

20.14 OPERATION AND MAINTENANCE REQUIREMENTS

Regular inspection and maintenance is important for the effective operation of pervious pavements. Maintenance responsibility for a pervious pavement and its surrounding area should be placed with an appropriate responsible organisation. Before handing over the pavement to the client, it should be inspected for clogging, litter, weeds and water ponding, and all failures should be rectified. After handover, the pavement should be inspected regularly, preferably during and after heavy rainfall to check effective operation and to identify any areas of ponding.

Pervious pavements need to be regularly cleaned of silt and other sediments to preserve their infiltration capacity. Extensive experience suggests that sweeping once per year should be sufficient to maintain an acceptable infiltration rate on most sites. However, in some instances, more or less sweeping may be required and the frequency should be adjusted to suit site-specific circumstances and should be informed by inspection reports.

A brush and suction cleaner (which can be a lorry-mounted device or a smaller precinct sweeper) should be used for regular sweeping. Care should be taken in adjusting vacuuming equipment to avoid removal of jointing material. Any lost material should be replaced. It is also possible to clean the surface using lightweight rotating brush cleaners combined with power spraying using hot water, as shown in **Figure 20.30**. This is done every two years at the site shown.

If the surface has clogged then a more specialist sweeper with water jetting and oscillating and rotating brushes may be required, especially for porous asphalt surfaces, to restore the surface infiltration rate to an acceptable level. The specialist equipment should be adjusted so that it does not strip binder from the aggregate in the asphalt.

The likely design life of grass reinforcement will be dictated by trafficking and is likely to be about 20 years if designed correctly. For concrete block permeable paving the design life should be no different from standard paving, assuming that an effective maintenance regime is in place to minimise risks of infiltration clogging. Porous asphalt will lose strength and begin to fatigue due to oxidation of the binder. This is likely to occur slightly faster in porous asphalt than normal asphalt, so the design life will be reduced slightly. Porous concrete should have a similar design life to a normal concrete slab.



Figure 20.30 Deep cleaning a supermarket car park, Dundee (courtesy Abertay University)

The reconstruction of failed areas of concrete block pavement should be less costly and disruptive than the rehabilitation of continuous concrete or asphalt porous surfaces due to the reduced area that is likely to be affected. Materials removed from the voids or the layers below the surface may contain heavy metals and hydrocarbons and may need to be disposed of as controlled waste. Sediment testing should be carried out before disposal to confirm its classification and appropriate disposal methods.

- Guidance on waste management is provided in **Chapter 33**.

Table 20.15 provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance Plans and schedules should be prepared during the design phase. Specific maintenance needs of the pervious pavement should be monitored, and maintenance schedules adjusted to suit requirements.

- Further detail on the preparation of maintenance specifications and schedules of work is given in **Chapter 32**.

TABLE 20.15 Operation and maintenance requirements for pervious pavements

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Many of the specific maintenance activities for pervious pavements can be undertaken as part of a general site cleaning contract (many car parks or roads are swept to remove litter and for visual reasons to keep them tidy) and therefore, if litter management is already required at site, this should have marginal cost implications.

Generally, pervious pavements require less frequent gritting in winter to prevent ice formation. There is also less risk of ice formation after snow melt, as the melt water drains directly into the underlying sub-base and does not have chance to refreeze. A slight frost may occur more frequently on the surface of pervious pavements compared to adjacent impermeable surfaces, but this is only likely to last for a few hours. It does not happen in all installations and, if necessary, this can be dealt with by application of salt. It is not likely to pose a hazard to vehicle movements.

► Generic health and safety guidance is presented in **Chapter 36**.

CDM 2015 requires designers to ensure that all maintenance risks have been identified, eliminated, reduced and/or controlled where appropriate. This information will be required as part of the health and safety file.



Phase I Environmental Assessment

Langstone Technology Park, Havant, PO9 1SA

Presented to Havant S.a.r.l

Issued: November 2020

Delta-Simons Project No. 15-0754.07



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Report Details

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About us

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Executive Summary

Site Use & Surrounding Area	The Site is occupied by a science park comprising a number of interlinked commercial offices and light industrial properties, with car parking, access roads and limited landscaping. The Site is located in a mixed commercial and residential area.
Environmental Setting	The Site is considered to be of a moderate environmental sensitivity given: the presence of Secondary A Aquifers (which comprises some cohesive deposits) over a Principal Aquifer; the proximity of the Mill Stream; the presence of statutory designated ecological sites downstream of the Site (Chichester and Langstone harbour); and the mixed commercial, light industrial and residential use of the surrounding area.
Contamination Potential	While chemical storage, diesel back-up generators and electrical substations were previously identified on-Site, the Site appeared well managed and no significant potential contamination concerns were noted associated with the current Site use. The Site was predominantly unoccupied until the development of a sewage works in the north-east by 1909. By 1973, the sewage works was no longer present, and the Site had been redeveloped into an IBM computer products manufacturer. Since the 1970's, some redevelopment has occurred on-Site, though the main buildings have largely remained unchanged. Potentially contaminative uses associated with the computer manufactory include previous 'wet' processes in B1000, diesel powered boilers in the area of the current gas boiler systems (B3000), an effluent treatment and chemical storage area in the area of B22, and effluent treatment and former chemical storage in the area of B41 and B42. Also, a former pollution incident was reported to have occurred in the 1980's, however, no further details are known. Based on the recent available information, two hotspots of hydrocarbon contamination have been identified with recommendations for off-Site removal, and it was considered for the areas investigated basic gas protection measures should be installed.
Contaminant Linkage Assessment & Land Contamination Conclusions	Delta-Simons has completed a land contamination risk assessment based upon available information. Information has indicated that significant widespread contamination is unlikely to be present. However, localised contamination was recently identified at the Site, which it has been recommended to be remediated (excavated) and given the historical use of the Site, the potential for further localised contamination to be present is possible. It is, therefore, considered that the risk of significant possible contaminant linkages to exist is low to moderate for a continued use and for the proposed redevelopment.
Key Land Contamination Recommendations	No further works are considered to be required for land contamination purposes in the context of an ongoing use. A number of recommendations have been provided associated with the proposed development in Section 4.1.
Overall Land Contamination Statement of Risk	On the basis of available information, Delta-Simons considers that with regard to potential land contamination issues and associated environmental liabilities, in its current use or future redevelopment, the Site represents an overall investment opportunity with a Low to Moderate risk.

Flood Risk Advisory	Based on the information reviewed, the majority of the Site is not located within an area considered to be of an elevated risk of fluvial flooding. Several areas of the Site are shown to be at potential risk of surface water flooding, however, no associated issues were reported on-Site with the exception of minor water ingress at Building 1000. Available information indicates that flooding events have occurred at the Site associated with surcharging of the foul system, however, it is understood that a non-return valve was installed at the Site. Whilst a Flood Risk Assessment is available for the current development proposals, it is likely that a further assessment and drainage strategy will be required to support the proposed redevelopment of the Client's masterplan.
This is intended as a summary only. Further detail and limitations of the assessment is 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 Havant S.a.r.l (the "Client") to carry out a Phase I Environmental Assessment of Langstone Technology Park, Havant, PO9 1SA (the "Site").

