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ENVIRONMENT

Richborough Estates
Phase 1 Development - Sandwich Road
Sholden

Phase 2 Geo-Environmental Assessment

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Phase 1 Development - Sandwich Road
Sholden
Phase 2 Geo-Environmental Assessment

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			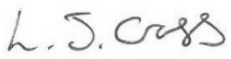		

Notice

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY	
Site Address	Sandwich Road, Sholden, Deal, CT14 0EX (approximate)
Site Setting	The Site is currently utilised as arable agricultural land, with several public footpaths crossing the Site. The Site is located in an agricultural and residential setting, with residential properties to the east and agricultural land to the south, west and north. The Site is split into two areas with the report focussing on the northern, Phase 1 area.
Site Investigation	The ground investigation comprised the advancement of three cable percussion boreholes to a maximum depth of 15.45m below ground level (bgl), eight dynamic sampler boreholes to a maximum depth of 5.45m (bgl), eleven trial pits to a maximum depth of 3.10m bgl, construction of three soakaway tests, and four following up ground gas and groundwater monitoring visits.
Ground Conditions Encountered	In generally the ground conditions comprised topsoil with maximum thickness of 0.6m underlain by locally absent Head Deposits to a maximum depth of 2.0m bgl overlying the Seaford Chalk Formation. No groundwater has been recorded on Site to date.
Geotechnical Appraisal	Shallow spread foundations set within the Seaford Chalk Formation at depths of between 1.0m and 2.0m are considered suitable to support lightly loaded residential developments of up to 100kPa assuming a footing width of either 600mm or 900mm is utilised. Heavier loadings may require wider footings. A ground bearing floor slab may offer suitable loading capacities where the development is placed on shallow spread foundations. However, this is dependent on the entire floor slab being wholly cast with one geological strata to avoid differential settlement. Soakaway drainage within the shallow chalk deposits is considered a viable option for the Site, however, these should be constructions positioned a minimum of 15m from any building due to the potential to create solution features within the underlying chalk bedrock. The Geotechnical Assessment should be confirmed following the completion of the geotechnical laboratory testing.
Environmental Appraisal	The environmental risk assessment has not identified significant sources of contamination which may represent a risk to human health. No significant risk to controlled water receptors has been identified at the Site. Furthermore, the predominantly hardstanding nature of the Proposed Development at the Site is likely to restrict water migration towards the underlying Principal Aquifer. The ground gas monitoring programme is in progress. To date, a single monitoring visit has been completed which has not identified any elevated hazardous ground gases. Based on the information collected to date the Site is classified as an NHBC Green Site (CS1).
Waste Assessment	Samples analysed from the Site using Hazwasteonline indicate the material at the Site to be classified as non-hazardous.
This summary should be read in conjunction with BWB's full report (ref. SRS-BWB-ZZ-XX-RP-YE-0004Ph2_Ph2-A1) and reflects an assessment of the Site based on information received by BWB at the time of production.	

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1. INTRODUCTION

Instruction

1.1 BWB Consulting (BWB) was instructed by Richborough Estates (the Client) to carry out a Phase 2 Geo-Environmental Assessment.

1.2 The Proposed Development is anticipated to comprise for the erection of residential properties with associated gardens, parking, green spaces and infrastructure. A proposed illustrative development plan is presented as **Appendix 1**.

1.3 It is understood that the development will be completed in two phases. This report focuses on the Phase 1 development area which is defined in **Figure 2:1.**

Previous Reports

1.4 The following geo-environmental reports have previously been completed for the Site:

- *'Phase 1 Geo-Environmental Assessment'* by BWB for Richborough Estates, reference SRS-BWB-ZZ-XX-RP-YE-0003-PH1, dated February 2021;

1.5 Familiarity with the above report is assumed although pertinent information has been included within this report, where appropriate.

Objectives

1.6 The objectives of the report are to assess:

- The prevailing ground and groundwater conditions across the Site;
- The potential presence and extent of contamination in shallow soil and groundwater beneath the Site;
- The significance and magnitude of the observed contamination through comparison of analytical data to appropriate published environmental screening criteria;
- The strength properties of the soil beneath the Site to enable foundation design; and
- The ground gas regime beneath the Site.

1.7 The above objectives will allow the preliminary Conceptual Site Model presented in the Phase 1 report to be verified and updated. The report has been completed in accordance with BS10175:2011(+A2:2017) 'Investigation of Potentially Contaminated Sites, Code of Practice' and EA Guidance on Risk Management of Land Contamination https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm.

1.8 This report presents the information obtained from a desk study and the supplementary ground investigations. The report, together with the associated Figures and Appendices, provides a Ground Investigation Report (GIR), as defined in BS EN 1997-1:2004 and BS EN 1997-2:2007.

Scope of Works

1.9 Intrusive ground investigation works were undertaken between 02nd August and Friday 11th August 2021 and comprised the following works:

