Intrusive Geoenvironmental and Geotechnical Site Assessment

Chapman Way
Tunbridge Wells
TN2 3EF

November 2023

561063.0000.0002

Prepared For:
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Executive Summary

TRC Companies Limited (TRC) was commissioned by Tavis House Stellar (Tunbridge Wells) LP, C/O Stellar Asset Management Limited, C/O Glenny LLP (the 'Client') to undertake a Tier 2 (formerly known as Phase II) Geoenvironmental and Geotechnical Site Assessment at Chapman Way, Tunbridge Wells, TN2 3EF (hereafter referred to as the 'Site').

This Executive Summary is part of the complete report; and findings, opinions or conclusions in this Executive Summary are made in context with the complete report. TRC recommends that the user reads the entire report for all supporting information related to findings opinions and conclusions.

Executive Summary	
Site Details	
Client	Tavis House Stellar (Tunbridge Wells) LP C/O Stellar Asset Management Limited C/O Glenny LLP
Site Address & Grid Reference	Chapman Way, Tunbridge Wells, TN2 3EF Easting 559399, Northing 141834
Site Area	1.58 ha
Proposed Development	Construction of three large, adjoined warehouse units in the north and two adjoined units in the south with associated car parks, service yards and landscaping.
Site Setting	
Current Site Use	The previous development of two warehouses, associated hardstanding and services were recently demolished, and the Site is currently inactive and has a large stockpile of demolition waste in the northern portion.
Site History	Earliest available mapping (1867) shows that the Site consisted of woodland and open farmland with a railway line at approximately 160m to the east. The Site remained vacant until 1903 when a brick and tile works was constructed to the south. A clay pit associated with the brick and tile works gradually extended to the location of the current Site (in 1909). Additional industrial buildings were constructed in the surrounding area (consisting of a gas works and a foundry) followed by additional residential buildings to the south. In 1975 the clay pit was listed as a tip which was subsequently developed into High Brooms Industrial Estate circa 1984; this coincided with the development of commercial/industrial buildings directly adjacent to the Site in all directions. Further commercial buildings were constructed on the Site in 1984 and 1993. Historically the surrounding land uses (<250m from the Site) were predominantly residential, commercial, and light industrial. Land uses of note include a gas works located 250m southeast of the Site and a gas works located 100m east.
Expected Geology	Archive borehole records suggest that between 5m and 10m of infill materials are present above the natural soils located on Site. The BGS geological records indicate that the Site is underlain by natural soils of the Wadhurst Clay Formation (Mudstone). Archive borehole records indicate that the top of Wadhurst Clay Formation has been proven beneath the Site to a depth of 18.8m bgl.
Expected Hydrogeology	The Wadhurst Clay Formation is an Unproductive Stratum and is therefore of low vulnerability. The Site is not located within a groundwater source protection zone and the nearest surface water feature is located 180m southeast of the Site.
Investigation Findings	
Ground Conditions	Made Ground was encountered between ground level and 18.50m, recording a maximum thickness of 18.50m.

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	Bedrock geology comprising the Wadhurst Clay Formation was encountered underlying the Made Ground, to depths in excess of 30.00m; the base of the stratum was not confirmed during the investigation.
Groundwater Conditions	Groundwater was not encountered during the investigation possibly due to masking from the flushing medium during the drilling process. However, during subsequent monitoring, perched groundwater was typically encountered between 0.80m bgl to 3.68m bgl within the Made Ground.
Geotechnical Assessment	
Geotechnical Hazards	The previous reports and ground investigation have identified several geotechnical hazards at the Site which relate to the proposed development. These are Made Ground to at least 18.50m bgl, buried obstructions, ground aggressive to buried concrete, volume change potential of soils and shallow groundwater and are discussed in detail along with mitigation measures in Section 6 of this report.
Foundations	Ground improvement by way of Controlled Modulus Columns could be applied followed by shallow foundations, subject to confirmation of viability of the method by a specialist contractor. Details of the foundation options including allowable bearing pressures are discussed in Sections 6.3 and 6.4.
Floor Slabs	Ground bearing slabs on previously treated Made Ground to a suitable specification could be adopted for the proposed development. Details are provided in Section 6.5 of this report.
Excavations	Excavations for shallow foundations, floor slabs, and laying services should be readily achievable using standard excavation plant. However, hard surfacing, old foundations, and obstructions within Made Ground may require the use of a breaking apparatus. Obstructions were encountered in Made Ground during the ground investigation. Dewatering measures such as local pumping from a sump may be required for any shallow perched groundwater within Made Ground. Details for anticipated excavations are provided in Section 6.6
Pavements	Assuming excavation formation soils to comprise Made Ground and based on the formation preparation outlined above, an equilibrium CBR value of 4% is recommended for pavements preliminary design. Confirmatory in-situ CBR testing at final formation level is recommended just prior to pavement construction. Details for proposed pavements are provided in Section 6.7 of this report.
Buried Concrete	With reference to BRE Digest SD1 (2005) and based on the results of the concrete classification tests a design sulphate class of DS-2 and an ACEC Class of AC-2 is recommended for both Made Ground and Wadhurst Clay Formation.
Soakaways	Soakaway testing did not form part of the scope of works. However, considering the significant thickness of Made Ground encountered across the Site, shallow soakaways with not be viable for the proposed development. Alternative drainage options should be considered by the scheme's drainage engineer.
Contaminated Land Assessment	
Human Health	Concentrations of hydrocarbons within the soil (Made Ground) exceeded the GAC for the proposed commercial/light industrial end use. Asbestos fibres were identified within two samples of Made Ground within RO104. Both of the samples that contained asbestos in soils were subject to quantification tests. The concentrations recorded were <0.001%. Approximately 80-90% of the proposed development, including the RO104 location, will be covered in hardstanding, which will act as a physical barrier

Executive Summary	
	against contact with contamination and therefore unlikely to present a significant risk to end users of the Site within the future development scenario. Neighbouring Site users and construction workers could come into contact with potential contamination, particularly during the construction phase.
Controlled Waters	The laboratory analysis reported elevated concentrations of General Inorganics, Speciated PAHs, Heavy Metals/ Metalloids and Petroleum Hydrocarbons exceeding the UK DWS and/or EQS within the groundwater samples analysed. The Site is directly underlain by the Wadhurst Clay Formation, which is designated as Unproductive Strata. In addition, the Site is not within a Groundwater Source Protection Zone and there are no active groundwater abstractions within 1km of the Site. Groundwater is not considered to be in hydraulic connection with any nearby surface water features due to the presence of low permeability deposits. Therefore, there is not considered to be a significant risk to controlled water receptors and further assessment or remediation of groundwater is not considered to be required.
Ground Gas and Organic Vapour	Gas monitoring indicates that the Site would be classified as Characteristic Situation 5 (high risk). It is recommended that further gas risk assessment is undertaken, and/or possible remedial mitigation measures to reduce and/or remove the source of ground gas. Guidance from CIRIA C665 lists the following typical scope of protective measures: • Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft) • All joints and penetrations sealed. • Proprietary gas resistant membrane and actively ventilated or positively pressurised underfloor sub-space with monitoring facility, with monitoring. • In ground venting wells and reduction of gas regime.
Remediation	Based on the results of the results of the generic risk assessments undertaken the following remediation/mitigation measures are recommended: • Capping of gardens/soft landscaped areas • Ground gas protection measures • Organic vapour protection measures • Installation of buried services in corridors of clean soil • Upgraded water supply pipework (subject to confirmation form water supply company)
Recommendations	
<u>Geoenvironmental</u> A remediation strategy is currently being prepared by TRC and will be issued separately to this report. A verification plan is likely to be required by the local planning authority. Further gas risk assessment is recommended. The selection of appropriate water supply pipework should be confirmed by the local water supply company.	

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Materials destined for off-site disposal to landfill may require further assessment in accordance with WM3 'Guidance on the classification and assessment of waste' (1st edition version 1.2 GB 2021) to determine their waste classification. If materials are to be re-used on site or imported from another development site, a materials management plan may be required in accordance with the CL:AIRE Definition of Waste: Development Industry Code of Practice in order to demonstrate that the material is not a waste. <u>Geotechnical</u> Consultation with a specialist contractor is recommended at an early stage to discuss the viability of the CMC ground treatment method.

1.0 Introduction

1.1 Appointment and Purpose

TRC Companies Limited (TRC) was commissioned by Tavis House Stellar (Tunbridge Wells) LP, C/O Stellar Asset Management Limited, C/O Glenny LLP (the 'Client'), to undertake a Tier 2 (formerly known as Phase II) Geoenvironmental and Geotechnical Site Assessment at Chapman Way, Tunbridge Wells, TN2 3EF (hereafter referred to as the 'Site').

A Site location plan is presented as Figure 1 in Annex A.

The purpose of this Tier 2 report is to assess geotechnical and geoenvironmental ground conditions to support ground improvement (CMC) design and advise on ground gas mitigation for proposed structures.

This Tier 2 report uses intrusive investigation methodologies to aid site characterisation and to inform the Client of potential environmental and geotechnical liabilities, identify risk, allow design development and inform cost estimates.

It is expected that this report will support the Client with future planning application for development of the Site for a proposed light industrial end use, as discussed in detail in the following Section.

1.2 Proposed Development

The proposed development construction of three large adjoined warehouse units in the north and two adjoined units in the south with associated car parks, service yards and landscaping , as indicated on PRC Architects drawing reference number 11476 / TE_12-100 Rev T2, dated 28/4/2023.

Based on the above, the proposed development is considered to fall into geotechnical category 2 with respect to BS EN 1997 (Eurocode 7).

The end user sensitivity is considered Low for the proposed industrial end use.

A proposed development plan is presented as Figure 2 in Annex A.

1.3 Available Information & Standards

This report is based on the following information:

- Historical uses of the Site and surroundings;
- Current use and condition of the Site;
- Environmental setting in terms of geology, hydrogeology, hydrology and surrounding land uses;
- Relevant publicly available environmental records;
- Previous reports for the Site as listed in Section 2.6; and,
- Intrusive investigation including geoenvironmental and geotechnical sampling and testing.

This report was conducted with due regard to the following guidance and standards:

- The National Planning Policy Framework;
- BS5930:2015 (+A1:2020) Code of Practice for Ground Investigations;
- BS EN 1997 Eurocode 7;
- BS8485:2015 (+A1:2019) Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings;
- BS8576:2013 Guidance on Investigations for Ground Gas – Permanent Gases and Volatile Organic Compounds (VOCs);
- BS10175:2011 (+A2:2017) Investigation of Potentially Contaminated Sites – Code of Practice; and,

- Land Contamination: Risk Management (LCRM) 2020;

The geotechnical appraisal has been carried out in accordance with Eurocode 7. Sections 1 to 5, together with Annexes A to E, comprise the Ground Investigation Report.

