



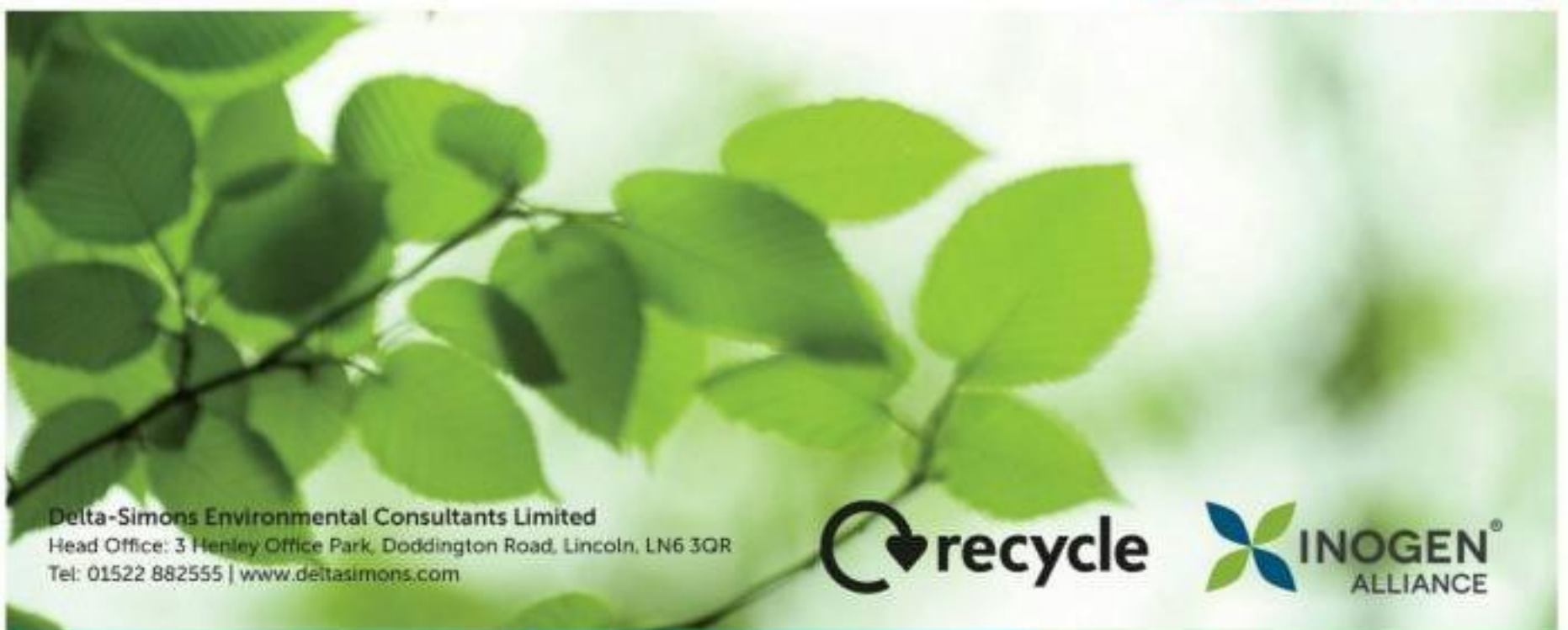
Phase I/II Geo-Environmental Assessment

Solent Road, Havant

Presented to **Chancerygate (Business Centre) Ltd**

Issued: March 2021

Delta-Simons Project No. 19-1058.01



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Report Details

Client	Chancerygate (Business Centre) Ltd
Report Title	Phase I/II Geo-Environmental Assessment
Site Address	Land at Solent Road, Havant, PO9 1DQ
Project No.	19-1058.01
Report Date	March 2021
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Quality Assurance

Issue No.	Status	Issue Date	Comments	Author	Technical Review	Authorised
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Executive Summary

Brief	Delta-Simons Environmental Consultants Limited ('Delta-Simons') was instructed by Chancerygate (Business Centre) Ltd (the 'Client') to undertake a Phase I/II Geo-Environmental Assessment for land at Solent Road, Havant, PO9 1DQ (hereafter referred to as the 'Site'). It is understood that the Site is to be redeveloped for a light industrial / commercial end use, including a two-storey office building. The purpose of this assessment is to identify the potential for land contamination issues to be present at the Site in the context of the proposed development, to support the planning application and to provide a geotechnical assessment.
Site Setting	The Site currently comprises a parcel of undeveloped overgrown grassland, with the exception of a disused tennis court in the north-eastern area of the Site. Brockhampton Stream encroaches the north-eastern Site boundary and continues to bound the Site to the north and west. Historically the Site appears to have comprised undeveloped agricultural land.
Ground Conditions	The current ground investigation recorded a variable thickness of topsoil and Made Ground, which is in turn underlain by superficial deposits comprising of Alluvium, Head Deposits and River Terrace Deposits, followed by Chalk bedrock. Monitoring of standpipes has identified shallow groundwater at the Site.
Land Contamination Assessment	<u>Human Health</u> Although detectable concentrations of heavy metals, PAHs and petroleum hydrocarbons have been detected within shallow soils, none have been recorded in excess of their respective GAC. It is therefore considered that no specific remediation is necessary with regards to the soils at the Site. Any topsoil imported onto the Site as part of the development works, or sourced from Site and re-used, should be tested to confirm suitability, prior to, and once placed, in landscaped areas. Although no elevated concentrations of contaminants have been identified, groundworkers and sub-surface maintenance workers should be made aware of the possibility of encountering contaminated soils through toolbox talks. Safe working procedures should be implemented, good standards of personal hygiene should be observed, and appropriate levels of PPE provided and utilised. This recommendation should be captured in Site health and safety documentation and in maintenance plans. <u>Controlled Waters</u> It is considered that the marginal exceedances of copper and nickel do not pose a significant risk to controlled waters on the basis that there is no on-Site source of copper or nickel, therefore, these concentrations are likely to be representative of background concentrations in the area. Furthermore, the underlying low permeability putty chalk is likely to form a confining layer above the Principal Aquifer, and bunds are present which will prevent lateral migration into the adjacent ponds. Therefore, no further action is considered to be required. <u>Built Environment</u> Confirmation should be sought from the Local Water Authority as to whether they will require upgraded pipework to be installed for new service installations, although this is considered to be unlikely. <u>Ground Gas</u> Based upon the results of the ground gas monitoring undertaken at the Site, the Site has been classified as CS2 – Low Risk. Ground gas protection measures are

	necessary under this scenario, and should achieve a score of 3.5 (Type B building) and 2.5 (Type C building), in accordance with BS:8485:2015+A1:2019. Any ground gas protection measures installed will also need to consider the incorporation of radon protective measures in accordance with BRE Report BR211 (2015) Radon: Protective measures for new buildings and as required by Building Regulations.
Geotechnical Assessment	The Made Ground is considered to be too unpredictable, variable, weak and compressible in its existing condition to be considered as a founding stratum, unless ground improvement, e.g. vibro replacement, is undertaken in line with a suitable earthworks specification. Based on the Site investigation undertaken shallow pad foundations placed within the natural strata are considered to be suitable for the Site, founded at a minimum depth of 1.5 m bgl within the loose to medium-dense gravels of the superficial Alluvium. Foundations should be founded on a consistent medium to avoid issues of differential settlement. A piled foundation solution using traditional bored or continuous flight auger (CFA) piles transferring loads to competent geology may be suitable for the expected design loads, utilising both skin friction and end bearing capacity. Where ground bearing floor slabs are feasible, all Topsoil, Made Ground and soft soils should be removed and the formation thoroughly proof rolled. Soft spots should be excavated and replaced with well-compacted granular material. Should ground improvement be undertaken, then this is also likely to result in a ground bearing slab being feasible, subject to confirmation from a suitably qualified ground improvement contractor. Based on the results of the plate load tests undertaken at the Site, it is recommended that a conservative CBR value of 1.3 % should be adopted for shallow soils, for preliminary pavement design for external areas. Soakaways are not considered feasible at the Site due to the shallow groundwater encountered during the Site investigation and subsequent monitoring visits. Groundwater should be anticipated during any excavations required as part of the proposed development, given that shallow groundwater has been encountered at the Site. Significant dewatering via sump and pump should be anticipated, however, treatment prior to disposal to sewer may be required. Buried concrete may be designed in accordance with DS-1 and ACEC Class AC-1. According to the Envirocheck® Report there is a very significant risk – moderate possibility of soluble rock risk in the north-west of the Site. Furthermore, the Site is indicated to have a moderate hazard potential for ground dissolution stability hazards in the north-east. However, the risk of dissolution features at the Site is considered to be low, on the basis that the Site is not indicated to be located in, or within 1 km, of any areas of mining instability, man-made cavities or natural cavities. Furthermore, given the presence of shallow groundwater at the Site, this is considered to further reduce the likelihood of dissolution features being present. No evidence of dissolution features was observed during the Site investigation. Despite the low risk, it is considered prudent that a watching brief is maintained during construction of the proposed development, in order to observe any evidence of dissolution features.

Recommendations	Based on the findings of this report, the following recommendations are made: ▲ Any topsoil imported onto the Site as part of the redevelopment works, or sourced from the Site and re-used, should be tested to confirm suitability, prior to, and once placed, in landscaped areas. It may be possible to re-use existing topsoil at the Site within landscaped areas, subject to further testing confirming it is suitable for use; ▲ Additional, unidentified localised areas of contamination may exist at the Site and an appropriate 'hotspot' protocol should be in place for groundworkers to act upon should such contamination be identified during the construction process; ▲ As with all development sites, groundworkers who are required to perform sub-surface work at the Site should be made aware of the known contaminants in soil and groundwater and the possibility of encountering additional localised low levels of contamination. Therefore, good standards of personal hygiene should be observed, and appropriate levels of PPE utilised where necessary; ▲ Based upon the results of the ground gas monitoring undertaken at the Site, the Site has been classified as CS2 – Low Risk. Ground gas protection measures are necessary under this scenario, and should achieve a score of 3.5 (Type B building) and 2.5 (Type C building), in accordance with BS:8485:2015+A1:2019; ▲ Any ground gas protection measures installed will also need to consider the incorporation of radon protective measures in accordance with BRE Report BR211 (2015) Radon: Protective measures for new buildings and as required by Building Regulations; ▲ Further waste classification testing is likely to be required to facilitate any off-Site disposal of ground materials, as well as waste acceptance criteria (WAC) testing should disposal to landfill be considered or required; ▲ A Materials Management Plan is likely to be required to inform any earthworks at the Site; ▲ Despite the low risk, it is considered prudent that a watching brief is maintained during construction of the proposed development, in order to observe any evidence of dissolution features; and ▲ Confirmation should be sought from the Local Water Authority as to whether they will require upgraded pipework to be installed for new service installation.
This is intended as a summary only. Further detail and the limitations of the assessment are provided within the main body of the Report.	

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1.0 Introduction

1.1 Appointment

Delta-Simons Environmental Consultants Limited ("Delta-Simons") was instructed by Chancerygate (Business Centre) Ltd (the "Client") to prepare a Phase I/II Geo-Environmental Assessment for land at Solent Road, Havant PO9 1DQ (the "Site").

1.2 Context & Purpose

The aim of the investigation is to complete a Geo-Environmental Site Investigation of the proposed development area. The investigation will obtain information regarding ground conditions, from which risks to end-users, the environment and structures can be assessed, with mitigation measures outlined, if necessary.

The investigation will provide geotechnical information in order to comment on the preliminary design of foundations and infrastructure. The report will provide recommendations for further work based on the findings of the investigation, if required.

It is understood that the Site is to be redeveloped for a light industrial / commercial end use, including a two-storey office building.

1.3 Scope of Works

The scope of the investigation and layout of this report has been designed with consideration of *CLR11* (Environment Agency, 2004a) and *BS 10175: 2013 Investigation of Potentially Contaminated Sites – Code of Practice* (BSI, 2011) and guidance on land contamination reports issued by the Environment Agency (EA) (2010a).

The project was carried out to an agreed brief as set out in Delta-Simons' proposal dated 14th June 2019 (ref. 19-1058.01). The scope of works is outlined in Section 3.

1.4 Existing Information

The following information has been used within the assessment:

- ▲ Current and Historical Ordnance Survey (OS) maps;
- ▲ British Geological Survey (BGS) data;
- ▲ Coal Authority (CA) online data;
- ▲ A Landmark Envirocheck® Report for the Site (Ref. 223283800_1_1), dated October 2019;
- ▲ Historical Maps included as part of the Envirocheck® Report;
- ▲ Information provided by Havant Borough Council;
- ▲ Soils Limited – Phase I Desk Study, Land to the north of Solent Road, Havant, Hampshire PO9 1DQ (Ref. 14252/DS) dated June 2014; and
- ▲ B.A. Hydro Solutions – Hydrogeological Risk Assessment, Portsmouth Water Head Office Redevelopment (Ref. 14150023) dated August 2014.

1.5 Limitations

The assessment is limited to the issues agreed within the proposal for the works. Notes on limitations associated with this assessment are provided in Appendix A. In addition, there are the following specific limitations that apply to this assessment:

- ▲ No proposed elevations have been provided;
- ▲ No foundation loadings for the proposed development have been provided;

- ▲ Soakaway testing was not possible due to presence of shallow groundwater; and
- ▲ The south-western area of the Site was inaccessible due to the presence of an unidentifiable underground utility.

2.0 Site Details

2.1 Site Setting

A summary of the current Site status, environmental setting and key historical features is presented below.