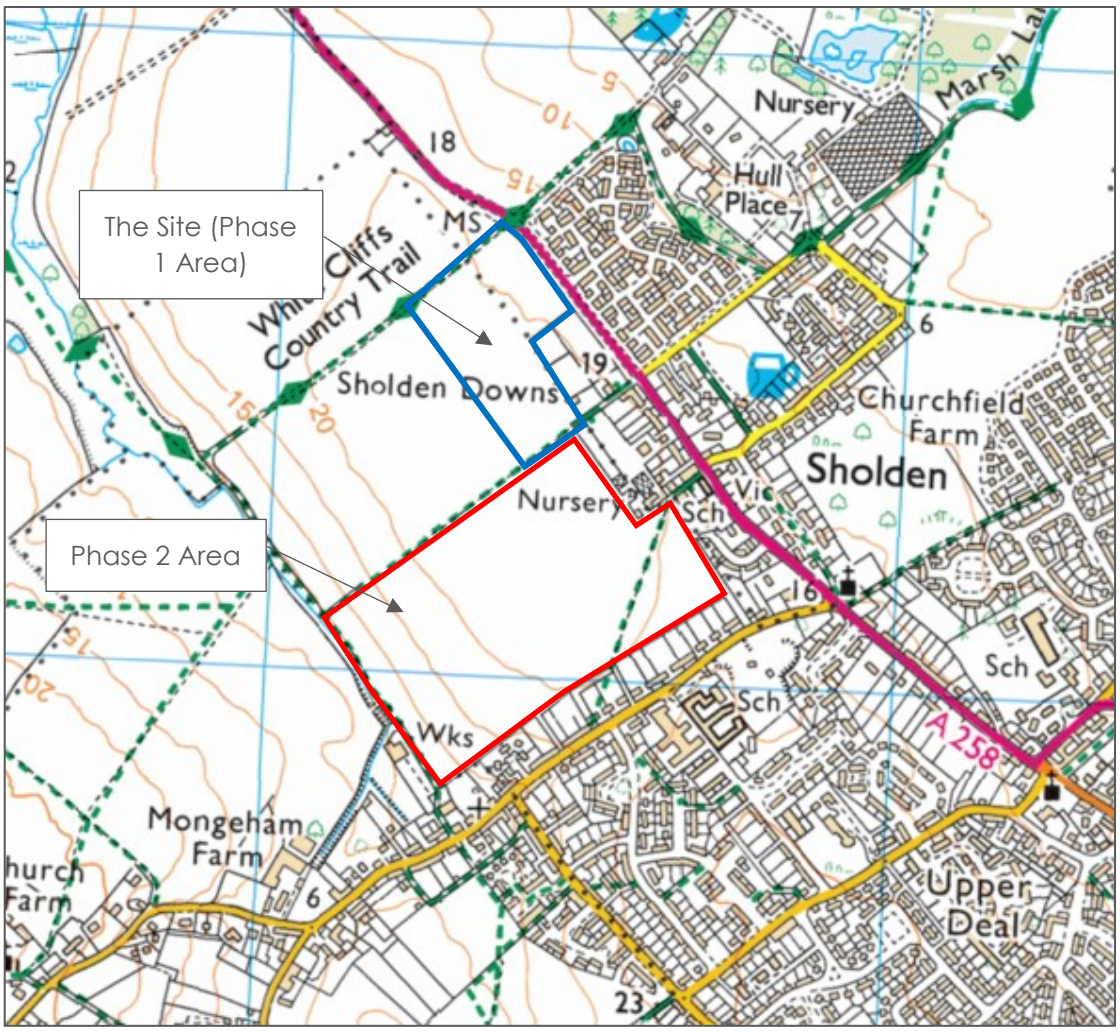
- Non-intrusive survey of excavation locations for underground utilities;
- Eleven machine excavated trial pits;
- Eight window sampler boreholes;
- Three cable percussive boreholes;
- Four soakaway drainage tests (BRE 365)
- Six gas and groundwater monitoring visits;
- Chemical analysis of soils and groundwater; and
- Geotechnical testing of soil.

2. THE SITE

Site Location

2.1 The Site is located at Sandwich Road, in Sholden, centred at approximate National Grid Reference 635433, 152135. The location of the Site is shown in **Figure 2.1.**

Figure 2:1: Site Location Plan:



Site Description

2.2 A full description of the Site (Phases 1 and 2) is presented within BWB Phase 1 Geo-Environmental Assessment (ref: SRS-BWB-ZZ-XX-RP-YE-0003-PH1), dated February 2021.

3. PUBLISHED GROUND CONDITIONS

Published Geology

3.1 British Geological Survey (BGS) mapping for the Site indicates that that superficial deposits are absent across the majority of the Site, with only the north eastern corner underlain by Head Deposits (clay and silt), extending off-site along the north-eastern boundary. The Site is wholly underlain by the bedrock geology of the Seaford Chalk Formation (SCF).

Hydrogeology

3.2 The underlying ground conditions have been classified by the Environment Agency (EA) as follows:

- Head Deposit: Unproductive Strata; and
- Seaford Chalk Formation: Principal Aquifer.

Hydrology

3.3 The closest mapped surface water feature to the Site is South Stream (a tributary of the River Stour), located 400m south-west of the Site

3.4 The Site is not indicated to be located within an EA designated flood zone

4. PRELIMINARY ENVIRONMENTAL RISK ASSESSMENT

Introduction

4.1 The risk posed by any contaminants in soil or groundwater will depend on the nature of the hazard, the probability of exposure, the pathway by which exposure occurs, and the likely effects on the receptors. A contaminant is defined as a substance that has the potential to cause harm, while a risk is considered to exist if such a substance is present in sufficient concentration to cause harm and a pathway exists for a receptor to be exposed to the substance.

4.2 The following sections discuss all the identified potential on and off-site sources, pathways and receptors in the context of the Proposed Development and plausible pollutant linkages which may represent a risk to identified receptors such as human health and/or controlled waters from the data gained from the desk study. At this stage the assessment is qualitative and aimed to determine all pollutant linkages, irrespective of significance or allowing for uncertainty.

4.3 Three impact potentials exist for any given site; these are:

- The site impacting upon itself;
- The site impacting on its surroundings; and
- The surroundings impacting on the site.

4.4 All three impacts need to be considered in a risk assessment.

4.5 A Source, Pathway, Receptor analysis has been undertaken for the site based on the information provided in the preceding sections. This is presented as Table 5 and further information about the risk classification scheme is included within Appendix 5.

4.6 Sources (S); These are potential or known sources of contamination that may relate to a former land use or present site feature or process (e.g. fuel storage tanks).

4.7 Pathways (P); A pathway is defined as a mechanism or route by which a contaminant comes into contact with, or otherwise affects a receptor. Pathways by which the identified receptors may be impacted upon in the context of the Proposed Development.

4.8 Receptors (R); Receptors are defined as people, living organisms, ecological systems, controlled waters, atmosphere, structures and utilities that could be adversely affected by contaminant(s).

4.9 Under the Construction Design Management (CDM) Regulations 2015, construction and maintenance contractors must undertake their own risk assessments and mitigation to protect their staff, other human receptors and the environment from potential contamination. By law potential risks to human health and the environment from construction activities must appropriately identified and all necessary steps taken to eliminate/manage that risk. Therefore, construction / maintenance workers are excluded as a receptor in the CSM.

4.10 A tabulated version of the Preliminary CSM based on the desk study and Site observations is presented in **Table 4:3.**

4.11 The Preliminary CSM covers both the Phase 1 and 2 development areas.

Table 4:1: Potential Sources of Contamination

Location	Potential Source	Contaminants of Potential Concern (CoPC)
On-site	Contamination associated former arable agricultural activities undertaken at the Site.	• Pesticides and herbicides
Off-site	Contamination associated with neighbouring commercial activity including works to the south-west and electricity substation along southern boundary.	• Heavy metals • Inorganics, such as cyanides, sulphates and nitrates • Volatile organic compounds (VOCs) • Semi-volatile organic compounds (SVOCs) including phenols and polycyclic aromatic hydrocarbons (PAHs) • Petroleum hydrocarbons • Polychlorinated biphenyls (PCBs)
	Alluvial deposits mapped along south-western boundary.	• Methane, carbon dioxide

