <http://www.environment-agency.gov.uk>)
- 1.14 CIEH '*Guidance on Comparing Soil Contamination Data with a Critical Concentration*', Chartered Institute of Environmental Health (CIEH) and Contaminated Land: Applications in Real Environments (CL:AIRE), May 2008.
- 1.15 DEFRA SP1010: Development of Category 4 Screening Levels for the Assessment of Land Affected by Contamination, published March 2014.
- 1.16 Contaminated Land: Applications in Real Environment (CL:AIRE) (2014). '*Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination*', Revision 2, DEFRA research project SP1010.
- 1.17 Generic Assessment Criteria for Human Health Risk Assessment, Nathanail CP, McCaffery C, Ashmore M, Cheng Y, Gillett A, Hooker P and Ogden RC
- 1.18 CLR 2, '*Guidance on preliminary site inspection of contaminated land*', Report by Applied Environmental, DoE 1994.

			Residential with home-grown produce			Residential without home-grown produce			Allotments			Commercial			Public Open Space - Resi			Public Open Space -Park						
			SOM	1.0	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6			
Type	Contaminants	Species	Year																					
Metals	Antimony		2010				550						7500									EIC/AGS/	CL:AIRE	2010
	Arsenic		2014	37			40			49			640			79			168			C4SL	DEFRA	2014
			2015	37			40			40			640			79			170			S4UL	LQM/CIEH	2015
	Beryllium		2015	1.7			1.7			35			12			2.2			63			S4UL	LQM/CIEH	2015
	Boron		2015	290			11000			45			240000			21000			46000			S4UL	LQM/CIEH	2015
	Cadmium		2015	11			85			1.9			190			120			532			S4UL	LQM/CIEH	2015
			2014	26			149			4.9			410			220			880			C4SL	DEFRA	2014
	Chromium	III	2015	910			910			18000			8600			1500			33000			S4UL	LQM/CIEH	2015
		VI	2014	21			21			170			49			23			250			C4SL	DEFRA	2014
		VI	2015	6			6			1.8			33			7.7			220			S4UL	LQM/CIEH	2015
	Copper		2015	2400			7100			520			68000			12000			44000			S4UL	LQM/CIEH	2015
	Lead		2014	200			310			80			2330			630			1300			C4SL	DEFRA	2014
	Mercury	Elemental	2015	1.2			1.2			21			58			16			30			S4UL	LQM/CIEH	2015
		Inorganic	2015	40			56			19			1100			120			240			S4UL	LQM/CIEH	2015
		Methyl	2015	11			15			6			320			40			68			S4UL	LQM/CIEH	2015
	Nickel		2015	130			180			53			980			230			800			S4UL	LQM/CIEH	2015
	Selenium		2015	250			430			88			12000			1100			1800			S4UL	LQM/CIEH	2015
	Vanadium		2015	410			1200			91			9000			2000			5000			S4UL	LQM/CIEH	2015
	Zinc		2015	3700			40000			620			730000			81000			170000			S4UL	LQM/CIEH	2015
	Benzene		2014	0.87			3.3			0.18			98			140			230			C4SL	DEFRA	2014
			2015	0.087	0.17	0.37	0.38	0.7	1.4	0.017	0.034	0.075	27	47	90	72	72	73	90	100	110	S4UL	LQM/CIEH	2015
	Toluene		2015	130	290	660	880	1900	3900	22	51	120	65000	110000	180000	56000	56000	56000	87000	95000	100000	S4UL	LQM/CIEH	2015
	Ethylbenzene		2015	47	110	260	83	190	440	16	39	91	4700	13000	27000	24000	24000	25000	17000	22000	27000	S4UL	LQM/CIEH	2015
	Xylenes	o-xylene	2015	60	140	330	88	210	480	28	67	160	6600	15000	33000	41000	42000	43000	17000	24000	33000	S4UL	LQM/CIEH	2015
		m-xylene	2015	59	140	320	82	190	450	31	74	170	6200	14000	31000	41000	42000	43000	17000	24000	32000	S4UL	LQM/CIEH	2015
		p-xylene	2015	56	130	310	79	180	310	29	69	160	5900	14000	30000	41000	42000	43000	17000	23000	31000	S4UL	LQM/CIEH	2015