Preliminary geotechnical recommendations are presented in Section 6 and these may need to be verified in a Geotechnical Design Report once structural details of the proposed development are confirmed.

1.4 Significant Assumptions

This report presents TRC's observations, findings, and conclusions as they existed on the date that this report was issued. This report is subject to modification if TRC becomes aware of additional information after the date of issue of this report that is material to its findings and conclusions.

The reliability of information provided by others to TRC cannot be guaranteed to be accurate or complete. Performance of this Tier 2 Geoenvironmental and Geotechnical Site Assessment is intended to reduce, but not eliminate, uncertainty of geoenvironmental and geotechnical conditions associated with the subject site; therefore, the findings and conclusions made in this report should not be construed to warrant or guarantee the subject site, or express or imply, including without limitation, warranties as to its marketability for a particular use. TRC found no reason to question the validity of information received unless explicitly noted elsewhere in this report.

1.5 User Reliance

This report was prepared for Tavis House Stellar (Tunbridge Wells) LP, C/O Stellar Asset Management Limited, C/O Glenny LLP. Reliance on this report by any other third party is subject to requesting and fully executing a reliance letter between TRC and the third party that acknowledges the TRC Standard Terms and Conditions with the Client, to the same extent as if they were the Client thereunder.

TRC has been provided with information from third parties for information purposes only and without representation or warranty, express or implied as to its accuracy or completeness and without any liability on such third parties part to revise or update the information. Where reliance has been provided by third parties to potential purchasers this is noted in our report.

2.0 The Site

2.1 Location

The Site comprises an approximate 1.58 ha plot of land located at Chapman Way, Tunbridge Wells, TN2 3EF, centred on National Grid Reference Easting 559399, Northing 141834.

A Site location plan is presented as Figure 1 in Annex A.

2.2 Site Description

The Site is an oval shaped parcel of land, approximately 150m long by 130m wide.

The Site is bounded on all sides by Chapman Way, which is within the High Brooms Industrial Estate. It is accessed via a large gate on Chapman Way at the south.

The Site is located within an area of predominantly commercial land use. Surrounding the Site are commercial warehouse type units, with a car body works mechanics, an aluminium supplier, a roofing supply company and various offices.

The previous development of two warehouses, associated hardstanding and services were recently demolished, and the Site is currently inactive and has a large stockpile of demolition waste in the northern portion. There is an area of hardstanding in the southeast of the Site. There are three electricity substations remaining on this area of hardstanding.

The Site has an average elevation of approximately 79m above Ordnance Datum (aOD). Topographically the Site is flat and has no discernible dips or mounds aside from the large stockpile of demolition waste in the northern portion.

2.3 Surrounding Area

Land uses in the immediate vicinity include the following principal features:

Table 2.1: Summary of Surrounding Land Use

Direction	Land Use
North	Commercial buildings consisting of a floor shop, an insurance company, an aluminium supplier, a music shop and a digital printers.
East	Commercial buildings consisting of a roofing supply shop, a climbing gym and two vehicular garages.
South	Commercial buildings consisting of a chimney sweeps, a vehicular garage, a plumbers merchant and a car washing service.
West	Commercial buildings consisting of a gymnastics studio, a vehicular bodyworks garage, a car accessories shop and a builders merchant.

2.4 Site Environmental Setting

2.4.1 Geology

The Site is underlain by variable thickness of Made Ground, over bedrock geology of the Wadhurst Clay Formation. The Tunbridge Wells Sand Formation is indicated to be present in the far north of the Site. Significant depths of Made Ground are anticipated associated with historical clay pits.

2.4.2 Hydrogeology

British Geological Survey (BGS) geological mapping and hydrogeological mapping presented by DEFRA (MAGIC website) indicate the following hydrogeological information for the Site:

Table 2.2: Summary of Hydrogeology

Geology	Geological Description	Aquifer Status	Aquifer Description
Bedrock: Wadhurst Clay Formation	Dark grey thinly-bedded mudstone	Unproductive Strata	Predominantly lower permeability strata which may in part have the ability to store and yield limited amounts of groundwater by virtue of localised features such as fissures, thin permeable horizons and weathering.

The Site does not lie within a groundwater source protection zone.

2.4.3 Hydrology

The nearest surface water feature is a small pond and inflowing stream 180m to the east of the Site.

2.5 Summary of Site History

Earliest available mapping (1867) shows that the Site consisted of woodland and open farmland with a railway line to the east. The Site remained vacant until 1903 when a brick and tile works were constructed to the south. The clay pit associated with the brick and tile works gradually extended onto the Site (1909). Additional industrial buildings were constructed in the surrounding area, consisting of a gas works and a foundry, followed by additional residential buildings to the south. By 1975, the clay pit was listed as a tip, which was subsequently developed into High Brooms Industrial Estate by 1984. This represents part of the latest development at the Site, as well as some surrounding commercial units. By 1993, further development had occurred on the Site to represent the latest development.

2.6 Previous Investigations, Reports or Remediation

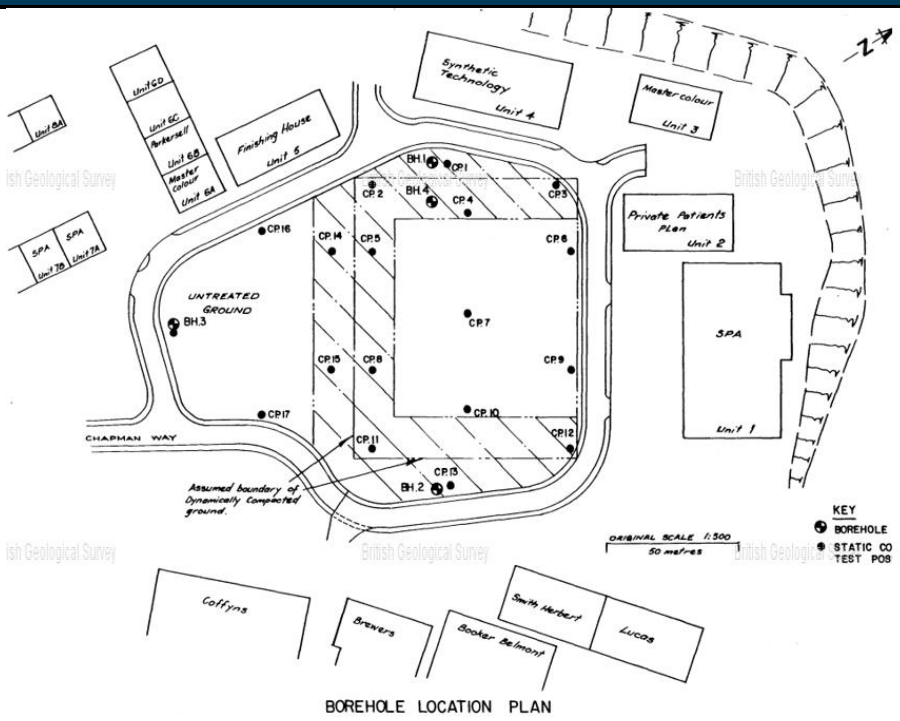
The following site-specific assessments have been reviewed and are referred to for information purposes only, as it is unknown whether the Client has got reliance on past reports.

Table 2.3: Summary of Previous Site Assessments

Report Title	Summary of Findings
'Phase I Environmental Site Assessment, Chapman Way, Tunbridge Wells (Report Ref. 417410) Produced by TRC Companies Limited (TRC)	Earliest available mapping (1867) shows that the Site consisted of woodland and open farmland with a railway line, located on an embankment, to the east. The Site remained vacant until 1909 when the brick and tile works, that had previously been constructed to the south, extended onto the Site. By 1909 a clay pit associated with the brick and tile works extended across the south-eastern part of the Site and a pond was located in the north of the Site. Additional industrial buildings were present in the surrounding area (consisting of a gas works and a foundry) followed by additional residential buildings to the south. By 1936 the clay pit is indicated to extend across the entire Site and details provided on the 1969 OS map indicated that the pit had extended further with numerous high walls associated with the pit and several ponds. The map also indicated that there were two zones where water issued from the highwalls with streams leading to the various ponds in the base of the pit. In 1975, the

Report Title	Summary of Findings
in December 2021	clay pit was listed as a tip, which was subsequently developed into High Brooms Industrial Estate circa 1984; this coincided with the development of commercial/industrial buildings directly adjacent to the Site in all directions. However, several of the highwalls remained to the north and west of the Site indicating that the pit was not completely backfilled. Further commercial buildings were constructed on the Site in 1984 and 1993. Borehole records suggest that between 5m and 18.8m of infill materials are present above the natural soils located on Site. The BGS geological records indicate that the Site is underlain by natural soils of the Wadhurst Clay Formation (Mudstone). Archive borehole records indicate that the Wadhurst Clay Formation has been proven beneath the Site to a maximum depth of 20m bgl. Made Ground is expected across the Site associated with previous quarrying and land filling activities that are known to have taken place at the Site. The bedrock geology is classified as an Unproductive Strata. The Site is not located within a Source Protection Zone. The closest surface feature to the Site is located 180m southeast of the Site and is referenced as an inland river. The BGS records indicate that the Site is in a lower probability radon area where less than 1% of homes are estimated to be at or above the Action Level. It was concluded in the report, that there could be potential contamination arising from the Made Ground associated with the redevelopment of the Site and landfill.
Phase I Assessment, CSC, Millennium House and Spectrum House, Chapman Way (WSP Report Ref. 12370220/001 dated July 2007)	This report includes a review of the Ordnance Survey maps and available desk study information. This report provides similar information to that included as part of the TRC Phase I Environmental Site Assessment, summarised above. The report details that at Spectrum House (located in the northern half of the Site) there were three constantly working generators that are supplied by three above ground storage tanks (AST) two of 5000 gallons and one of 2500 gallons, an additional backup generator and diesel storage tank are housed on the back of a lorry trailer, a 625 kilo Volt-ampere (KVA) uninterruptible power supply (UPS) and an underground storage tank (UST) with 50,000 litre capacity. Also present on this land is an electricity substation and two store units (at least one used to store potentially hazardous substances). Information obtained from the Contaminated Land Officer at Tunbridge Wells Borough Council refers to the Sites former use as Chapman's Quarry and details from the Kent Landfill Atlas as having received inert material and some slow degradable matter.
Geo-Environmental and Geotechnical Interpretative Report. CSC, Millennium House and Spectrum	The copy of the report provided at the time of the Phase I TRC Report, was considered draft and did not include a full set of results of the investigation. Made Ground was encountered to at least 12.45m. The boreholes were generally terminated within the Made Ground, although the Wadhurst Clay may have been encountered at the base of BH1. The Made Ground comprised cohesive and granular materials with fragments of concrete, slag, brick, wood, plastic, metal and natural lithologies.