Table 4:2: Relevant Potential Pathways and Receptors

Receptors	Pathways
Human Health: • Future Site users (residential) • Neighbouring public (residential • Intrusive maintenance workers	• Dermal contact with soil or dust • Incidental ingestion of soil and/or dust • Inhalation of dust and/or fibres • Ingestion of contaminated vegetables and/or soil attached to vegetables • Inhalation of vapours • Migration and accumulation of ground gas in enclosed spaces leading to inhalation or explosion
Controlled Waters: • Groundwater (Principal Aquifer beneath the Site, Secondary A Aquifer and SPZ in close proximity and groundwater abstraction borehole to north-east) • Surface water (South Stream)	• Leaching of soil contaminants • Vertical and lateral migration • Surface run-off
Property: • Underground utilities • Building structures	• Direct contact • Accumulation and explosion of gas

Table 4:3: Preliminary Conceptual Site Model

Source	Pathway	Receptor	Con	Prob	Risk	Potential Mitigation/Investigation Requirements
On-site sources as detailed in **Table 4:1**.	Dermal contact with, and incidental ingestion of soil and/or dust. Inhalation of dust and/or fibres.	Future Site users (residential)	Mi	Lw	L	Buildings and hardstanding within the Proposed Development will limit the potential for direct contact with and minimise dust generation from potentially contaminated soils at the Site post construction. In public open space and garden areas the provision of a clean capping layer would restrict direct access to potentially contaminated soils. It is recommended that an intrusive ground investigation be completed in order to assess the extent of any potential contamination at the Site. The exposure of intrusive maintenance workers can be mitigated by the adoption of suitable working methods, utilising appropriate personal protective equipment (PPE) and maintaining good hygiene.
		Intrusive maintenance workers				
	Ingestion of contaminated vegetables and/or soil attached to vegetables.	Future Site users (residential)	Mi	UL	VL	In garden areas where there is the potential for allotments, the provision of a clean capping layer would with appropriate demarcation at depth would limit the potential for vegetables to be grown in potentially contaminated soils.
	Leaching and permeation through soil profile.	Groundwater (Principal Aquifer beneath the Site, Secondary A Aquifer and SPZ in close proximity and groundwater abstraction borehole to north-east)	Mi	Lw	L	No groundwater or surface water data is currently available for the Site. Ground investigation should include the installation of groundwater monitoring wells to allow for sampling of groundwater for chemical analysis, in order to assess whether potentially unacceptable levels of CoPC are present. The recommendations of DEFRA and EA guidance document '*Pollution prevention for businesses*' should be considered during construction.
	Vertical and lateral migration of contaminants.					
	Surface run-off.	South Stream				
	Direct contact.	Water utility pipes	Mi	Lw	L	Organic compounds in the shallow soils could taint the water supply. A ground investigation and subsequent laboratory analysis should be undertaken to inform the design of new services.

Source	Pathway	Receptor	Con	Prob	Risk	Potential Mitigation/Investigation Requirements
		Buried structures/ foundations	Mi	Lw	L	Sulphates and low pH in the ground could accelerate the degradation of buried concrete structures (e.g. foundations). Ground investigation should include an assessment of the concrete design class.
Off-site sources as detailed in **Table 4:1**.	Migration and accumulation of ground gases in enclosed spaces leading to asphyxiation (carbon dioxide) or explosion (methane).	Future Site users (residential)	Mi	Lw	L	Made Ground surrounding the site could possibly represent a source of ground gas. It is recommended that ground gas monitoring be completed as part of an intrusive ground investigation in order to characterise the ground gas regime at the site.
	Lateral migration of contaminated groundwater.	Groundwater (Principal Aquifer beneath the Site, Secondary A Aquifer and SPZ in close proximity and groundwater abstraction borehole to north-east)	Mi	Lw	L	Where possible, groundwater monitoring wells should be located along the Site boundaries in order to delineate any potential contamination.
VH = Very High, H = High, M = Moderate, M/L = Moderate/Low, L = Low, VL = Very Low KEY: Sv = Severe, Md = Medium, Mi = Mild, Mr = Minor, Hi = High, Li = Likely, Lw = Low Likelihood, Ul = Unlikely						

5. PHASE II ENVIRONMENTAL AND GEOTECHNICAL GROUND INVESTIGATION

5.1 Intrusive ground investigation works were undertaken between 02nd August and Friday 11th August 2021 and comprised the following works:

- Clearance of investigation locations by a specialist buried services tracing company;
- Collection of coordinates and elevations of exploratory hole locations;
- The advancement of three cable percussive boreholes (BH101 to BH103 inclusive) to a maximum depth of 15.45m bgl with completion of Standard Penetration Tests (SPTs) and installations of gas and groundwater monitoring well in two locations;
- Advancement of eight boreholes (DS101 – DS108) by dynamic sampling drilling techniques, to a maximum depth of 5.45m bgl with completion of SPTs and installations of gas and groundwater monitoring wells;
- The advancement of eleven machine excavated trial pits (TP101 to TP111 inclusive) to a maximum depth of 3.20m bgl;
- The installation of three BRE 365 soakaway testing locations (SA101 to SA103);
- Collection of environmental soil and groundwater water samples for chemical analysis at a UKAS and MCERTS accredited laboratory;
- Collection of bulk and disturbed soil samples for geotechnical analysis at a UKAS accredited laboratory;
- Four post investigation ground gas and groundwater level monitoring visits (one completed to date); and
- Permeability testing undertaken in one borehole location on Site (BH102).

5.2 An exploratory hole location plan is presented as **Drawing 1**. The exploratory hole records are presented as **Appendix 2**, SPT calibration certificates are presented as **Appendix 3**, soakaway and permeability testing results are presented as **Appendix 4** and ground gas and groundwater monitoring results presented as **Appendix 5**.

5.3 The Site investigation works were carried out in general accordance with BS5930:2015 'Code of Practice for Site Investigations' and BS10175:2011 'Investigation of Potentially Contaminated Sites'.

Chemical Sampling Strategy

5.4 The Phase 1 Geo-Environmental Assessment did not identify any significant sources of contamination, therefore, all investigation locations were positioned to provide spatial coverage across the Site.

Chemical Analytical Strategy

Soil Strategy

5.5 Selected soil samples collected from exploratory hole locations were sent to I2 Analytical Services (UKAS and MCERTS accredited) for chemical analysis. The following chemical analytical testing was undertaken:

- Ten soil samples tested for a soil suite (BWB Standard Suite) comprising arsenic, barium, beryllium, water soluble boron, cadmium, chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium, vanadium, zinc, water soluble sulphate (2:1 extract), total phenols, total cyanide, free cyanide, complex cyanide, fraction of organic carbon, pH, Polycyclic Aromatic Hydrocarbons (PAHs) (United States Environment Protection Agency priority 16 compounds) and Total Petroleum Hydrocarbons (TPH) C6-C40;
- Four soil samples for asbestos screening;
- Two samples tested for a suite of pesticide and herbicides; and
- Two soil samples tested for a suite of common leachable contaminants, namely arsenic, barium, beryllium, water soluble boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium, zinc, water soluble sulphate (2:1 extract), sulphate, total cyanide and pH.