Petroleum Hydrocarbons Fractions	Aliphatic >C5 - C6		2015	42	78	160	42	78	160	730	1700	3900	3200	5900	12000	570000	590000	600000	95000	130000	180000	S4UL	LQM/CIEH	2015
	Aliphatic >C6 - C8		2015	100	230	530	100	230	530	2300	5600	13000	7800	17000	40000	600000	610000	620000	150000	220000	320000	S4UL	LQM/CIEH	2015
	Aliphatic >C8 - C10		2015	27	65	150	27	65	150	320	770	1700	2000	4800	11000	13000	13000	13000	14000	18000	21000	S4UL	LQM/CIEH	2015
	Aliphatic >C10 - C12		2015	130	330	760	130	330	770	2200	4400	7300	9700	23000	47000	13000	13000	13000	21000	23000	24000	S4UL	LQM/CIEH	2015
	Aliphatic >C12 - C16		2015	1100	2400	4300	1100	2400	4400	11000	13000	13000	59000	82000	90000	13000	13000	13000	25000	25000	26000	S4UL	LQM/CIEH	2015
	Aliphatic >C16 - C35		2015	65000	92000	110000	65000	92000	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000	S4UL	LQM/CIEH	2015
	Aliphatic >C35 - C44		2015	65000	92000	140000	65000	92000	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000	S4UL	LQM/CIEH	2015
	Aromatic >C5 - C7		2015	70	140	300	370	690	1400	13	27	57	26000	46000	86000	56000	56000	56000	76000	84000	92000	S4UL	LQM/CIEH	2015
	Aromatic >C7 - C8		2015	130	290	660	860	1800	3900	22	51	120	56000	110000	180000	56000	56000	56000	87000	95000	100000	S4UL	LQM/CIEH	2015
	Aromatic >C8 - C10		2015	34	83	190	47	110	270	8.6	21	51	3500	8100	17000	5000	5000	5000	7200	8500	9300	S4UL	LQM/CIEH	2015
	Aromatic >C10 - C12		2015	74	180	380	250	590	1200	13	31	74	16000	28000	34000	5000	5000	5000	9200	9700	10000	S4UL	LQM/CIEH	2015
	Aromatic >C12 - C16		2015	140	330	660	1800	2300	2500	23	57	130	36000	37000	38000	5100	5100	5000	10000	10000	10000	S4UL	LQM/CIEH	2015
	Aromatic >C16 - C21		2015	260	540	930	1900	1900	1900	46	110	260	28000	28000	28000	3800	3800	3800	7600	7700	7800	S4UL	LQM/CIEH	2015
	Aromatic >C21 - C35		2015	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015
	Aromatic >C34 - C44		2015	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015
	Aliphatic + Aromatic >C44 - C70		2015	1600	1800	1900	1900	1900	1900	1200	2100	3000	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015
Polycyclic Aromatic Hydrocarbons (PAH' s) (mg/kg)	Acenaphthene		2015	210	510	1100	3000	4700	6000	34	85	200	84000	97000	100000	15000	15000	15000	29000	30000	30000	S4UL	LQM/CIEH	2015
	Acenaphthylene		2015	170	420	920	2900	4600	6000	28	69	160	83000	97000	100000	15000	15000	15000	29000	30000	30000	S4UL	LQM/CIEH	2015
	Anthracene		2015	2400	5400	11000	31000	35000	37000	380	950	2200	520000	54000	540000	74000	74000	74000	150000	150000	150000	S4UL	LQM/CIEH	2015
	Benzo(a)anthracene		2015	7.2	11	13	11	14	15	2.9	6.5	13	170	170	180	29	29	29	49	56	62	S4UL	LQM/CIEH	2015
	Benzo(a)pyrene		2014			5			5.3			5.7			76			10			21	C4SL	DEFRA	2014
			2015	2.2	2.7	3	3.2	3.2	3.2	0.97	2	3.5	35	35	36	5.7	5.7	5.7	11	12	13	S4UL	LQM/CIEH	2015
	Benzo(b)fluoranthene		2015	2.6	3.3	3.7	3.9	4.0	4.0	0.99	2.1	3.9	44	44	45	7.1	7.2	7.2	13	15	16	S4UL	LQM/CIEH	2015
	Benzo(ghi)perylene		2015	320	340	350	360	360	360	290	470	640	3900	4000	4000	640	640	640	1400	1500	1600	S4UL	LQM/CIEH	2015
	Benzo(k)fluoranthene		2015	77	93	100	110	110	110	37	75	130	1200	1200	1200	190	190	190	370	410	440	S4UL	LQM/CIEH	2015
	Chrysene		2015	15	22	27	30	31	32	4.1	9.4	19	350	350	350	57	57	57	93	110	120	S4UL	LQM/CIEH	2015
	Dibenz(a,h)anthracene		2015	0.24																				