1.2 Context & Purpose

The aim of this assessment is to consider the potential for land contamination related liabilities to be present prior to the potential investment of the Site, and future redevelopment with several new buildings for the park.

1.3 Scope of Works

The scope of works undertaken for this assessment was:

- ▲ Review of the environmental setting of the Site, including the current use/ status of the Site and surrounding area, and review of the geology, hydrogeology and hydrology;
- ▲ Review of the historical activities of the Site and surrounding area;
- ▲ Review of regulatory database information relating to the Site;
- ▲ Review of the online planning records for the Site;
- ▲ Consult and review information from the Local Authority in relation to Part 2A of the Environmental Protection Act;
- ▲ Review of relevant third party reports relating to the Site or surrounding area;
- ▲ Develop an outline Conceptual Site Model and a qualitative assessment of the potential for land contamination related liabilities to be present; and
- ▲ Complete a review of the flood risk associated with the Site.

A list of the data sources consulted is provided in Appendix A.

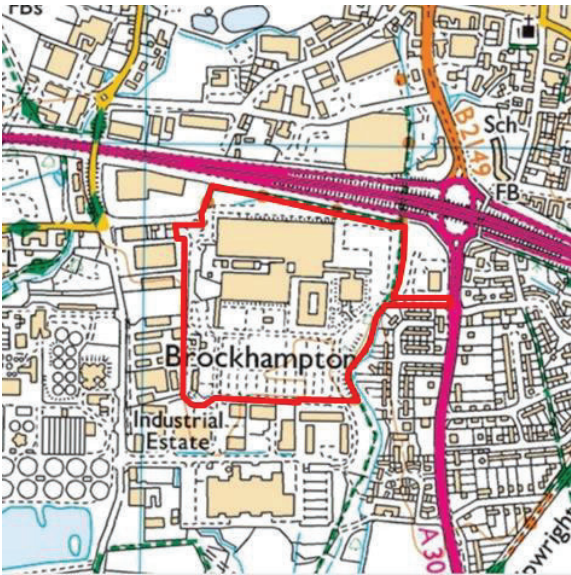
The scope of works did not include a Site reconnaissance; however, Delta-Simons have previously undertaken visits in 2015, 2018 and 2019.

1.4 Limitations

The standard limitations associated with this assessment are presented in Appendix B.

2.0 Site Context & Data Review

2.1 Site Information

 Contains OS data ©, Crown Copyright and Database Right (2020)		 Bing maps	
Site Location		Site Layout	
Co-ordinates	Centred approximately at National Grid Reference 471300, 105700.	Elevation	Approximately 4 to 8 m AOD
		Area	14.3 Ha
Site Location	The Site is located to the south-west of the junction of the A27 and A3023, in the Langstone area of Havant.		
Current Site Use	The Site is occupied by a science park comprising a number of interlinked commercial offices and light industrial buildings, with car parking in the south, east and north of the Site, hardstanding and access roads and landscaping confined to limited areas. A brief summary of the building uses is summarised below: ▲ Building 1000 (B1000) – predominantly offices (partly vacant) with some laboratories and a warehouse; ▲ Building 2000 (B22) – general maintenance store and water softening equipment; ▲ Building 3000 (B3000) – main plant room (including boilers and chillers); ▲ Building 4000 (B4000) – offices and canteen; ▲ Building 5000 (B5000) – data centre, offices and small electronics repair centre; ▲ Building 6000 (B6000) – main reception, offices and call centres; ▲ Building 7000 (B7000) – offices and laboratories; ▲ Building 41 (B41) – gym; ▲ Building 42 (B42) – electrical substation; and ▲ A nursery is also present in centre of the Site.		