Co-ordinates	Centred approximately at National Grid Reference 471120, 106170	Elevation	4 m AOD
		Area	1.54 Ha
Site Location	The Site is located off Solent Road, approximately 0.5 km west of Havant town centre. A Site Location Map is provided as Figure 1.		
Current Site Use	The Site currently comprises a vacant parcel of vegetated (grassed) land with a tennis court in the north east of the Site area. Brockhampton stream runs within the north-eastern Site boundary.		
Surrounding Area	The Site is bound to the north by Brockhampton springs (comprising two lakes) and soft landscaping, with Portsmouth Water Company offices and residential properties beyond. The Site is bound to the east by Bosmere Medical Centre, light industrial units ('The Tanneries' industrial estate), and residential properties, with retail units, a petrol filling station, and a vehicle repairs centre beyond. To the south is Solent Road and retail units. A waste water and sewage treatment facility is located 0.5 km to the south of the Site. The Site is bound to the west by Brockhampton stream and light industrial / retail units beyond.		
Proposed Development	It is understood that the Site is to be redeveloped for a light industrial / commercial end use, including a two-storey office building. A proposed development plan is included as Drawing 1 (Site Plan Layout Option 13). Identified human and built environment receptors (R) relevant to the proposed development comprise: ▲ Construction workers. ▲ Third parties during construction (adjacent Site users and adjacent residents). ▲ Future Site users and maintenance workers. ▲ The Built Environment (new buildings and infrastructure / utilities).		

2.2 Environmental Setting

Published Geology	From the published British Geological Survey (BGS) online mapping viewer, the Site is indicated as being underlain by superficial deposits of Alluvium consisting of Clay, Silt, Sand and Gravel. Superficial Head (Clay and Gravel) and River Terrace Deposits (Sand, Silt and Clay) are also mapped in the vicinity of the Site, and are considered likely to extend beneath the Alluvium on-Site. The bedrock geology is indicated to comprise Chalk of the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation (undifferentiated). Made Ground may be present in the vicinity of the tennis courts on Site, overlying the superficial deposits. A nearby BGS borehole (Ref. SU70NW149) located approximately 60 m north-east of the Site records the following geology: ▲ Topsoil to a depth of 0.3 m bgl; ▲ Firm friable grey brown and grey mottled silty clay, with occasional flint gravel to a depth of 1.5 m bgl;
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	▲ Loose to medium dense fine, medium and coarse flinty gravel with frequent flint cobbles in a light brown silty clay matrix. Matrix becoming chalky at 6.0 m, to a depth of 6.8 m bgl; ▲ Fragments and cobbles of weak intact chalk in a soft to firm structureless chalk matrix, with occasional flint gravel and cobbles, to a depth of 15.9 m bgl; ▲ Firm light brown sandy clay with flint cobbles to a depth of 16.3 m bgl; and ▲ Fragments and cobbles of weak intact chalk in a soft to firm structureless chalk matrix, with occasional flint gravel and cobbles, to a depth of 20.0 m bgl.
Hydrogeology	The EA classify the superficial Alluvium deposits as a Secondary A Aquifer, whilst the Chalk bedrock is classified as a Principal Aquifer. The EA data also indicates that the western part of the Site is located within a Zone I (Inner Protection Zone) groundwater Source Protection Zone. According to the Envirocheck® Report, there are six licensed abstraction records from groundwater located within 500 m of the Site. The closest three abstraction records are located approximately 150 m north-west of the Site, operated by Portsmouth Water Ltd / Portsmouth Water Co, and used for potable supply. According to the Envirocheck® Report there is a very significant risk – moderate possibility of soluble rock risk in the north-west of the Site. However, the Site is not located in, or within 1 km, of any areas of mining instability, man-made cavities or natural cavities, therefore, the risk of dissolution features being present on-Site is considered to be low.
Hydrology	The nearest surface water feature is Brockhampton Stream located inside the north-eastern Site boundary, which then runs adjacent to the northern and western Site boundaries. According to the Envirocheck® Report, there are no licensed abstraction records from surface water located within 500 m of the Site.
Coal Mining and Ground Stability	The Site is not located in an area affected by coal mining, mining instability, man-made mining cavities or natural cavities. According to the Envirocheck® Report, the Site has a very low hazard potential for collapsible, landslide and shrinking or swelling clay ground stability hazards. The Site has a low hazard potential for running sand ground stability hazards. The Site has a moderate hazard potential for compressible ground stability hazards and ground dissolution stability hazards in the north-west and north-east of the Site, respectively.
Radon Gas	The Site lies within an intermediate probability radon area where 3 to 5% of homes are estimated to be at or above the Action Level. The Envirocheck® data indicates that basic radon protective measures are necessary in the construction of new buildings at the Site.
Ecological Receptors	It is understood from information provided within the Envirocheck® Report that the Site lies within a Nitrate Vulnerable Zone. No further ecological receptors are present within 500 m of the Site.
Heritage Interest	According to sketchmap.co.uk, the closest area of heritage interest is located approximately 40 m to the west of the Site associated with a Grade II Listed building (The Old Manor House).
Flood Risk	According to information from the Environment Agency Flood Map for Planning, the south-western and north-eastern areas of the Site are located within a Flood Zone 3 –

	High Probability of Flooding. The central and north-western areas of the Site are located within a Flood Zone 2 – Moderate Probability of Flooding. Information included within the Landmark Envirocheck® indicates that the Site lies within an area that has a Potential for Groundwater Flooding to Occur.
Unexploded Ordnance (UXO)	According to Zetica online risk mapping, the Site is located in a Moderate Risk area with regards to UXO. Further information is provided in Section 4.1.1.
Environmental Sensitivity	The Site is considered to be of a moderate to high environmental sensitivity given the presence of the Zone I groundwater Source Protection Zone, underlying Secondary A and Principal Aquifers and proximity of surface water features.

2.3 Historical Use of the Site & Surrounding Area

Approach	The historical development of the Site and surrounding area has been assessed through a review of available historical OS maps and Google Earth historical satellite imagery. A summary of the key historical Site uses and developments in the surrounding area is presented below. Copies of the historical maps are included as Appendix B.
Historical Features On-Site	From the earliest reviewed mapping produced in 1867-1868 the Site appears to be undeveloped, and is considered likely to be used for agricultural purposes, denoted by the presence of field boundaries. Brockhampton Stream is shown to encroach onto the north-western boundary of the Site, and is shown to be in its current location from circa 1953. Mapping published circa 1954-1969 identifies a 'trough' encroaching onto the north-western corner of the Site. Mapping published circa 1987-1989 indicates the presence of tennis courts within the north-eastern area of the Site.
Potentially Contaminative Historical Features Off-Site	Potential sources of contamination within 250 m of the Site include: ▲ Mapping produced in 1867-1868 indicates Portsmouth water works approximately 100 m to the north of the Site, including a large reservoir approximately 10 m from the north-east boundary of the Site. A washing factory is present adjacent to the eastern Site boundary. A tannery is shown approximately 20 m from the north-western Site boundary, and an engine house is present approximately 100 m to the north-west; ▲ Mapping produced in 1897 indicates that an additional reservoir is present approximately 10 m from the northern boundary of the Site, and the washing factory to the east of the Site is labelled as 'Chamois Leather Works'. A brewery is present approximately 250 m to the north-west of the Site; ▲ Mapping from 1909 no longer indicates the presence of the tannery to the north-west of the Site and the associated buildings appear to have been demolished. The brewery beyond is now labelled as a public house. Approximately 200 m to the north-east is a parchment works; ▲ Mapping published in 1932 indicates an unspecified pit approximately 20 m from the north-eastern corner of the Site. The leather works adjacent to the east of the Site have expanded significantly eastward; ▲ Mapping produced circa 1938-1942 identifies tanks located to the north of the engine house approximately 100 m to the north-west of the Site; ▲ Maps dated 1953-1987 identify a chimney and unspecified tanks approximately 200 m to the north-west. The aforementioned pit is no longer marked, potentially

	having been infilled. A tank is identified 50 m to the south-east of the Site, which appears to have also been present unlabelled since the earliest mapping in 1867-68. To the south-west of the Site approximately 200 m away are four unspecified works with an adjoining electricity substation; ▲ OS mapping published 1954-1969 identifies allotment gardens 200 m to the north of the Site. A depot is identified approximately 150 m to the south-east of the Site, alongside an unspecified factory, an electronics factory, and an engineering works approximately 200 m from the south-eastern Site boundary. An unspecified works is present approximately 50 m to the north-west of the Site; ▲ Mapping produced circa 1959-1973 indicates the previously unspecified works 200 m to the south-west of the Site to comprise a boatbuilding works; ▲ Mapping published circa 1961-1974 identifies a further previously unspecified works 200 m south-west of the Site to be an engineering works; ▲ An OS survey plan published in 1969 identifies a further previously unspecified works 200 m to the south-west of the Site to be a joinery works; ▲ Mapping produced circa 1969-1989 identifies the former allotment gardens to the north of the Site to accommodate water works buildings and an electricity substation from 100-150 m from the Site's northern boundary. A further electricity substation is marked approximately 125 m to the north-east of the Site amongst the leather works. Approximately 100 m to the south-east of the Site are a further two electricity substations, a plastics factory, and an unspecified factory and warehouse. Approximately 50 m to the south of the Site is an unspecified factory, an engineering works, an electronics factory, a foundry, and two electricity substations. The unspecified works approximately 50 m to the north-west of the Site is no longer marked and occupies a smaller footprint, indicating demolition. The tanks and chimney identified in 1953-1987 mapping are no longer present; ▲ An OS plan published in 1973 identifies redevelopment of the former leather works to the east of the Site into multiple units comprising an unspecified depot and two warehouses, a printing works, 'Highbury Technical College' relating to electrical engineering, an engineering works, a sheet metal works, electricity substation, with three tanks at approximate distances of 0 m, 50 m, and 70 m from the Site boundary respectively; ▲ Mapping published circa 1987-1989 indicates an unspecified laboratory and electrical substation approximately 125 m to the north of the Site. A tank is identified approximately 50 m from the north-western corner of the Site; and ▲ Mapping produced in 2000 indicates the demolition of the unspecified factory, electronics factory, and engineering works first identified in mapping from 1954-1969 approximately 200 m to the south-east of the Site, with the area appearing to be redeveloped to comprise a superstore with associated parking.
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2.4 Environmental Database Review

Approach	The Landmark Envirocheck® Report provides a database of environmental information held by various statutory bodies including the EA, Local Authority (LA), Health & Safety Executive (HSE) and HPA amongst others. A full copy of the Envirocheck® Report is provided in Appendix C and the most relevant information is summarised below.
Features On-Site	The Envirocheck® Report does not include any further entries pertaining to the Site (other than previously mentioned).

Potentially Contaminative Features Off-Site	Pertinent entries included within the Envirocheck® Report located within 250 m of the Site include: ▲ Six Discharge Consents, the nearest of which is located 5 m to the west of the Site involving the discharge of other matter surface water into a freshwater stream/river. The consent was revoked in March 1997; ▲ One Integrated Pollution Prevention and Control located approximately 170 m to the north-west of the Site associated with waste landfilling (any other landfill to which the 2002 Landfill Regulations apply), dated April 2005 (superseded by variation); ▲ One Local Authority Pollution Prevention and Controls located approximately 125 m to the south-east of the Site, relating to dry cleaning ('Solent Cleaners Ltd') (permitted); ▲ One Pollution Incident to Controlled Waters located approximately 130 m to the west of the Site, involving deliberate disposal of miscellaneous suspended solids from a construction site into a drain. The incident was categorised as a Category 3 minor incident; ▲ Six Registered Radioactive Substances, the nearest of which is registered to Apollo Fire Detectors Ltd approximately 50 m to the south of the Site, relating to disposal of radioactive waste. All licences within 250 m of the Site are revoked/cancelled or superseded by a substantial or non-substantial variation; ▲ Nine areas of Potentially Infilled Land (water), the nearest of which is located approximately 85 m east of the Site and was mapped in 1932; ▲ One Registered Waste Treatment or Disposal Site located approximately 190 m to the east of the Site. It is licenced by Larkham Bros Ltd, with authorised waste listed as scrap metal; ▲ Seventy Contemporary Trade Directory Entries comprising; electronic equipment manufacturers, blinds manufacturer, glass products manufacturers, mechanical engineers, case manufacturers, commercial vehicle bodybuilders and repairers, plastics injection moulders, tool designers and manufacturers, garage services, sheet metal works, plant and machinery repairs, MOT testing centres, precision engineers, dry cleaners, builders' merchants, car body repairs, metal finishing services, brewers, furniture manufacturers, catering equipment service and repairs, garden machinery sales and servicers, paint and varnish strippers, used car dealership, picture restorations, control panel manufacturers, computer recycling and disposal, paint sprayers, metal spinners, tyre dealers, office equipment sales, plastic product manufacturers, marine engineers and equipment sales, general engineers, metal finishing services, industrial and commercial machinery, printing services, and joinery manufacturers; ▲ One Fuel Station Entry associated with a Tesco Extra supermarket located approximately 130 m south-east of the Site; ▲ Twenty-six Commercial Services Points of Interest, the nearest of which is located approximately 55 m south of the Site and relates to vehicle repair, testing and servicing. The remaining entries include vehicle cleaning services, recycling and disposal services, and metalworkers (inc. blacksmiths); ▲ Fourteen Manufacturing and Production Points of Interest, the nearest of which is located approximately 10 m north-east of the Site and relates to generic tanks. The remaining entries include tanks, business parks, industrial estates, and unspecified works/factories; and ▲ Seven Public Infrastructure Points of Interest, including; weirs, sluices, petrol filling stations, and a public transport station.
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	Within 500 m of the Site, the following pertinent entries have been identified: ▲ Two Licensed Waste Management Facilities (Landfill Boundaries), both of which are located approximately 360 m north-west of the Site and are named as Bedhampton Landfill and Bedhampton Waterworks, respectively. Bedhampton Landfill is categorised as an inert landfill, with the licence dated April 2005. Bedhampton Waterworks is categorised as a landfill taking non-biodegradable wastes (not construction), with the licence dated February 1992 (inactive); ▲ Seven Licensed Waste Management Facilities (Locations), the nearest of which is located approximately 375 m south of the Site, operated by Teleplan and White Electronics B V. The facility is categorised as a WEEE treatment facility, with the licence dated June 2013, surrendered in January 2019. The remaining facilities are categorised as transfer stations taking non-biodegradable wastes; household, commercial and industrial transfer stations; inert landfills; and landfills taking non-biodegradable wastes (not construction).
Implications for Land Contamination Risk	No potential sources of contamination have been identified at the Site from the regulatory information. Potential off-Site sources of contamination have been identified that will be considered in the preliminary risk assessment.