5.6 The results of the soil chemical testing are presented as **Appendix 6**.

Geotechnical Strategy

5.7 The cable percussive borehole locations, dynamic sampler borehole locations and trial pits were positioned to assess ground conditions, strength properties and characteristics across the wider Site, with soakaway tests undertaken to the northeast and south of the Site.

5.8 In-situ soil strength testing comprising SPTs were undertaken with the cable percussive. SPT 'N' values are included on the exploratory hole logs presented as **Appendix 2**.

5.9 Selected disturbed and bulk samples were collected from the investigation locations and sent to the geotechnical project laboratory (I2 Analytical Services), which is UKAS accredited. The following geotechnical testing was undertaken;

- Seven samples tested for moisture content;
- Seven samples tested for Atterberg (liquid and plastic) limits;
- Two samples tested for particle size distribution by pipette;
- Nine samples tested for BRE Suite comprising aqueous sulphate and pH; and
- Twelve samples tested for Saturated Moisture Content on chalk;

5.10 The geotechnical testing is still in progress, the results will be presented and assessed within an updated report.

6. GROUND CONDITIONS ENCOUNTERED

Geological Summary

6.1 The ground conditions recorded confirmed the published geology discussed in the Phase 1 report with varying thicknesses of topsoil overlying Head deposits underlain by the Seaford Chalk Formation. The Head Deposits, which are indicated to only be present along the north-eastern boundary of the Site were found to be more wide spread then anticipated.

6.2 The recorded ground conditions are summarised below. Uncorrected SPT results collected from the borehole locations are presented on the exploratory hole records presented in **Appendix 2**.

Geological Descriptions

Topsoil

6.3 Topsoil was encountered consistently across the at thicknesses of between 0.15m and 0.60m. The composition also displayed consistency, typically comprising brown gravelly clayey silty sand, or slightly sandy gravelly silty clay with rootlets. Gravel included subangular to rounded fine to coarse flint.

6.4 The depth of topsoil over the Site is quite consistently averaging between 0.30-0.40m bgl.

Head Deposits

6.5 Head Deposits were encountered within the majority of the exploratory holes at the Site beneath the Topsoil with thicknesses raging between 0.10m and 2.00m.

6.6 It is generally formed by granular materials; brown clayey gravelly fine to medium sand. Gravel is angular to subangular fine to medium chalk and flint. Cohesive, stiff brown friable slightly sandy slightly gravelly clay was encountered within an area covered by TP01, TP02, TP05 and TP108, all located in the northeast sector of the Site. Gravel has been found to be angular to subangular, fine to medium of flint and chalk.

Seaford Chalk Formation

6.7 The Seaford Chalk Formation was encountered within all intrusive locations across the Site and was recorded from depths of between 0.3m to the deepest boreholes at 15.45m bgl, with the final thicknesses not proven. The weathered section had a thickness ranging from 0.20 to 0.90m and were commonly found below the Head Deposit or directly underlying the topsoil. In general, weathered Seaford Chalk Formation is found to deepen towards the east. Arisings were typically recorded as:

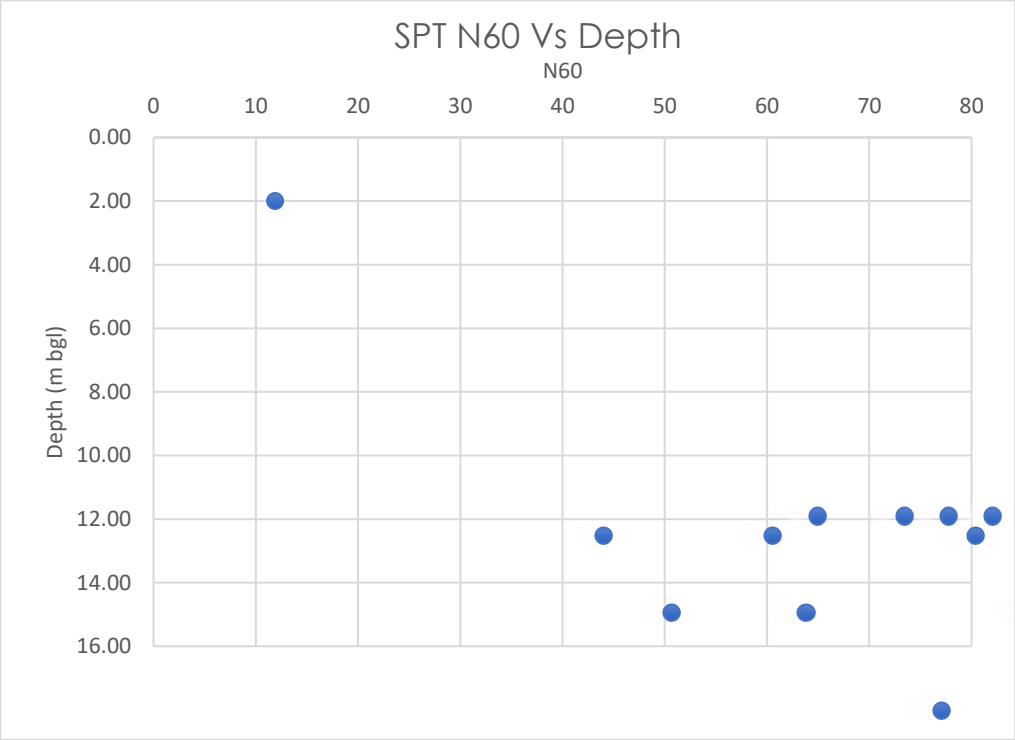
- Structureless chalk recovered as a cream or light brown sandy silty gravel with rare flint;

- Structureless chalk composed of white or off-white with brown weathering slightly silty gravel; and
- Structureless chalk composed of sandy angular gravel a low cobble content and occasional flint gravel. Clasts are white with rare black spots and iron staining medium density and weak with occasional orange staining on clast surface.

6.8 SPT N_{60} values within the Seaford Chalk Formation were recorded between 4 and 70 blows, indicating loose to very dense deposits.

6.9 SPT results collected from the borehole locations are presented on the exploratory hole records presented in **Appendix 2**. A plot of corrected SPT 'N' Value vs. Depth is presented as **Figure 6.1** below.

Figure 6:1: SPT N_{60} Vs. Depth



In Situ Testing

Falling Head Permeability Testing

6.10 Permeability testing was undertaken within the chalk at BH102 location to the east of the Site, with a testing section between 1.00-15.00m. The results of the testing undertaken are presented as **Appendix 4** and are summarised within **Table 6:3** below.