			Residential with home-grown produce			Residential without home-grown produce			Allotments			Commercial			Public Open Space - Resi			Public Open Space -Park						
			SOM	1.0	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6			
Type	Contaminants	Species	Year																					
	Fluoranthene		2015	280	560	890	1500	1600	1600	52	130	290	23000	23000	23000	3100	3100	3100	6300	6300	6400	S4UL	LQM/CIEH	2015
	Fluorene		2015	170	400	860	2800	3800	4500	27	67	160	63000	68000	71000	9900	9900	9900	20000	20000	20000	S4UL	LQM/CIEH	2015
	Indeno(1,2,3-cd)pyrene		2015	27	36	41	45	46	46	9.5	21	39	500	510	510	82	82	82	150	170	180	S4UL	LQM/CIEH	2015
	Naphthalene		2015	2.3	5.6	13	2.3	5.6	13	4.1	10	24	190	460	1100	4900	4900	4900	1200	1900	3000	S4UL	LQM/CIEH	2015
	Phenanthrene		2015	95	220	440	1300	1500	1500	15	38	90	22000	22000	23000	3100	3100	3100	6200	6200	6300	S4UL	LQM/CIEH	2015
	Pyrene		2015	620	1200	2000	3700	3800	3800	110	270	620	54000	54000	54000	7400	7400	7400	15000	15000	15000	S4UL	LQM/CIEH	2015
	Coal Tar(Bap as surrogate matter)		2015	0.79	0.98	1.1	1.2	1.2	1.2	0.32	0.67	1.2	15	15	15	2.2	2.2	2.2	4.4	4.7	4.8	S4UL	LQM/CIEH	2015
Chloroalkanes & alkenes	1,2 Dichloroethane		2015	0.0071	0.011	0.019	0.0092	0.013	0.023	0.0046	0.0083	0.016	0.67	0.97	1.7	29	29	29	21	24	28	S4UL	LQM/CIEH	2015
	1,1,1 Trichloroethane		2015	8.8	18	39	9	18	40	48	110	240	660	1300	3000	140000	140000	140000	57000	76000	100000	S4UL	LQM/CIEH	2015
	1,1,2,2 Tetrachloroethane		2015	1.6	3.4	7.5	3.9	8	17	0.41	0.89	2	270	550	1100	1400	1400	1400	1800	2100	2300	S4UL	LQM/CIEH	2015
	1,1,1,2 Tetrachloroethane		2015	1.2	2.8	6.4	1.5	3.5	8.2	0.79	1.9	4.4	110	250	560	1400	1400	1400	1500	1800	2100	S4UL	LQM/CIEH	2015
	Tetrachloroethene		2015	0.18	0.39	0.9	0.18	0.4	0.92	0.65	1.5	3.6	19	42	95	1400	1400	1400	810	1100	1500	S4UL	LQM/CIEH	2015
	Tetrachloromethane (Carbon Tetrachloride)		2015	0.026	0.056	0.13	0.026	0.056	0.13	0.45	1	2.4	2.9	6.3	14	890	920	950	190	270	400	S4UL	LQM/CIEH	2015
	Trichloroethene		2015	0.016	0.034	0.075	0.017	0.036	0.08	0.041	0.091	0.21	1.2	2.6	5.7	120	120	120	70	91	120	S4UL	LQM/CIEH	2015
	Trichloromethane		2015	0.91	1.7	3.4	1.2	2.1	4.2	0.42	0.83	1.7	99	170	350	2500	2500	2500	2600	2800	3100	S4UL	LQM/CIEH	2015
Explosives	Vinyl Chloride (chloroethene)		2015	0.00064	0.00087	0.0014	0.00077	0.001	0.0015	0.00055	0.001	0.0018	0.059	0.077	0.12	3.5	3.5	3.5	4.8	5	5.4	S4UL	LQM/CIEH	2015
	2,4,6 Trinitrotoluene		2015	1.6	3.7	8.1	65	66	66	0.24	0.58	1.4	1000	1000	1000	130	130	130	260	270	270	S4UL	LQM/CIEH	2015
	RDX (Hexogen/Cyclonite/1,3,5-trinitro-1,3,5-triazacyclohexane)		2015	120	250	540	13000	13000	13000	17	38	85	210000	210000	210000	26000	26000	27000	49000	51000	53000	S4UL	LQM/CIEH	2015
	HMX (Octogen/1,3,5,7-tetrenitro-1,3,5,7-tetrazacyclo-octane)		2015	5.7	13	26	6700	6700	6700	0.86	1.9	3.9	110000	110000	110000	13000	13000	13000	23000	23000	24000	S4UL	LQM/CIEH	2015
Pesticides	Aldrin		2015	5.7	6.6	7.1	7.3	7.4	7.5	3.2	6.1	9.6	170	170	170	18	18	18	30	31	31	S4UL	LQM/CIEH	2015
	Dieldrin		2015	0.97	2	3.5	7	7.3	7.4	0.17	0.41	0.96	170	170	170	18	18	18	30	30	31	S4UL	LQM/CIEH	2015