Previous Site Reconnaissance	Delta-Simons has conducted Site visits on 29th July 2015, 27th April 2018 and 18th June 2019 as part previous assessments. A series of Site photographs from the walkovers are presented as Appendix C and a Site Plan showing the references to the main features is presented as Figure 1. Pertinent information that was observed or reported on-Site is summarised as follows: ▲ A large waste storage area and waste processing building (E and 1C, Figure 1) constructed in circa 2011 was present in western part of Site, comprising: two compactors for general, mixed recycling and cardboard waste, trade waste bins and wheelie bins. A large water tank and pump room was also located in this area. Two further waste storage areas comprising the same waste streams but also including feed waste were located adjacent to the backup generator by B4000 (1D, Figure 1) and within B4000 (1E, Figure 1) associated with food waste and banded waste cooking oil storage (spill kits were noted to be present). Dark staining was noted on the asphalt hardstanding in the vicinity of the waste cooking oil. A large cooking pot containing waste oil was also noted in this area without secondary containment. A Waste Electrical and Electronic Equipment (WEEE) bin and a fluorescent light bulb container were stored at ground level in B1000 (1F Figure 1); ▲ A diesel back-up generator with an associated banded 1,400 L capacity aboveground storage tank (AST) and a battery bank was located on an enclosed concrete platform between B3000 and B4000 (1D, Figure 1). No staining was noted beneath the external fill point or within the tank bund, however, minor staining was present beneath the generator unit. Spill kits were observed in this area. The Site representative stated that the AST was refilled manually using 200 L drums once per year. The bund was also fitted with a leak alarm; ▲ A tenant operated diesel-powered back-up generator with an associated approximate 6,000 L capacity AST was located adjacent to the west of B2000 (1G, Figure 1). The Site representative informed Delta-Simons of a small diesel leak, however, this was contained within the generator's transmitter box in 2018. The total amount of spilled oil was approximately 3 L; ▲ The Site representative stated that there were a further three tenant operated diesel-powered back-up generators located within B1000. However, no access was granted during the Site walkover; ▲ Two sprinkler pumps were located in B1000 (1F, Figure 1) of which one was electricity powered and one diesel powered. The diesel powered pump was connected by aboveground pipework to an approximate 1,000 L capacity AST situated in a bund. No hydrocarbon staining was noted within the bund or within the vicinity of the pipework and pump. The Site representative indicated that the AST was refilled manually from drums using a hand pump; ▲ Asbestos containing materials (ACMs) are common across the Site. An online, interactive register is held and asbestos signage is present in several areas. Envirochem were reportedly responsible for annual reinspection and asbestos removal at the Site. A secure ACMs store (assumed from maintenance activities) and fire extinguisher store was located within B1000 Area 3 (1F, Figure 1). ACMs are collected by a specialist contractor on an ad-hoc basis; ▲ A former chemical storage and processing area (V, Figure 1) was present in the south-west of the Site. Only concrete plinths and bunds remained, and no significant staining was observed. One of the bunds was reportedly undergoing infilling with construction materials (asphalt, concrete etc.). A former vehicle washdown area/catchment pit was present in this area, and an area of adjacent car parking was noted to be partially flooded; ▲ The area in the south-west (V, Figure 1) in 2015 was reportedly associated with a deionised water production plant and caustic storage area, in addition to an effluent treatment plant and buffer holding tanks. Used engines/ motors were noted to be stored on pallets externally in this area in 2015;
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	▲ In 2018, a newly landscaped area with a vent pipe (assumed associated with drainage) was located along the south-western Site boundary; ▲ A former gardener's store was present in the south-west (N, Figure 1); ▲ A secure drum store with several 200 L capacity drums containing substances marked as toxic organic solids, mixed agrochemicals and agrochemical washings (some provided with drip trays) was situated at ground floor level in the south-western area of B1000. A compressed gas cylinder store was also located in this area which included air, nitrogen, hydrogen and helium (F, Figure 1). A bunded 10,000 L capacity AST for diluted waste process fluid, associated with fertilizer application research, was additionally located in the area of the drum store; ▲ A waste pallet storage area and compactor were present to the west of B5000 (G, Figure 1); ▲ Gardening waste storage, a contractor parking area and former electricity substation were located to the south-west of B5000 (H, Figure 1); ▲ A total of 15 electrical plant rooms were present across the Site (including J, K and L, Figure 1), including substations, transformers and electrical switch gear. All appeared to be in good order and no spillages of transformer oils was noted, barring minor staining within a transformer bund to the east of B3000. During the walkover in 2018, Delta-Simons was informed by the Site representative that all PCBs had been removed and converted to silicone-based oils; ▲ A building (B22) in the north-west of the Site (M, Figure 1) was used as a general maintenance store and contained a brine tank, water softening tanks and rainwater tanks. Also, present were: two 200 L capacity drums containing switchgear insulating oil on a wooden pallet; two 200 L drums containing waste water and glycol mix; a small hazardous chemical store; battery store; paint locker; rock salt store; gardening equipment; and chemical store. Delta-Simons was informed by the Site representative that a former pH testing and deionising plant had been removed approximately 10 years ago. A disused waste process water treatment plant was also located in B22; ▲ During the 2015 walkover, the Site Facilities Manager stated that the area around B22 had been used by the former tenant (IBM) as a chemical store and processing area, with two remnant ASTs remaining in 2015. The former processes were understood to include air and chemical extraction systems, solvent recovery plant, carbon absorption tanks, and storage of hydrochloric acid, sodium hyperchloride, xylene, nitrogen and cyanide; ▲ B3000 (1H, Figure 1) contained three gas boilers, water treatment chemicals (zinc chloride, biocide, sodium nitrite and potassium hydroxide all provided with secondary containment) and three chillers; ▲ During the 2018 walkover, a small diesel spill from a vehicle was reported in the south-west of the southern car park area, which was reported to have been managed with spill kits. Also, empty cooking oil drums and an abandoned vehicle were identified next to the Mill Stream; ▲ In 2015, Delta-Simons was informed by the Facilities Manager that a pollution incident which required remediation works had occurred in 1984, however, no further details were available; ▲ A surface water pump house was present to the east of B6000 (O, Figure 1); ▲ According to a drainage plan provided for review on-Site, eight oil interceptors are present within the Site's surface water drainage system (including P & Q, Figure 1) which were reported to be inspected every six months and serviced/ emptied every 18 months. The Site representative indicated that surface water runoff from the eastern area of the Site discharges into the Mill Stream; and
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	▲ A discharge consent (Ref: 725513403, dated 13th July 2007) for the release of waste-water from the cooling tower system to the sewer is held on-Site. <i>While chemical storage, diesel back-up generators and electrical substations were present on-Site, the Site appeared well managed and no significant potential contamination concerns were noted associated with the current Site use. However, based on discussions with Site personnel and observations, potentially contaminative processes were undertaken on-Site associated with the former use, particularly in the south-west and in the central western area. A former pollution incident was also reported in the 1980's.</i>	
Current Surrounding Area	North	Landscaping and the A27 with a retail park beyond (including a petrol filling station).
	East	The Mill Stream with a hotel, restaurant and residential properties with gardens beyond.
	South	Endeavour Business Park comprising commercial office and distribution units.
	West	Commercial office, distribution and light manufacturing units with a sewage works beyond.
	<i>The surrounding land use is considered to represent a potential off-Site source of contamination.</i>	
Future Redevelopment	It is understood that the Client may undertake redevelopment of the Site in future. Planning permission has been granted for 'Part-demolition of Building 1000 and associated works; the erection of new flexible use industrial units; and a new parking layout with associated works' on 22nd July 2020 (reference: APP/19/00703). However, the current proposed masterplan includes additional redevelopment of the majority of the Site to include the demolition of several buildings and refurbishment of Buildings 4000 and 6000, with the addition of a multi-storey car park. A copy of the masterplan is provided as Drawing 1.	

2.2 Environmental Setting

Geology	From Geology Mapping within the Envirocheck® Report and information provided by the BGS, the Site is indicated as being predominantly underlain by superficial deposits of Alluvium comprising clay, silt, sand and gravel. River Terrace Deposits, comprising sand, silt and clay are shown in the north-western and south-western corners of the Site. A small area of Head Deposits, comprising clay and gravel, is shown in the south-west of the Site between the boundary of the Alluvium and Terrace Deposits. The underlying bedrock comprises the Lewes Nodular, Seaford, Newhaven, Culver and Portsdown Chalk Formations. An area of Made Ground is shown adjacent to the north-east of the Site. While no Made Ground is shown on-Site from available BGS mapping, given the development history, Made Ground would be anticipated to be present above the superficial deposits.
Specific Geology	During an investigation across the southern area of the Site in 2019, ground conditions identified comprised: ▲ Tarmac and sub-base, or grass and topsoil, underlain by Made Ground (granular deposits with brick, concrete and occasional pottery and slate or cohesive deposits with gravels including flint, concrete and occasional brick and chalk) to 3.1 metres below ground level (m bgl);

	▲ Superficial River Terrace/ Brickearth across the majority of the Site comprising silty, sandy gravelly Clay, with silty peat identified at one location to, and also clayey sandy gravel to 5.5 m bgl; ▲ Weathered Chalk bedrock comprising sandy gravelly clay or clayey sandy gravel with gravel comprising chalk and flints to 6.0 m bgl; over ▲ Chalk to a maximum depth of 24.9 m bgl. Fragments of organic material (including decaying wood, rootlets and grass) were also identified at three locations between 0.2 m and 3.1 m bgl.
Hydrogeology	The EA classifies the superficial deposits as Secondary A Aquifers and the Chalk as a Principal Aquifer. The EA data also indicates that the Site is not in a designated groundwater Source Protection Zone (SPZ), however, a SPZ 1 (inner zone) is located approximately 170 m to the north-east associated with two potable groundwater abstractions listed 460 m to the north and 710 m to the north-west. During a recent investigation, groundwater was identified within the superficial deposits between 2.1 and 2.8 m bgl rising to 2.0 and 2.5 m bgl. Within the two deeper locations, groundwater was identified at depths of 5.8 and 6.0 m bgl rising to 3.0 m bgl.
Hydrology	The Mill Stream is located adjacent to the east of the Site, which flows to the coast approximately 750 m to the south. According to the Envirocheck® Report, there are no licensed abstraction records from surface water located within 1 km of the Site.
Coal Mining	The Site is not located within an area that is potentially affected by coal mining activity.
Radon Gas	The Site lies within an area where less than 1% and 3-5 % are at or above the Public Health England recommended "action level" for radon. The Envirocheck® Report indicates that basic radon protective measures are necessary in the construction of new buildings or extensions at the Site.
Ecological Receptors	It is understood that there is a tree preservation order in place for the north-western area of the Site. It is understood from information provided within the Envirocheck® Report that the Chichester and Langstone Harbour, listed 315 m to the south and 459 m to the south east of the Site, is classed as: an Area of Outstanding Natural Beauty; a Ramsar Site; a Site of Special Scientific Interest; and a Special Protection Area.
Heritage Interest	According to historicengland.org.uk, the closest area of heritage interest is located approximately 95 m to the north-east of the Site associated with a Grade II Listed Building (Langstone Hotel). The Solent Maritime located 545 m south-west is also classified as a Special Area of Conservation.
Environmental Sensitivity	<i>The Site is considered to be of a moderate environmental sensitivity given: the presence of Secondary A Aquifers (which comprises some cohesive deposits) over a Principal Aquifer; the proximity of the Mill Stream; the presence of statutory designated ecological sites downstream of the Site (Chichester and Langstone harbour); and the mixed commercial, light industrial and residential use of the surrounding area.</i>

