

R. CARR GEOTECHNICAL SERVICES

Ref: 3767/20

**PROPOSED REDEVELOPMENT AT
REAR OF 2-28 CAMPBELL ROAD,
GRAVESEND, KENT DA11 0JY.**

PHASE 2 REPORT ON SUBSOIL INVESTIGATIONS

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Appendix A Subsoil Investigations
Appendix B Laboratory Test Results

1. Introduction

- 1.1 This report has been prepared on behalf of Gravesend Churches Housing Association Ltd, prospective developers of the site located to the rear of nos. 2-28 Campbell Road, Gravesend.
- 1.2 The proposed development comprises the demolition of existing lock-up garages and the construction of three terraced and two semi-detached dwellings with associated areas of garden and vehicular parking.
- 1.3 This report should be viewed in conjunction with a Phase I Desk Study Report undertaken by R Carr Geotechnical Services (report reference: 3753/20 dated February 2020). The site had comprised undeveloped land until it was developed for use as lock-up garages by local residents during the middle part of the twentieth century. Little change appeared to have occurred to the site since the time of its original development and the garages remain in use, albeit in a rather dilapidated condition. A low to moderate risk to human health, groundwater and plants was identified by the desk study from the following on-site sources of potential contamination
- Possible leakages and spillages of petroleum hydrocarbons (TPH) volatile organic compounds (VOC) and semi-volatile organic compounds (SVOC) resulting from vehicle maintenance e.g. fuel, lubricants and solvents
 - Toxic metals, TPH, polyaromatic hydrocarbons (PAH) possibly present in site surfacing and sub-base materials
- 1.4 A low risk was identified to the site from off-site sources of potential contamination. Radon protection measures are not required within the design of the proposed development and the site's surface topography was not observed to indicate the presence of excessive quantities of underlying made ground. A low risk from on-site sources of ground gas was therefore considered applicable.
- 1.5 Two historic landfill sites were identified by the desk study within 50m and 200m to the north of the site, though it was considered unlikely unlikely that biodegradable

material had been deposited within the infill material. A low to moderate risk to the site was therefore identified from:

- Off-site emissions of ground gases emanating from the landfill sites to the north

2. Topography

- 2.1 The site is located on relatively level ground to the east of Campbell Road (OS Land Ranger map reference TQ 634 736).

3. Geology

- 3.1 Reference to the local Geological Survey sheet (no. 271, Dartford) has indicated that the site is located on the Seaford member of the White Chalk subgroup (formerly referred to as the Upper Chalk).
- 3.2 The White Chalk consists of soft, white, friable limestone that is 95% calcium carbonate and contains scattered nodular and tabular flint. The upper surface of the Chalk is often deeply convoluted and may contain solution pipes filled with more recent deposits.

4. Hydrology and Hydrogeology

- 4.1 No surface water bodies were identified by the desk study within 500m of the site.
- 4.2 The Chalk is the Principal Aquifer of the area with high groundwater vulnerability. A Principal Aquifer is defined by the Environment Agency as a “highly permeable formation with known or possible presence of significant fracturing”. These tend to be highly productive and capable of supporting public supply and other abstractions. Soil Classification: Soils of High Leaching Potential (U).

5. Subsoil Investigations

- 5.1 An intrusive ground investigation comprising five boreholes advanced to a depth of 3m with a tracked windowless sampler was carried out in accessible areas of the site

on 16th March 2020 (WS1-WS5). The boreholes were positioned between the existing buildings in order to obtain an even coverage of the site and to include areas of proposed garden. An additional borehole was carried out to a depth of 1m in the area of proposed planting scheduled for the southwest corner of the site (WS6). Disturbed samples of soil were retained in plastic containers and glass jars for geotechnical testing and contamination analysis at UKAS Accredited laboratories. The samples were transported to the respective laboratories immediately after completion of the site work.

- 5.2 Details of the soils encountered by the intrusive investigation are provided within strata logs contained in Appendix A, but can be conveniently summarised as follows:

Depth	Stratum
Ground level – 0.2m/0.4m	FILL – topsoil/loose asphalt, sandy clay/sand with fine to coarse brick, chalk, clinker, concrete and flint gravel/cobbles
0.2m/0.4m – 0.9m/1.9m	HEAD DEPOSITS – friable/soft sandy to very sandy CLAY//medium dense brown clayey SAND with scarce to abundant fine to coarse chalk and flint gravel
0.9m/1.2m - 2m/2.2m (absent in WS3 and WS5)	Weathered CHALK – stiff sandy CLAY with very abundant fine to coarse chalk and flint gravel
1m/2.2m – 4m+	SEAFORD CHALK – weak medium density CHALK with scarce flint gravel Grade IV C4

- 5.3 No groundwater was encountered within 3m of the site surface and the sides of the boreholes remained stable throughout drilling.