2.5 Planning Review/Regulatory Enquiries

On-line Planning Portal	Havant Borough Council	Date Accessed	04/11/2019
Findings	No planning applications have been identified pertaining to the Site. An application (Ref.03/61715/001) for land adjacent to the Site's south-eastern boundary (Address: Land adjacent to 8-26 Brockhampton Lane, Havant, PO9 1LZ) grants permission for the erection of a primary medical care centre with associated car parking in October 2006. The planning application includes a decision notice which imposed the following contaminated land conditions on the proposed development: ▲ Condition 15: No development shall take place until the developer has carried out adequate investigation to assess the degree of contamination of the site and to determine its water pollution potential. The methods and extent of the investigation shall be agreed with the Planning Authority before any work commences. Details of appropriate measures to prevent pollution of groundwater and surface water, including provisions for monitoring, shall then be submitted to and approved in writing by the Planning Authority; ▲ Condition 16: No soakaway shall be constructed in contaminated ground; and ▲ Condition 17: The method of piling foundations for the development shall be carried out in accordance with the scheme to be approved in writing by the Planning Authority prior to any development commencing. No site investigation report has been identified pertaining to the adjacent site.		
Part 2A of the Environmental Protection Act (EPA) 1990	Information from the Environmental Control Officer at Havant Borough Council has indicated that the Site has not been prioritised for proactive inspection in connection with the Council's duties under Part 2A of the EPA 1990. They are unaware of any specific potentially contaminating land use features known to be associated with the Site. The Environmental Control Officer stated that Site investigations have taken place in surrounding areas on Solent Road and Brockhampton Lane. On adjacent land artesian		

	groundwater conditions have been present within the Principal Aquifer, which are very likely to continue onto the Site. Two plots to the north of the Site boundary have been identified to contain transboundary contamination. Transboundary contaminant migration is considered to be the most likely cause for any contamination found on Site. The email correspondence between Delta-Simons and Havant Borough Council is included as Appendix D.
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2.6 Previous Reports

List of Reports	Delta-Simons has obtained the following reports relating to the Site: ▲ Soils Limited – Phase I Desk Study, Land to the north of Solent Road, Havant, Hampshire PO9 1DQ (Ref. 14252/DS) dated June 2014; and ▲ B.A. Hydro Solutions – Hydrogeological Risk Assessment, Portsmouth Water Head Office Redevelopment (Ref. 14150023) dated August 2014. Pertinent information obtained from a review of the documents is presented below and copies of these reports are appended as Appendix E.
Soils Limited Phase I Desk Study (June 2014)	The report outlines the findings of a Phase I Desk Study and Site Walkover and forms a preliminary conceptual site model and risk assessment based upon a residential future Site use. The only additional information provided within this report is from a walkover. The Site Walkover record indicates the current Site use to be an open field with restricted access. A tennis court is present in the north-east of the Site with Site-wide grass and occasional trees and shrubbery. No potential contamination sources are noted on-Site. The following recommendations were made as a result of the report findings: ▲ A demolition and construction risk assessment must be undertaken, and appropriate measures taken to mitigate against contaminant mobilisation and to monitor impact to controlled waters; ▲ A Phase II Intrusive Investigation should be undertaken to investigate and assess pollutant linkages identified within the preliminary conceptual site model. Remediation would be required should this reveal contamination at the Site; and ▲ A geotechnical Site investigation should be undertaken to provide data to enable the design of foundations, drainage, and other infrastructure.
B.A. Hydro Solutions Hydrogeological Risk Assessment (August 2014)	The report establishes the potential impact on springs located on the Portsmouth Water Head (PWL) Office site (including the Site and surrounding area to the north) resulting from planned redevelopment works, through a geophysical survey and collation of available information to form a hydrogeological conceptual understanding of the site in order to develop a risk assessment with suggested mitigation methods. A geophysical survey using electrical resistivity was undertaken to determine the profile of the chalk bedrock, resulting in the following observations being made: ▲ The Chalk is generally dipping towards the north east in the south of the site, and to the north-west in the north of the site along a line through the centre of the site. This is assumed to be the fault line or corridor of faulting; ▲ The difference in the depth to the Chalk is up to 24 m from the north to the south side of the fault line. This displacement will have resulted in the Chalk being more fractured thus allowing groundwater to move upwards more easily on the northern side of the site; and ▲ The observed displacement across the structure explains why the springs occur along an east to west line. The springs are considered to be present due to the

	Chalk being almost at ground level. It is possible that there may be another fault(s) with an east to west alignment on or very close to the southern boundary, which may have dropped the Chalk deeper just to the south. Further information considered as part of the risk assessment includes: ▲ Putty chalk is present between the superficial deposits and chalk bedrock, forming a confining layer above the Principal Aquifer. This would prevent vertical migration of contaminants; and ▲ Bunds are located to either side of the ponds and springs in the centre of the Portsmouth Water Head Office site, extending to the confining layer above the Principal Aquifer. This would prevent lateral migration of the contaminants to the ponds or springs. Based on the conceptual understanding of the Site, the risk assessment found that due to the nature of the springs, development of part of the Site could be permitted providing certain activities are prevented and others are restricted and/or carefully controlled. The principle risk to the springs would be during any Site development, it is therefore a critical period which would need to be carefully planned, designed, managed and supervised to minimise the risk posed to the springs. The current activities on Site were considered to represent a greater risk to the springs than the proposed development although these continue without problems due to appropriate controls and measures in place. Beyond the construction period the risks posed to the springs from the proposed development would become low. Careful planning of the development will mitigate the risk posed by utilities/services, drainage and the impact activities in the area could have on the springs. Recommendations for the proposed development include: ▲ Any works must have RAMS produced prior to the works starting and must be approved by Portsmouth Water; ▲ Only DWI Regulation 31(4)(b) material should be used if they are to come into contact with potable water; ▲ No piling, boring, foundations, belowground structures or excavations are to be permitted within 3 m of the top of the Chalk; ▲ Any historical breaches of the clay bund should be reinstated; ▲ Hydraulic testing of the bund at intervals along its length is recommended; ▲ No soakaways, swales or SUDS are to be permitted; ▲ Access by the general public to the springs or ponds in the centre of the Portsmouth Water Head Office site needs to be prevented; ▲ Any new car parks within must be fitted with oil interceptors; ▲ No industrial activities are to be permitted on the proposed development; and ▲ All works involving utilities, drainage or below ground excavation work must be carefully installed with the express permission of PWL, and should heed to their specifications and installation methods to minimise potential contamination The risk zones and planned development figure included within the assessment as Figure 26 indicates the Site area to be at low risk, although an area of high risk is shown to encroach onto the south-western corner. It is noted that no development is proposed in the high risk area as it forms part of the flood protection zone open space as shown in Drawing 1.
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3.0 Preliminary Conceptual Site Model

3.1 Introduction

A Conceptual Site Model (CSM) represents the relationships between contaminant sources, pathways and receptors, to support the identification and assessment of Possible Pollutant Linkages (PPL).

3.2 Potential Contamination Sources

Identified potential contamination sources are presented in the following table:

Ref	Source	Location	Dates Present	Potential Associated Contaminants of Concern
S1	Potential Made Ground deposits	On-Site	Unknown	Asbestos, heavy metals, PAHs, petroleum hydrocarbons, hazardous ground gas
S2	Integrated Pollution Prevention and Control associated with waste landfilling	170 m north-west of the Site	Dated April 2005	Hazardous ground gas
S3	Areas of potentially infilled land	Within 250 m of the Site	Unknown	Hazardous ground gas
S4	Two Licensed Waste Management Facilities (Landfill Boundaries)	360 m north-west of the Site	Dated April 2005 and February 1992, respectively	Hazardous ground gas
S5	Seven Licensed Waste Management Facilities (Locations)	Within 500 m of the Site	Various licence dates	Hazardous ground gas
S6	Various current and historical industrial land uses including various works (water, leather, brewery, parchment, engineering, boatbuilding, joinery, plastics, foundry, printing, sheet metal, and other unspecified works/factories) and associated tanks	Within 250 m of the Site in all directions	Post 1867 to present	Various, depending on land use within various works, but including heavy metals, PAHs and petroleum hydrocarbons
S7	Seventy Contemporary Trade Directory Entries	Within 250 m of the Site	Unknown	Various depending on land use, but including heavy metals, PAHs and petroleum hydrocarbons
S8	One Fuel Station Entry	130 m south-east of the Site	Unknown to present	Petroleum hydrocarbons

S9	Intermediate probability radon area	On-Site	N/A	Radon gas
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3.3 Potential Receptors

Relevant potential receptors are considered to include:

- ▲ R1 - Construction workers.
- ▲ R2 - Third parties during construction (adjacent Site users and adjacent residents).
- ▲ R3 - Future Site users and maintenance workers.
- ▲ R4 – The on-Site and adjacent Brockhampton Stream water course and nearby surface water receptors.
- ▲ R5 - The underlying Aquifers.
- ▲ R6 - The Built Environment (new buildings and infrastructure / utilities).

3.4 Potential Pathways

The potential pathways are considered to be as follows:

- ▲ P1 - Direct contact, ingestion or inhalation of soil bound contaminants / dust during or following redevelopment.
- ▲ P2 - Inhalation of organic vapours associated with contamination.
- ▲ P3 - Migration of ground gas / vapours into on-Site buildings causing asphyxiation, risk of explosion or harmful effects.
- ▲ P4 - Leaching of contamination into groundwater followed by migration of groundwater to the wider groundwater environment or discharge to surface waters.
- ▲ P5 - Direct contact between aggressive ground conditions and new infrastructure.

Risk ratings are based on the classifications given in Appendix L.

Pollutant Linkage Assessment					
Source(s)	Pathway(s)	Receptor(s)	Risk Rating	Justification & Mitigation (if required)	Requires Investigation
S1 Potential Made Ground deposits	Direct contact/ ingestion and inhalation of dust, vapours and asbestos fibres.	Future Site users. Groundworkers and off-Site human receptors during the redevelopment or during any sub-surface maintenance works.	Low Risk	Any potential Made Ground deposits on-Site are considered likely to be limited in extent, given the limited development of the Site. Furthermore, given that the proposed development is to be covered in buildings and hardstanding, with limited landscaped areas, the risk to future Site users is considered to be low. It is recommended that an environmental investigation is undertaken at the time of any geotechnical investigation at the Site in order to advise on the soil quality beneath the Site, in the context of the proposed light industrial / commercial development. The risk posed to construction workers and off-Site human receptors during the redevelopment of the Site is considered to be low, as safe working procedures should be implemented, good standards of personal hygiene should be observed and appropriate levels of personal protective equipment (PPE / RPE) provided and utilised to reduce the potential risks.	Y
	Leaching of contamination into groundwater and vertical and lateral migration of contamination through permeable deposits below the Site.	Secondary A and Principal Aquifer On-Site and adjacent Brockhampton Stream and nearby surface water features	Low to Moderate Risk	Limited potential sources of contamination have been identified on-Site, however, given the permeability of the underlying Secondary A and Principal Aquifers, the potential for groundwater contamination to be present beneath the Site, and associated risks to controlled waters, cannot be discounted. The risk is therefore considered to be Low to Moderate. It is recommended that groundwater samples are obtained during the recommended intrusive investigation in order to assess the risk to the underlying aquifers.	Y
	Direct infiltration in water supply pipes.	Service conduits.	Low Risk	Although significant potential sources of contamination have not been identified on-Site, it is considered prudent to undertake hydrocarbon testing of the shallow soils at the time of any environmental investigation to provide recommendations for the upgrading of any potable service pipes. The Local Water Authority should be consulted to advise on this matter.	Y

Pollutant Linkage Assessment					
Source(s)	Pathway(s)	Receptor(s)	Risk Rating	Justification & Mitigation (if required)	Requires Investigation
S6 Various current and historical industrial land uses including various works (water, leather, brewery, parchment, engineering, boatbuilding, joinery, plastics, foundry, printing, sheet metal, and other unspecified works/factories) and associated tanks S7 Seventy Contemporary Trade Directory Entries S8 One Fuel Station Entry	Lateral migration and subsequent indoor inhalation of volatile vapours.	Groundwater beneath the Site and future Site users.	Low to Moderate Risk	Although potential current and historical off-Site sources of contamination have identified, the risk of contamination migrating onto the Site through permeable deposits is considered to be Low to Moderate, given the presence of bunds and putty chalk indicated in previous B.A. Hydro Solutions report. This should be considered as part of recommended intrusive Site investigation works.	Y
S1 Potential Made Ground deposits on-Site S2 Integrated Pollution Prevention and Control associated with waste landfilling S3 Areas of potentially infilled land S4 Two Licensed Waste Management Facilities (Landfill Boundaries) S5 Seven Licensed Waste Management Facilities (Locations) S9 Intermediate probability radon area	Accumulation of gas in enclosed spaces and sub-floor voids.	Buildings and future Site users.	Low to Moderate Risk	There is potential for any Made Ground beneath the Site to generate hazardous ground gases. Furthermore, given the potential off-Site sources of ground gas identified, it is considered prudent to undertake a period of ground gas monitoring following the recommended intrusive investigation at the Site in order to characterise the ground gas regime. The Site is located within an area where basic radon protective measures are required, any ground gas protection measures installed will need to consider the incorporation of radon protective measures in accordance with BRE Report BR211 (2015) Radon: Protective measures for new buildings and as required by Building Regulations.	Y

4.0 Site Investigation

4.1 Intrusive Investigation

Delta-Simons carried out intrusive investigation work from 13th to 15th November 2019 to assess the potential linkages identified in the outline conceptual model (see Section 3.0 above) and to provide geotechnical information.