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, Google Earth historical satellite imagery and other sources. A summary of the key historical Site uses and developments in the surrounding area is presented below. Copies of pertinent historical maps are included as Appendix D.
Historical Features On-Site	From the earliest available mapping dated 1867, the Site was predominantly in agricultural use with small unspecified buildings, watercourses, and an orchard partially located in the north-west. On 1897 mapping, an aqueduct and sluice were labelled along a watercourse in the south of the Site, subsequently labelled as a drain from 1953 mapping. By 1909 mapping, the north-east of the Site was developed with a sewage works with associated filter and sludge beds, and an engine house. Further development to both the sewage works and small buildings are noted between 1932 and 1969 mapping. From 1953 mapping, an allotment garden was labelled in the centre of the Site. From 1968 mapping, the entire Site had been redeveloped with a works and hardstanding in the centre of the Site. A separate building and an electricity substation were located in the south of the Site also at this time. It is noted that slopes are shown surrounding the majority of the buildings suggesting that Site levels were raised. Between 1984 and 1989 mapping, the Site was further developed to a layout largely consistent with the current format when the southern third of the Site was redeveloped with car parking removing the former structure in this area. Also, the south-west of the Site was occupied by several tanks, with further tanks and an electricity substation labelled in the west of the Site. A review of aerial imagery provided by Google Earth shows the Site in its contemporary layout between 1999 and current imagery, with the exception of minor reconfiguration of plant and buildings in the south-west of the Site and around B22.
Historical Information from other Sources	From internet searches, it is understood that the current Langstone Technology Park was formerly used by IBM as a computer products manufacturer (known as IBM Havant where many IBM computer products were made, such as disk files, mainframe computers, printers, ATMs, multiplexors and mid-range computers). In 1994, the Site began trading as Xyratex. A WSP 2005 assessment (discussed in Section 2.7) reported that the Site representative stated that B1000 was historically used for wet manufacturing processes. This included activities such as etching and substrate processes. The Site representative also reported to WSP that remediation in the form of decontamination of acid, arsenic and copper penetrated concrete was undertaken in 1998/ 1999 in B1000. This is reported to have involved the removal of concrete until it was proven that the remaining concrete was no longer contaminated. Effluents generated from B1000 were reported to be transferred to B41 (south-west corner of the Site) for treatment. After treatment processes were undertaken, the effluent was discharged from the Site via foul sewer. This discharge was reportedly regulated by a trade effluent discharge consent. The effluent treatment facilities were no longer operational in 2005 and had been partially decommissioned. It was also reported that B41 was historically used as a de-ionising water treatment plant. WSP indicated that B42 was reportedly formerly used for the storage of petroleum mixtures. A report produced by Campbell Reith Hill (discussed further in Section 2.7) suggests that the wider area was associated with decoy sites to draw German bombing raids away from areas such as Portsmouth during the Second World War.

Potentially Contaminative Historical Features Off-Site	Potential sources of contamination within 100 m of the Site include: ▲ Buildings associated with the wider sewage works located adjacent to the north of the Site between 1909 and circa 1969 mapping; ▲ Havant Mill (corn) located approximately 60 m to the north-east of the Site between 1867 and circa 1967 mapping; ▲ A works and plastics factory located approximately 25 m to the south-west of the Site from 1973 to the most recent map edition of 2015; ▲ A boatbuilding works/ unspecified works located approximately 50 m to the north-west of the Site from 1973. The unit was labelled as an unspecified works from 1993 and remains present; ▲ A pumping station with tank located approximately 25 m to the south-east of the Site from 1973 to circa 1993; ▲ A marine accessory works located approximately 60 m to the west of the Site from 1973. The unit increased in size by 1989 and was located 25 m west and the unit remains present; ▲ Industrial properties including factories, an electronics factory, an engineering works and a warehouse located approximately 80 m to the north of the Site from 1969 to circa 2006 when a large number of these were redeveloped as a superstore with a petrol filling station; and ▲ Further industrial units (including unspecified works, engineering works and factories) to the west from 1987 to the present. Within the wider area, pertinent features include Budd's Farm Sewage Works from approximately 125 m west from 1963. The works increased in size by 1969 and 1993, and remains present.
Unexploded Ordnance (UXO)	According to the Zetica risk map, the UXO risk at the Site is moderate. A Detailed Unexploded Ordnance Report by 1st Line Defence (DA8760-00, dated May 2019) has been identified for the Site. Overall, the report considered that there was a medium risk from German aerial delivered UXO and anti-craft UXO, with a low to medium risk from items of Allied Ordnance. A copy of the report is included within the Previous Reports as Appendix H.
Implications for Land Contamination Risk	<i>The historical uses of the Site, most notably the sewage works, computer manufacturing and ancillary processes, are considered to represent potential sources of contamination. Potential sources of contamination identified in the surrounding area include a mill, a sewage works, factories, an engineering works, a warehouse, a boatbuilding works/ works, a plastics factory, works, a pumping station with a tank and a petrol filling station.</i>

2.4 Environmental Database Review

Approach	The Landmark Envirocheck[®] Report provides a database of environmental information held by various bodies including the EA, Local Authority (LA), Health & Safety Executive (HSE) and the British Geological Survey (BGS) amongst others. A full copy of the Envirocheck[®] Report is provided in Appendix E and the most relevant information is summarised below.
Features On-Site	There are several relevant entries included within the Landmark Envirocheck[®] Report relating to the Site, summarised as follows: ▲ Four Discharge Consents (two noted to be 1 m off-Site; however, the operator names are consistent with the on-Site discharges) for the discharge of 'other matter-surface water' into a freshwater river, first granted in April 1978. The Site