Table 6:1: Permeability Testing Results

Test Location	Geology	Calculation Methodology	Permeability (m/s)	Permeability Class	Drainage Characteristics
BH102	Chalk	Basic Time Lag Method	NA	Low	Good

Test Location	Geology	Calculation Methodology	Permeability (m/s)	Permeability Class	Drainage Characteristics
		General Method	$4.07x10^{-11}$	Practically Impermeable	Practically Impervious

Soakaway Permeability Testing

6.11 Permeability testing in line with BRE 365 guidance was undertaken in three locations (SA101, SA102 & SA103) across the northeast and the south of the Site. The results of the testing undertaken are presented as **Appendix 4** and are summarised within **Table 6:3** below.

Table 6:2: BRE 365 Soakaway Testing Results

Test Location	Geology	Test no.	Soil Infiltration Rate (m/s)	Permeability Class	Drainage Characteristics
SA101	Seaford Chalk Formation	1	$1.66x10^{-03}$	High	Good
		2	$1.11x10^{-03}$	High	Good
		3	$1.35x10^{-03}$	High	Good
SA102	Seaford Chalk Formation	1	$4.07x10^{-04}$	Medium	Good
		2	$2.50x10^{-04}$	Medium	Good
		3	$2.09x10^{-04}$	Medium	Good
SA103	Seaford Chalk Formation	1	$1.48x10^{-05}$	Medium	Good
		2	$1.22x10^{-05}$	Medium	Good

Hydrogeology

6.12 All boreholes were found to be absent of groundwater during the single groundwater monitoring visit completed to date. This assessment will be updated following the completion of the groundwater monitoring programme.

Hydrology

6.13 No surface water monitoring has been undertaken as part of this investigation.

Contamination Observations

No significant evidence of contamination was noted during the ground investigation, groundwater sampling visit or subsequent gas and groundwater monitoring period.

7. GEOTECHNICAL ASSESSMENT

Introduction

7.1 The proposed development is anticipated to comprise for the erection of residential properties with associated gardens, parking, green spaces and infrastructure. Foundation loads for the proposed development and floor slabs are not known currently.

7.2 To all extents of the Site, topsoil is present with a thickness of 0.3m to 0.4m. Cohesive soils were encountered only in the northern area with a maximum thickness of 0.50m and to a maximum depth of 1.00m. Granular materials from both the Head Deposit and the weathered Seaford Chalk Formation reached a maximum depth of 2.40m in the south and northeast of the Site. Deposits of the Seaford Chalk Formation encountered at the Site have been classified as Grade Dc, with the deposits recovered as structureless or remoulded where clasts of intact chalk lumps dominate resulting in the material generally behaving as a granular, coarse soil. Silt dominant chalk was often recorded within the disturbed sections of the dynamic sampler and cable percussion boreholes. Gravel sized and rare cobble sized flint are occasionally present at most depths. SPT refusals or dense section of the chalk correlate with the flint presence.

Foundation Solutions

Traditional Foundations

7.3 Based upon the SPT results, shallow spread foundations set within the Seaford Chalk Formation at depths of between 1.0m and 2.0m are considered suitable to support lightly loaded residential developments of up to 100kPa assuming a footing width of either 600mm or 900mm is utilised. Heavier loadings may require wider footings. This will need to be confirmed on receipt of geotechnical laboratory results.

Floor Slabs

7.4 A ground bearing floor slab may offer suitable loading capacities where the development is placed on shallow spread foundations. However, this is dependent on the entire floor slab being wholly cast with one geological stratum to avoid differential settlement.

Roads and Pavements

7.5 Based upon guidance within Interim Advice Note 73/06 (IAN73/06) Revision 1 2009, roads should be designed with CBR's between 3% and for 5%, which should be confirmed by in-situ testing once detailed designs are available.

Drainage

7.6 Three soakaway drainage tests in line with BRE 365 guidance have been completed across the Site along the less elevated east sector, recording an average infiltration rate

of 6.36x10^{-04}, which classifies the permeability as medium and the drainage characteristic as good.

7.7 A deeper falling head permeability test was undertaken within the chalk at BH102 located to the east of the Site, recording hydraulic conductivity of 4.07x10^{-11} which classify the permeability as practically Impervious and the drainage characteristic as practically impermeable. However, this falling head test result may have been influenced by the length of the testing section and also by the disturbance created by the drilling technique that could have led to the sealing of fractures within the chalk.

7.8 Based upon the above, it is considered that soakaway drainage could be considered across the Site, especially within the top section of the chalk. However, any soakaway drains should be positioned a minimum of 15.0m away from any structures due to the potential to create solution features within the underlying chalk.

Excavations

Ease of Excavation

7.9 Excavations using backhoe excavators are expected to be suitable within shallow deposits and weathered chalk across the Site.

Legislation on Personnel Entry to Excavations

7.10 It is recommended that no excavations should be entered without appropriate support and a full risk assessment should be completed prior to entry. Mitigation measures to protect from accumulating ground gases (if present) should be implemented.

Groundwater

7.11 All boreholes were found to be absent of groundwater during the single groundwater monitoring visit completed to date. It is considered unlikely that groundwater will be encountered during any excavation works at the Site, however, should any water be encountered, removal using conventional construction of sumps and submersible pumps should be feasible, depending on depths and any shoring techniques in place.

Chemical Attack on Buried Concrete

7.12 Water soluble sulphate concentrations in soils varied from 0.006 g/l to 0.02 g/l with soil pH values ranging from 8.3 to 9.0.

7.13 Total sulphur concentration ranged from 0.019 % to 0.04 %.

7.14 In accordance with the recommendations of BRE Special Digest 1, 'Concrete in Aggressive Ground' 2005, the conditions of the soils at the Site would therefore be classified as Design Sulphate Class DS-1 and ACEC Class AC-1 for soils and groundwater, when considering the most appropriate type of concrete to be used at the Site in order to resist chemical attack from elevated sulphate present in the soils (assuming mobile groundwater in non pyritic soils).

8. PRELIMINARY GROUND GAS ASSESSMENT

Introduction

8.1 Ground gas assessment has been undertaken to assess the risks associated with ground gases and volatile vapours to new buildings and their occupants. The results obtained have been assessed in line with relevant guidance (notably CIRIA C665).

8.2 Based on the desk study and the ground investigation undertaken, no significant sources of hazardous ground gases have been identified on Site.

8.3 To date, a single monitoring visit has been completed with a further five visits to be completed over the next 10 weeks, therefore this assessment is preliminary.