4.1.1 Health & Safety Considerations

Service plans for the Site were provided by the Client; and a utilities clearance specialist attended the Site on 13th November 2019 to trace services on and around the Site prior to excavation of exploratory hole locations.

An initial assessment of the Site identified a potential risk in relation to Unexploded Ordnance (UXO) and so a specific UXO study was obtained from 6 Alpha Associates Limited. The report identified the following precautionary measures which were applied for the works:

- ▲ Specialist staff safety and awareness briefings;
- ▲ Operational UXO emergency response plan; and
- ▲ On-Call EOD Engineer.

Future Contractors should undertake their own assessment of UXO risk in relation to their specific proposed scope of works.

4.2 Scope of Ground Investigation and Rationale

4.2.1 Scope

The ground investigation comprised the following items:

- ▲ Service avoidance exercise;
- ▲ Supervision of all works by a Delta-Simons Geo-Environmental engineer. All intrusive locations were logged to BS5930:2015 Code of Practice for Site Investigations;
- ▲ Excavation of five (5 No.) shallow trial pits for California Bearing Ratio (CBR) testing (CBR1 to CBR5);
- ▲ Excavation of eight (8 No.) trial pits (TP101 to TP108) to a maximum depth of 1.90 m bgl;
- ▲ Excavation of three (3 No.) hand pits (HP101 to HP103) to a maximum depth of 0.60 m bgl; and
- ▲ Drilling of four (4 No.) cable percussive boreholes (BH101 to BH104) to a maximum depth of 10.00 m bgl.

4.2.2 Rationale

Location	Rationale	Key Contaminants of Concern
BH101 to BH104, TP102 and TP106	Targeting the area within the proposed building footprint.	Asbestos, Heavy Metals, Petroleum Hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs)
TP101, TP103 to TP105, TP107 and TP108	Targeting the remainder of the Site to provide a representative coverage of the area.	Asbestos, Heavy Metals, Hydrocarbons, PAHs
CBR1 to CBR5	Provide factual data with relation to pavement design in proposed car parking areas.	-
HP101 to HP103	Targeting areas of the Site in the vicinity of off-Site historical land uses of concern.	Asbestos, Heavy Metals, Hydrocarbons, PAHs

4.3 Ground Investigation Factual Data

The investigation locations were surveyed in by the appointed surveying contractor to an accuracy of approximately +/- 0.1m. An Approximate Exploratory Hole Location Plan is presented as Figure 2.

Delta-Simons engineer verified borehole logs are presented as Appendix F, the SPT Calibration Certificates, in accordance with BS EN ISO 22476-3:2005 (incorporating corrigendum No. 1 2007), Geotechnical investigation and testing - Field testing - Part 3: Standard penetration test for SPT trip hammers are provided in Appendix F.

4.4 In-Situ Testing and Sampling

SPT tests were undertaken in all boreholes at 1.00 m intervals until 5.50 m bgl, then every 1.5 m bgl thereafter. The results of these tests are presented in the borehole logs included as Appendix F.

California bearing ratio (CBR) was measured using plate load tests in trial pit locations (CBR1 to CBR5). Test results are presented in Appendix G.

Sampling comprised disturbed tub, jar and bulk samples as detailed on the borehole logs.

4.5 Geotechnical Laboratory Testing

A selection of soil samples were submitted to the UKAS accredited laboratory for a range of geotechnical testing, the results of which are included in Appendix H.

The programme of geotechnical testing undertaken on samples obtained from the natural soils is presented within the table below. The purpose of the laboratory testing was to assess the classification properties of the soils encountered in order to inform the outline geotechnical design advice.

Analysis	No. Tested	Rationale
Moisture content	2	To enable geotechnical assessment of cohesive soils
Plastic and liquid limits	2	To enable geotechnical assessment of cohesive soils
Particle size distribution	6	To enable geotechnical assessment of granular soils

4.6 Environmental Sampling, In-Situ Testing and Laboratory Analysis

Soils collected for laboratory analysis were placed in a variety of containers appropriate to the anticipated testing suite. Samples were stored in accordance with Delta-Simons' quality procedures to maintain sample integrity and preservation and to minimise the chance of cross contamination. Records of the samples taken as part of the Site investigation works, including their depths and location, are included within the exploratory hole records in Appendix F.

Groundwater samples were collected from BH101, BH102, BH103 and BH104 on 21st November 2019. The groundwater samples were collected using a dedicated disposable bailer.

Samples analysed for environmental purposes were placed in chilled cool boxes on Site and transported to the laboratory for analysis on completion of the Site investigation works / groundwater sampling visit.

The rationale for chemical analysis is presented in the table below and the results of the chemical laboratory testing are included in Appendix I and J.

Analytes	No. of Samples Tested		Rationale
	Soil	Ground-water	
Asbestos	10	-	Common potential contaminant - Analysed in all samples of Made Ground.
As, Cd, Cu, Cr, Hg, Pb, Ni, Zn, speciated Polycyclic Aromatic Hydrocarbons (PAH)	10	4	Potential contaminants of concern, common to many sites.
Total Petroleum Hydrocarbons, Criteria Working Group Method (TPHCWG), Benzene, Toluene, Ethylbenzene and Xylene (BTEX)	10	4	Common potential contaminant.
(pH, sulphate), acid soluble sulphate, total sulphur	8	(4)	To assess potential for chemical attack on buried concrete.

4.7 Monitoring Programme

Four rounds of groundwater level and ground gas monitoring were undertaken on the newly installed wells (BH101 to BH104) between 21st November and 13th December 2019. Measurements of the depth to groundwater within the monitoring wells were taken using an electronic dip meter. The groundwater level monitoring sheets are included as Appendix K.

To characterise the ground gas regime at the Site, an infrared gas meter was used to measure gas flow, concentrations of carbon dioxide (CO₂), methane (CH₄) and oxygen (O₂) in percentage by volume. Initial and steady state concentrations were recorded. The atmospheric pressure before and during monitoring, together with the weather conditions, was recorded. All monitoring results obtained to date together with the temporal conditions are contained within Appendix K.

5.0 Ground Summary

5.1 Introduction

The sections below summarise the ground and groundwater conditions encountered during the Site investigation.

5.2 Ground Model

A summary of the observed ground conditions at the Site is provided below.

Summary of Observed Ground Conditions				
Strata	Typical Strata Description	Depth Range of Strata Base (m)	Maximum Proven Thickness (m)	Comments
Topsoil	Topsoil comprised grass over brown sandy gravelly clay with gravel content comprising of flint.	0.25 – 0.60	0.60	Topsoil was encountered in all locations, with the exception of HP102, TP102, TP103, TP105 and TP106.
Made Ground	Made Ground comprised brown gravel and sandy gravelly clay. Gravel comprised flint, brick and sandstone. Clinker, ceramic and plastic were also encountered.	0.25 – 0.60	0.60	Made Ground was identified in TP102, TP103, TP105, TP106, HP102 and BH102. Macadam was recorded to be overlying the Made Ground in TP103.
Alluvium	Alluvium was predominantly described as brownish/yellowish grey sand and gravel mixtures with cohesive deposits encountered in BH101 comprising of sandy gravelly clay, with gravel of flint.	0.50 – 3.50	3.25	-
Head Deposits	Head Deposits were encountered as yellow / light brown clayey sandy gravel in BH101 and BH102 and as very sandy, very gravelly clay in BH104. Gravel content comprised flint.	3.70 – 4.50	2.60	Head Deposits were only encountered in BH101, BH102 and BH104.
River Terrace Deposits	River Terrace Deposits were encountered as greyish brown sand and gravel, with gravel comprising of flint.	9.50	7.00	River Terrace Deposits were only encountered in BH103
Weathered Chalk Formations	The weathered chalk bedrock was initially described as yellowish brown gravel with varying proportions of clay and sand, becoming cohesive with depth. Cohesive deposits were described as structureless chalk composed of cream slightly sandy gravelly clay.	10.00 (not proven)	-	-

No evidence of dissolution features was observed during the Site investigation.

5.3 Visual and Olfactory Evidence of Contamination - Soils

No visual or olfactory evidence of potential gross contamination was observed during the investigation.

5.4 Groundwater

5.4.1 Strikes During Investigations

Groundwater strikes recorded as excavation progressed during the Site investigation range from 0.80 to 7.00 m bgl (4.30 to -1.89 m AOD). The groundwater strikes are summarised below.

Exploratory Hole	Water strike during drilling (m bgl)	Water strike during drilling (m AOD)	Stratum	Comment
BH101	1.00	4.17	Alluvium	Strike recorded by drillers. Rose to 0.80 m bgl after 20 minutes.
BH101	3.70	1.47	Weathered Chalk bedrock	Strike recorded by drillers.
BH102	1.00	4.40	Head Deposits	Strike recorded by drillers. Rose to 0.80 m bgl after 20 minutes.
BH102	5.00	0.40	Weathered Chalk bedrock	Strike recorded by drillers. Rose to 1.50 m bgl after 20 minutes.
BH103	0.60	4.41	Alluvium	Strike recorded by drillers. Rose to 0.30 m bgl after 20 minutes.
BH104	1.00	4.11	Alluvium	Strike recorded by drillers. Rose to 0.60 m bgl after 20 minutes.
BH104	7.00	-1.89	Weathered Chalk bedrock	Strike recorded by drillers. Rose to 4.50 m bgl after 20 minutes.
TP101	0.80	4.33	Alluvium	-
TP102	1.10	4.14	Alluvium	Seepage
TP104	0.90	4.17	Weathered Chalk bedrock	-
TP105	1.20	3.69	Weathered Chalk bedrock	Seepage
TP106	1.60	3.34	Alluvium	Seepage
TP107	1.20	4.00	Weathered Chalk bedrock	Seepage
TP108	1.80	3.07	Weathered Chalk bedrock	Seepage

5.4.2 Levels During Monitoring Programme

Groundwater levels were monitored on a total of four occasions between 21st November and 13th December 2019. Monitoring data is provided in Appendix K and summarised in the table below.

Exploratory Hole	Response Zone		Water level during monitoring Max to Min Range		LNAPL Y/N	Stratum
	m bgl	m AOD	m bgl	m AOD.		
BH101	0.5 – 6.5	4.67 to -1.33	0.35 – 0.48	4.82 – 4.69	N	Topsoil
BH102	0.5 – 6.5	4.90 to -1.10	0.44 – 0.64	4.96 – 4.76	N	Topsoil and Alluvium
BH103	0.5 – 6.5	4.51 to -1.49	0.22 – 0.41	4.79 – 4.60	N	Made Ground
BH104	0.5 – 6.5	4.61 to -1.39	0.56 – 0.74	4.55 – 4.37	N	Alluvium

Groundwater levels during monitoring varied between 0.22 and 0.74 m bgl (4.79 to 4.37 m AOD) within the Made Ground and Alluvium.

5.5 Visual and Olfactory Evidence of Contamination - Groundwater

No visual or olfactory evidence of potential gross contamination was observed during the investigation.

5.6 Material Properties

The table below summarises the factual material properties based upon the results of in-situ and laboratory test data and where appropriate provides derived geotechnical parameters.

Parameter	Topsoil	Made Ground	Alluvium	Head Deposits	River Terrace Deposits	Chalk
Moisture Content – w	-	-	-	-	-	23% - 28%
Liquid Limit - wL	-	-	-	-	-	28% - 30%
Plastic Limit - wP	-	-	-	-	-	18%
Plasticity Index - IP	-	-	-	-	-	10%
Uncorrected SPT N Value	-	-	6 - 14	3 - 16	8 - 33	4 - 17
Corrected ¹ SPT (N ₆₀)	-	-	6 - 14	3 - 17	8 - 35	4 - 18
SPT N values corrected for energy delivered to drive rods utilising the determined energy ratio (E _r): $N_{60} = (E_r \times N) / 60$ after BS EN ISO 22476-3:2005 [Ref. 5]						
From laboratory test results						

5.7 Geochemical Testing

Geochemical analysis was undertaken on eight (8 No.) soil samples of the natural strata, tested for selective contaminants (BRE Special Digest 1:2005 (3rd Edition), Concrete in Aggressive Ground, the results of which are summarised in the table below.

Tests	No. of Tests	Minimum	Maximum
Soil - pH	13	7.4	8.5
Soil - Total Sulphur	8	0.018%	0.137%

Tests	No. of Tests	Minimum	Maximum
Soil – Acid Soluble Sulphate	8	0.042%	0.197%
Soil - Water Soluble Sulphate	13	15 mg/L	95 mg/L
Water – pH	4	7.5	9.3
Water - Sulphate	4	42.2 mg/L	206 mg/L

5.8 Ground Gas Data

Gas monitoring results are presented in Appendix K and are summarised in the table below, a total of four rounds of gas monitoring were undertaken over a period of four weeks.

Barometric pressures ranged from 985 mB (visit 4) to 1017 mB (visit 2).

Exploratory Hole	Steady Gas Concentration (%v/v)						Steady Flow Rate (l/hr)		Response Zone (m bgl)		Stratum
	Methane		Carbon Dioxide		Oxygen						
	Min	Max	Min	Max	Min	Max	Min	Max	From	To	
BH101	<0.1	0.1	0.2	0.5	20.8	21.2	<0.1	<0.1	0.5	6.5	Alluvium, Head Deposits and weathered Chalk bedrock
BH102	<0.1	0.1	0.1	0.9	19.0	21.5	<0.1	<0.1	0.5	6.5	Topsoil, Alluvium, Head Deposits and weathered Chalk bedrock
BH103	<0.1	0.1	1.2	1.2	18.8	18.8	0.2	1.0	0.5	6.5	Topsoil, Alluvium and River Terrace Deposits
BH104	<0.1	0.1	0.8	1.7	17.8	21.3	0.1	0.3	0.5	6.5	Alluvium and weathered Chalk bedrock

6.0 Geotechnical Assessment

6.1 Summary of Development Proposals

It is understood that the Site is to be redeveloped for a light industrial / commercial end use, including a two-storey office building. An area of undeveloped, open space is to be retained as a flood protection zone. A proposed development plan is provided as Drawing 1.