	representative previously informed Delta-Simons that a discharge consent for the release of wastewater from the cooling towers into the sewers is held on-Site; ▲ Two revoked Integrated Pollution Controls associated with Adflex Solutions Ltd for processes involving halogens within the chemical industry. The permit, dated 1997, is assumed to be associated with a former operator at the Site; ▲ A Part B Permit (formerly Local Authority Pollution Prevention and Control) was granted to Teleplan and White Electronics in June 2013. From an internet search this is understood to be associated with the assembly of hard disk drive testers; ▲ A Licensed Waste Management Facility associated with Teleplan and White Electronics relating to a WEEE treatment facility in the west. The licence was issued in June 2013; ▲ Several areas of potentially infilled land which appear to be associated with the former drainage ditch network; and ▲ Three Contemporary Trade Directory Entries for a printers', general engineers and computer manufacturer.
Potentially Contaminative Features Off-Site	Pertinent entries in the Landmark Envirocheck® Report located within 100 m of the Site includes: ▲ Four Part B Permits associated with the coating of metal and plastic, and for the respraying of road vehicles; ▲ Two Pollution Incidents to Controlled Waters located 80 m east (minor incident) associated with the release of oils to a stream in 1995 and 95 m north-east (significant incident) associated with diesel in the stream from vehicle washing and de-waxing in January 1997; ▲ Four Registered Radioactive Substances located 45 m and 90 m north-west for the disposal of radioactive waste; and ▲ Thirty-three Contemporary Trade Directory Entries, which includes: tool design and manufacture; domestic appliance servicing; air conditioning; cleaning services; engineers (general, precision and aviation); spraying (paint & coatings); garage services (body builders and repairs); crane hire and sales; electronic component manufacture; and marine electrical services. Within the wider area, pertinent entries include: ▲ A Historical Landfill located 190 m to the south-west of the Site that was licensed to accept wastes types including household; no dates are provided; ▲ A Local Authority Recorded Landfill Site located 210 m to the south-west of the Site that was licensed to accept household, acid and commercial waste until December 1965; ▲ A Fuel Station Entry and Part B Permit associated with a petrol station located 140-150 m north of the Site; and ▲ A obsolete Fuel Station Entry located 140 m to the west of the Site.
Implications for Land Contamination Risk	<i>The former chemical processes and waste management facility are considered to represent potential on-Site sources of contamination. Whilst entries within the immediate vicinity of the Site have been identified, they are considered to represent limited potential sources of off-Site contamination.</i>

2.5 Planning Review

On-line Planning Portal	Havant Borough Council	Date Accessed	19/10/2020
Findings	From a review of the Council's online planning database, a large number of applications have been identified for the Site. These include a number of extensions, new car parking areas, new buildings, the creation of ditches and culverts, and for the installation of infrastructure (including a fume cupboard, waste compactor, back-up generators and cooling units) between the early 1990s and 2013. Pertinent applications identified include the following: ▲ <u>APP/10/00272</u> – 'Demolition of existing steel-clad building and two portacabins to make way for a single storey timber framed building to house a 52 place nursery school'. This application was granted consent in September dated 2010. No contaminated land conditions were set. ▲ <u>APP/13/00411</u> – 'Extension of standby generator room to accommodate attenuating louvre for installation of additional generator unit and installation of 6 Liebert and 3 Excool roof mounted cooling units'. This application was granted consent in June 2013; and ▲ <u>APP/15/00484</u> – 'Change of use from store to gym facility of B41'. This application was granted consent in July 2015. Whilst no contaminated land planning conditions were set, correspondence with the Environmental Control Officer dated July 2015, which included a Site inspection, indicated that while the potential for contamination could not be ruled out, the officer was satisfied that the change of use could go ahead without the need for intrusive ground investigation. However, this was caveated to say that should the area be redeveloped, the potential contamination risks should be further assessed. An Envirochem laboratory analysis report is provided which appears to relate to effluent in the area. The context of the testing is not clear and appears for waste disposal. The contaminant levels are generally low; ▲ <u>APP/19/00296</u> – 'Erection of a new building entrance structure, reception lobby refurbishment and associated hard and soft landscaping works (Building 6000)'. This application was granted consent in May 2019. No contaminated land conditions were set; ▲ <u>APP/19/00297</u> – 'Proposed alteration to the existing east facing elevation to accommodate a new entrance threshold and associated external works (Building 6000)'. This application was granted consent in June 2019. No contaminated land conditions were set; ▲ <u>GEN/19/00354</u> – 'EIA Screening Opinion - Erection of new industrial units and rationalisation of south car park, demolition of part of the northernmost building with new elevation on the remaining part of the building, new screen on adjacent building and extension to existing car park'. No documentation was available to view on the online planning portal. This application was decided in May 2019, however, there is no information to confirm whether an EIA was undertaken; and ▲ <u>APP/19/00703</u> – 'Part-demolition of Building 1000 and associated works; the erection of new flexible use industrial units; and a new parking layout with associated works to layout and access and felling of two trees subject to a Tree Preservation Order (Norway Maples)'. The application was granted in July 2020. As part of the application a Preliminary Risk Assessment (19-0687.01) by Delta-Simons was submitted, and information from the Environmental Control Officer indicates that the Council were in agreement of the recommendation for intrusive investigation. Subsequently, a contaminated land condition was imposed as Condition 9 and		

	required: an intrusive investigation (Part 1), and if required the submission of an appropriate remediation strategy (Part 2) and verification plan (Part 3). Copies of the relevant documentation is provided as Appendix F.
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2.6 Regulatory Authority Consultation

Local Authority – Part 2A	From correspondence in August 2015 with the Contaminated Land Officer (CLO) at Havant Borough Council, the CLO confirmed that the Site is not considered to be a priority for inspection under Part 2A of the EPA 1990. During a subsequent telephone conversation as part of a 2018 assessment and email exchange in 2020, the CLO confirmed that the Site's status under Part 2A remains unchanged.
Local Authority – Additional Comments	The CLO confirmed in August 2015 that the former uses of the science park were associated with manufacturing, research and development and waste processing activities. Potential sources of contamination identified by the CLO include on-Site transformers, boiler house, UPS facilities, fuel stores, flammables storage and sealed drainage systems with the majority concentrated in the south-west of the Site. The CLO noted in August 2015 that they had undertaken a visit to the south-western corner of the Site (associated with planning application APP/15/00484). No comments in relation to significant concerns were identified at that time. Whilst the CLO identified potential sources of contamination from diesel fuel and 'flammables' likely to be toluene BTEX and possible plasticisers (phthalate, vinyl chloride), the CLO noted that given the good management practices, provision and condition of containment and the lack of staining or spillages, the risk of contaminant release was considered to be low. The CLO also noted that the Council is aware of three separate reports associated with the Site, however, it was not known if these were in the public domain: ▲ Travers Morgan, dated 1993; ▲ Structural Soils Ltd, dated 1995; and ▲ GVA Grimley, dated 1999. As part of the 2018 enquiry, the CLO issued several reports relating to the Site or nearby land, which are discussed in Section 2.7. A copy of the previous and current Regulatory Authority response is included as Appendix G.
Building Control	The WSP 2005 report (discussed in Section 2.7) references consultation with the Building Control Officer at Havant Borough Council. The Officer is reported to have informed WSP that the Site was raised above ground level thereby reducing the possibility for flooding. The Officer is reported to have commented that they were unaware of any significant ground stability issues within the area. However, they were aware that part of the subject Site had been built with piled foundations. WSP reported that the Officer was unaware of any ground gas problems in relation to the historical use of the Site or from current neighbouring site activities. Additionally, WSP reported that the Officer was not aware of any flooding issues in the immediate area of the Site, although the Officer did confirm that the 'Langstone Mill Stream' adjacent the Site boundary was known to be susceptible to partial flooding further inland.