Report Title	Summary of Findings
House, Chapman Way (WSP Report Ref. 12370220/002 dated November 2007) – draft report only	WS2 was located in the area of the UST and WS3, WS4 and WS4A were located in the area of the ASTs. Hydrocarbon contamination was noted within the Made Ground across the Site. Groundwater levels ranged between 1.11 and 2.01mbgl. Very high levels of methane were encountered in BH3 and elevated levels were recorded in other wells. The presence of hydrocarbon impacted soil could pose a risk to human health. To ensure that there is no pathway to industrial end users it was recommended that part of any work near surface hydrocarbon impacted soil associated with walled tank enclosures should be excavated and disposed of as hazardous waste. It was concluded that buildings not sensitive to settlement could be founded on a raft foundation. Alternatively, a piled foundation solution would need to be adopted. As the base of the Made Ground was no information on likely pile lengths could be provided. It was concluded in the report that buried dense ordinary Portland cement concrete should not deteriorate due to sulphate or acid attack and concrete should be designed to satisfy strength and workability criteria. As a minimum concrete was recommended to be designed to Class DS1 and AC1s.
Historical BGS Borehole Records, 1987	The BGS had information associated with respect to four historical boreholes drilled at the Site. Included with the borehole logs was a location plan (copy below) which suggested that the northern part of the Site may have been treated by dynamic compaction. No specific details were provided; however, an assumed boundary of the dynamically compacted ground was provided which suggested that the southern part of the Site was untreated. The plan also indicated that there appeared to be a number of static cone penetration test (CPT) locations across the Site. The information associated with these CPTs has not been obtained.

Report Title	Summary of Findings
	
Phase II Geo-Environmental Site Assessment, TRC Report No. 417410.0001, Dated December 2021	The ground investigation comprised three cable percussive boreholes to a maximum depth of 25m, four window sample boreholes to a maximum depth of 5m, construction of six monitoring wells, laboratory testing, and field monitoring of ground gas and groundwater levels. A bituminous surfacing was encountered at surface overlying the Made Ground in all exploratory locations during the TRC investigation with a thickness of 0.1m. Underlying this, Made Ground soils were encountered in all exploratory locations, with a variable thickness of 9.5m to >15.0m and was encountered to a maximum proven depth of 15m bgl (BH102). The Made Ground was proved to a maximum depth of 18.8m bgl during previous investigation and could be deeper elsewhere on the Site. Wadhurst Clay Formation was encountered below Made Ground. The top of Wadhurst Clay Formation, where encountered (BH101 and BH103 only), was at around 9.60m bgl. The maximum depth of Made Ground and Wadhurst Clay Formation encountered during past boreholes was presented in Table 5 of that report; that table is repeated below for completeness.

Report Title	Summary of Findings

Table 5: Summary of Geological Depths

Borehole Reference	Location	Maximum Depth of Made Ground Recorded (m bgl)	Maximum Depth of the Wadhurst Clay Recorded (m bgl)
BH101	Centre-South	9.6	>10.3
BH102	East	>15.0	Not Encountered
BH103	Northwest	9.65	>10.0
WS101	West	>5.0	Not Encountered
WS103	East	>5.0	Not Encountered
WS104	Southeast	>1.3	Not Encountered
WS105	Southwest	>5.0	Not Encountered
TP54SE92	Northeast	>8.0	Not Encountered
TQ54SE93	East	9.8	>13.5
TQ54SE94	Southwest	18.8	>20.0
TQ54SE95	Northeast	>5.0	Not Encountered
WSP-WS1	North	>5.0	Not Encountered
WSP-WS2	Northwest	>1.2	Not Encountered
WSP-WS3	Centre	>4.5	Not Encountered
WSP-WS4A	Centre	>11.45	Not Encountered
WSP-WS6	Southeast	>0.9	Not Encountered
WSP-WS7	South	>5.0	Not Encountered
WSP-WS8	South	>0.85	Not Encountered
WSP-BH1	Northeast	11.45*	*Wadhurst Clay possibly encountered between 11.45 and 11.5mbgl.
WSP-BH2	Northwest	>12.45	Not Encountered
WSP-BH3	Centre-South	>11.65	Not Encountered

Notes:

I. Where > is noted, this is because the depth of the specified stratum extends greater than the maximum depth recorded.

II. Note Encountered – In these locations the referenced stratum was not encountered as the full extent of the overlying stratum was not penetrated.

During the window sampling groundwater was encountered at depths of between 3.5m and 4.0m bgl. Groundwater was also encountered during the drilling of BH102 at a depth of 3.0m rising to 2.5m after 20 minutes. During subsequent gas and groundwater monitoring, groundwater resting levels were recorded at between 0.44m and 1.38m bgl.

Heavy metals, speciated PAHs, and petroleum hydrocarbons were detected at the Site in concentrations that do not exceed the relevant screening values for the proposed development. It is not considered that these concentrations require widespread remediation for the proposed development and risks to future users could be readily managed through breaking of pathways via the placement of engineered hardstanding barriers such as building floor slabs and external yards. Areas of soft landscaping should be capped with an appropriate clean capping layer with a geotextile membrane installed as a marker layer.

Whilst some exceedances were identified when screened against the UK DWS, the concentrations were not considered to be significant. There are no drinking water abstractions in close vicinity of the Site, and it is not located within an Environment Agency (EA) designated groundwater Source Protection Zone (SPZ). In addition to this, the Wadhurst Formation is classified as an Unproductive Strata which will likely limit the migration of groundwater which is likely to remain within the Made Ground in the

Report Title	Summary of Findings
	backfilled pit. Therefore, it is considered unlikely that the Site poses a significant risk to controlled waters. The gas monitoring results has identified that there are considerably elevated concentrations of methane present in more than one monitoring well. Based on the results, the Site would be classified as Characteristic Situation 4 (moderate to high risk). For foundation purposes a deep foundation solution like piling or CMC ground treatment was recommended in that report subject to the input of specialist contractors to confirm viability of such methods. Additional deep ground investigation to support design was recommended.

3.0 Ground Investigation

3.1 Scheduled Scope of Works

The scheduled TRC Tier 2 investigation scope of works comprised:

- Four rotary core boreholes (RO101, RO102, RO103, RO104) to a maximum depth of 30m;
- 10 cone penetrometer tests (CPT) to a maximum depth of 25m;
- Eight DCP CBR (DCP01, DCP02, DCP03, DCP04, DCP05, DCP06, DCP07, DCP08) to a maximum depth of 1m;
- In-situ logging, ground sampling and testing;
- Field screening for contamination using a Photo-Ionisation Detector (PID);
- Construction of four gas and groundwater monitoring wells;
- Field monitoring of bulk ground gases and groundwater levels on six occasions;
- Ground gas sampling on one occasion; and,
- Collection of groundwater samples for laboratory testing.

3.2 Investigation Rationale

The ground investigation was designed by TRC on behalf of the Client to gather information on the geoenvironmental and geotechnical ground, groundwater and ground-borne gas conditions at the Site in order to support ground improvement (CMC) design.

Akso, the TRC investigation aimed to gain good general coverage of the Site and cover as much as possible data gaps from previous ground investigations.

Table 3.1: Summary of Exploratory Hole Locations

Exploratory Hole	Location
RO101	Located in the north of the Site in the west of the larger proposed building footprint
RO102	Located in the northeast of the Site in the east of the larger proposed building footprint
RO103	Located in the centre of the Site in an area of proposed hardstanding
RO104	Located in the south of the site in the smaller proposed building footprint.
CPT101	Located in the north of the Site in the west of larger proposed building footprint, slightly north of RO101
CPT102	Located in the north of the Site in the centre of the larger proposed building footprint between RO101 and RO102
CPT103	Located in the northeast of the Site in the east of the larger proposed building footprint to the northeast of RO102
CPT104	Located in the centre of the Site in the west of the area of proposed hardstanding
CPT105	Located in the centre of the Site in the centre of the area of proposed hardstanding north of RO103
CPT106	Located in the centre of the Site in the east of the area of proposed hardstanding east of RO103
CPT107	Located in the centre of the Site in the west of the area of proposed hardstanding
CPT108	Located in the centre of the Site in the east of the area of proposed hardstanding
CPT109	Located in the southwest of the site in the smaller proposed building footprint.
CPT110	Located in the south of the site in the smaller proposed building footprint, slightly north of RO103
DCP01	Located in the west of the Site
DCP02	Located in the centre of the Site
DCP03	Locate din the south of the Site
DCP04	Located in the south-east of the Site

DCP05	Located in the central portion of the Site adjacent to CP04
DCP06	Located in the central portion of the Site
DCP07	Located in the western portion of the Site
DCP08	Located in the south of the Site

3.3 Investigation Methodology

3.3.1 Ground Investigation

The TRC Tier 2 investigation was conducted at the Site between 4th September and 15th September 2023. TRC commissioned Borehole Solutions to undertake the rotary core drilling. Each exploratory hole was advanced using an Multidrill SL. Insitu Site Investigations were commissioned to undertake the cone penetration tests (CPTs). Each CPT was conducted using a 20-tonne wide track crawler unit. The drilling works were overseen by a TRC engineer who performed field assessment and logging of the exploratory holes.

The works included the following key actions:

- Review of available underground services plans for the Site;
- Each of the proposed exploratory hole locations was cleared using a Cable Avoidance Tool (CAT) and ground penetrating radar (GPR) by an independent utility surveyor;
- Rotary core drilling was performed at each location by the drilling contractor, including in-situ geotechnical testing. Dynamic sampling methods were used within soils at shallower depths prior to rotary coring being undertaken at greater depths;
- On-site ground logging, testing, and assessment of potential indicators of contamination;
- Field screening using a PID;
- Collection of soil and groundwater samples for environmental and geotechnical laboratory analysis;
- Construction of gas and groundwater monitoring wells in four borehole locations, RO101, RO102, RO103 and RO104; and,
- Surveying of the exploratory holes final locations.

The following alterations to exploratory hole positions and final depths were made during the course of the ground investigation:

- Six additional CPTs were conducted due to shallow refusals at original locations. The additional CPTs were conducted in proximity to the original locations;
- RO101 was terminated at 10.00m bgl due to refusal on an obstruction within Made ground;
- RO103 was moved from its proposed location approximately 20m to east to investigate a potential pit reported in historical mapping and to increase the coverage of the geotechnical investigation;
- CPT101 was terminated at 8.77m bgl due to refusal on total pressure;
- CPT102 was terminated at 12.72m bgl due to refusal on total pressure;
- CPT103 was terminated at 17.22m bgl due to refusal on total pressure;
- CPT104 was terminated at 6.72m bgl due to refusal on total pressure;
- CPT105 was terminated at 0.05m bgl due to refusal on total pressure;
- CPT105A was terminated at 16.56m bgl due to refusal on total pressure;
- CPT106 was terminated at 0.30m bgl due to refusal on total pressure;
- CPT107 was terminated at 0.05m bgl due to refusal on total pressure;
- CPT107A was terminated at 16.24m bgl due to refusal on total pressure;
- CPT108 was terminated at 0.07m bgl due to refusal on total pressure;
- CPT108A was terminated at 0.18m bgl due to refusal on total pressure;
- CPT108B was terminated at 0.07m bgl due to refusal on total pressure;
- CPT109 was terminated at 0.31m bgl due to refusal on total pressure;
- CPT109A was terminated at 0.27m bgl due to refusal on total pressure; and,
- CPT109B was terminated at 0.11m bgl due to refusal on total pressure.