At the time of writing, structural and floor loadings and final levels were unknown. Consequently, the information provided below should be treated as preliminary and will be subject to review once a scheme and levels have been finalised.

6.2 Foundations

6.2.1 Spread Foundations

The Made Ground is considered to be too unpredictable, variable, weak and compressible in its existing condition to be considered as a founding stratum, unless ground improvement, e.g. vibro replacement, is undertaken in line with a suitable earthworks specification.

Based on the Site investigation undertaken shallow pad foundations placed within the natural strata are considered to be suitable for the Site, founded at a minimum depth of 1.5 m bgl within the loose to medium-dense gravels of the superficial Alluvium. Foundations should be founded on a consistent medium to avoid issues of differential settlement.

For preliminary design, the table below shows a number of typical pad sizes and associated allowable bearing capacities that may be assumed, based on the ground conditions proven during this investigation and soil strengths assumed above, with settlements restricted to <25 mm.

Footing Dimensions	Depth (m bgl)	Strata	Allowable Bearing Capacity (kN/m ²)	Maximum Load (kN)
1.00 x 1.00 m pad	1.50	Gravel	165	165
2.00 x 2.00 m pad			95	380

All foundation excavations should be inspected by a suitably qualified geotechnical engineer prior to casting to ensure the appropriate depth, founding medium and strength characteristics have been achieved.

6.2.2 Ground Improvement Techniques

It is considered that where the achievable bearing capacity of shallow soils is not sufficient, a ground improvement solution may provide a suitable option for foundation loads. Any ground improvement proposed at the Site should be designed and warranted by a suitably experienced and qualified ground improvement contractor.

Vibro Replacement

Vibro replacement involves the use of a long and heavy vibrating poker to form stone columns over the depth of soil requiring treatment (likely to the full depth of the Made Ground). Structural loads may then be supported, on shallow, nominally reinforced pad and strip footings. The placement of columns under the slabs may allow a traditional ground bearing construction to be adopted. Such a programme may be more economical than a piled scheme.

Excavation and Replacement

Excavation and replacement is not considered to be a feasible ground improvement method at the Site.

6.2.3 Piling

A piled foundation solution using traditional bored or continuous flight auger (CFA) piles transferring loads to competent geology may be suitable for the expected design loads, utilising both skin friction and end bearing capacity.

The precise method of pile installation and applicability of proprietary systems, diameters and depths required would need to be informed based on the results of this investigation, by discussions with a piling contractor with suitable experience in clay. Additional deeper boreholes may be required by a piling contractor to inform pile design.

Individual pile/pile group loads will be a function of the surface area of the piles to be employed at the Site and their method of construction.

Normal static and dynamic load testing (including uplift tests) should be considered to achieve satisfactory quality control/assurance in accordance with good practice.

There will be a requirement for the placement of a suitably engineered piling mat, which should be designed and validated by a suitably qualified and experienced engineer.

6.2.4 Floor Slabs

Where ground bearing floor slabs are feasible, all Topsoil, Made Ground and soft soils should be removed and the formation thoroughly proof rolled. Soft spots should be excavated and replaced with well-compacted granular material.

Should ground improvement be undertaken, then this is also likely to result in a ground bearing slab being feasible, subject to confirmation from a suitably qualified ground improvement contractor.

6.3 Roads and Pavements

Based on the results of the plate load tests undertaken at the Site, it is recommended that a conservative CBR value of 1.3 % should be adopted for shallow soils, for preliminary pavement design for external areas. The plate load test results are included as Appendix G.

6.4 Soakage Tests

Soakaways are not considered feasible at the Site due to the shallow groundwater encountered during the Site investigation and subsequent monitoring visits.

6.5 Excavations & Obstructions

It is expected that conventional mechanical excavators will readily remove the topsoil, Made Ground and Alluvium likely to be encountered in shallow excavations although a breaker may be required to remove any existing concrete hardstanding in the area of the tennis courts.

All shallow foundation or services excavations at the Site should be considered unstable, therefore, temporary support of all excavations should be considered when excavating on-Site.

6.6 Groundwater

Groundwater should be anticipated during any excavations required as part of the proposed development, given that shallow groundwater has been encountered at the Site. Significant dewatering via sump and pump should be anticipated, however, treatment prior to disposal to sewer may be required.

6.7 Slopes & Retaining Features

Slopes and retaining features are not currently present on-site and are not expected to be included within the proposed development.

6.8 Earthworks

At the time of writing, finished levels were unclear although, it is understood that to some degree earthworks may be required as part of the proposed development. A significant cut and fill operation is not anticipated.

Materials used as fill will need to be placed to a suitable engineering specification with the degree of compaction required will be dependent on end usage and serviceability criteria. For example, a lesser degree of compaction may be suitable for paved areas than for building platforms supporting foundations and ground bearing slabs. Uplift in areas where vibro replacement is to be used should comprise granular fill placed loosely, or with nominal compaction.

Further earthworks testing will be required prior to completion of a suitably detailed earthworks specification for the works.

6.9 Chemical Attack on Buried Concrete

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

6.10 Dissolution Features

According to the Envirocheck® Report there is a very significant risk – moderate possibility of soluble rock risk in the north-west of the Site. Furthermore, the Site is indicated to have a moderate hazard potential for ground dissolution stability hazards in the north-east. However, the risk of dissolution features at the Site is considered to be low, on the basis that the Site is not indicated to be located in, or within 1 km, of any areas of mining instability, man-made cavities or natural cavities. Furthermore, given the presence of shallow groundwater at the Site, this is considered to further reduce the likelihood of dissolution features being present. No evidence of dissolution features was observed during the Site investigation.

Despite the low risk, it is considered prudent that a watching brief is maintained during construction of the proposed development, in order to observe any evidence of dissolution features.

7.0 Generic Quantitative Risk Assessment

7.1 Introduction

The presence of hazardous substances in or on a site is generally only of concern if an actual or potential unacceptable risk exists. Legislation and guidance on the assessment of contaminated sites, consistent with UK best practice, acknowledges the need for a tiered risk-based approach. A Preliminary Risk Assessment is presented in Section 3.0. This section represents a Generic Quantitative Risk Assessment (GQRA) being a comparison of site contaminant levels against Generic Assessment Criteria.

7.2 Human Health GQRA

The assessment of risks in relation to human health has been undertaken using Generic Assessment Criteria as detailed within the appropriate tables. Risks from soil, groundwater and Non-Aqueous Phase Liquids (NAPL) have been considered.

The end use scenario adopted for the assessment is a commercial end use, considered appropriate based on the proposed light industrial / commercial development.

7.2.1 Risks from Soil Sources

Based on the proposed use of the Site for light industrial use, the soil and groundwater chemical data has been compared against a commercial end use GAC for 1% soil organic matter (SOM) content.

None of the contaminant concentrations reported in soil exceeded the relevant Generic Assessment Criteria (GAC). Therefore, the soil contaminant concentrations are not considered likely to represent a risk to human health.

The laboratory results for contaminants exceeding detection limit compared to their respective GAC are presented in the table below.

The primary exposure pathways considered in the risk assessment are as follows:

- ▲ Ingestion of soil and indoor dust and / or oral background exposure;
- ▲ Inhalation of dust (background and indoor);
- ▲ Direct dermal contact; and
- ▲ Inhalation of vapour (background and indoor).

Contaminant	No. Samples	Max Conc. (mg/kg)	GAC (mg/kg)	GAC Source	No. Exceed GAC	Volatile	Location of Exceedances (depth) = Concentration (mg/kg)	Area of Site of Exceedance
Asbestos	10	Not-detected	Detected	DS	0	N	-	-
Metals and metalloids (only those above detection)								
Arsenic	10	19	640	LQM	0	N	-	-
Cadmium		1.8	190	LQM		N		
Chromium III		32	8,600	LQM		N		
Copper		140	68,000	LQM		N		
Lead		330	2,300	C4SL		N		
Mercury		1.3	1,100	LQM		Y		
Nickel		18	980	LQM		N		
Zinc		210	730,000	LQM		N		
Polyaromatic Hydrocarbons (only those above detection)								
Phenanthrene	10	0.35	22,000	LQM	0	N	-	-
Fluoranthene		0.95	23,000	LQM		N		
Pyrene		0.88	54,000	LQM		N		
Benzo[a]anthracene		0.57	170	LQM		N		
Chrysene		0.59	350	LQM		N		
Benzo[b]fluoranthene		0.89	44	LQM		N		
Benzo[k]fluoranthene		0.20	1,200	LQM		N		
Benzo[a]pyrene		0.57	35	LQM		N		
Indeno(1,2,3-c,d)pyrene		0.34	500	LQM		N		
Benzo[g,h,i]perylene		0.37	3,900	LQM		N		
Petroleum Hydrocarbons (only those above detection)								
Aliphatic TPH >C21-C35	10	39	1,600,000	LQM	0	N	-	-
Aliphatic TPH >C35-C40		34	1,600,000	LQM		N		

Contaminant	No. Samples	Max Conc. (mg/kg)	GAC (mg/kg)	GAC Source	No. Exceed GAC	Volatile	Location of Exceedances (depth) = Concentration (mg/kg)	Area of Site of Exceedance
Aromatic TPH >C21-C35	10	52	28,000	LQM	0	N	-	-
Aromatic TPH >C35-C40		26	28,000	LQM		N		
Total Petroleum Hydrocarbons		92	5,000	DS		Y		
Notes: Shaded = Maximum concentration exceeds GAC C4SL = Category 4 Screening Levels (C4SLs) published by DEFRA. DS = In-house GAC derived by Delta-Simons Environmental Consultants Ltd, 2018. LQM = Land Quality Management/CIEH S4UIs for Human Health Risk Assessment, 2014.								

Although detectable concentrations of heavy metals, PAHs and petroleum hydrocarbons have been encountered within shallow soils at the Site, none of the Site-specific contaminants of concern were recorded at concentrations in excess of their respective GAC.

No asbestos has been detected within shallow soils at the Site.

7.2.2 Risks from Groundwater Sources

Based on the proposed use of the Site for light industrial / commercial use, the soil and groundwater chemical data has been compared against a commercial / industrial end use GAC to assess risks from groundwater sources to indoor air and subsequent vapour inhalation indoors.

None of the Site-specific contaminants of concern were recorded at concentrations in excess of their detection limits/respective GAC.

The water analysis results are considered further in the Conceptual Site Model (CSM) presented in Section 9.0 with regard to potential pollutant linkages.

7.2.3 Risks from Non-Aqueous Phase Liquids (NAPL)

Soil and groundwater exposure models used in generating Generic Assessment Criteria do not account for the potential for NAPL to represent a source of risk to human health, principally due to the production of vapours. Whilst it is possible to calculate theoretical soil saturation limits, in reality, due to co-solubility effects, these are not an appropriate indicator of the presence of NAPL. In order to assess the presence of NAPL, for petroleum hydrocarbons, an assessment criterion of 5,000 mg/kg has been applied based on professional experience.

The following has been identified in relation to NAPL at the Site:

- ▲ No observations of NAPL were made within the soils observed during drilling;
- ▲ No concentrations of Total Petroleum Hydrocarbons in excess of 5,000 mg/kg were recorded;
- ▲ No NAPL was measured during groundwater monitoring works.

On this basis, there is no evidence of NAPL being present on the Site.

7.3 Controlled Waters/Water Environment GQRA

7.3.1 Groundwater Results

The approach adopted to assessing risks to Controlled Waters/Water Environment is based principally on considering the concentrations of contaminants identified within the groundwater samples obtained in comparison to relevant GAC.

Given the 'prevent and limit' approach of the Water Framework Directive (2000/60/EC) and the identified receptors, a range of Water Quality Standards (WQS) have been applied as Generic Assessment Criteria (GAC), these include Water Framework Directive standards and thresholds (WFD), the Freshwater Environmental Quality Standards (EQS), the UK Drinking Water Quality Standards (DWQS), WHO Guidelines for Drinking Water Quality or SEPA resource protection values which have been used as initial conservative GAC to assess whether groundwater contamination requires further assessment or discussion in terms of the risks to controlled waters. Where specific water quality standards are not available, Delta-Simons has adopted surrogate values based on professional judgement (DS GAC).

Groundwater contaminant concentrations that exceed the applied GAC are then considered in the context of the Site's environmental setting as to whether further qualitative or quantitative assessment is required as described in subsequent sections. Laboratory results above relevant detection limits are summarised in the table below with a comparison to the GAC applied.

Contaminant	No. Samples	Max Conc. (µg/l)	GAC (µg/l)	GAC Source	No. Exceed GAC	Location of Exceedances	Area of Site of Exceedance
Metals and Metalloids							
Arsenic	4	2.92	10	DWQS 2016	0	-	-
Cadmium		0.10	0.53	WFD 2015c	0	-	-
Chromium III		4.3	7.21	WFD 2015c	0	-	-
Copper		14	2.12	WFD 2015c	4	BH101, BH102, BH103, BH104	Site-wide
Lead		2.3	2.54	WFD 2015c	0	-	-
Nickel		17	8.48	WFD 2015c	2	BH102 and BH103	East and centre of the Site
Zinc		7.4	23.1	WFD 2015c	0	-	-
Notes: Shaded = Maximum concentration exceeds GAC. DWQS 2016 = The Water Supply (Water Quality) Regulations 2016 [UK Drinking Water Standards] WFD2015c = Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015. Schedule 5 Table 1 – Threshold Values for Groundwater							

Marginally elevated concentrations of copper and nickel have been identified within the groundwater at the Site. These concentrations are considered likely to be representative of background concentrations, as there is not considered to be a plausible source of these contaminants at the Site.

Petroleum hydrocarbons and PAHs were below the limits of detection for all the groundwater samples tested.