2.7 Previous Reports

List of Reports	Delta-Simons has obtained the following reports relating to the Site and wider area: ▲ Ground Investigation Report, IBM, Langstone Road by Soils Limited dated April 1994 (extracts only and relates to land off Site to the south); ▲ Wetland Study by Symonds Travis Morgan dated April 1997 (relates to land off-Site to the south); ▲ Contamination Assessment Report by Campbell Reith Hill dated May 2001 (relates to land off-Site to the south); ▲ Site Investigation Report by STATS dated October 2003 (relates to the north-west of the Site); ▲ Phase I Environmental Audit by WSP dated September 2004 (relates to the entire Site); ▲ Geo-Environmental Appraisal Report by Clancy Consulting, dated October 2019 (relates to the north-east and south of the Site; and ▲ Supplementary Site Investigation by Clancy Consulting, dated September 2020 (relates to the north-east and south of the Site). Copies of the reports are provided in Appendix H.
Soils Limited Ground Investigation (1994)	The available information comprises extracts only, with no Site plan or context of the assessment, however, the following was reported: ▲ Significant contamination was not identified in soil samples; ▲ Facial coliforms were identified in a groundwater sample (indicated to likely be associated with an 'offsite' sewage works or damaged foul pipe); ▲ No putrescible materials that could give rise to hazardous gases was encountered; ▲ A landfill site was located to the west; ▲ No significantly elevated ground gases were recorded; and ▲ Piles or ground improvement was recommended.
Symonds Travis Morgan Wetland Study (1997)	The report relates to land to the south and presents a detailed hydrogeological study associated with the then proposed development to the south of the Site. While the majority of the information is irrelevant to this assessment, a plan in the report confirms that the above Soils Limited Ground Investigation relates to land off-Site to the south of the Site.
Campbell Reith Hill Contamination Assessment (2001)	The report relates to land off-Site to the south and indicates the following pertinent information: ▲ Previous investigations are reported to have identified that historically sewage sludge spreading may have taken place. One of these investigations reported elevated levels of mercury concentrations in the drainage ditches and waters adjoining the site. The spreading of sewage sludge and a historical nearby plating works were identified as possible sources. No recordable concentrations of mercury were however identified in the soils by the following investigation; and ▲ Slightly elevated concentrations of polycyclic aromatic hydrocarbons (PAH) and arsenic were recorded in soils and sediment from drainage ditches, however, they were below the adopted screening criteria.

STATS Site Investigation Report (2003)	The report relates to the north-western area of the Site in relation to a proposed new paved car park and roundabout (which does not appear to have been taken forward). The assessment comprised a desk study and ground investigation comprising the excavation of 13 trial pits and 8 dynamic cone penetration tests (to generate CBR values). No exploratory hole plan is provided. Pertinent points are summarised as follows: ▲ A sub-surface concrete tank was uncovered which was presumed to be related to the sewage works that were present on the Site. The tank was found to be in-filled with a clayey sand containing many whole bricks and occasional metalwork; ▲ Elevated copper and zinc were recorded, although below Delta-Simons screening values, and all other soil contamination was below the screening criteria adopted by STATS. No groundwater analysis was conducted; ▲ Geotechnical hazards reported included shrinkable clay soils, compressible soils, obstructions, Made Ground and silt rich soils; ▲ Aggressive Chemical Environment for Concrete (ACEC) Classification is AC-1s with a Design Sulphate Class of DS-1 was reported. STATS suggested that a design CBR value of 6% could be adopted; and ▲ STATS considered the Site fell into the "moderately low subsidence risk" category relating to potential chalk dissolution and states that Edmund's database of known natural and man-made chalk solution features illustrates there are no such features in the immediate vicinity of the Site.
WSP Phase I (2005)	The report was undertaken in the context of the proposed investment purchase of the Site. Potentially contaminative activities identified during a Site walkover were limited to the storage of diesel fuel in two above ground storage tanks (with a total capacity of 3,000 litres) and the storage of waste materials. No significant issues were identified associated with the current use of the Site. The following third-party reports were also reviewed by WSP as part of the assessment (not seen by Delta-Simons): ▲ A 1999 Environmental Monitoring Program undertaken by CASELLA Ltd. The report detailed results of effluent monitoring, industrial emissions monitoring, groundwater monitoring, surface water monitoring and building fabric monitoring. It was stated that the report reviewed a number of intrusive and non-intrusive investigations, which identified potential issues associated with: low concentrations of toluene and purgeable hydrocarbons from effluent monitoring for B2000; groundwater contamination associated with chlorinated solvents; and copper contamination within a concrete slab. It was noted by WSP that the effluent treatment facility had been decommissioned, that the identified groundwater contamination was outside of the Site boundary and that the concrete slab had been remediated; ▲ A 1999 Initial Ground Investigation by Soil Consultants Limited (reported to have been associated with the northern area of the Site), which was stated to have identified potential issues associated with elevated levels of cadmium within two boreholes, and elevated levels of arsenic, lead, copper, zinc and mercury within a single borehole, however, it was noted by WSP that the soil guidance values used for comparison at that time were no longer applicable; and ▲ A 2004 Addendum, Site Investigation Report undertaken by STATS. It was stated that the report identified potential issues associated with elevated levels of ground gas within Made Ground. It was noted that the report was based on a single monitoring event and did not record flow rate. It is also suggested that Batelle UK Limited and Havant International Limited had an outstanding intrusive investigation report for the north-west area of the Site, with intrusive

	boreholes placed west of B1000 to assess groundwater and other ground environmental factors. This report has not been seen by Delta-Simons. WSP concluded that based upon the information and intrusive investigations reviewed, no significant contamination issues had been identified for the continued commercial use of the Site. However, it was noted that the potential presence of residual contamination, which may require remediation in the event of redevelopment could not be discounted. It was considered that the Site represented a low/ medium environmental risk.
Geo-Environmental Appraisal (2019)	Clancy undertook an intrusive investigation in July 2019 across the north-eastern and southern areas of the Site to support the demolition and redevelopment works detailed in planning application APP/19/00703. The report also includes limited discussion of the UXO Report discussed above in Section 2.3. Investigation works at the Site included the advancement of eight window sampler boreholes to 5.5 m bgl, four hand trial pits to 1.4 m bgl, four cable percussive boreholes to 24.9 m bgl and the excavation of two trial pits for soakaway testing purposes. Visual and olfactory evidence of hydrocarbon contamination was identified at two locations (WS2 & WS5) between 1.0 to 1.6 m and 2.5 to 3.5 m, respectively. From nine samples of Made Ground and six samples of natural soils, no elevated levels (in comparison to Site Screening Values (SSV)) of inorganic contaminants for a commercial/ industrial end use were identified. In regard to organic determinands, elevated levels of hydrocarbons (aliphatic C10-12, C12-16 & Aromatic C12-16) were identified at WS2 and WS5 noted to be above 'Water Screening Values'. It is noted that from a review of the values, these fall below Delta-Simons soil Generic Assessment Criteria (GAC) for a commercial/ industrial use; however, exceed GAC values for potable water. It was noted by Clancy that no elevated levels of hydrocarbons were identified from samples taken from 3.9 m bgl. Clancy noted that WS2 was located in an area of former waste storage and existing substation, with WS5 located adjacent to historical tanks in the west which were considered to likely be the source of contamination. From four rounds of gas monitoring, carbon dioxide levels were identified up to 7.2 % v/v with a maximum flow rate of 0.7 l/hr. No elevated levels of methane were identified. The Site was considered to represent a Characteristic Situation 1; however, given the level of carbon dioxide (above 5 %), depth and nature of the Made Ground, and presence of peat in the area, Clancy recommended for the Site to be raised to a Characteristic Situation 2. Overall, the following recommendations were provided: ▲ Additional investigations in the area of WS2 and WS5 to delineate the identified hydrocarbon contamination with regards to controlled waters; ▲ Preparation of a remediation strategy following delineation; ▲ The installation of gas protection measures in line with CS2 within new units with independent verification; and ▲ The consideration of UXO during future excavations with the potential for supervision by an EOD engineer to brief and support site personnel.
Supplementary Investigation (2020)	Clancy undertook a supplementary investigation across the south of the Site in July 2020. The report also makes note of two letter reports by Clancy Consulting from September 2019 (10/1425/002) and June 2020 (10/1425/003), which have not been seen by Delta-Simons; however, information from these was noted to be included within the report. Further works at the Site included the advancement of two cable percussive boreholes to 20.0 m bgl, and twenty-five window sample boreholes to 4.5 m bgl.