	Atrazine		2015	3.3	7.6	17.4	610	620	620	0.5	1.2	2.7	9300	9400	9400	1200	1200	1200	2300	2400	2400	S4UL	LQM/CIEH	2015
	Dichlorvos		2015	0.032	0.066	0.14	6.4	6.5	6.6	0.0049	0.01	0.022	140	140	140	16	16	16	26	26	27	S4UL	LQM/CIEH	2015
	Alpha - Endosulfan		2015	7.4	18	41	160	280	410	1.2	2.9	6.8	5600	7400	8400	1200	1200	1200	2400	2400	2500	S4UL	LQM/CIEH	2015
	Beta - Endosulfan		2015	7	17	39	190	320	440	1.1	2.7	6.4	6300	7800	8700	1200	1200	1200	2400	2400	2500	S4UL	LQM/CIEH	2015
	Alpha -Hexachlorocyclohexanes		2015	0.23	0.55	1.2	6.9	9.2	11	0.035	0.087	0.21	170	180	180	24	24	24	47	48	48	S4UL	LQM/CIEH	2015
	Beta -Hexachlorocyclohexanes		2015	0.085	0.2	0.46	3.7	3.8	3.8	0.013	0.032	0.077	65	65	65	8.1	8.1	8.1	15	15	16	S4UL	LQM/CIEH	2015
Chlorobenzenes	Gamma -Hexachlorocyclohexanes		2015	0.06	0.14	0.33	2.9	3.3	3.5	0.0092	0.023	0.054	67	69	70	8.2	8.2	8.2	14	15	15	S4UL	LQM/CIEH	2015
	Chlorobenzene		2015	0.46	1	2.4	0.46	1	2.4	5.9	14	32	56	130	290	11000	13000	14000	1300	2000	2900	S4UL	LQM/CIEH	2015
	1,2-Dichlorobenzene		2015	23	55	130	24	57	130	94	230	540	2000	4800	11000	90000	95000	98000	24000	36000	51000	S4UL	LQM/CIEH	2015
	1,3-Dichlorobenzene		2015	0.4	1	2.3	0.44	1.1	2.5	0.25	0.6	1.5	30	73	170	300	300	300	390	440	470	S4UL	LQM/CIEH	2015
	1,4-Dichlorobenzene		2015	61	150	350	61	150	350	15	37	88	4400	10000	25000	17000	17000	1700	36000	36000	36000	S4UL	LQM/CIEH	2015
	1,2,3,-Trichlorobenzene		2015	1.5	3.6	8.6	1.5	3.7	8.8	4.7	12	28	102	250	590	1800	1800	1800	770	1100	1600	S4UL	LQM/CIEH	2015
	1,2,4,-Trichlorobenzene		2015	2.6	6.4	15	2.6	6.4	15	55	140	320	220	530	1300	15000	17000	19000	1700	2600	4000	S4UL	LQM/CIEH	2015
	1,3,5,-Trichlorobenzene		2015	0.33	0.81	1.9	0.33	0.81	1.9	4.7	12	28	23	55	130	1700	1700	1800	380	580	860	S4UL	LQM/CIEH	2015
	1,2,3,4,-Tetrachlorobenzene		2015	15	36	78	24	56	120	4.4	11	26	1700	3080	4400	830	830	830	1500	1600	1600	S4UL	LQM/CIEH	2015
	1,2,3,5,- Tetrachlobenzene		2015	0.66	1.6	3.7	0.75	1.9	4.3	0.38	0.9	2.2	49	120	240	78	79	79	110	120	130	S4UL	LQM/CIEH	2015
	1,2,4, 5,- Tetrachlobenzene		2015	0.33	0.77	1.6	0.73	1.7	3.5	0.06	0.16	0.37	42	72	96	13	13	13	25	26	26	S4UL	LQM/CIEH	2015
	Pentachlorobenzene		2015	5.8	12	22	19	30	38	1.2	3.1	7	640	770	830	100	100	100	190	190	190	S4UL	LQM/CIEH	2015
Phenols & Chlorophenols	Hexachlorobenzene		2015	1.8	3.3	4.9	4.1	5.7	6.7	0.47	1.1	2.5	110	120	120	16	16	16	30	30	30	S4UL	LQM/CIEH	2015
	Phenols		2015	120	200	380	440	690	1200	23	42	83	440	690	1300	440	690	1300	440	690	1300	S4UL	LQM/CIEH	2015
	Chlorophenols (4 Congeners)		2015	0.87	2	4.5	94	150	210	0.13	0.3	0.7	3500	4000	4300	620	620	620	1100	1100	1100	S4UL	LQM/CIEH	2015
Others	Pentachlorophenols		2015	0.22	0.52	1.2	27	29	31	0.03	0.08	0.19	400	400	400	60	60	60	110	120	120	S4UL	LQM/CIEH	2015
	Carbon Disulphide		2015	0.14	0.29	0.62	0.14	0.29	0.62	4.8	10	23	11	22	47	11000	11000	12000	1300	1900	2700	S4UL	LQM/CIEH	2015
	Hexachloro-1,3-Butadiene		2015	0.29	0.7	1.6	0.32	0.78	1.8	0.25	0.61	1.4	31	66	120	25	25	25	48	50	51	S4UL	LQM/CIEH	2015
	Sum of PCDDs, PCDFs and dioxin-like PCB's.		2012			8			8			8			240							SGV	DEFRA	2012