In-situ Soil Strength Tests

- 5.4 Standard Penetration Tests (SPTs) undertaken as drilling progressed provided the

following soil strength results:

Depth (m)	N value				
	WS1	WS2	WS3	WS4	WS5
1	14	15	1	37	24
2	16	24	17	18	26
3	27	19	17	24	18

5.5 A standpipe was installed in borehole WS1 in order to ascertain whether the site is being impacted by emissions of ground gases from the landfill sites to the north. The well was formed by the insertion of a slotted plastic pipe within the borehole, surrounded with shingle and provided with a bentonite seal, gas tap and protective cover.

5.6 Monitoring has been undertaken on one occasion since the installation of the well. Tests were undertaken with a GFM436 gas analyser, the following results being obtained:

Date and Reference	Flow Rate (Litres/hr)	Weather and Pressure	Methane % V/V	Carbon Dioxide % V/V	Oxygen %V/V	PID
23/03/20 WS1	0.0	Sunny after overnight frost 1023 mb	0.0	1.2	19.5	1.0

5.7 The available results of the gas monitoring have revealed no traces of methane and a maximum carbon dioxide concentration of 1.2% v/v. A Gas Screening Value (GSV) for the site has been calculated utilising the maximum recorded carbon dioxide concentration of 1.2% v/v and zero flow rate in compliance with guidance documents CIRIA, NHBC, CIEH and British Standards:

$$GSV = 1.2/100 \times 0.0 = 0.012 \text{ l/hr}$$

The GSV indicates a Characteristic Situation 1 (very low risk) as defined by CIRIA Report C665 (Table 8.5: Modified Wilson & Card Classification).

6. Laboratory Testing

Geotechnical Tests

- 6.1 Atterberg classification tests undertaken on representative samples of the Head Deposits obtained from boreholes WS1 at 1m and WS3 at 1.5m have categorised the subsoil as clay of low and intermediate plasticity (CL and CI). Such soils do not normally exhibit significant changes in volume.
- 6.2 A particle size distribution test carried out on a sample of the weathered Chalk obtained at 1.5m in WS2 has provided the following analysis of soil composition:

Reference	Clay %	Silt %	Sand %	Gravel %
WS2 1.5m	22.7	25.6	29.1	22.6

- 6.3 Chemical testing undertaken on representative soil samples recovered at depths of 1m and 1.5m has determined soil pH of 8.3 to 8.5 with water soluble sulphate as 0.03 to 0.07 g/L (Class DS-1).

Contamination Tests

- 6.4 Near-surface soil samples obtained from the boreholes at a depth of 0.25m have been analysed for a suite of common contaminants including speciated PAH, petroleum hydrocarbon fractions (TPH/CWG), VOC, SVOC and presence of asbestos. The results of the tests are provided in Appendix B, having been compared with the following soil screening criteria for residential development:
- Contaminated Land Exposure Assessment model (CLEA) 2015
 - LQM/CIEH S4ULs for Human Health Risk Assessment 2015
 - SP1010 Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document 2014
- 6.5 Elevated concentrations of Lead (213 mg/kg and 296 mg/kg) have been detected within the samples obtained from WS1 and WS3. The soil guideline value for Lead provided by SP1010 is 200 mg/kg.

- 6.6 Concentrations of the remaining substances detected within the samples were within the utilised soil screening criteria, TPH fractions being below laboratory detection limits. VOC and SVOC were also below laboratory detection levels and no evidence of asbestos fibres was observed within the samples.
- 6.7 Leachate analysis has been undertaken on four soil samples obtained at a depth of 1m in boreholes WS1, WS3, WS4 and WS5, the results of the tests having being compared with UK Drinking Water Quality Standards (DWQS). All contaminant concentrations were within currently available DWQS. TPH fractions were below laboratory detection levels.

7. Discussion/Recommendations

- 7.1 The investigation has revealed that the site is underlain by a mantle of clayey Head Deposits extending 0.9m to 1.9m below ground level, being overlain by a 0.2m to 0.4m capping of made ground (FILL). The Seaford Chalk was penetrated at depths of 1m to 2.2m, a 0.8m to 1.1m thick layer of weathered Chalk being present between the Head Deposits and the intact Seaford Chalk on the east side of the site. The soft consistency of the Head Deposits at the location of WS3 was probably attributable to surface water ingress due to pooling of recent heavy rain on this area of the site.
- 7.2 Groundwater was not encountered within 3m of the site surface and is considered unlikely to occur for some considerable depth. The hydrogeology of the site may however be subject to seasonal variations throughout the year.