The groundwater analysis results are considered further in the CSM presented in Section 9.0 with regard to potential pollutant linkages.

7.4 Built Environment

7.4.1 Potable Water Supply Pipes

The investigation requirements for the selection of potable water pipe material are set out in UKWIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites (UKWIR, 2010). This report has very specific and onerous investigation requirements and as such the detailed investigation of each utility route was not within the scope of this investigation.

A preliminary review of the results indicates that a relevant linkage is unlikely to exist associated with organic contaminants and therefore it is considered unlikely that upgraded water supply pipes will be required, however, this should be confirmed with the Local Water Authority.

It should be noted that at the time of this investigation the future routes of water supply pipes had not been established, hence the investigation and sampling strategy is not likely to be considered fully compliant with UKWIR recommendations. Consequently, a targeted investigation and specific sampling/analytical strategy may be required at a later date once the route(s) of the supply pipe(s) are known. In addition, it is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements for assessment, which may not necessarily be the same as those recommended by UKWIR.

7.4.2 Building Materials

Risks to building materials associated with aggressive ground conditions is addressed in Section 6.9.

7.5 Waste Classification

This investigation was not undertaken to classify materials in terms of waste disposal. Where waste disposal is required, then a specific and detailed investigation in accordance with Environment Agency Guidance WM3 would typically be required.

Should soils be required to be disposed of from Site, the results of the chemical analysis should be forwarded to the proposed receiving facility who will determine what criteria they will accept the waste from Site as. Further investigation in addition to specific waste acceptance criteria (WAC) analysis may be required.

Considering the nature of the materials encountered, more cost efficient and sustainable methods of removing the material should be considered prior to disposal at landfill (e.g. registering with the CL:AIRE Register of Materials) in an attempt to find a site with a requirement for import of materials.

8.0 Bulk Ground Gas Risk Assessment

8.1 Ground Gas Conceptual Site Model

8.1.1 Sources

Historically the Site has been subjected to limited development, including tennis courts and ditch excavations.

The Made Ground generally comprises soft sandy / gravelly clay and sand and gravel mixtures. The gravel content included flint, sandstone, brick, and clinker. Occasional plastic and ceramic fragments were also recorded. The Made Ground is therefore considered to represent a potential source of ground gas, although the volume of putrescible material appears to be low.

Surrounding historical land uses, which include former industrial facilities and areas of potentially infilled land, may represent localised off-site sources of ground gases.

Two Licensed Waste Management Facilities (Landfill Boundaries), seven Licensed Waste Management Facilities (Locations) and one Integrated Pollution Prevention and Controls associated with waste landfilling, have been identified within 500 m of the Site.

8.1.2 Receptors

The principal receptors under consideration are future Site users. Other receptors include adjacent site users, residents and future maintenance / construction workers.

8.1.3 Pathways

The underlying geology is likely to be of variable permeability with respect to ground gases. The Made Ground is heterogeneous and likely to allow preferential migration locally. The underlying Alluvium, Head Deposits and River Terrace Deposits is predominantly sand and gravel mixtures and likely to allow for preferential migration from below and also lateral migration. The weathered Chalk bedrock has initially been encountered as granular deposits, followed by cohesive deposits at depth, which are likely to limit vertical migration from below.

Based on the above, there is potential for migration of ground gas from off-Site sources.

The most significant pathways with respect to future Site users relate to the potential for gases to enter future buildings. At present, no gas protection measures are assumed. Consequently, ingress into buildings may be possible through voids in the floor including service entry points and cracks.

Future maintenance/construction workers may come into contact with hazardous ground gases via entry into below ground confined spaces such as excavations or service entries/inspection points.

8.2 Duration & Extent of Monitoring

Tables 5.5a and 5.5b within CIRIA C665 detail current recommended monitoring duration and frequency for sites in the UK. Based on the identification of potential sources in the preceding section, the gas generation potential is considered to be moderate, whilst the sensitivity of the proposed development is considered to be low.

Gas monitoring has been carried out upon the Site on four separate occasions between 21st November and 13th December 2019.

The locations of the monitoring wells are highlighted on Figure 2 and indicate representative coverage beneath the proposed building footprints as shown on Drawing 1.

Barometric pressures during the gas monitoring period ranged from 985 mBar to 1017 mBar. Three of the four visits were completed during periods of falling pressure.

8.3 Ground Gas Risk Assessment

8.3.1 Background

Based on the proposed light industrial / commercial end use, the following document has been consulted when assessing the gas regime at the Site:

- ▲ British Standards Institute (BSI, 2019): Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings, BS:8485:2015+A1:2019.

The presence of a source of hazardous gas within the ground does not necessarily indicate a risk will be present. Consideration of recorded gas flows together with source concentrations can allow an initial assessment to be made of the potential both for generation and subsequent migration of gas. A Characteristic Situation (CS) is derived from an assessment of the ground gas data and forms the basis of determining mitigation measures.

8.3.2 Gas Screening Value (GSV)

The Gas Screening Value (gas concentration as a fraction x maximum recorded flow) is used to provide an initial assessment of risks to future Site users. The GSVs calculated for the monitoring wells are presented in the following table.

Location	Maximum Methane (%v/v)	Maximum Carbon Dioxide (%v/v)	Maximum Flow Rate (l/hr)	GSV / Characteristic Situation				Flooded well (Frequency)
				Methane		Carbon Dioxide		
				GSV	CS	GSV	CS	
BH101	0.1	0.6	0.1	0.0010	1	0.0006	1	Y (1/4)
BH102	0.1	0.9	<0.1	0.0010	1	0.0009	1	N
BH103	0.1	1.2	7.7	0.0077	1	0.0924	2	N
BH104	0.1	1.7	8.8	0.0088	1	0.1496	2	N

It was not possible to obtain gas readings from BH101 during the first monitoring visit due to the well being flooded above the level of the gas bung.

The preliminary data indicates that the Site can be provisionally classified as CS2 (low hazard potential) in accordance with BS:8485:2015+A1:2019 Table 2.

8.4 Ground Gas Risk Mitigation

It is recommended that a CS2 rating is assumed for design purposes.

BS:8485:2015+A1:2019 provides a scoring system to determine the appropriate protection measures for a proposed development in accordance with the identified ground gas regime. Table 3 of BS:8485:2015+A1:2019 summarises typical UK building types, which for this development will comprise Type B (private / commercial) and Type C (commercial / public). Table 4 details the points required for the Characteristic Situation, which for CS2 is 3.5 and 2.5, respectively. This can be achieved by a combination of the following:

- ▲ Structural barriers (Table 5)
- ▲ Ventilation (Table 6)
- ▲ Gas Membrane (Table 7)

The above should be considered in conjunction with the proposed foundation / floorslab design to achieve the minimum score required within BS:8485:2015+A1:2019.

The above assessment relates solely to future Site users. Given the nature of the ground gas regime at the Site, no further works are considered necessary to protect 3rd parties / surrounding occupiers. Entry to excavations

/ confined spaces should be restricted to personnel with relevant Confined Spaces training and with prior confirmation of atmospheric conditions.

8.5 Radon

The Site is located within an area where basic radon protective measures are required, any ground gas protection measures installed will need to consider the incorporation of radon protective measures in accordance with BRE Report BR211 (2015) Radon: Protective measures for new buildings and as required by Building Regulations.

8.6 Organic Vapours

No sources of volatile vapours have been identified at the Site. Therefore, specific vapour resistant membranes are not considered to be necessary within the proposed development.

9.0 Revised Conceptual Site Model

A revised CSM is presented in the table below and has been formulated taking into account all of the available data from the Delta-Simons intrusive investigation, suitable for a Site with a proposed commercial end-use.

Revised Conceptual Site Model				
Source	Pathways	Receptors	Confirmed Risk?	Mitigation
Detectable concentrations of heavy metals, PAHs and petroleum hydrocarbons within shallow soils. Marginally elevated concentrations of copper and nickel within the groundwater.	Direct contact, ingestion and/or inhalation of soil/dust	Human health – future Site users	No	Although detectable concentrations of heavy metals, PAHs and petroleum hydrocarbons have been detected within shallow soils, none have been recorded in excess of their respective GAC. It is therefore considered that no specific remediation is necessary with regards to the soils at the Site. Any topsoil imported onto the Site as part of the redevelopment works, or sourced from the Site and re-used, should be tested to confirm suitability, prior to, and one placed, in landscaped areas (if proposed).
		Human health – construction workers	No	Despite no elevated contamination concentrations being recorded within the soils at the Site, short-term risk to construction workers would be mitigated by the use of PPE and provision of suitable welfare facilities. This recommendation should be captured in Site health and safety documentation and in maintenance plans.
	Migration of contaminants into groundwater	Secondary A and Principal Aquifers	No	It is considered that the marginal exceedances of copper and nickel do not pose a significant risk to controlled waters on the basis that there is no on-Site source of copper or nickel, therefore, these concentrations are likely to be representative of background concentrations in the area. Furthermore, the underlying low permeability putty chalk is likely to form a confining layer above the Principal Aquifer, and bunds are present which will prevent lateral migration into the adjacent ponds.
	Migration of contaminants into surface waters	Brockhampton Stream		
	Direct infiltration in water supply pipes	Service conduits	Possible	Hydrocarbons, especially aromatics and chlorinated solvents, are known to permeate plastic pipes. Assessment of the risk to water pipes for any new supply will have to be undertaken as a requirement of the statutory undertakers who should be provided with a copy of this Assessment and provide recommendations for upgrading of potable water supply pipes, if considered necessary.

Revised Conceptual Site Model				
Source	Pathways	Receptors	Confirmed Risk?	Mitigation
Limited Made Ground deposits on Site. Migration of ground gas from historic off-Site sources. Radon gas	Indoor exposure via enclosed space accumulation of ground gas	Human health – future Site users and construction workers	Yes	Based upon the results of the ground gas monitoring undertaken at the Site, the Site has been classified as CS2 – Low Risk. Ground gas protection measures are necessary under this scenario, and should achieve a score of 3.5 (Type B building) and 2.5 (Type C building), in accordance with BS:8485:2015+A1:2019. Any ground gas protection measures installed will also need to consider the incorporation of radon protective measures in accordance with BRE Report BR211 (2015) Radon: Protective measures for new buildings and as required by Building Regulations.
Potentially unidentified 'hotspots' of contamination, which may be present in areas of the Site that have not been directly investigated	All pathways	All receptors	Unknown	As with all redevelopment works, a 'hotspot' protocol should be in place for groundworkers to act upon during any future redevelopment of the Site. Safe working procedures should be implemented, good standards of personal hygiene should be observed, and appropriate levels of PPE provided and utilised. This recommendation should be captured in Site health and safety documentation and in maintenance plans.

10.0 Conclusions & Recommendations

10.1 Geotechnical Summary

The Made Ground is considered to be too unpredictable, variable, weak and compressible in its existing condition to be considered as a founding stratum, unless ground improvement, e.g. vibro replacement, is undertaken in line with a suitable earthworks specification.

Based on the Site investigation undertaken shallow pad foundations placed within the natural strata are considered to be suitable for the Site, founded at a minimum depth of 1.5 m bgl within the loose to medium-dense gravels of the superficial Alluvium. Foundations should be founded on a consistent medium to avoid issues of differential settlement.

A piled foundation solution using traditional bored or continuous flight auger (CFA) piles transferring loads to competent geology may be suitable for the expected design loads, utilising both skin friction and end bearing capacity.

Where ground bearing floor slabs are feasible, all Topsoil, Made Ground and soft soils should be removed and the formation thoroughly proof rolled. Soft spots should be excavated and replaced with well-compacted granular material. Should ground improvement be undertaken, then this is also likely to result in a ground bearing slab being feasible, subject to confirmation from a suitably qualified ground improvement contractor.

Based on the results of the plate load tests undertaken at the Site, it is recommended that a conservative CBR value of 1.3 % should be adopted for shallow soils, for preliminary pavement design for external areas. Soakaways are not considered feasible at the Site due to the shallow groundwater encountered during the Site investigation and subsequent monitoring visits.

Groundwater should be anticipated during any excavations required as part of the proposed development, given that shallow groundwater has been encountered at the Site. Significant dewatering via sump and pump should be anticipated, however, treatment prior to disposal to sewer may be required.

Buried concrete may be designed in accordance with DS-1 and ACEC Class AC-1.

According to the Envirocheck® Report there is a very significant risk – moderate possibility of soluble rock risk in the north-west of the Site. Furthermore, the Site is indicated to have a moderate hazard potential for ground dissolution stability hazards in the north-east. However, the risk of dissolution features at the Site is considered to be low, on the basis that the Site is not indicated to be located in, or within 1 km, of any areas of mining instability, man-made cavities or natural cavities. Furthermore, given the presence of shallow groundwater at the Site, this is considered to further reduce the likelihood of dissolution features being present. No evidence of dissolution features was observed during the Site investigation. Despite the low risk, it is considered prudent that a watching brief is maintained during construction of the proposed development, in order to observe any evidence of dissolution features.

10.2 Contamination Issues

The investigation has been carried out in order to provide information on the quality of the soil and groundwater beneath the Site in the context of land contamination and provide information on the ground gas regime beneath the Site for a light industrial / commercial end use. The assessment is being completed prior to the proposed redevelopment of the Site.

10.2.1 Human Health

Although detectable concentrations of heavy metals, PAHs and petroleum hydrocarbons have been detected within shallow soils, none have been recorded in excess of their respective GAC. It is therefore considered that no specific remediation is necessary with regards to the soils at the Site.

Any topsoil imported onto the Site as part of the development works, or sourced from Site and re-used, should be tested to confirm suitability, prior to, and once placed, in landscaped areas.

Although no elevated concentrations of contaminants have been identified, groundworkers and sub-surface maintenance workers should be made aware of the possibility of encountering contaminated soils through toolbox talks. Safe working procedures should be implemented, good standards of personal hygiene should be observed, and appropriate levels of PPE provided and utilised. This recommendation should be captured in Site health and safety documentation and in maintenance plans.