	Ground conditions identified Made Ground (consistent with the material identified in 2019) to 1.1 m bgl. Visual and olfactory evidence of contamination was identified at one location. From three samples of Made Ground and twenty-four samples of natural ground, a slight exceedance of perylene was identified at one location; however, given the very low value and relatively low volatility, this was not considered to represent a significant risk to future Site users. Total petroleum hydrocarbon (TPH) compounds were recorded in Made Ground in excess of solubility limits at two hotspot locations along with a number of elevated volatile organic compounds (VOC) and semi-volatile organic compounds (SVOC). From six groundwater samples, slight exceedances of lead and nickel were identified at one location, along with marginally elevated total PAH (maximum of 0.96 µg/l) and TPH (maximum of 283 µg/l); however, the concentrations were not considered to be significantly elevated. It was noted by Clancy that no elevated source of PAHs was identified within soils, and it was considered that this was representative of either an off-Site source or on-Site source which had not yet been identified. Based on testing it was considered that the majority of Made Ground and natural soils would be suitable for disposal as non-hazardous waste with localised TPH impacted soils requiring disposal to a hazardous waste landfill. Overall recommendations for the proposed development included the following: ▲ Development of a Remediation Method Statement; ▲ Development of a Materials Management Plan if Site won soils are proposed for re-use on-Site; ▲ Excavation and removal of identified contamination hotspots in the vicinity of WS2 and WS5 with subsequent inspection and verification of excavation works; ▲ Implementation of a watching brief for previously unidentified soil contamination during the groundworks; ▲ Collection and laboratory analysis of soil samples from finished formation level across the Site to verify that residual contaminant concentrations are below guidance values; and ▲ Provision of a Verification Report to assist with discharge of planning conditions relating to contaminated land.
Implications for Land Contamination Risk	<i>Several ground investigation reports appear to have been produced for the Site, a number of which have not been seen by Delta-Simons. Based on the recent available information, two hotspots of hydrocarbon contamination have been identified with recommendations for off-Site removal, and it was considered for the areas investigated basic gas protection measures should be installed.</i>
Implications for Redevelopment	<i>Considering the recent investigations only covered areas in the north-east and south, and the proposed development covers the majority of the Site, further intrusive investigation is recommended.</i>

2.8 Flood Risk Advisory

Initial Flood Risk Review	A review of mapping provided by the EA indicates that whilst the majority of the Site is not located within an area at risk of flooding from rivers or the sea, a small area of the access road is shown to be at medium risk of fluvial flooding from Mill Stream. Anecdotal information previously provided from a Site representative indicates that this small area of the access road does not have a history of flooding.
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	The EA Long-Term Flood Risk Map (Surface Water) indicates the majority of the Site largely to be at very low risk from surface water flooding. There are localised areas of low risk, small areas of medium risk (around the boundary of Building 5000 and the south-west corner of Building 7000), and an isolated pocket of high risk associated with a localised topographical depression south of Building 1000. During previous Site visits, Delta-Simons was informed that all surface water from the car parking passes through interceptors and a surface water pumping station in the east of the Site, prior to discharge into the Mill Stream. It was also noted that water ingress occasionally occurs within a electrical switch room located within Building 1000 following intense rainfall with evidence of sandbags and flood barrier observed at the entrance. The Site is located within an area considered to be at potential susceptibility from groundwater flooding; however, no incidents of groundwater flooding have previously been highlighted. Delta-Simons has previously reviewed a Foul Water Flood Risk Assessment produced by Atkins in 2008 (2008 FRA) which highlighted an incident of historic foul water sewer flooding in 2008 due to surcharge of the foul water system. The 2008 FRA also recommended several mitigation measures to prevent flooding associated with the foul water systems on-Site. Information provided to Delta-Simons in 2019 indicates that a non-return valve was installed near Building 7000, which is likely to reduce the risk of sewer flooding at the Site. It should be noted that all the flood maps are <u>indicative</u> only.
Clancy Consulting Flood Risk Assessment and SUDS Strategy (2019)	A FRA and SUDS strategy was produced for the Site in 2019 associated with the proposed reconfiguration of Building 1000, addition of car parking and redevelopment of the south-western area of the Site. Overall, it was considered that the development area was at low risk of flooding (from all sources) with the proposed drainage to attenuate flows from impermeable areas to current run off rates through underground geocellular tanks, oversized pipes, permeable paving and flow control devices. Two letter reports by Clancy have also been identified from August and October 2019 which further discuss the potential flood risk at the Site following comments from the EA. The letter reports note that a flood defence (embankment) is present to the east of the Site which comprises a crest height of approximately 2 m above the modelled river level (including 20% climate change) which would therefore provide suitable protection from potential flood events.
Implications for Flood Risk	<i>Based on the information reviewed, the majority of the Site is not located within an area considered to be of an elevated risk of fluvial flooding. Whilst a small area of the access road in the east of the Site is shown to be at moderate risk of flooding associated with the Mill Stream, this is understood to be protected by an embankment.</i> <i>Several areas of the Site are shown to be at potential risk of surface water flooding, however, no associated issues were reported on-Site with the exception of minor water ingress at Building 1000.</i> <i>Available information indicates that flooding events have occurred at the Site associated with surcharging of the foul system, however, it is understood that a non-return valve was installed at the Site.</i>
Implications for Redevelopment	<i>Whilst a Flood Risk Assessment is available for the current development proposals, it is likely that a further assessment and drainage strategy will be required to support the proposed redevelopment of the Client's masterplan.</i>

3.0 Land Contamination Risk

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 Contaminant Linkages (PCL).

Where PCL are identified, a preliminary risk assessment is undertaken to assess the likelihood that each possible linkage exists and to determine whether these pose potentially unacceptable risks to identified receptors and require further assessment. Where this linkage is of a form that subsequently leads to the potential for land being identified as 'contaminated land' under the terms of Part 2A of the Environmental Protection Act 1990, the linkage is termed a significant contaminant linkage.

At the preliminary risk assessment stage, which is typically based upon desk study information and Site reconnaissance, the decision on whether a PCL poses a potentially unacceptable risk is based upon professional judgement. The significance of the PCL will also be determined dependant on the context of the land use and the purpose of the assessment.

Assessing risks from land contamination underpins the suitable for use approach adopted under Part 2A of the Environmental Protection Act 1990 and its associated regulatory regime.