NOTE

Priority Guideline (mg kg⁻¹)

				Residential with home-grown produce			Residential without home-grown produce			Allotments			Commercial			Public Open Space - Resi			Public Open Space -Park		
SOM				1.0	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6
Type	Contaminants	Species	Year																		
	1	Site Specific Assessment Criteria (SSAC) (Soils Limited)																			
	2	2014: Category 4 Screening Level (C4SL) (Contaminated Land: Application in Real Environment (CL:ARE), 2014)																			
	3	2012: Soil Guideline Value (SGV) (Environment Agency, 2009)																			
	4	2015: Suitable 4 Use Level (S4UL) (Nathanail <i>et al</i> , 2015)																			
				For Generic Risk Assessment, the values in Bold have priority																	
				Table reviewed February 2020																	

Appendix E Information Provided by the Client



20-102 - Worcester Close

Pre-application Meeting 02

June 2022



BPTW brings together specialisms in Architecture and Planning to transform not just physical spaces, but people's lives. Our work tells our story. We are bold. We are innovative. We care.

For 30 years we have worked with many of the UK's leading developers and housing providers to create desirable new homes and places. With over 120 staff, our teams are made up of individual experts who cultivate a friendly, creative and collaborative partnership with everyone we work with. From start to finish, we are committed to deliver success on every measure.

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1.0 Introduction

1.1 Site Location - Macro

This document has been prepared on behalf of Gravesham Borough Council to present the proposals for the site on Worcester Close for the purposes of a follow-up pre-application meeting.

The site is located within the Istead Rise village, Borough of Gravesham, county of Kent.



Wider Site Location



Site Location

- Key
- Site

Major Roads

1

Downs Way Medical Practice

3

The Forest Memories of Kent

5

Istead Rise Primary School
- Bus Stop

Minor Roads

2

Istead Rise Community Centre

4

Supermarket / Shops



1.2 Site Location - Micro

The site is located on Worcester Close within the Istead Rise village. The existing site forms an irregular triangular shape and consists of a number of trees.

North of the site is Downs Way Medical Practice and a community centre. To the south, the site narrows and adjoins the properties facing onto the corner of Worcester Close. The eastern boundary runs along Worcester Close and the western boundary terminates Bramley Close.

A pedestrian path runs along the west boundary of the site from The Drove Way to the Downs Way Medical Practice.



Site Location

Key

 Site Boundary



1.3 Existing Site Layout

The site has an area of circa 0.139 ha. and is currently an undeveloped area with a number of mature trees. Vehicular access to the site is from Worcester Close with additional pedestrian access from Bramley Close.



Existing Site Layout

1.4 Site Photographs

The following images show the site from the north, east, west and south.

The first image shows the irregular topography within the red line boundary, raised in some areas more than others (particularly to the north).



View from Worcester Close



View from Worcester Close



View from Bramley Close



View from Worcester Close



Key Plan

1.5 Pre-application Meeting 01 Summary

The proposals presented at the initial pre-application meeting included 9 homes contained within a single flat block with a combination of 1 bed and 2 bed homes.

Primary access to the flat block is to the south through a communal entrance fronting onto a landscaping with car parking. Ancillary spaces are incorporated adjacent to the communal entrance and within the landscape. Homes are designed to be dual aspect with private amenity to the south and north.

Summary

- > 4 x 2B4P Flats.
- > 5 x 1B2P Flats.
- > 9 new homes in total, designed to be M4(2) compliant.
- > All dwellings have their own parking space plus other 3 for visitors. 12 spaces in total.
- > 7 tree to be removed & replaced on 1:2 basis.

Feedback

Feedback from the meeting included the following key points:

- > Maximise frontage onto Worcester Close.
- > Review footprint to respect the established build line of the adjacent properties on Bramley Close
- > Review the massing to complement the adjacent buildings.
- > Retain the parking to preserve the existing trees to the south.