- DCP02 and DCP03 were not conducted due to equipment failure.

The exploratory hole location plan for the ground investigation undertaken, is presented as Figure 3 in Annex A.

The exploratory hole logs are presented in Annex C and include the in-situ sampling and testing undertaken at the Site. The CPT report is presented in Annex D.

3.3.2 Groundwater and Ground Gas Monitoring

The ground conditions encountered with respect to the response zone of the monitoring installations are summarised in the table below.

Table 3.2: Monitoring Wells Summary

Exploratory Hole	Response Zone (m bgl)	Response Zone Strata (m bgl)	
RO101	1.00 - 10.50	1.00 – 10.50	Made Ground
RO102	1.00 – 17.00	1.00 – 17.00	Made Ground
RO103	1.00 – 16.50	1.00 – 16.50	Made Ground
RO104	1.00 – 18.00	1.00 – 18.00	Made Ground

Groundwater and ground gas monitoring was conducted by a TRC technician on six occasions. The dates of the monitoring visits were 20th and 27th September and 5th, 11th, 17th and 24th October 2023. During each visit, groundwater elevation and potential presence of any free phase oils was measured using an oil/water interface probe. Gas monitoring was undertaken using a portable gas analyser at each monitoring well head. The field assessment gathered data relating to the concentrations of permanent ground gases (e.g. methane, carbon dioxide, carbon monoxide and oxygen).

Also, Ground Gas Solutions (GGS) attended Site on one occasion to conduct groundwater and ground gas monitoring as well as ground gas sampling using a TDL500 gas analyser. The date of this visit was the 11th October 2023.

Groundwater sampling was also undertaken in boreholes RO101, RO102, RO103 and RO104 using a dedicated disposable bailer.

3.4 Geotechnical In-Situ Testing

In-situ testing was undertaken for geotechnical purposes. The details of the in-situ test results are presented in the logs within Annex C and in the field data within Annex D.

The Site based geotechnical testing is summarised in the table below.

Table 3.3: In-situ Tests (Geotechnical)

Test Type and Standard	Number
Standard penetration test (BS EN ISO 22476-3:2005+A1:2011)	45
Hand penetrometer (UK Specification for Ground Investigation, 3rd Edition)	73
Dynamic cone penetrometer (TRL Probe Method)	8

Test Type and Standard	Number
Cone penetration testing (BS EN ISO 22476-1:2012)	10

Any limitations to the in-situ testing that require consideration during the evaluation of the data are described in the following paragraphs.

Although the Standard Penetration Test (SPT) is a standardised test, uncorrected SPT 'N' values display a considerable amount of scatter. Calibrated SPT hammers were used during the ground investigation and in our evaluation, presented in Section 5, the results have been normalised to 'N_{60}' in accordance with Eurocode 7.

Some elevated SPT N values, likely due to encountering cobbles in Made Ground were recorded between 1.00m and 18.00m bgl. As discussed in Section 5, these are not considered representative of the stratum as a whole and have been discounted from subsequent analysis, discounted SPT results are summarised below:

- RO101 10.50m bgl
- RO102 1.00m bgl
- RO102 3.00m bgl
- RO103 10.50m bgl
- RO103 16.50m bgl
- RO104 1.00m bgl

SPT refusals were recorded within the Wadhurst Clay Formation as a result of the stratum being encountered as weak mudstone.

The pocket penetrometer apparatus, due to operational reasons, provides only an estimate of the unconfined compressive strength and the undrained shear strength as is it less precise than other test methods, especially when undertaken on samples obtained from dynamic sampling equipment. Given the limitations of this test method, in isolation, it is only considered indicative of the undrained shear strength for foundation purposes. However, it can provide useful information on the relative intact strength of soils so as to assist with the assessment of desiccation.

The dynamic cone penetrometer (DCP) has been used to provide estimates of the in-situ CBR. Dynamic cone penetrometer testing provides an estimate of CBR rather than a direct measurement of this parameter. The DCP apparatus is better suited to coarser, stronger materials and so the accuracy of the results may be limited in soft and/or cohesive soils. In addition, as a handheld probe, it can be deflected or return anomalous readings due to obstructions or large particles. In addition, in-situ estimates of CBR value are influenced by the conditions that prevail at the time of testing, which may be different to those that prevail at the time of construction or over the lifetime of the pavement.

Determination of soil types and properties from Cone Penetration Testing (CPT) is based on empirical correlations and is open to interpretation. Similarly, estimates of strength are based on empirical relationships.

The above factors have been considered in the appraisal of geotechnical results presented in Section 5.

3.5 Geotechnical Laboratory Testing

Laboratory testing was undertaken for geotechnical purposes.

The geotechnical laboratory testing is summarised in the table below.

Table 3.4: Laboratory Tests (Geotechnical)

Test Type and Standard (BS 1377 unless stated differently)	Number
Water (moisture) content (BS EN ISO 17892-1)	20
Bulk density (BS EN ISO 17892-2)	6
Liquid and plastic limits and plasticity index (BS EN ISO 17892-12)	12
Particle size distribution - wet sieving (BS EN ISO 17892-4)	6
One dimensional consolidation (BS EN ISO 17892-5)	2
Single stage 100mm UU triaxial compression test (BS EN ISO 17892-8)	6
Uniaxial compressive strength of rock (ISRM)	2
Point load strength determination of rock (ISRM)	15
Water soluble sulphate content 2:1 aqueous extract (BRE SD1 2005)	11
Total sulphur content (BRE SD1 2005)	11
Acid soluble sulphate content (BRE SD1 2005)	11
Soil pH (BRE SD1 2005)	11
Sulphate content in groundwater (BRE SD1 2005)	4
Groundwater pH (BRE SD1 2005)	4

As with in-situ testing, it is necessary to consider the limitations associated with any laboratory testing and to review any potentially anomalous results. In all geotechnical tests the specimen is selected from a much larger volume of material which may have an inherent degree of variability, particularly in Made Ground.

Water content determinations on disturbed samples may not be representative due to the disturbance arising from the sampling process. Moisture content results can be influenced by climatic factors, and it cannot be guaranteed that the values determined at the time of investigation will be the same as those at the time of construction.

Obtaining coarse grained soils from boreholes can result in a loss of materials due to the nature of the sampling process. This can have an influence on the results of particle size distribution analyses.

Determination of the undrained shear strength can be affected by sample disturbance. Whilst this is reduced by the use of UT100 sampling equipment, it cannot be fully eliminated and requires due consideration in appraising the results, especially where an elevated number of blows were required to retrieve the sample. In addition, an element of sample disturbance cannot be avoided when extruding and preparing samples in the laboratory.

Determination of the undrained shear strength can also be affected by the presence of fissures or laminations in soils. The application of a suitable confining pressure in the test can reduce this, but the results can still be affected to a certain degree.

Determination of the consolidation properties, (m_v and C_v) can be affected by sample disturbance. Whilst this is reduced by the use of UT100 sampling equipment, it cannot be fully eliminated and requires due consideration in appraising the results, especially where an elevated number of blows were required to retrieve the sample. In addition, an element of sample disturbance cannot be avoided when extruding and preparing oedometer samples in the laboratory.

In oedometer tests the rate and magnitude of strain experienced by the soil sample are much higher than that experienced in-situ, which may have implications for the coefficient of volume compressibility, m_v, thus determined.

The coefficient of vertical consolidation, C_v, is recognised as one of the most difficult parameters to determine. This is mainly a result of the internal micro-fabric of the soil such as fissures and laminations in the soils, which tend to decrease the drainage path length but may not be represented in the relatively small sample tested. Typically, an accuracy within one order of magnitude is to be expected. In addition, C_v will tend to decrease with decreasing void ratio as the test is progressed. Determinations of C_v in the laboratory should be treated as an approximation of likely field performance.

The above factors have been considered in the appraisal of the geotechnical results given in Section 5.

The full set of laboratory geotechnical results is presented in Annex E.

3.6 Environmental Laboratory Analysis

A total of 28 soil samples was collected for environmental analysis during the investigation works. All soil samples were packed in laboratory provided containers and delivered to I2 Analytical (I2) for chemical analysis.

All soil samples were collected in order to provide environmental data on the quality of near surface and shallow soils beneath the Site. Representative samples of Made Ground were collected where feasible. The analytical suite of soils included the following parameters:

- Asbestos (Made Ground/Fill Materials only);
- Heavy metals suite;
- Polycyclic aromatic hydrocarbons (PAH);
- Total petroleum hydrocarbons – Criteria Working Group (TPH-CWG); and,

Leachate samples were prepared from selected soil samples by I2 Analytical (I2) and analysed for the following:

- Heavy metals suite;
- Polycyclic aromatic hydrocarbons (PAH); and,
- Total petroleum hydrocarbons – Criteria Working Group (TPH-CWG);

Further analysis, including waste acceptance criteria (WAC) testing was undertaken on four composite samples representative of the spoil generated during the investigation in order to inform off-site disposal.

Groundwater samples were collected from all four boreholes. The samples were sent to I2 Analytical (I2) and analysed for the following:

- Heavy metals suite;
- Polycyclic aromatic hydrocarbons (PAH);
- Total petroleum hydrocarbons – Criteria Working Group (TPH-CWG);
- pH; and,
- Sulphates.

The full set of chemical results are presented in Annex F.

4.0 Ground Conditions

4.1 Ground Profile

The current investigation observed that the soils underlying the Site generally comprised the following:

Table 4.1: Ground Profile

Stratum	From		To		Thickness (m)
	m bgl	m aOD[1]	m bgl	m aOD[1]	
Made Ground	0.00	78.60	18.50	60.10	18.50
Wadhurst Clay Formation	18.50	60.10	>30.00	<48.60	>11.50

1. Assuming a ground level of 78.60m aOD across the Site.

The ground conditions encountered correspond with the previous investigations conducted on the Site. Except for thick Made Ground associated with historical clay pits, the ground conditions encountered correspond with the publicly available records of ground conditions published by the British Geological Survey (BGS). Published BGS borehole records within or near the Site area found similar conditions.

4.2 Made Ground

Made Ground was encountered in all of the exploratory holes from ground level to depths of between 17.00m and 18.50m bgl.