Methodology

8.4 The assessment of potential ground gas generation is based on the observation of trends and changes in gas evolution by the direct measurement of ground gases from gas wells. The works included measurement of methane, carbon dioxide, oxygen, hydrogen sulphide, carbon monoxide, gas flows and barometric pressure. A PID survey was undertaken to measure volatile organic compounds within the borehole response zones.

Results

8.5 The minimum and maximum steady state concentrations recorded for borehole flow, oxygen, carbon dioxide and methane are summarised below in **Table 8:1**. The full ground gas monitoring results are presented in **Appendix 5**.

Table 8:1: Summary of Recorded Ground Gas Results

Borehole ID	Targeted Geology	Steady Flow (l/hr)		Carbon Dioxide (%v/v)		Methane (%v/v)	
		Max.	Steady.	Max.	Steady.	Max.	Steady.
BH101	Chalk	<0.1	<0.1	1.4	1.2	<0.1	<0.1
BH102	Chalk	<0.1	<0.1	4.2	1.2	<0.1	<0.1
DS101	Head	<0.1	<0.1	1.5	1.3	<0.1	<0.1
DS102	Chalk	<0.1	<0.1	1.2	1.0	<0.1	<0.1
DS103	Chalk	<0.1	<0.1	1.4	1.1	<0.1	<0.1
DS104	Chalk	<0.1	<0.1	1.5	0.8	<0.1	<0.1
DS105	Chalk	<0.1	<0.1	1.6	1.6	<0.1	<0.1
DS106	Chalk	<0.1	<0.1	0.7	0.7	<0.1	<0.1
DS107	Chalk	<0.1	<0.1	1.6	1.6	<0.1	<0.1
DS108	Chalk	<0.1	<0.1	1.0	0.9	<0.1	<0.1

8.6 The atmospheric pressures were recorded as follows:

- Round 1 – 1011mB during the site visit falling from 1016mB over the preceding 12 hours;

8.7 Hydrogen sulphide and carbon monoxide concentrations were not recorded above the limit of detection of the equipment during the monitoring visit.

8.8 PID concentrations were recorded at a concentration of <0.1ppm (the limit of detection of the equipment).

Risk Assessment

8.9 CIRIA Report 665 "Assessing Risks Posed by Hazardous Ground Gases to Buildings" presents current best practice on the assessment of ground gases for commercial and residential buildings (with the exception of low rise traditional housing). The report presents a risk based approach based on gas screening levels which depend on both the concentration and emission rate of gas from the ground. Gas screening levels are calculated as follows:

$$Gas\ screening\ value\ (l/hr) = \frac{gas\ concentration\ (\%)\ X\ measured\ borehole\ flow\ rate\ (l/h)}{100}$$

8.10 Maximum gas screening levels of 0.0016 were recorded giving a classification of an NHBC Green Site (CS1 – very low risk). This assessment will be updated following the completion of the gas monitoring programme.

9. HUMAN HEALTH RISK ASSESSMENT

9.1 Contamination test data have been compared to generic site assessment criteria (GSAC) for a commercial end use. The criteria include reference to the LQM/CIEH S4ULs for Human Health Risk Assessment Copyright Land Quality Management Limited reproduced with permission; publication number S4UL3271. The results of the soil chemical laboratory results are provided within **Appendix 6** with a table summarising the results presented as **Appendix 7**.

9.2 The GSACs have been developed with the following assumptions which have been changed from the CLEA default parameter set: Soil type is a sandy loam with an organic matter content of 1%.

Pathways

9.3 Contamination data have been compared to generic site assessment criteria (GSAC) for a residential use (i.e. using all pathways for that end use) based on an organic matter content of 1%.

9.4 The Site is to be developed for residential end use and therefore the key receptor is considered to be a female child and GSACs for a residential end use with private gardens have been considered.

9.5 Exposure pathways considered in this assessment are presented in **Table 9:1**.

Table 9:1: Residual Exposure Pathways

Source:	Shallow Soils			Deep Soils
Pathway	Residential housing with private gardens	Residential housing with communal landscaped areas	Residential housing with hard standing areas	Residential housing
Ingestion of Soil	✓	✓	×	×
Ingestion of site derived household dust	✓	✓	×	×
Ingestion of contaminated vegetables	✓	×	×	×
Ingestion of soil attached to vegetables	✓	×	×	×
Dermal contact with Soil	✓	✓	×	×
Dermal contact with site derived household dust	✓	✓	×	×
Inhalation of fugitive soil dust	✓	✓	×	×
Inhalation of fugitive site derived household dust	✓	✓	×	×
Inhalation of vapours outside	✓	✓	✓	✓

Source:	Shallow Soils			Deep Soils
Inhalation of vapours inside	✓	✓	✓	✓

Sources

9.6 The results of the chemical analyses identified consistently low concentrations of contaminants within tested soil samples.

9.7 When the results were screened against the LQM S4ULS for a commercial end use development, all contaminants in all analysed soil samples were below relative screening criteria and therefore not considered to pose an unacceptable risk to human health.

9.8 All herbicide and pesticide concentrations were recorded below the laboratories lowest level detection with the exception of DDE-o,p' (pesticide), which was recorded with a concentration of 20µg/kg (TP103) and 24µg/kg (TP106). Given the very low concentration, no risk to human health is considered present. The topsoil present on Site is considered likely to be suitable for reuse across the proposed development subject to further testing at a suitable sampling frequency.

9.9 No asbestos has been identified in the four samples analysed from the Phase 1 area.

10. CONTROLLED WATERS RISK ASSESSMENT

10.1 The results of soil leachate analysis are presented as **Appendix 2**.

10.2 No groundwater or surface water testing has been undertaken as part of this assessment. However, soil leachability has been undertaken for a number of metals in the Made Ground. The soil leachability results are presented within **Appendix 8**.

10.3 The controlled waters assessment considers the potential impact of on-site contamination to pertinent controlled waters receptors identified at the Site including:

- Principal Aquifer beneath the Site within Seaford Chalk formations; and
- South Stream surface water feature located 400m west of the Site.

Pathways

10.4 Controlled water risk assessment has been undertaken through assessment of leachable concentrations of contaminants in soil referring to exposure pathways considered and referencing **Table 10:1**.

Table 10:1: Controlled Water Exposure Pathways

Controlled Waters Exposure Pathway	Receptor
Leaching of soil contamination into recharge infiltration	✓
Vertical migration of impacted pore water through unsaturated zone into underlying aquifer	✓
Horizontal migration of groundwater through aquifer to off site receptors	✓

10.5 The Site is underlain by the Seaford Chalk Formation (Principal Aquifer). Therefore, UK Drinking Water Standards (DWS) have been adopted as the relevant screening criteria.