Based upon the results of the ground gas monitoring undertaken at the Site, the Site has been classified as CS2 – Low Risk. Ground gas protection measures are necessary under this scenario, and should achieve a score of 3.5 (Type B building) and 2.5 (Type C building), in accordance with BS:8485:2015+A1:2019.

Any ground gas protection measures installed will also need to consider the incorporation of radon protective measures in accordance with BRE Report BR211 (2015) Radon: Protective measures for new buildings and as required by Building Regulations.

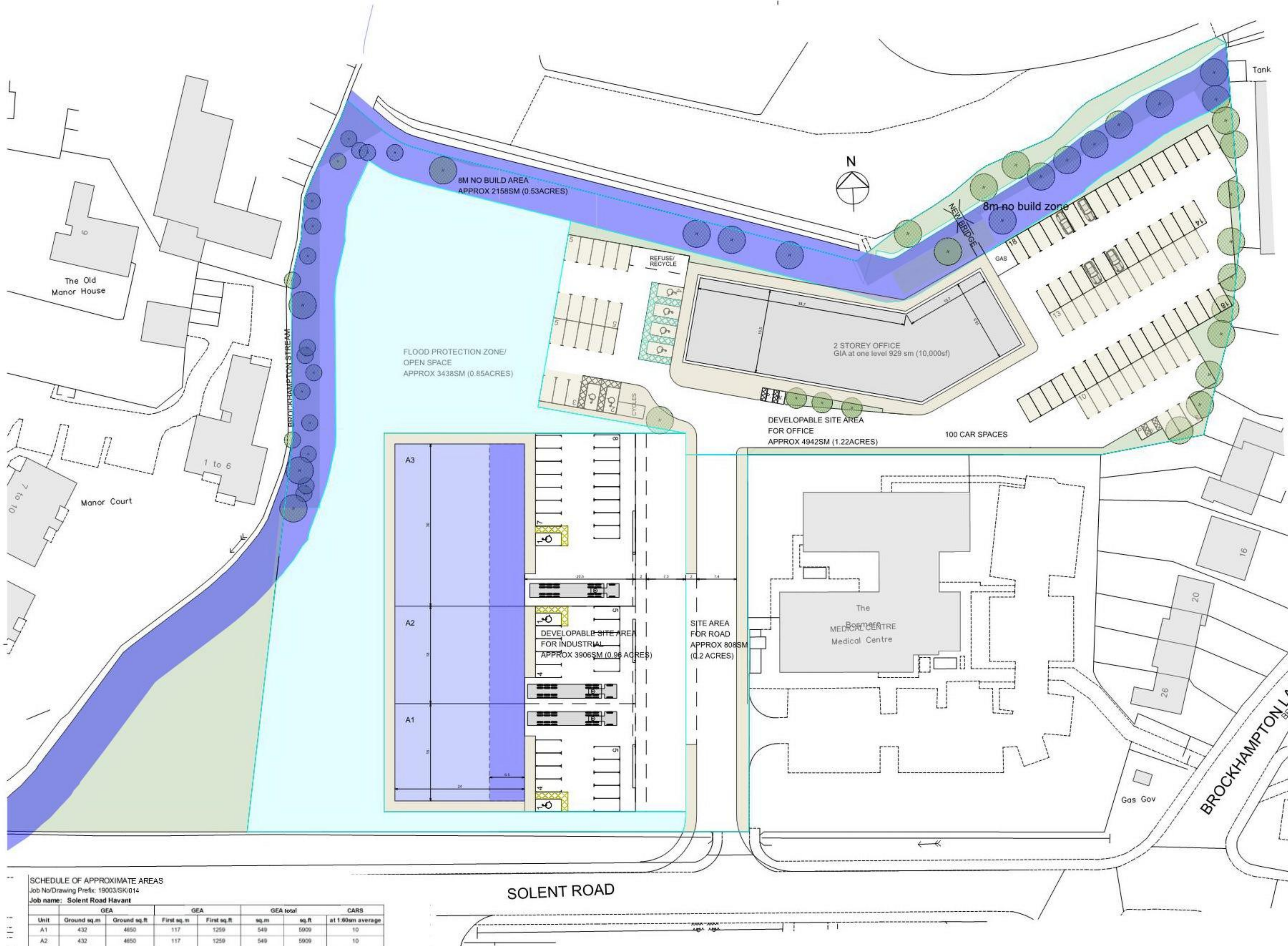
10.2.2 Controlled Waters

It is considered that the marginal exceedances of copper and nickel do not pose a significant risk to controlled waters on the basis that there is no on-Site source of copper or nickel, therefore, these concentrations are likely to be representative of background concentrations in the area. Furthermore, the underlying low permeability putty chalk is likely to form a confining layer above the Principal Aquifer, and bunds are present which will prevent lateral migration into the adjacent ponds. Therefore, no further action is considered to be required.

10.3 Recommendations for Supplementary Work

- ▲ Any topsoil imported onto the Site as part of the redevelopment works, or sourced from the Site and re-used, should be tested to confirm suitability, prior to, and once placed, in landscaped areas. It may be possible to re-use existing topsoil at the Site within landscaped areas, subject to further testing confirming it is suitable for use;
- ▲ Additional, unidentified localised areas of contamination may exist at the Site and an appropriate 'hotspot' protocol should be in place for groundworkers to act upon should such contamination be identified during the construction process;
- ▲ As with all development sites, groundworkers who are required to perform sub-surface work at the Site should be made aware of the known contaminants in soil and groundwater and the possibility of encountering additional localised low levels of contamination. Therefore, good standards of personal hygiene should be observed, and appropriate levels of PPE utilised where necessary;
- ▲ Based upon the results of the ground gas monitoring undertaken at the Site, the Site has been classified as CS2 – Low Risk. Ground gas protection measures are necessary under this scenario, and should achieve a score of 3.5 (Type B building) and 2.5 (Type C building), in accordance with BS:8485:2015+A1:2019.;
- ▲ Any ground gas protection measures installed will also need to consider the incorporation of radon protective measures in accordance with BRE Report BR211 (2015) Radon: Protective measures for new buildings and as required by Building Regulations;
- ▲ Further waste classification testing is likely to be required to facilitate any off-Site disposal of ground materials, as well as waste acceptance criteria (WAC) testing should disposal to landfill be considered or required;
- ▲ A Materials Management Plan is likely to be required to inform any earthworks at the Site;
- ▲ Despite the low risk, it is considered prudent that a watching brief is maintained during construction of the proposed development, in order to observe any evidence of dissolution features; and
- ▲ Confirmation should be sought from the Local Water Authority as to whether they will require upgraded pipework to be installed for new service installation.

Drawing 1 – 19003-SK-014 Site Plan Layout Option 13



SCHEDULE OF APPROXIMATE AREAS

Job No/Drawing Prefix: 19003/SK/014

Job name: Solent Road Havant

Unit	GEA		GEA		GEA total		CARS
	Ground sq.m	Ground sq.ft	First sq.m	First sq.ft	sq.m	sq.ft	
A1	432	4650	117	1259	549	5909	10
A2	432	4650	117	1259	549	5909	10
A3	720	7750	195	2099	915	9849	16
Total	1584	17050	429	4618	2013	21668	36

Site Area for industrial

excl. road: 3906 m² 0.97 Acres

Site Coverage: 40.55%

Site Density: 51.54%

Car Parking: Havant Local Authority standard: B1C/B2 Industrial - 1:45, B8 1:90. Blended average 1:60sm

Areas are approx GEA .
Parking shown for offices - 100 spaces as requested
NB Havant standard for offices is 1/30sm

NOTES

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Do not scale. Work only to figured dimensions.

Subject to Statutory Approvals.

Subject to survey

Subject to design development

Where applicable this drawing is to be read in conjunction with other consultants drawings and with the specification.

All dimensions to be checked on site prior to commencement of work.

Subject to Rights of Light Approval.

As Built drawings are based on information provided by the Contractor.

Positions of all underground services should be considered approximate.

Rev	Description	Chk	Date
-----	-------------	-----	------

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RIBA
Chartered Practice

cornisharchitects

Project Title.
**SOLENT ROAD
HAVANT**

Drawing Title.
Site Plan Layout Option 13

Drawing Status.
PRELIMINARY

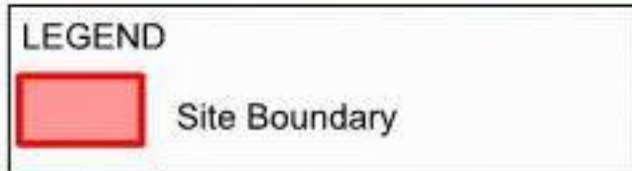
0 5 metres 40

Drawn By: E D Scale: 1:500 @ A2 Date: 23/05/2019 Chk'd By:

Chancerygate

Drawing No. 19003 - SK - 014 Rev. -

Figure 1 – Site Location Map



Scale: 1 / 10,000 @ A4

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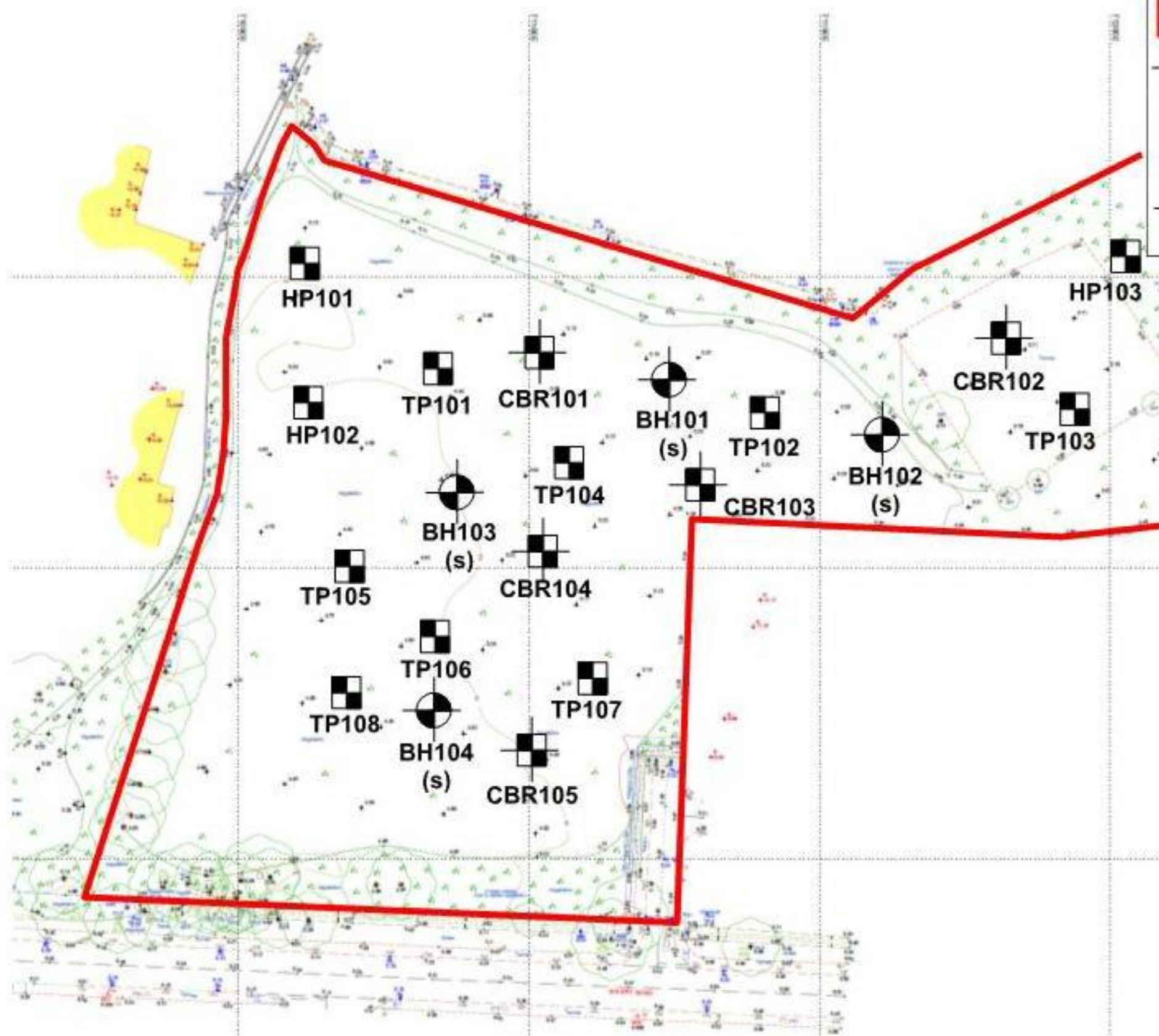
	TITLE: Site Location Map Solent Road Havant	DRAWN BY: KD	SCALE: To Scale@A4	PROJECT NO: 19-1058
		CREATED BY: AN	REVISION: 1	FIGURE NO: 1
		DATE: 10 December 2019		

Figure 2 – Approximate Exploratory Hole Location Plan



LEGEND

-  Site Boundary
-  Cable Percussion Borehole
-  Standpipe
-  Trial Pit / Hand Pit
-  CBR Location



Appendix A – Limitations

Limitations

The recommendations contained in this Report represent Delta-Simons professional opinions, based upon the information listed in the Report, exercising the duty of care required of an experienced Environmental Consultant. Delta-Simons does not warrant or guarantee that the Site is free of hazardous or potentially hazardous materials or conditions.

Delta-Simons obtained, reviewed and evaluated information in preparing this Report from the Client and others. Delta-Simons conclusions, opinions and recommendations has been determined using this information. Delta-Simons does not warrant the accuracy of the information provided to it and will not be responsible for any opinions which Delta-Simons has expressed, or conclusions which it has reached in reliance upon information which is subsequently proven to be inaccurate.