Foundations

- 7.3 It is essential that foundations should extend below the depth of any made ground or compressible soil and penetrate competent, load-bearing material. An acceptable bearing pressure of 80 kN/m² is applicable within the Head Deposits, increasing to 120 kN/m² within both the weathered Chalk and the intact Seaford Chalk. NHBC classification of the Head Deposits: Soil of Low Volume Change Potential. The underlying Chalk can be considered as non-plastic, therefore unlikely to exhibit changes in volume. Due to the variation in consistency between the Head Deposits

and the underlying Chalk it is recommended that all foundations are extended into the weathered or intact Chalk.

- 7.4 Sulphate determination has indicated that special precautions would not be required within a subterranean concrete mix placed upon the site (see BRE Special Publication 1 (2005) "Concrete in Aggressive Ground").

Revised Risk Assessment

- 7.5 Elevated concentrations of Lead which could pose a risk to human health and plant life were detected in boreholes WS1 and WS3, the former borehole being positioned within the area of proposed garden for Units 1 and 2 whereas WS3 was located on the site of the proposed access road. Remediation will therefore be required within the proposed gardens but will not be necessary beneath permanent hardstanding as pathways for contaminants to reach end users will be severed.
- 7.6 A low risk to groundwater is considered applicable as low contaminant mobility has been identified by the leachate tests and groundwater has not been detected within 3m of the site surface. No surface water bodies have been identified within 500m of the site.
- 7.7 A low risk to potable water services is considered applicable as TPH, VOC and SVOC were below laboratory detection levels.
- 7.8 The following ground gas risk assessment has been undertaken in compliance with the methodology proposed by CL:AIRE research bulletin RB17 (2012):
1. Potential sources of off-site gas migration have been identified to the north of the site, though the infilled features are unlikely to contain bio-degradable material. The available results of gas monitoring do not indicate that the site is being impacted by emissions of ground gases.
 2. No radon protection measures are required within the development.
 3. The average depth of made ground beneath the site is much less than 3m.
 4. The Fill material comprises re-worked natural soils which do not produce methane and can only produce carbon dioxide.
 5. The total organic carbon content of the Fill is less than 6%.

In addition, TPH VOC and SVOC were not detected beneath the site.

Remediation Method Statement

- 7.9 With reference to BRE document "Cover systems for land regeneration" (2004) in areas of proposed garden for Units 1 and 2 excavation of the Fill material to a depth of 600mm is recommended. It may be possible to reduce the area of excavation required by delineating more precisely the lateral extent of Lead contamination with further soil sampling and laboratory testing. Excavated soil should be removed from the site to an appropriately licensed depository. **The reduction in site level should be fully documented with photographic evidence for inclusion within a Closure Report for the site.**
- 7.10 Haulage transfer notes should be retained as evidence that contaminated soil has been disposed of at a suitably licensed depository and for inclusion within the Closure Report.
- 7.11 Remediation will not be necessary beneath the footprints of the proposed structures or under areas of permanent hardstanding, as pathways for contaminants to reach end users will be severed.
- 7.12 Excavated soil removed from areas of proposed garden should be replaced by imported subsoil/topsoil which has been independently tested in order to ensure that it is free from contamination and suitable for use on the site.
- 7.13 Site workers should be provided with appropriate protective clothing and washing facilities. Dust emissions should be minimised as far as possible in order to safeguard both site workers and the occupants of adjacent buildings.
- 7.14 On the basis of the available information a low risk from ground gases and contaminant vapours has been identified to the site therefore gas protection measures are unlikely to be necessary within the design of the development. A confirmatory gas monitoring report will be issued following further site visits.
- 7.15 It must be noted that the site is underlain by a Principal Aquifer therefore every

precaution should be taken during the course of the development in order to prevent the escape and subsequent migration of pollutants into the underlying strata. Fuel and/or lubricants utilised by contractors' plant should be stored in a secure, preferably bunded area of the site.

- 7.16 In the event that contamination not detected by the intrusive investigations is encountered during the course of the development, the nature of the contamination must be adequately assessed and dealt with in an appropriate manner. Evidence of contamination may include discoloured or malodorous soil and/or the presence of ash, clinker or asbestos fragments.
- 7.17 Any asbestos-containing materials found to be present within the existing structures should be removed and disposed of by an experienced contractor.
- 7.18 The findings and recommendations contained within this report should be made available to the Contaminated Land Officer of the local Planning Authority prior to the commencement of the development.
- 7.19 This report has been prepared from information obtained at representative locations of the site. Although significant variations in ground conditions are considered unlikely, no responsibility can be accepted for any such variations that may exist beneath the site in hitherto uninvestigated areas.



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