The Made Ground was heterogeneous in nature and generally comprised either greyish brown, silty, sandy gravelly clays or slightly gravelly sand. Sand was fine to coarse grained. Gravel was sub-angular to angular, fine to coarse grained of brick, bitumen, sandstone, black stained wood, glass, concrete and ironstone. A low to medium cobble density of brick, sandstone and concrete was recorded locally. Occasional fragments of metal rebar, plastic, calcareous material, woodwool insulation, wood and bitumen were recorded throughout. Pockets of peat were encountered locally at various depths.

Refusal due to an obstruction was encountered within the Made Ground in the exploratory hole RO101 at 10.50m bgl. A hydrocarbon odour and oily sheen was observed at depths between 4.50m and 14.00m bgl at RO104.

4.3 Wadhurst Clay Formation

Bedrock geology comprising the Wadhurst Clay Formation was encountered underlying Made Ground in the exploratory holes RO102, RO103 and RO104 to depths in excess of 30.00m bgl. The base of the stratum was not confirmed during the investigation.

The Wadhurst Clay Formation was homogenous in nature and generally comprised extremely weak to weak light bluish grey mudstone locally interbedded with stiff light grey clay with dark grey mudstone laminations between 18.00m and 21.00m bgl.

4.4 Groundwater

Water strikes were not observed during the exploratory works, however any groundwater presence may have been masked by the flush medium used to progress drilling. The results of the subsequent monitoring visits are summarised in the table below.

Table 4.2: Groundwater Observations

Exploratory Hole	Water Strikes				Standing Water Level During Monitoring			
	Struck		Rose to		Shallowest		Deepest	
	m bgl	m aOD	m bgl	m aOD	m bgl	m aOD	m bgl	m aOD
RO101	-	-	-	-	0.80	78.02	1.03	77.79
RO102	-	-	-	-	2.87	75.69	3.68	74.88
RO103	-	-	-	-	0.80	77.63	1.39	77.04
RO104	-	-	-	-	1.68	76.82	3.14	75.36

During this phase of ground investigation, groundwater was not encountered, and any strikes were likely masked by the drilling medium. During previous investigation phases, groundwater was encountered during the fieldworks between 2.50m and 4m bgl.

During subsequent monitoring, groundwater was typically encountered between 0.80m bgl to 3.68m bgl within the Made Ground. During past monitoring, groundwater resting levels were recorded between 0.44m and 1.38m bgl.

The groundwater monitoring data are presented in Annex D.

According to the ground investigation and monitoring data, perched groundwater is anticipated within Made Ground at depths ranging from 0.44m bgl to 4m bgl.

Groundwater may be subject to seasonal variations especially after periods of prolonged rain or drought.

4.5 Visual and Olfactory Evidence of Contamination

Visual and olfactory evidence of contamination was encountered during the ground investigation, as detailed in the table below.

Table 4.3: Evidence of Contamination

Exploratory Hole	Depth (m bgl)	Comments	
RO101	0.00 – 1.50	Made Ground	Plastic
	2.65 – 3.00	Made Ground	Bitumen, metal fragments
	9.30 – 10.50	Made Ground	Bitumen
	10.20 – 10.50	Made Ground	Black stained wood, oily sheen
	12.00 – 17.10	Made Ground	Black stained wood
RO102	10.20 – 10.50	Made Ground	Black stained wood, oily sheen
	12.00 – 17.10	Made Ground	Black stained wood
RO103	0.00 – 1.00	Made Ground	Woodwool insulation, wood
	2.00 – 3.00	Made Ground	Brick, concrete
	5.00 – 10.50	Made Ground	Plastic wires, black stained wood
	12.00 – 17.00	Made Ground	Bitumen, black stained wood, glass fragments
RO104	0.00 – 0.45	Made Ground	Bitumen
	0.45 – 1.00	Made Ground	Black stained wood, Potential asbestos (corrugated roof sheet fragment)
	4.50 – 7.75	Made Ground	Clinker, faint hydrocarbon odour, oily sheen

	7.75 – 9.00	Made Ground	Wood
	9.00 – 10.50	Made Ground	Clinker, faint hydrocarbon odour, oily sheen, black stained wood
	10.50 – 12.20	Made Ground	Clinker, black stained wood, faint hydrocarbon odour, oily sheen
	17.50 – 18.50	Made Ground	Metal wiring

5.0 Geotechnical Assessment

5.1 Strata Properties

5.1.1 Made Ground

During this ground investigation phase, thirty-eight SPTs conducted in the Made Ground, yielded N_{60} values ranging between 4 and 63, highlighting the variable strength of the material.

Six dynamic cone penetrometer (DCP) tests were undertaken within Made Ground. The CBR values generally ranged between 2% and 25%. A large number of elevated CBR values were recorded that likely relate to the probe refusing on coarse gravel and cobbles within Made Ground.

Six particle size distribution tests undertaken on samples of the Made Ground recorded 0% cobbles, 1% to 54% gravel, 8% to 77% sand and 22% to 84% clay/silt. These results indicate the high lithological variability of the stratum.

Nineteen moisture content tests undertaken on samples of the Made Ground recorded values in the range of 0.50% to 30.5%.

Nine Atterberg limits tests undertaken on samples of the Made Ground recorded values in the range of 23% to 44% for the liquid limit, 16% to 22% for the plastic limit, and 7% to 22% for the plasticity index. The modified plasticity index was 2% to 19%. The results indicate that the Made Ground is of intermediate plasticity and of negligible to low volume change potential (VCP) in accordance with NHBC Standards.

Two one dimensional consolidation (oedometer) test were conducted on undisturbed samples of Made Ground retrieved from depths of 7.50m and 9.50m bgl. The oedometer tests yielded coefficient of volume compressibility (m_v) values in the range of 0.029 – 1.20m²/MN and coefficient of consolidation (Cv) values in the range of 1.10 – 10.0m²/year. The values of both parameters are stress dependent and their applicability should be assessed on the basis of the relevant stress range. The detailed laboratory results attached in Annex E should be consulted for selecting the values applicable to the proposed stress range, if required, for the final design.

Six unconsolidated undrained triaxial tests undertaken on samples of Made Ground recorded undrained shear strengths in the range of 16kN/m^2 to 55kN/m^2.

The CPT results indicate SPT N60 values as low as 2 to 5 and Cu values as low as 10kPa to 40kPa, respectively to at least 16.00m depth for Made Ground deposits, indicating the variable and relatively poor engineering properties of the material. The full CPT report can be found in Annex D.

Table 5.1: Summary of Ground Parameters for Made Ground

Soil Parameters	Number of Tests	Range of Results	Characteristic Value[1]
Liquid Limit (%)	9	23-44	44
Plastic Limit (%)	9	16-22	22
Plasticity Index (%)	9	7-22	22
Modified Plasticity Index (%)	9	2-19	19
Plasticity	9	CL - CI	CI
Volume Change Potential (NHBC)	9	Negligible - Low	Low
Moisture Content (%)	19	0.5 - 30.5	-
Bulk Density (Mg/m^3)	6	1.87 - 2.36	2.00
California Bearing Ratio (%)	8	2-15	3

Soil Parameters	Number of Tests	Range of Results	Characteristic Value[1]
SPT N_{60} Values	38	4-63	Refer to Figure 4 in Annex A
Undrained Shear Strength (Cu) (kN/m^2)	6	16 - 55	-
Coefficient of Volume Compressibility (mv) (m^2/MN)	2	0.029 – 1.20	Stress dependent – Refer to Annex E for detailed results
Coefficient of Consolidation (C_v) (m^2/year)	2	1.10 – 10.00	Stress dependent – Refer to Annex E for detailed results

1. Cautious estimate

5.1.2 Wadhurst Clay Formation

Boreholes within the stratum were progressed via rotary coring, with the first 2m – 5m of competent rock being retained for subsequent laboratory analysis.

A total of seven SPTs conducted in the Wadhurst Clay Formation yielded N_{60} values in excess of 67. For the purposes of this assessment SPT refusals were conservatively considered to be N=50. The results indicate SPT refusals at depths where the stratum was encountered as extremely weak to weak rock.

Rock Quality Designation (RQD) values recorded in the logs, for the borehole lengths that core was retrieved, were variable ranging from 0% to 76%.

Solid Core Recovery (SCR) values recorded in the logs were also variable ranging from 11% to 81%.

Two moisture content test undertaken on samples of the stratum recorded a values in the range of 9.80% - 35.30%

A single Atterberg limits test undertaken on a locally cohesive fraction of the stratum recorded values of 40% for the liquid limit, 20% for the plastic limit, and 20% for the plasticity index. The modified plasticity index was 11%. The results indicate that the cohesive fractions of the stratum is of intermediate plasticity and of low volume change potential (VCP) in accordance with NHBC Standards.

A total of 15 point load strength tests undertaken on samples of the stratum indicated point load strength index $Is_{(50)}$ values generally ranging from 0.02MPa to 0.11MPa. An outlier value of 0.71 is not considered representative of the stratum. The samples for point load strength tests were obtained at depths ranging from 18.00m to 30.00m bgl. Based on experience and literature a relationship of UCS = $I_{s(50)}$ x 12, provides a cautious estimate of uniaxial compressive strength (UCS) values between 0.24MPa and 1.32MPa.

Two uniaxial compressive strength (UCS) tests undertaken on samples of Wadhurst Clay Formation yielded very low UCS values ranging from 0.21MPa to 0.30MPa. The samples for uniaxial compressive strength testing were obtained from depths ranging from 24.00m to 27.00m bgl.

Hand penetrometer results in the stratum indicated unconfined compressive strength values greater than 0.60MPa.

Table 5.2: Summary of Ground Parameters for Wadhurst Clay Formation

Soil Parameters	Number of Tests	Range of Results	Characteristic Value[1]
Bulk Density (Mg/m^3)	2	2.26 - 2.29	2.28
Moisture Content (%)	2	9.80 – 35.3	-
SPT N_{60} Values	7	67	Refer to Figure 4 in Annex A
Point Load Index, $Is_{(50)}$ (MPa)	15	0.02 – 0.71	0.05
Uniaxial Compressive Strength (MPa)	2	0.21 – 0.30	0.60

1. Cautious estimate

5.2 Buried Concrete

Eleven soil samples, comprising ten from the Made Ground and one from the Wadhurst Clay Formation, were subjected to pH and water soluble sulphate determinations.

The characteristic value of water soluble sulphate was 345mg/l for Made Ground, and 310mg/l for the Wadhurst Clay Formation.

The same eleven soil samples were subjected to total sulphur and acid soluble sulphate content testing to allow an assessment to be made in relation to the potential thaumasite form of concrete attack. One of the oxidisable sulphides values calculated for Wadhurst Clay Formation was in excess of 0.3% (0.56%). However, it is expected that bedrock geology will not be exposed to surface conditions during the construction of the proposed scheme, given the depths at which it was encountered. Consequently a modification to DS class is not proposed for Wadhurst Clay Formation.