Soil Leachability

10.6 A summary of the soil leachate concentrations and adopted guideline concentrations are presented within **Appendix 8**. All concentrations are below the adopted guideline concentrations with the exception of zinc which recorded one marginally elevated concentration of 12µg/l (DWS criteria of 10.9µg/l) at location TP108. Given the marginal exceedance and very low concentrations of heavy metals in the shallow soils across the Site, BWB consider this leachable contaminant represents a very low risk to control waters, therefore, this exceedance will not be considered further.

11. ENVIRONMENTAL RISK ASSESSMENT

Introduction

11.1 The human health risk assessment has not identified any potential sources of contamination that represent a risk to human health. Additionally, the controlled waters risk assessment has not identified contaminants that represent a risk to the underlying Principal Aquifer or other controlled waters receptors.

11.2 The ground gas monitoring programme is currently being progressed, to date a single monitoring visit has been completed which has not identified any elevated hazardous ground gases. Based on the information collected to date the Site is classified as an NHBC Green Site (CS1 – very low risk).

12. ENVIRONMENT LIABILITY ASSESSMENT

Statutory Liability

12.1 The contaminated land regime has implications for those who cause or knowingly permit land to be contaminated, or who own or occupy land that is contaminated.

12.2 Contaminated land is defined in Section 78A (2) of Part IIA of the Environmental Protection Act 1990 as:

"Any 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 land, that:

- Significant harm is being caused or there is a significant possibility of such harm being caused; or
- Significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being, caused."

12.3 Harm is defined in Section 78(4) of the Environmental Protection Act 1990 as:

- "Harm to the health of living organisms or other interference with ecological systems of which they form part and, in the case of man, includes harm to his property."

12.4 Once an area of land has been identified as contaminated land, appropriate persons will be identified as being responsible for the cost of cleaning up the land by the enforcing authority. The appropriate person will be liable for all or part of the remediation of the land. Two classes of appropriate person have been identified:

- Class A appropriate persons are those who caused or knowingly permitted the pollutants to be in, on or under the land.
- Class B appropriate persons are the owners(s) or occupier(s) of the land.

12.5 Where no Class A appropriate persons can be identified, then Class B appropriate persons may become liable.

12.6 Under statutory guidance for definition of contaminated land, sites may be classified into 4 categories. Categories 1 and 2 would meet the definition of contaminated land and categories 3 and 4 would not meet the definition.

12.7 It is considered that this Site would fall within Category 3 based on the limited contamination sources identified at the Site.

12.8 Based on the information available regarding the Site, the potential for Statutory Authority action based on "pollution of controlled water" or "significant harm" as defined by Part IIA of the Environmental Protection Act 1990 is considered to be **LOW**.

Third Party Liability

12.9 Based on the information contained in this report, it is the opinion of BWB that the potential for legal action by surrounding landowners, based on the potential for contamination to migrate off-site, is considered to be **LOW**.

Public Relations

12.10 It is considered that there is a **LOW** risk of public relations being tarnished as a result of the development.

13. WASTE MANAGEMENT

Waste Classification

13.1 Soil samples have been characterised against hazardous waste criteria using Hazwasteonline. The results of the waste classification are presented in **Appendix 9**. The assessment indicates that the soils analysed are likely to be classified as non-hazardous. The waste classification assessment only applies to those soils that have been tested. If other soils are to be disposed of off-site then further analysis may be required.

13.2 Asbestos has not been recorded in the soil samples analysed at the Site. The presence of visible asbestos containing materials in waste or at concentrations exceeding 0.1% by weight will classify the waste as mixed and require disposal as hazardous waste irrespective of the chemical properties of the waste.

13.3 Should any soils require disposal off-site an assessment of waste classification of the soils for disposal should be made by a competent person. Further chemical analysis may be required to fully characterise waste soils for disposal to landfill or re-use off-site. WAC analysis may be required for disposal of soils as inert or hazardous.

14. CONCLUSION AND RECOMMENDATIONS

Conclusions

14.1 In general, the ground conditions comprised topsoil with maximum thickness of 0.6m underlain by locally absent Head Deposits to a depth of 2.0m bgl overlying the Seaford Chalk Formation. All boreholes were found to be absent of groundwater during the one groundwater monitoring visit completed to date.

Environmental

14.2 The environmental risk assessment has not identified significant sources of contamination which may represent a risk to human health, and no significant risk to controlled water receptors has been identified at the Site.

14.3 The topsoil present on Site is considered likely to be suitable for reuse for the proposed development subject to further testing at appropriate frequencies.

14.4 Samples analysed from the Site using Hazwasteonline indicate the soils at the Site would be classified as non-hazardous for waste disposal purposes.

14.5 The ground gas monitoring programme is currently being progressed, to date a single monitoring visit has been completed which has not identified any elevated hazardous ground gases. Based on the information collected to date the Site would be classified as an NHBC Green Site (CS1).

Geotechnical

14.6 Shallow spread foundations set within the Seaford Chalk Formation at depths of between 1.0m and 2.0m are considered suitable to support lightly loaded residential developments of up to 100kPa assuming a footing width of either 600mm or 900mm is utilised. Heavier loadings may require wider footings.

14.7 A ground bearing floor slab may offer suitable loading capacities where the development is placed on shallow spread foundations. However, this is dependent on the entire floor slab being wholly cast with one geological strata to avoid differential settlement.

14.8 Soakaway drainage within the shallow chalk deposits is considered a viable option at the Site, however, these should be constructed a minimum of 15m from any building due to the potential to create solution features within the underlying chalk bedrock.

14.9 The Geotechnical Assessment should be confirmed following the completion of the geotechnical laboratory testing.

15. REFERENCES

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3. British Standards Institution, (BSI), BS 10175:2011+A2:2017, Investigation of Contaminated Sites – Code of Practice

4. British Standards Institution, (BSI), BS5930:2015) Code of practice for ground investigations

5. British Standards Institution, (BSI), BS EN 1997-1:2004 Incorporating corrigendum February 2009, Eurocode 7 – Geotechnical Design – Part 1: General rules.

6. British Standards Institution, (BSI), BS EN 1997-2:2007 Incorporating corrigendum June 2010, Eurocode 7 – Geotechnical Design – Part 2: Ground Investigation and testing.

7. Building Research Establishment Special Digest 1 *Third Edition*. Concrete in Aggressive Ground (2005)

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13. Department for Environment Food and Rural Affairs (DEFRA), 2012, Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance.