This Report was prepared by Delta-Simons for the sole and exclusive use of the Client and for the specific purpose for which Delta-Simons was instructed. Nothing contained in this Report shall be construed to give any rights or benefits to anyone other than the Client and Delta-Simons, and all duties and responsibilities undertaken are for the sole and exclusive benefit of the Client and not for the benefit of any other party. In particular, Delta-Simons does not intend, without its written consent, for this Report to be disseminated to anyone other than the Client or to be used or relied upon by anyone other than the Client. Use of the Report by any other person is unauthorised and such use is at the sole risk of the user. Anyone using or relying upon this Report, other than the Client, agrees by virtue of its use to indemnify and hold harmless Delta-Simons from and against all claims, losses and damages (of whatsoever nature and howsoever or whensoever arising), arising out of or resulting from the performance of the work by the Consultant.

Appendix B – Historical Maps

Historical Mapping Legends

Ordnance Survey County Series 1:10,560

	Gravel Pit		Sand Pit		Other Pits
	Quarry		Shingle		Orchard
	Osiers		Reeds		Marsh
	Mixed Wood		Deciduous		Brushwood
	Fir		Furze		Rough Pasture
	Arrow denotes flow of water		Trigonometrical Station		
	Site of Antiquities		Bench Mark		
	Pump, Guide Post, Signal Post		Well, Spring, Boundary Post		
	285 Surface Level				
	Sketched Contour		Instrumental Contour		
	Main Roads		Minor Roads		
	Sunken Road		Raised Road		
	Road over Railway		Railway over River		
	Railway over Road		Level Crossing		
	Road over River or Canal		Road over Stream		
	Road over Stream				
	County Boundary (Geographical)				
	County & Civil Parish Boundary				
	Administrative County & Civil Parish Boundary				
	County Borough Boundary (England)				
	County Borough Boundary (Scotland)				
	Rural District Boundary				
	Civil Parish Boundary				

Ordnance Survey Plan 1:10,000

	Chalk Pit, Clay Pit or Quarry		Gravel Pit
	Sand Pit		Disused Pit or Quarry
	Refuse or Slag Heap		Lake, Loch or Pond
	Dunes		Boulders
	Coniferous Trees		Non-Coniferous Trees
	Orchard		Scrub
	Bracken		Heath
	Marsh		Reeds
	Building		Glasshouse
	Sloping Masonry		Pylon
	Cutting		Embankment
	Road Under		Road Over
	Level Crossing		Foot Bridge
	Standard Gauge Multiple Track		Standard Gauge Single Track
	Siding, Tramway or Mineral Line		Narrow Gauge
	Geographical County		Administrative County, County Borough or County of City
	Municipal Borough, Urban or Rural District, Burgh or District Council		Borough, Burgh or County Constituency
	Civil Parish		
	Boundary Post or Stone		Police Station
	Church		Post Office
	Club House		Public Convenience
	Fire Engine Station		Public House
	Foot Bridge		Signal Box
	Fountain		Spring
	Guide Post		Telephone Call Box
	Mile Post		Telephone Call Post
	Mile Stone		Well

1:10,000 Raster Mapping

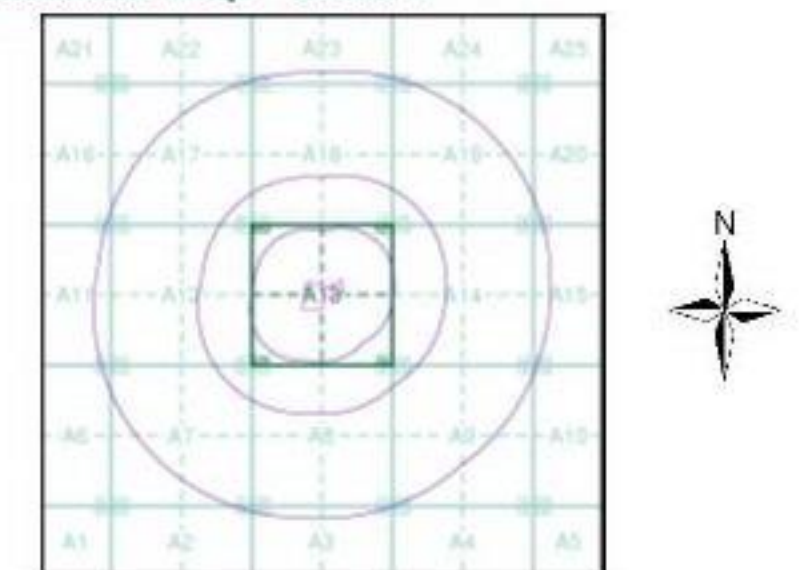
	Gravel Pit		Refuse tip or slag heap
	Rock		Rock (scattered)
	Boulders		Boulders (scattered)
	Shingle		Mud
	Sand		Sand Pit
	Slopes		Top of cliff
	General detail		Underground detail
	Overhead detail		Narrow gauge railway
	Multi-track railway		Single track railway
	County boundary (England only)		Civil, parish or community boundary
	District, Unitary, Metropolitan, London Borough boundary		Constituency boundary
	Area of wooded vegetation		Non-coniferous trees
	Non-coniferous trees (scattered)		Coniferous trees
	Coniferous trees (scattered)		Positioned tree
	Orchard		Coppice or Osiers
	Rough Grassland		Heath
	Scrub		Marsh, Salt Marsh or Reeds
	Water feature		Flow arrows
	Mean high water (springs)		Mean low water (springs)
	Telephone line (where shown)		Electricity transmission line (with poles)
	Bench mark (where shown)		Triangulation station
	Point feature (e.g. Guide Post or Mile Stone)		Pylon, flare stack or lighting tower
	Site of (antiquity)		Glasshouse
	General Building		Important Building



Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Hampshire & Isle Of Wight	1:10,560	1870	3
Sussex	1:10,560	1879 - 1880	4
Hampshire & Isle Of Wight	1:10,560	1898	5
Sussex	1:10,560	1899	6
Hampshire & Isle Of Wight	1:10,560	1909 - 1910	7
Sussex	1:10,560	1914	8
Sussex	1:10,560	1914	9
Sussex	1:10,560	1914	10
Hampshire & Isle Of Wight	1:10,560	1932	11
Sussex	1:10,560	1932	12
Hampshire & Isle Of Wight	1:10,560	1932	13
Sussex	1:10,560	1932	14
Sussex	1:10,560	1932	15
Hampshire & Isle Of Wight	1:10,560	1933	16
Hampshire & Isle Of Wight	1:10,560	1933	17
Hampshire & Isle Of Wight	1:10,560	1938 - 1942	18
Ordnance Survey Plan	1:10,000	1962 - 1963	19
Ordnance Survey Plan	1:10,000	1966	20
Ordnance Survey Plan	1:10,000	1972 - 1975	21
Ordnance Survey Plan	1:10,000	1982	22
Havant	1:25,000	1983	23
Portsmouth	1:10,000	1988	24
Ordnance Survey Plan	1:10,000	1990 - 1992	25
10K Raster Mapping	1:10,000	2000	26
10K Raster Mapping	1:10,000	2006	27
VectorMap Local	1:10,000	2019	28

Historical Map - Slice A



Order Details

Order Number: 223283800_1_1
 Customer Ref: 19-1058.01
 National Grid Reference: 471120, 106170
 Slice: A
 Site Area (Ha): 1.54
 Search Buffer (m): 1000

Site Details

Land at Solent Road, HAVANT, PO9 1DQ

Landmark
 INFORMATION GROUP

Tel: 0844 844 9952
 Fax: 0844 844 9951
 Web: www.envirocheck.co.uk

Russian Military Mapping Legends

1:5,000 and 1:10,000 mapping

a. Not drawn to scale b. Drawn to scale



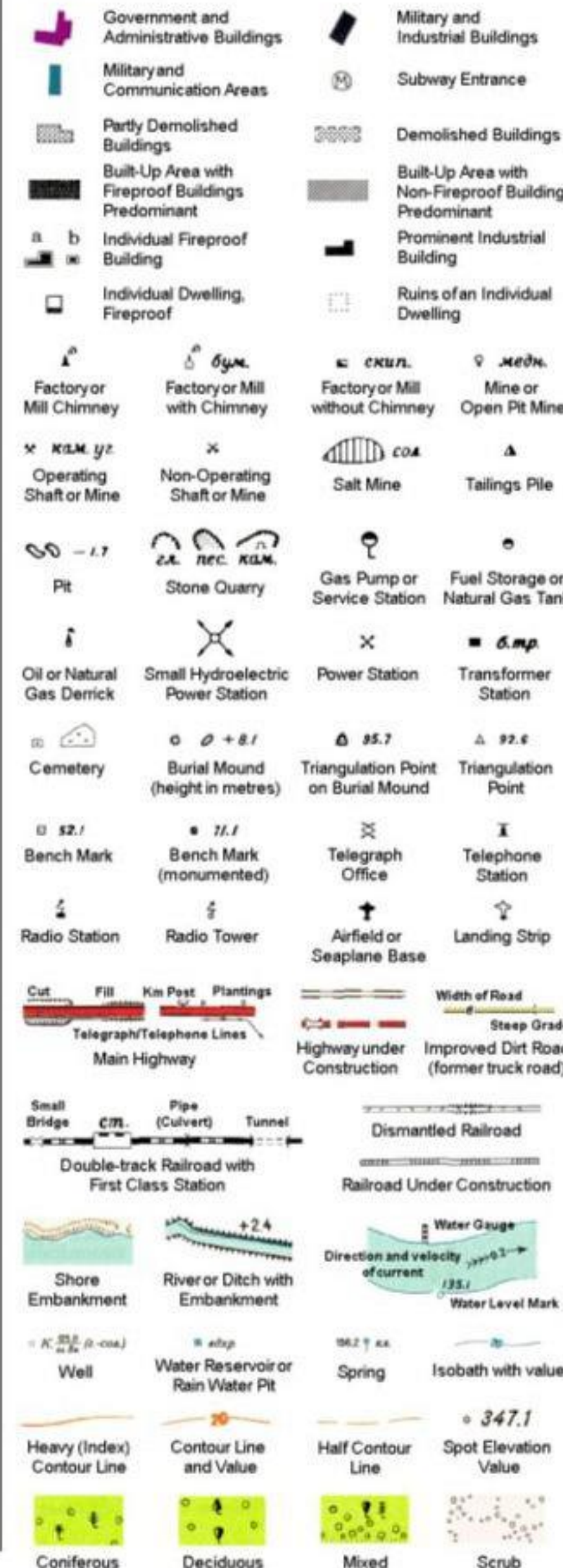
243.8 Values for prominent elevations
186.0 Numbers for spot elevations, depth soundings, contour lines, etc.
0.2 Velocity of the current, width of river bed, depth of river
182.12 Fractional terms: length and capacity of bridges; depth of fords and condition of the river bottom; height of forest and the diameter of trees

Russian Alphabet (For reference and phonetic interpretation of map text)

А а (A) Б б (B) В в (V) Г г (G) Д д (D) Е е (E) Ё ё (YO) Ж ж (ZH) З з (Z) И и (I) Й й (Y) К к (K) Л л (L) М м (M) Н н (N) О о (O) П п (P) Р р (R) С с (S) Т т (T) У у (U) Ф ф (F) Х х (KH) Ц ц (TS) Ч ч (CH) Ш ш (SH) Щ щ (SHCH) Ъ ъ (-) Ы ы (Y) Ь ь (') Э э (E) Ю ю (YU or IU) Я я (YA or IA)

1:25,000 mapping

a. Not drawn to scale b. Drawn to scale



Key to Numbers on Mapping

SU70_Havant

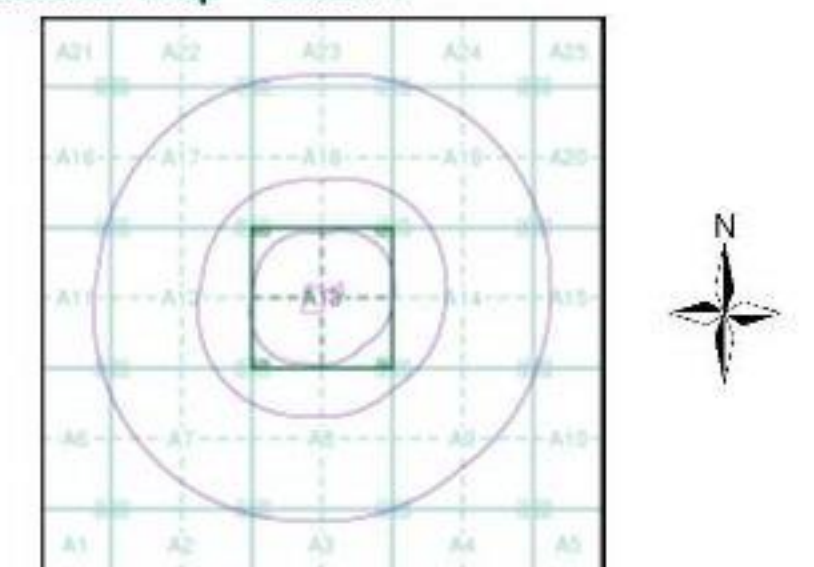
No.	Description
7	Factory (Chemicals)
10	Post Office
15	Railway Station (Freight And Passenger)
16	Sewage Works
17	Sewage Works



Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Hampshire & Isle Of Wight	1:10,560	1870	3
Sussex	1:10,560	1879 - 1880	4
Hampshire & Isle Of Wight	1:10,560	1898	5
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Sussex	1:10,560	1914	9
Sussex	1:10,560	1914	10
Hampshire & Isle Of Wight	1:10,560	1932	11
Sussex	1:10,560	1932	12
Hampshire & Isle Of Wight	1:10,560	1932	13
Sussex	1:10,560	1932	14
Sussex	1:10,560	1932	15
Hampshire & Isle Of Wight	1:10,560	1933	16
Hampshire & Isle Of Wight	1:10,560	1933	17
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10K Raster Mapping	1:10,000	2006	27
VectorMap Local	1:10,000	2019	28

Russian Map - Slice A



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