The characteristic value of pH was 7.4 for Made Ground, and 8.2 for Wadhurst Clay Formation.

Four samples of groundwater obtained during the monitoring programme were subjected to sulphate and pH determinations. The highest recorded value of sulphate was 695 mg/l and measured pH values ranged from 7.9 – 8.3. The characteristic value of pH for groundwater was 7.9.

Overall, with reference to the BRE Digest SD1 (2005), and considering the results of both soil and groundwater samples, a design sulphate class of DS-2 and an ACEC Class AC-2 is appropriate for both Made Ground and Wadhurst Clay Formation. Mobile groundwater and brownfield conditions have been assumed.

6.0 Geotechnical Recommendations

6.1 General

It is proposed to develop the Site for the construction of three large adjoined warehouse units in the north and two adjoined units in the south, with associated car parks, service yards and landscaping. Current proposals are indicated in Figure 2 in Annex A.

Details of the proposed structures, anticipated loadings and serviceability criteria were under development at the time of the writing of this report. Further investigation may be required once proposals are fully developed and a detailed Geotechnical Design Report may need to be prepared.

The primary purpose of this report is to identify risk, allow design development and inform cost estimates. This report does not constitute a detailed design report for the proposed development.

For the purposes of this assessment, TRC assumed that finished ground levels will be at, or close to, existing ground levels. In the event that these levels are changed, then this assessment should be revisited to examine potential changes in recommendations.

6.2 Geotechnical Hazards

The previous reports and the ground investigation have identified a number of geotechnical hazards at the Site which relate to the proposed development. These are summarised below and discussed in more detail in the following sections along with mitigation measures where appropriate.

- Deep Made Ground / infilled ground was recorded to depths of at least 18.50m. Thicker Made Ground up to 18.80m bgl was previously recorded in historical boreholes. Thicker Made Ground cannot be ruled out across the Site;
- Buried obstructions, such as old foundations and cobbles, boulders and steel obstructions in the thick Made Ground;
- Ground conditions aggressive to buried concrete;
- Volume change potential of soils; and,
- Shallow groundwater level.

6.3 Foundations

As described in Section 4, the Site is underlain by Made Ground to at least 18.50m bgl over Wadhurst Clay Formation to depths in excess of 30m bgl.

The Made Ground, unless treated to an appropriate specification, is not considered a competent foundation stratum due to its lithological variability, poor engineering properties and susceptibility to settlement.

It is likely the most cost-effective foundation solution for the proposed scheme would comprise a ground improvement scheme followed by shallow strip or pad foundations. Details of ground improvement options are discussed in the following section.

Alternatively, a piled foundation solution could be considered for the proposed development.

6.4 Ground Improvement

Ground improvement may enable shallow foundations to be used for the proposed structures. The advice of reputable specialist contractors experienced in the ground conditions discussed in this report should be sought. They should be responsible for the selection of appropriate equipment and the final design of the treatment.

Thick Made Ground was encountered across the Site to at least 18.50m depth. Thicker Made Ground up to 18.80m bgl was previously recorded in historical boreholes. Thicker Made Ground cannot be ruled across the Site. The Made Ground is not considered a suitable bearing stratum due it's inherent metastable nature and poor engineering properties.

On this basis, considering the results of CPTs and ground conditions observed within boreholes, the Site would require ground improvement to a depth of at least 16.00m bgl, and locally to at least 19.00m bgl. Ground improvement beyond this depth cannot be excluded should Made Ground be encountered to greater depths. ABPs in the region of 125kPa - 150kPa should be achievable following a successful ground improvement scheme subject to confirmation by a specialist contractor.

Given the significant depths to which ground improvement is required, techniques such as Vibro Stone Columns (VSC) or Vibro Concrete Columns (VCC) would not be viable at the Site. It is likely Controlled Modulus Columns (CMC) would be the most suitable method to effectively treat the ground conditions present at the Site.

Asbestos contamination has been encountered in the Made Ground in one location (RO104), as discussed in section 7. This may have particular implications for the use of controlled modulus columns (CMC) so particular control measures or prior remediation may be required.

Unless the finally selected treatment scheme deals with the volume change potential of the soils on-Site, in the vicinity of retained, removed, or proposed vegetation, final foundation depths and heave precautions are recommended to be determined in accordance with Chapter 4.2 of the NHBC Standards, based on a 'low' volume change (shrink-swell) potential for the Made Ground.

The potential presence of obstructions within the Made Ground should be considered in the selection of the most appropriate treatment method and equipment.

6.5 Floor Slabs

Ground bearing floor slabs on previously treated Made Ground is likely to be the most cost-effective solution for the proposed structures, provided that the required settlement tolerances can be achieved.

It is anticipated that the design of the finally selected ground treatment solution will deal with the 'low' volume change potential of the Site soils in the vicinity of any retained/removed/proposed vegetation in accordance with Chapter 4.2 of the NHBC Standards.

Advice from a specialist ground treatment contractor should be sought once the required floor loadings and settlement tolerances are known.

6.6 Excavations

Excavations for shallow foundations, floor slabs, and laying services should be readily achievable using standard excavation plant. However, hard surfacing, old foundations and obstructions within Made Ground may require the use of a breaking apparatus. Obstructions were encountered in Made Ground during the investigation.

For any load bearing formations, careful inspection should be undertaken to ensure placement in competent strata unless ground treatment has been carried out and properly validated. Any soft spots identified should be excavated and replaced with compacted granular fill or lean mix concrete. Concrete should be placed as soon as possible following excavation to avoid softening of the ground. A similar recommendation is also made for road pavement formations, although compacted granular fill could be used instead of concrete.

Any relic foundations or other subterranean structures beneath the footprint of the proposed buildings should be fully grubbed out. Such excavations should be surveyed and backfilled with an acceptable granular fill,

placed and compacted to an engineering specification. The same recommendations are made for excavations that may be required to remove soil contamination.

In areas of road pavements and hard standing, relic subterranean structures should be broken down to around 1m below finished Site level to minimise the risk of differential settlement due to the presence of hard spots. In soft landscaped areas it may be possible to limit such operations to 0.50m bgl.

Stability in excavation faces in Made Ground cannot be relied on and allowance should be made for battering faces back to a safe angle of repose, or providing shuttering. Support or battering of the excavation faces to a safe angle of repose will be required for all excavations where man entry is necessary, the nature and extent of which will need to be evaluated under CDM regulations.

Perched groundwater is anticipated sporadically within Made Ground. An allowance for local pumping from a sump should be made for any shallow groundwater may be encountered during construction.

Groundwater levels vary seasonally, and the timing of the construction programme may influence the volumes of groundwater that need to be managed. The developer should also consider the impact of weather and potential for rainwater and surface run-off to accumulate within excavations.

Water pumped from excavations may require pre-treatment prior to discharge. This could include settlement tanks to reduce silt and suspended solids. Contamination has been identified at the Site, therefore further filtration or other such treatment during the construction stage is considered likely. The contractor should consult with the local water authority and/or Environment Agency to obtain necessary discharge consents and agree the scope of pre-treatment prior to any discharge required.

6.7 Pavements

Due to the thickness and the low volume change potential of the Made Ground which may create settlement issues, pavement surfaces in light loaded car park areas should be constructed in flexible materials such as bituminous compounds or block paving which are more easily able to accommodate ground movement and can be more easily repaired. Heavily loaded areas such as concrete yards and loading areas where less ground settlement can be tolerated, could be constructed on previously treated ground and/or reinforced subbase with geogrids/geotextiles to satisfy design criteria.

It is recommended that any fill proposed is placed and compacted in accordance with a suitable specification based on the Specification for Highway Works (SHW 600 series). The formation level should be rolled and inspected for any soft or loose material. These materials should be removed and replaced with granular fill placed and compacted in accordance with a suitable specification.

Assuming excavation formation soils to comprise Made Ground and based on the formation preparation outlined above, an equilibrium CBR value of 4% is recommended for preliminary design purposes.

In-situ CBR testing at formation level prior to construction is recommended to confirm the design CBR values adopted.

Laboratory test results of Made Ground were indicative of frost susceptibility.

6.8 Buried Concrete

In the consideration of sulphate attack on buried concrete, reference has been made to BRE Digest SD1 (2005) which classifies the Site as a brownfield Site with mobile groundwater conditions. Additionally, as Wadhurst Clay Formation can be pyrite bearing, it has also been necessary to assess the potential for the thaumasite form of attack in case these strata are disturbed.

Based on the results of the concrete classification tests, a design sulphate class of DS-2 and an ACEC Class of AC-2 are recommended for both Made Ground and Wadhurst Clay Formation.

6.9 Soakaway Potential

Soakaway testing did not form part of the scope of works. However, considering the significant thickness of Made Ground encountered across the Site, shallow soakaways with not be viable for the proposed development. Alternative drainage options should be considered by the scheme's drainage engineer.

7.0 Human Health Risk Assessment

7.1 Soil Assessment

In order to appraise the significance of the concentrations reported by laboratory testing, TRC has assessed each contaminant species that is elevated above the laboratory method detection limits (MDL) against published screening criteria referred to as Generic Assessment Criteria (GAC). GACs are derived from the following reference material:

- Land Quality Management Limited and Chartered Institute of Environmental Health (November 2014), the LQM/CIEH S4ULs for Human Health Risk Assessment. Document reference: S4UL3435;
- Development of Category 4 Screening Levels for assessment of land affected by contamination – SP1010 (September 2014);
- LQM S4Uls: evaluation of 2017USEPA Toxicological Review of Benzo(a)pyrene; and,
- LQM/CIEH S4Uls for Nickel according to land use (Revised August 2015).

TRC has selected GACs for a commercial or industrial, based on the proposed development comprising commercial/industrial end use.

A conservative value of 1% of soil organic matter (SOM) has been assumed based on the soil type.

A summary of the laboratory data and the screening tables with relevant GACs is presented in Annex G.

7.2 Heavy Metals

Minor concentrations of heavy metals were detected in soil samples (both Made Ground and natural soils). None of the concentrations exceeded the GACs.

7.3 Hydrocarbons

Free phase hydrocarbons were not identified in soils during the ground investigation. All samples that recorded exceedances of the GAC were obtained from the RO102 at 10.40m bgl.

Table 7.1: Summary of Soil Exceedances

Contaminant	GAC (mg/kg)	Maximum Concentration (mg/kg)	Location of Maximum Concentration	No. of Exceedances
□en□□□□□l□□r□n□ene	□□	77	RO102	1
□en□□□□□rene	□□	67	RO102	1
Di□en□□□□□n□r□□ene	□□□	10	RO102	1

7.4 Asbestos

Asbestos fibres in soil were encountered within 2 samples of Made Ground. The samples containing asbestos were found to contain Chrysotile and Amosite fibres in soil. Asbestos quantification was undertaken on these samples and identified a concentration of <0.001% fibres in soil.