14. Environment Agency report Land Contamination Risk Management, 2020.

15. Environment Agency 2008, Updated technical background to the CLEA model Science Report – SC050021/SR3

16. Environment Agency 2008, Human health toxicological assessment of contaminants in soil Science Report – SC050021/SR2

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18. Environment Agency 2008, A review of body weight and height data used within the Contaminated Land Exposure Assessment model (CLEA) Project SC050021/ Technical Review 1

19. Environment Agency, 2006, Remedial Targets Methodology, Hydrogeological Risk Assessment for Land Contamination

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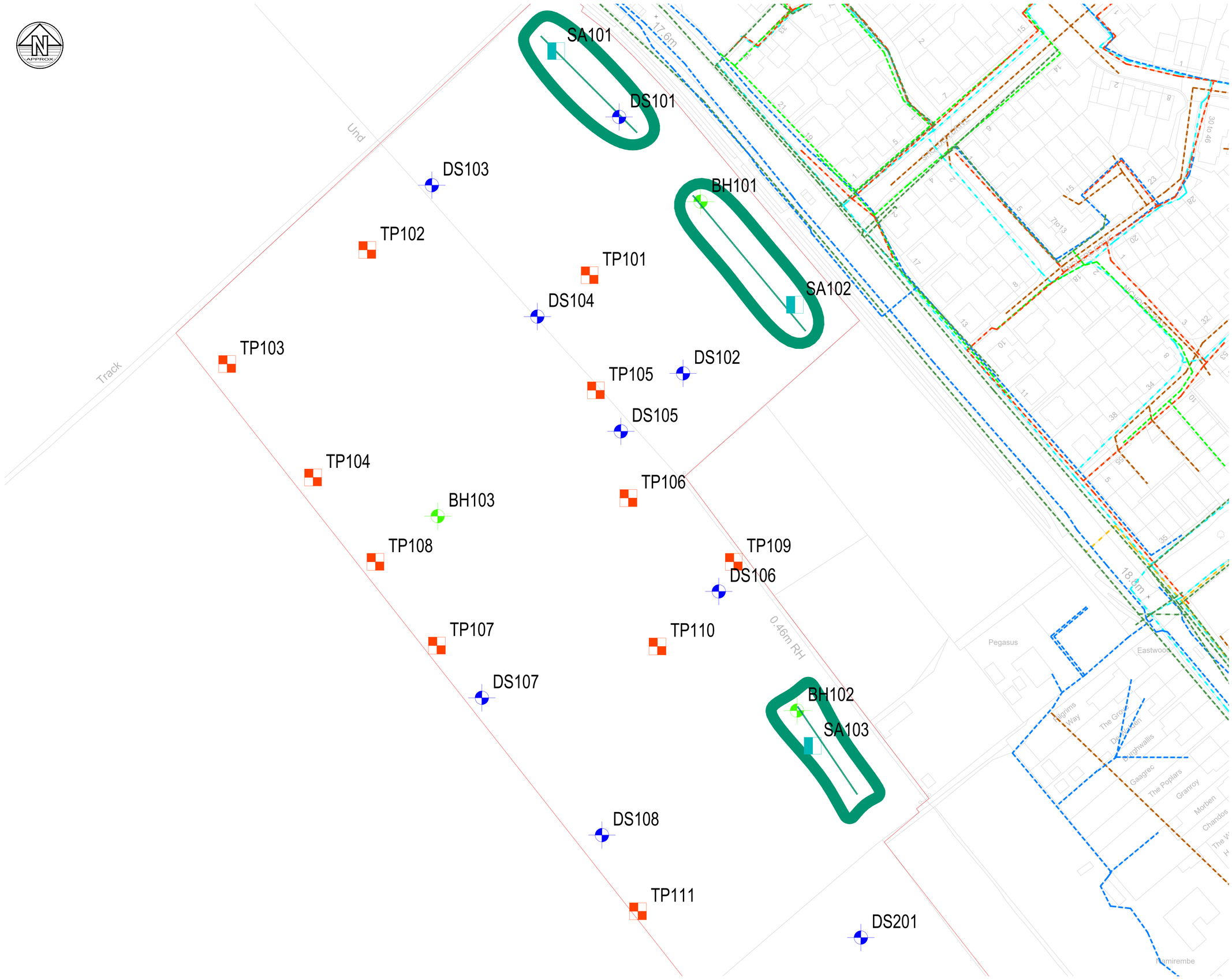
DRAWINGS

Drawing 1: Exploratory Hole Location Plan



Notes

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
3. All dimensions in metres unless noted otherwise. All levels in metres unless noted otherwise.
4. Any discrepancies noted on site are to be reported to the engineer immediately.
5. The accuracy of the services information shown on this drawing cannot be guaranteed and is only an indicative representation. The information shown is based upon asset record drawings from statutory authorities. It is given without liability or warranty.
6. The contractor shall be responsible for verifying the exact location of all statutory undertakers apparatus and other public/private drainage/services in consultation with the relevant operator/service provider.
7. BWB has the capability of tracing and recording on-site services with locations recorded on topographical survey data.
8. All services are taken from record (TFR) unless otherwise noted as surveyed (S) or proposed (R).
9. All services are underground unless otherwise noted as overhead (OH).
10. Abandoned services may not be shown on this plan.
11. Information concerning the position if existing utility infrastructure has been extracted from record mapping obtained from statutory undertakers

Statutory Undertakers	Date Obtained
Southern Water	27/03/2020
UK Power Networks	30/03/2020
Southern Gas Networks	13/10/2020
BT/Openreach	15/10/2020
SSEN	13/10/2020
Indigo Pipelines	13/10/2020

Legend

- EASTERN PARCEL BOUNDARY
- WESTERN PARCEL BOUNDARY
- EXISTING BT APPARATUS
- EXISTING BT OVERHEAD APPARATUS
- EXISTING SSEN LV APPARATUS
- EXISTING SGN LP GAS APPARATUS
- EXISTING SGN MP GAS APPARATUS
- EXISTING INDIGO PIPLINES GAS APPARATUS
- EXISTING UKPN LV UNDERGROUND APPARATUS
- EXISTING UKPN LV OVERHEAD APPARATUS
- EXISTING UKPN ASSUMED 33kV OVERHEAD APPARATUS
- EXISTING SOUTHERN WATER FOUL SEWER
- EXISTING SOUTHERN WATER SURFACE WATER SEWER

DS** Dynamic Sampling Borehole

TP** Trial Pit

SA** Soakaway Pit

BH** Cable Percussion Borehole

Rev	Date	Details of issue / revision	Drw	Rev
P1	July 21	Draft Issue	CR	

Issues & Revisions

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Client
Richborough Estates

Project Title
Sandwich Road Sholden

Drawing Title
Exploratory Hole Location Plan

Drawn:	CR	Reviewed:			
BWB Ref:	BMW2914	Date:	July 21	Scale@A1:	NTS

Drawing Status
Draft

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
		V1

APPENDICES