Proposed Site Layout



Proposed Aerial View

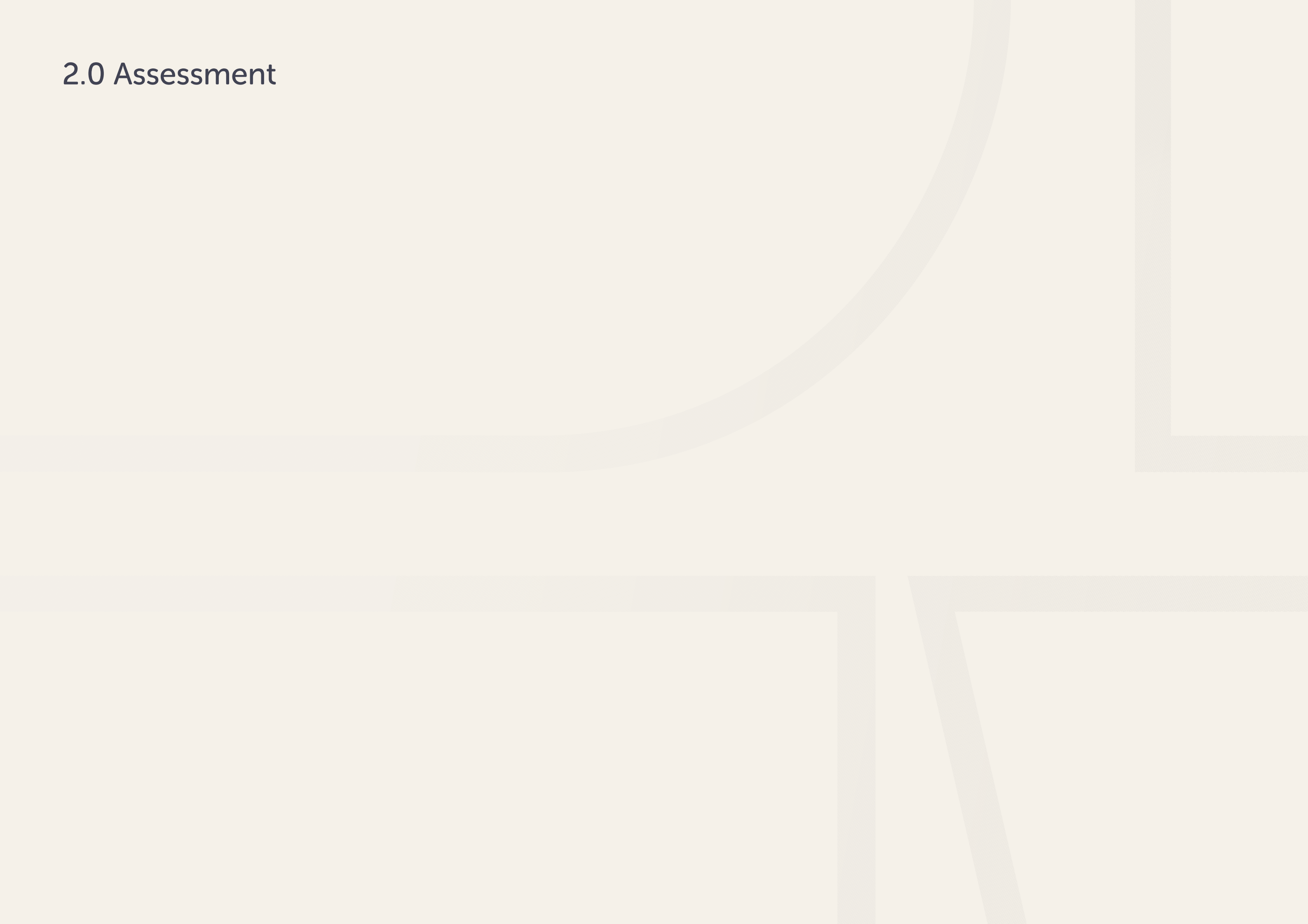


Proposed View from Worcester Close



Proposed View from New Access Road

2.0 Assessment



2.1 Local Vernacular

Character

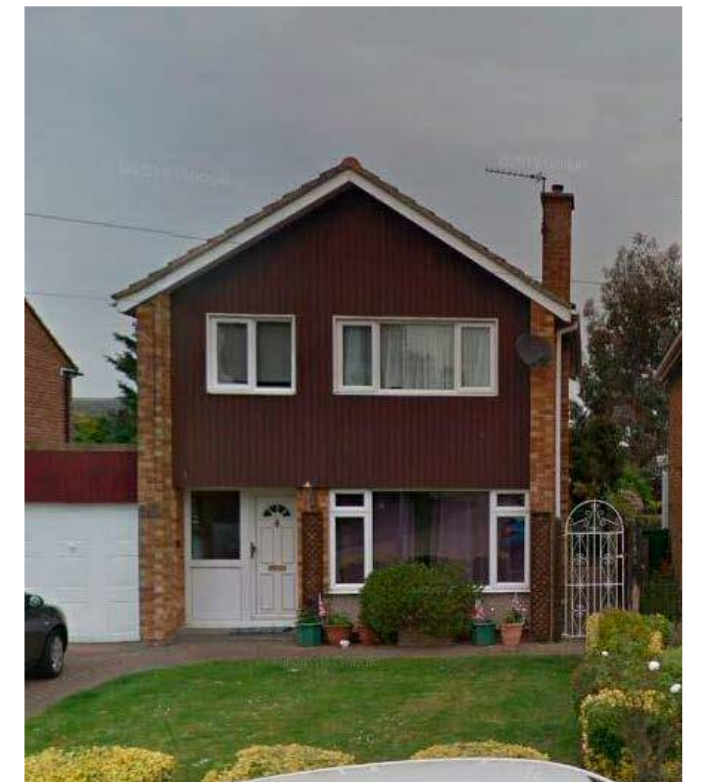
To ensure the emerging proposals respond to the character of the local area an initial review of the characteristics of the local buildings has been completed.