Asbestos fragments were identified in exploratory hole RO104 in the south of the Site. Chrysotile was identified at 0.75m bgl and amosite was identified at 5.50m bgl.

7.5 Discussion

Out of the 28 soil samples sent for laboratory analysis, one sample from the Made Ground exceeded the GAC's for a commercial end use for Benzo(b)fluoranthene, Benzo(a)pyrene and Dibenz(a,h)anthracene (RO102 at a depth of 10.40m).

Asbestos fibres were identified in the south of the Site between 0.75m and 5.5 m bgl within the Made Ground. A former tile works, and warehouse unit was noted to be present in this part of the Site. Chrysotile and amosite have both been used in producing roofing shingles, building construction and building insulation. The timing of the previous development's construction aligns with beginning of the phasing out of chrysotile and amosite as a construction material. As the asbestos fibres and fragments of asbestos were identified within the first 6m of Made Ground, the proposed foundation construction method and any future earthworks should consider the risk from asbestos in soils and the location of asbestos that has been identified on Site.

8.0 Controlled Waters Risk Assessment

In order to appraise the significance of the groundwater/soil leachate concentrations recorded, TRC has assessed each contaminant species that is elevated above the laboratory LOD against the following published guidance values:

- Drinking Water Standards England and Wales (2000) (amended), and;
- Environmental Quality Standards (EQS) for freshwater

Groundwater monitoring recorded groundwater in all four monitoring wells ranging from 0.80m bgl to 3.68m bgl. No free phase oils or hydrocarbons odours were identified. Groundwater samples were taken from each borehole and were sent to DETS Ltd for laboratory analysis.

8.1 Groundwater Assessment

The laboratory analysis reported elevated concentrations of General Inorganics, Speciated PAHs, Heavy Metals/ Metalloids and Petroleum Hydrocarbons exceeding the UK DWS in 4 groundwater/soil leachate samples collected. All four samples, from the separate monitoring wells were found to have at least one exceedance of Speciated PAHs, with Acenaphthylene (aq) encountered in every monitoring well. Exceedances of the DWS for Fluoranthene (aq) were recorded in samples from RO103 and RO104. The exceedances of General Inorganics, Heavy Metals/ Metalloids and Petroleum Hydrocarbons were all within RO104. The exceedances are summarised in the below table.

Table 8.1: Summary of Groundwater Exceedances

Contaminant	DWS (µg/l)	Maximum Concentration (µg/l)	Location of Maximum Concentration	No. of Exceedances
Sulphate as SO_4	250,000	695,000	RO104	1
Naphthalene (aq)	0.1	0.27	RO103	1
Acenaphthylene (aq)	0.1	6.7	RO104	4
Fluoranthene (aq)	0.1	3.34	RO104	2
Anthracene (aq)	0.1	1.97	RO104	1
Phenanthrene (aq)	0.1	0.84	RO104	1
Fluorene (aq)	0.1	0.83	RO104	1
Chrysene (aq)	0.1	0.43	RO104	1
Boron (dissolved)	0.1	0.16	RO104	1
Nickel (dissolved)	20	30	RO101	1

The Site is not within a Groundwater Source Protection Zone (SPZ).

There are no active licensed groundwater abstractions within 1km of the Site.

The Site is underlain directly by the Wadhurst Clay Formation which is designated as a Secondary B aquifer.

8.2 Surface Water Assessment

The laboratory analysis reported elevated concentrations of General Inorganics, Speciated PAHs and Heavy Metals/ Metalloids exceeding the EQS in 4 groundwater/soil leachate samples collected. All four monitoring wells were found to have exceedances in Speciated PAHs, with elevated levels of Fluoranthene (aq) reported in each monitoring well. RO104 was also found to have an exceedance in Anthracene (aq). Exceedances in Heavy Metals/ Metalloids were found within all four monitoring wells. RO101, RO102 and RO103 were found to have exceedances in Nickel (dissolved). RO101 had exceedances in Zinc (dissolved). RO104 was found to have an exceedance of Mercury (dissolved). The exceedances are summarised in the below table.

Table 8.2: Summary of Groundwater Exceedances

Contaminant	EQS (µg/l)	Maximum Concentration (µg/l)	Location of Maximum Concentration	No. of Exceedances
Sulphate as SO_4	250,000	695,000	RO104	1
Fluoranthene (aq)	0.1	3.34	RO104	4
Anthracene (aq)	0.1	1.97	RO104	1
Mercury (dissolved)	0.07	0.20	RO104	1
Nickel (dissolved)	4	30	RO101	3
Zinc (dissolved)	10.9	12	RO101	1

The nearest surface water feature is a small pond and inflowing stream 180m to the east of the Site. The Site is underlain by low permeability strata and groundwater is considered unlikely to be in hydraulic connection with surface waters.

8.3 Discussion

The contaminant exceedances within the groundwater are generally located within the south of the Site. This could be linked to the former brick and tile works that was present in this area. There are no drinking water abstractions in close vicinity of the Site and it is not located without an Environmental Agency (EA) designated groundwater Source Protection Zone (SPZ). In addition to this, the Wadhurst Clay Formation is classified as Unproductive Strata which will likely limit the migration of groundwater. This suggests the contamination is likely to remain within the Made Ground in the backfilled pit, located on Site. It is considered unlikely that the Site poses a significant risk to controlled water beyond the boundary of the former pit.

9.0 Ground Gas and Organic Vapour Risk Assessment

A preliminary ground gas risk assessment has been undertaken in accordance with British Standard BS 8485:2015+A1:2019 and CIRIA C665 to assess the impact of permanent ground gases upon the proposed development.

The dataset is considered to be representative and comprehensive due to one of the monitoring rounds having been conducted over a falling pressure trend (to represent the worst-case scenario) and the remaining rounds having been conducted over a steady pressure trend.

9.1 Ground Gas Assessment

Field monitoring for permanent ground gases was performed at six monitoring well locations on six occasions, during the 20th and 27th September and 5th, 11th, 17th, and 24th October 2023. The maximum concentrations are summarised in the table below and the complete monitoring data are provided within Annex D.

Table 9.1: Summary of Gas Monitoring Results

Location	Maximum Methane Concentration (%v/v)	Maximum Carbon Dioxide Concentration (%v/v)	Minimum Oxygen Concentration (%v/v)	Flow Rate (l/hr)	
				Maximum	Second Highest
RO101	20.3	15.9	0.3	0.3	0.1
RO102	99.5	4.1	0.1	65.0*	20.4
RO103	88.3	3.6	0.1	52.0*	1.8
RO104	46.4	2.1	3.4	0.2	0.1

* Monitoring equipment pump failure due to negative pressure within standpipe.

Methane was detected in all of the monitoring wells during all six monitoring visits. The highest concentrations were detected in RO102 and RO103, with the former having peaked at 99.5% during the first monitoring visit. The concentrations of methane generally remained consistently elevated within RO102, RO103 and RO104. During the first round of monitoring, methane was recorded at 2.7% within RO101, and by the last round increased to 32.1%.

Carbon dioxide was detected in all of the monitoring wells with concentrations ranging from 2.1% to 15.9%, with the latter having been detected within RO101 during the fourth monitoring round.

Oxygen concentrations were significantly depleted in the monitoring wells and was noted to correlate to higher methane and carbon dioxide concentrations in these monitoring wells.

Flow rates ranging from 52 l/hr to 65 l/hr were recorded within RO102 and RO103 during the fourth monitoring round. However, these values have been discounted due to having been associated with monitoring equipment pump failure due to negative pressure within the standpipes. The second highest flow rate was recorded within RO102 during the fifth monitoring round.

During the monitoring, atmospheric air pressures varied between 993 mb and 1017 mb and included a falling pressure trend during the first monitoring round and steady pressure trends during the remaining rounds. However, it is to be noted that atmospheric air pressures remained near to or above 1000 mb, and relatively steady carbon dioxide and methane concentrations were recorded within all wells during all six occasions.

TRC has assessed the permanent ground gas concentrations in accordance with current guidance (BS8485:2015). Based on the results, a gas screening value (GSV) of 20.3 l/hr was calculated, which would classify the Site as Characteristic Situation 5 (high risk).

9.2 Organic Vapour from Soil Assessment

For hydrocarbons and other VOCs the LQM S4ULs are considered to be protective of human health from indoor inhalation of organic vapour. Based on the results presented in Section 7, there were exceedances of volatile contaminants within RO102 (north-east of the Site). In addition, free phase hydrocarbons were identified in soils during the ground investigation.

Field monitoring detected low PID readings in the borehole. The highest concentration was identified within RO101 and RO104 (0.3 ppm). The PID readings are consistent with the results of the soil analysis.

Organic vapour protection measures are not considered to be required.

9.3 Organic Vapour from Groundwater Assessment

In order to appraise the significance of volatile substances in groundwater to human health, TRC has assessed each contaminant species that is elevated above the laboratory LOD against the following published guidance values:

- SoBRA, Development of Generic Assessment Criteria for Assessing Vapour Risks to Human Health from Volatile Contaminants in Groundwater, Version 1 (2017).

There are no exceedances of the SoBRA GAC.

9.4 Discussion

Based on the results of this assessment, and similar results obtained during the previous investigation (Phase II Environmental Site Assessment, TRC Report No. 417410.0001, Dated December 2021), the Site is designated as Characteristic Situation CS5 (high risk) in accordance with CIRIA C665. It is recommended that further gas risk assessment is undertaken, and/or possible remedial mitigation measures to reduce and/or remove the source of ground gas. Guidance from CIRIA C665 lists the following typical scope of protective measures:

- Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft)
- All joints and penetrations sealed.
- Proprietary gas resistant membrane and actively ventilated or positively pressurised underfloor sub-space with monitoring facility, with monitoring.
- In ground venting wells and reduction of gas regime.

10.0 Contaminated Land Risk Assessment

The methodology of this risk assessment uses the source-pathway-receptor pollutant linkage to provide a qualitative appraisal of environmental risks and potential liabilities associated with soil and groundwater contamination at the Site. The conceptual site model (CSM) has been prepared considering the proposed end use as commercial/light industrial.

10.1 Sources of Contamination

The ground investigation performed at the Site by TRC identified the following sources of contamination:

- Asbestos fibres in soil in Made Ground in RO104 in south of Site;
- Concentrations of hydrocarbons within soils in the Made Ground in RO102 in the northeast of the Site;
- Concentrations of boron and nickel in excess of DWS in groundwater within RO101 in the north of the Site and RO104 in the south of the Site;
- Concentrations of mercury, nickel and zinc in excess of EQS in groundwater within RO101 in the north of the Site and RO104 in the south of the Site;
- Concentrations of General Inorganics in excess of DWS and EQS in groundwater within RO104;
- Concentrations of Speciated PAHs in excess of DWS and EQS in groundwater across the Site;
- Very high levels of methane ground gas in Made Ground across the Site; and,
- Moderate levels of carbon dioxide in the Made Ground in the northwest of the Site

10.2 Pathways

Based on the information presented in this report the following potentially active pathways have been identified. Consider both construction phase and operational phase.

- Dermal contact or ingestion with soil and groundwater ;
- Inhalation of soil dust or respirable fibres of asbestos;
- Leaching of contaminants and vertical migration into groundwater;
- Contact with buried services; and,
- Migration of ground gas/organic vapour and ingress into buildings

10.3 Receptors

Based on the information presented in this report the following receptors have been identified.

- Future site users could come into contact with soil contamination in areas of soft landscaping or with ground gas/organic vapour in indoor and/or outdoor air;
- Neighbouring site users could come into contact with contaminated soil dust, originating from construction activities;
- Construction and maintenance workers could be exposed to contamination during groundworks and future maintenance works;
- Construction materials could come into contact with contamination in the ground;
- Groundwater – the Site in underlain by a Secondary B aquifer; and,
- Surface waters – The small unnamed pond and stream to the east of the Site;

10.4 Revised Conceptual Site Model

The following CSM has been prepared to take into consideration the findings from the intrusive investigation.

Table 10.1: Revised Conceptual Site Model

Source	Pathway	Receptor	Risk
Concentrations of hydrocarbons in the soil Asbestos fibres identified within the Made Ground in the south of the Site	Dermal contact, ingestion and inhalation pathways	Future site users	**Low to Moderate** Exceedance of contaminants and asbestos fibres were identified within the soil. The proposed Site will be primarily covered in buildings and hard standing within the building footprint, providing a physical barrier against contact with contaminants. It is recommended that localised soft landscaping areas are managed by an appropriate capping layer with a geotextile marker layer installed at the base of the capping layer.
		Neighbouring site users	**Low to Moderate** Neighbouring site users could be exposed to contaminated soil dust and/or respirable fibres of asbestos, particularly during the construction phase. Mitigation measures could include construction site management solutions such as dust control.
		Construction and maintenance workers	**Low to Moderate** Risk pathway to be mitigated via Personal Protective Equipment (PPE), good hygiene practices and construction site management. Any works which may disturb asbestos must be undertaken in accordance with the Control of Asbestos Regulations (CAR) 2012 and a Plan of Work will be required to manage risks from asbestos.
	Contact with buried services	Buried services	**Low** Proposed development to consider risk of residual contamination and incorporate protective measures as appropriate. This may include clean service corridors and / or

Source	Pathway	Receptor	Risk
			use of chemically resistant pipework.
Heavy metal and speciated PAHs contamination exceeding the EQS and DWS screening criteria for groundwater	Leaching of contaminants and vertical migration into groundwater	Groundwater underlying the Site	**Low** The underlying bedrock is classified as Unproductive Strata therefore migration of contaminants will likely be limited.
	Lateral migration n groundwater/surface runoff	Surface water (River Example)	**Low** The Site is directly underlain by low permeability clays of the Wadhurst Clay Formation and groundwater is considered unlikely to be in hydraulic connection with off-site surface water features.
Ground gas concentrations indicative of Characteristic Situation 5	Migration of ground gases/organic vapour within granular strata and ingress into buildings/confined spaces	Future site users	**High** The Site is classified as Characteristic Situation Level 5 (High Risk). It is recommended that further gas risk assessment is undertaken, and/or possible remedial mitigation measures to reduce and/or remove the source of ground gas.
		Construction workers	**Moderate to High** Pathway to be managed through good construction practices and mitigation of risks when working in confined spaces.

11.0 Summary and Conclusions

11.1 Findings

The Site comprises an approximate 1.58 ha plot of land located at Chapman Way, Tunbridge Wells, TN2 3EF. The Site investigation targeted locations relating to the proposed development, which will comprise the construction of three large adjoined warehouse units in the north and two adjoined units in the south with associated car parks, service yards and landscaping.

The ground conditions were found to comprise thick Made Ground overlying extremely weak to weak mudstones. The mudstones are interpreted to represent the Wadhurst Clay Formation.

Soil samples submitted for laboratory testing were screened against GAC's for a commercial end use, based on the proposed development. Minor concentrations of heavy metals were detected but none exceeded the GAC's.

No free phase oils or hydrocarbons odours were identified during the investigation.

Asbestos fibres were encountered within 2 samples of Made Ground. The concentration of the fibres within the soils was found to be less than 0.001%. Potential fragments of asbestos were noted during the SI at location RO104 within Made Ground.

During the ground investigation, no groundwater was encountered, possibly due to groundwater being masked by the flush medium used during the drilling process. During subsequent monitoring, groundwater was typically encountered between 0.80m bgl to 3.68m bgl within the Made Ground. This is expected to represent perched groundwater within the Made Ground.

Elevated levels of ground gases, specifically methane and carbon dioxide, were detected during monitoring visits.

11.2 Summary of Geotechnical Assessment

The primary purpose of this assessment is to identify geotechnical risk, allow design development and inform cost estimates for a CMC ground treatment scheme. This report does not constitute a detailed geotechnical design report for the proposed development.

The previous reports and current ground investigation have identified a number of geotechnical hazards at the Site which relate to the proposed development. These are Made Ground and infilled ground to depths of at least 18.80m, buried obstructions, ground aggressive to buried concrete, volume change potential of soils and shallow groundwater, and are discussed in detail along with mitigation measures in section 6 of this report.

Ground improvement by way of Controlled Modulus Columns could be applied followed by shallow foundations, subject to feasibility confirmation by a specialist contractor. Details of the foundation options including allowable bearing pressures are discussed in sections 6.3 and 6.4.

Ground bearing slabs on previously treated Made Ground to a suitable specification could be adopted for the proposed development. Details are provided in section 6.5 of this report.

Recommendations about proposed excavations, earthworks, classification for buried concrete design, and proposed pavements for the development are given in sections 6.6 to 6.8.

Shallow soakaways with not be viable for the proposed development. Alternative drainage options should be considered by the scheme's drainage engineer.

11.3 Summary of Contaminated Land Risk Assessment

11.3.1 Soil

Concentrations of hydrocarbons within the soil exceeded the GAC for the proposed commercial/light industrial end use. There is considered to be a potential risk to end users of the Site and to construction and maintenance works and neighbouring site users during the construction phase.

Asbestos fibres were identified within two samples of Made Ground within RO104. Both of the samples contained concentrations of asbestos <0.001%. The asbestos identified in the samples tested is considered to pose a low risk to future site users, as the Site will be predominately covered in buildings or hardstanding. However, asbestos in soil is considered as a risk to future site construction workers if not adequately addressed. Any works which may disturb asbestos must be undertaken in accordance with the Control of Asbestos Regulations (CAR) 2012 and a Plan of Work will be required to manage risks from asbestos.

11.3.2 Groundwater

The laboratory analysis reported elevated concentrations of General Inorganics, Speciated PAHs, Heavy Metals/ Metalloids and Petroleum Hydrocarbons exceeding the UK DWS or EQS within the groundwater samples analysed.

The Site is directly underlain by the Wadhurst Clay Formation, which is designated as Unproductive Strata. In addition, the Site is not within a Groundwater Source Protection Zone and there are no active groundwater abstractions within 1km of the Site. Groundwater is not considered to be in hydraulic connection with any nearby surface water features due to the presence of low permeability deposits. Therefore, there is not considered to be a significant risk to controlled water receptors and further assessment or remediation of groundwater is not considered to be required.

11.3.3 Ground Gas and Organic Vapour

Based on the results of this assessment the Site would be classified as Characteristic Situation 5. It is recommended that further ground gas risk assessment is undertaken, prior to confirming the extent of the required ground gas mitigation measures.

11.3.4 Remediation and Mitigation Measures

Based on the results of the results of the generic risk assessments undertaken the following remediation/mitigation measures are recommended:

- Capping of gardens/soft landscaped areas
- Further gas risk assessment and ground gas mitigation measures
- Installation of buried services in corridors of clean soil
- Upgraded water supply pipework (subject to confirmation form water supply company)

Any works which have the potential to disturb asbestos must be undertaken in accordance with CAR 2012 and a Plan of Work will be required. An asbestos in soils management plan should be prepared to further assess risks associated with the asbestos in soils identified.

The selection of appropriate water supply pipework should be confirmed by the local water supply company.

A remediation strategy and verification plan are likely to be required by the local planning authority.

Materials destined for off-site disposal to landfill may require further assessment in accordance with WM3 ‘Guidance on the classification and assessment of waste’ (1st edition version 1.2 GB 2021) to determine their waste classification.

If materials are to be re-used on site or imported from another development site, a materials management plan may be required in accordance with the CL:AIRE Definition of Waste: Development Industry Code of Practice in order to demonstrate that the material is not a waste.

Annex A: Figures

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		P01	FIRST ISSUE			
			Initials	TS	TS	30/08/23
		REV.	REVISION NOTES/COMMENTS			
			Initials			

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GLENNY LLP

PROJECT
CHAPMAN WAY, TUNBRIDGE WELLS

TITLE
SITE LOCATION PLAN

TRC PROJECT NO.
561063

SCALE
7500:1 @ A3
1250:1 @ A3

PURPOSE OF ISSUE
SUITABLE FOR INFORMATION

STATUS

DRAWING NO
FIGURE 01

REVISION
PO1

North

Figured dimensions only are to be used. All dimensions to be checked onsite. Differences between drawings and between drawings and specification or bills of quantities to be reported to the PRC Group.

Revisions:		Drawn / Chkd:	Date:
T1	PRELIMINARY ISSUE	DF/GW	13.04.2023
T2	SITE LAYOUT AMENDED		28.04.2023

Scale 1:500

0 25 50 m

Preliminary Issue

Client: TAVIS HOUSE

Project: CHAPMAN WAY TUNBRIDGE WELLS

Drawing Title: SITE LAYOUT

Scale @ A1: 1 : 500 | Checked by: GW | Date: 23.03.2023

Job No: 11476 | Stage _ Drawing No: TE_12-100 | Rev: T2

Issue Status: Construction ☐ Preliminary ■ Information ☐ Approval ☐ Tender ■

28/04/2023 12:47:35

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TAVIS HOUSE STELLAR (TUNBRIDGE WELLS) LP

PROJECT: CHAPMAN WAY, TUNBRIDGE WELLS

TITLE: PROPOSED DEVELOPMENT PLAN

TRC PROJECT NO.: 561063

SCALE: N/A

PURPOSE OF ISSUE: SUITABLE FOR INFORMATION

STATUS:

DRAWING NO: FIGURE 02

REVISION: PO1