The local setting contains a wide range of features and details that could inform the design quality of this proposal.

The character of the area is predominantly residential.

There is a wide array of styles throughout the area, however there are a few repeating styles that could be appropriated for use within the proposed development. In summary, some of the predominant features are:

- Irregular facade treatments
- Low eaves
- Strong gable roof feature
- Predominantly brick facades
- Use of different materials on the facade
- Windows in the centre of pitched roof
- Large windows in the ground floor



Rhythm & Proportion



1 - Bramley Close



2 - Worcester Close



Key Plan



3 - Weald Close



4 - The Drove Way

2.2 Site Constraints

The site includes a number of constraints:

- > The site is an irregular shape, wider at the north, and narrows to the south.
- > Habitable room windows overlook the site from the existing adjacent houses.
- > There is no vehicular access from Bramley Close.
- > There is a significant level change across the site.
- > The site contains a number of existing trees.



Key

- Site Boundary
- Existing Trees
- Existing Pedestrian Access
- No Vehicular Access
- 21m Overlooking Distance
- Existing Frontage
- Change in Level

Site Constraints Diagram

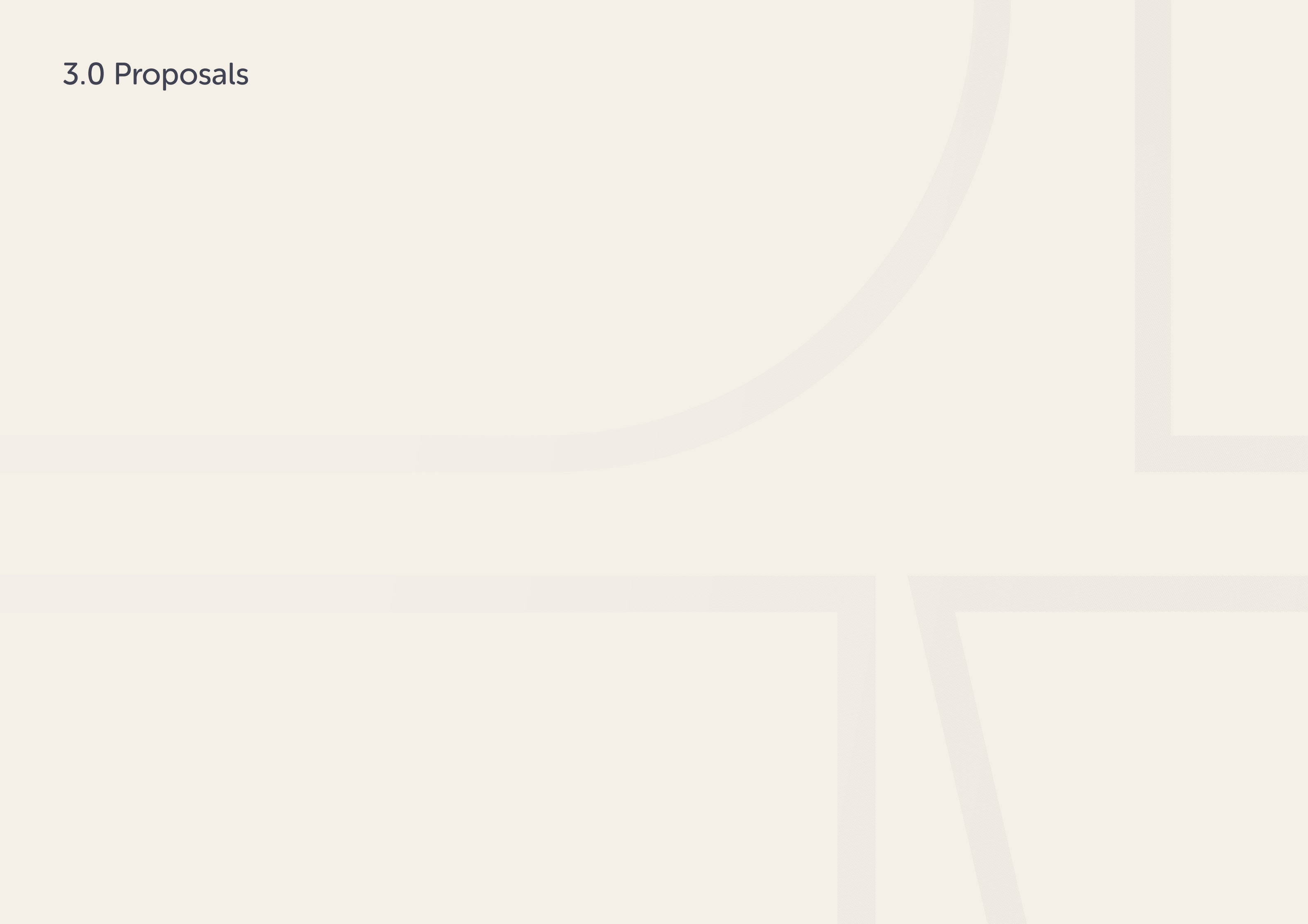
2.3 Site Opportunities

Additionally, the site includes a number of opportunities:

- > Opportunity to retain the established build line to provide homes facing south onto a landscaped courtyard.
- > Provide new street frontage along Worcester Close with a focal point at the end of Bramley Close and Worcester Close.
- > Potential for car parking provision to the south in order to minimise the need to remove existing trees.
- > Potential to provide a new pedestrian access to the surgery to the north along the eastern boundary of the site as there is currently no pavement or path.



3.0 Proposals



3.1 Site Layout

The layout has been developed following our site analysis to enhance active frontage onto Worcester Close and provide a focal point from Bramley Close. The footprint of the building has been further considered to respect the established build line, in keeping with adjacent buildings on Bramley Close.

The proposals include 8 homes for general needs consisting of a mixture of 1 bed and 2 bed homes.

To support these homes, the proposals are set within generous landscaped amenity. Parking has been located to the south with vehicular access from Worcester Close to preserve the existing trees where possible and retain the existing tree lined character.

The proposed landscaping has been carefully considered to maximise soft landscaping and planting to enhance the quality of the proposed development. Landscaping materials minimise the impact on the existing trees and complement the wider area incl. permeable paving, block paving.

Summary

- > 8 new homes in total
- > All dwellings have their own parking space
- > All dwellings are dual or triple aspect
- > 7 trees to be removed & replaced on 1:2 basis subject to tree survey and arboriculturist input.

Schedule of Accommodation	
1B2P	4
2B4P	4
Total Dwellings	8
New parking spaces	10

Key

- Site Boundary
- 1B2P
- 2B4P
- Private Access
- Communal Access



Site Layout

3.2 Internal Layout

Ground Floor

Homes have been laid out to reinforce the connection with the landscape with entrances from the landscaped courtyard. All homes will have their own private amenity in the form of private balconies or terraces in addition to the communal amenity areas at ground level.

Cycle parking and refuse storage is envisaged to form part of the landscaping strategy.

Target GIAs

1 Bed 2 Person - 50 sqm
2 Bed 4 Person - 70sqm

Key

- Site Boundary
- 1B2P
- 2B4P
- Private Access
- Communal Access



Ground Floor Plan

First Floor

The layouts have been considered to maximise the quality of the individual homes whereby all dwellings are dual or triple aspect, ensuring adequate daylight with outlook onto amenity and landscaping.

The envisaged architectural character and materials is in keeping with the surrounding area including pitched roofs with prominent gable ends, smaller horizontal windows, red brick and tile hanging.

Key

Site Boundary

1B2P

2B4P

Private Access

Communal Access

The First Floor Plan illustrates a residential development with two distinct housing blocks. The left block, designated as 1B2P (yellow), consists of three units. Each unit features a Living/Kitchen/Diner area (25.0 m²), a Bed 1 (12.0 m²), a Bath, and a Store (1.5 m²). The right block, designated as 2B4P (blue), consists of four units. Each unit features a Living/Kitchen/Diner area (28.0 m²), a Bed 1 (11.6 m²), a Bed 2 (11.6 m²), a Bath, and a Store (2.0 m²). A central staircase provides access between the two blocks. The site includes a 'Landscaped Courtyard' at the bottom, a 'Site Boundary' marked by a red line, and a north arrow in the bottom left corner. Private access is indicated by yellow arrows, and communal access is indicated by red arrows.

First Floor Plan

3.3 Massing

Views



Proposed Aerial View



Proposed View from New Access Road



Proposed View from Worcester Close



Proposed View from Bramley Close

3.4 Precedents

Architectural



BPTW- Beechwood Village



BPTW- Rochester Riverside



BPTW - Newhall



BPTW- Thrale Almshouses



BPTW- Rochester Riverside



BPTW- Eldon Street



Proctor & Matthews- SmartLIFE



PRP- Manchester Road

Landscape



Wildlife Friendly Planting



Smooth Concrete flags with Textured Concrete Blocks/Setts



Natural Play



Wildflower Meadow



Permeable Surface Treatment



Seating Incorporated into Landscaping



Rain Garden



Hedges Adjacent to Parking



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Appendix F Trial Hole Photographs



Photo 1: WS1: 0.00m – 4.00m bgl



Photo 2: WS2: 0.00m – 4.00m bgl



Photo 3: WS3: 0.00m – 4.00m bgl



Photo 4: WS4: 0.00m – 4.00m bgl



Photo 5: WSI location. View looking west.



Photo 6: WS2 location. View looking northeast.



Photo 7: WS3 location. View looking east.



Photo 8: WS4 location. View looking west.

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