3.2 Conceptual Site Model

The Site is occupied by a science park comprising a number of interlinked commercial offices and light industrial properties, with car parking in the south, east and north of the Site, hardstanding and access roads, and landscaping confined to limited areas. While chemical storage, diesel back-up generators and electrical substations were previously identified on-Site, the Site appeared well managed and no significant potential contamination concerns were noted associated with the current Site use.

The Site was predominantly unoccupied until the development of a sewage works in the north-east by 1909. By 1973, the sewage works was no longer present, and the Site had been redeveloped into an IBM computer products manufacturer. Since the 1970's, some redevelopment has occurred on-Site, though the main buildings have largely remained unchanged. Potentially contaminative uses associated with the computer manufactory include previous 'wet' processes in B1000, diesel powered boilers in the area of the current gas boiler systems (B3000), an effluent treatment and chemical storage area in the area of B22, and effluent treatment and former chemical storage in the area of B41 and B42. Also, a former pollution incident was reported to have occurred in the 1980's, however, no further details are known.

Potential sources of contamination identified in the surrounding area include a mill, a sewage works, factories, an engineering works, a warehouse, a boatbuilding works/ works, a plastics factory, works, a pumping station with a tank and a petrol filling station.

The Site is considered to be of a moderate environmental sensitivity given: the presence of Secondary A Aquifers (which comprises some cohesive deposits) over a Principal Aquifer; the proximity of the Mill Stream; the presence of statutory designated ecological sites downstream of the Site (Chichester and Langstone harbour); and the mixed commercial, light industrial and residential use of the surrounding area.

Based on the recent available information, two hotspots of hydrocarbon contamination have been identified with recommendations for off-Site removal, and it was considered for the areas investigated basic gas protection measures should be installed.

3.3 Contaminant Linkage Assessment

Based on the information reviewed within this Report, the following preliminary risk assessment table has been formulated, which identifies all PCL in the context of the Sites proposed redevelopment.

Risk definitions used for the following assessment are provided as follows:

- ▲ Low risk – Low likelihood and either no or mild severity. Negligible/ unlikely contaminated land situation. Either no action recommended, or possible action during changes in conditions;

- ▲ Moderate risk – Likely probability and medium severity. Plausible contaminated land situation. Possible action recommended following further risk assessment; and
- ▲ High risk – High likelihood and severe severity. Likely or demonstrable contaminated land situation. Action (possibly urgent) recommended.

Contaminant Linkage Assessment				
Source(s)	Pathway(s)	Receptor(s)	Risk Rating	Justification & Mitigation (if required)
Potentially contaminated soils and/or groundwater located beneath the Site.	Direct contact/ ingestion and inhalation of dust and vapours.	Site users.	Low Risk	Whilst the presence of further localised contamination is possible, given the Site is to be predominately covered by buildings and hardstanding, which will significantly constrain the associated pathways, the risk is considered to be low.
	Direct contact, ingestion and inhalation of dust and vapours.	Maintenance workers during any future sub-surface works at the Site.	Moderate Risk	Site workers may become exposed to localised contaminated soils and shallow groundwater during intrusive groundworks undertaken at the Site. Safe working practices should be undertaken and appropriate Personal Protective Equipment (PPE) should be used that will reduce the risk to low.
	Leaching of contaminants and vertical migration.	Groundwater beneath the Site.	Low to Moderate Risk	Previous investigations across the southern area of the Site have identified localised contamination and the potential for further localised contamination to be present is possible. Also, there is the potential for contaminants to be mobilised during construction works, and in the absence of Site-wide available information, the risk is considered to be low to moderate.
	Permeation of hydrocarbons through plastic pipe work.	Water supply pipes.	Low to Moderate Risk	Hydrocarbons, especially aromatics and chlorinated solvents are known to permeate plastic pipes, particularly when encountered at high concentrations. Whilst widespread hydrocarbon contamination was not previously identified, the proposed redevelopment may introduce water supply pipes to potentially localised areas of contamination. Upgraded water supply pipes may be required in order to reduce this risk to low.
	Lateral migration through any groundwater beneath the Site.	Off-Site receptors (neighbouring properties/ users and nearby surface water).	Low to Moderate Risk	The Mill Stream is located adjacent to the east of the Site and available information indicates that groundwater will be present at shallow depth. While the buildings and hardstanding across the majority of the Site will limit potential contaminant migration, the construction activities may mobilise contaminants. Therefore, the risk to off-Site receptors is also considered to be low to moderate.
Ground gas.	Vertical and lateral migration of ground gases.	Site users & the buildings on-Site.	Low to Moderate Risk	Based on the available information, slightly elevated levels of carbon dioxide were previously identified in the southern and north-eastern areas of the Site in line with Characteristic Situation 2. The Site is also partially located within an intermediate radon gas area. Based on the proposed development, basic gas protection measures are likely to be required in any new buildings.
Potentially contaminated soil and groundwater from off-Site sources.	Lateral migration and subsequent inhalation.	Groundwater beneath the Site and future Site users.	Low Risk	Whilst potential off-Site sources of contamination have been identified, given the proposed use of the Site, which will be predominantly covered by buildings and hardstanding, the risk to Site users is considerably reduced. Overall, the risk is considered to be low.

4.0 Conclusions & Recommendations

4.1 Land Contamination/ Ground Conditions

Risk Assessment Summary/ Conclusions	Delta-Simons has completed a land contamination risk assessment based upon available information. Information has indicated that significant widespread contamination is unlikely to be present. However, localised contamination was recently identified at the Site, which it has been recommended to be remediated (excavated) and given the historical use of the Site, the potential for further localised contamination to be present is possible. It is, therefore, considered that the risk of significant possible contaminant linkages to exist is low to moderate for a continued use and for the proposed redevelopment.
Recommendations – Ongoing Use	No further works are considered to be required for land contamination purposes in the context of an ongoing use.
Recommendations – Future Redevelopment	Given that a future redevelopment of the Site is proposed that covers a wider area than originally investigated, it is expected that the regulatory bodies will require a further intrusive investigation, under the planning process. In the first instance, it is recommended that an up to date Preliminary Risk Assessment is completed and submitted along with any future planning application. Following an updated Preliminary Risk Assessment and Ground Investigation, a Detailed Quantitative Risk Assessment (DQRA) may be required in order to confirm whether any remedial works are required and in order to derive Site-specific remediation targets. Following a DRQA, localised remedial works is possible. Also, additional costs could be incurred by: any ground materials requiring off-Site disposal; the upgrading of water supply pipes; the provision of ground gas/ radon protection measures; and importing clean/ certified topsoil in any areas of future landscaping. Ground conditions are variable with deeper areas of Made Ground and relic foundations from historical structures. Ground improvement and/ or a piled foundation solution are likely to be required, which costs should be considered. It is also prudent to further consider the potential for encountering UXO during future groundworks. Any ground workers who are required to perform sub-surface work at the Site should be made aware of the possibility of encountering localised contamination. Therefore, good standards of personal hygiene should be observed with appropriate levels of PPE provided and utilised and toolbox talks given to contractors prior to the commencement of works.

4.2 Statement of Risk/Land Contamination Liability Assessment

This Assessment considers both perceived and actual risks using the contaminant linkage concept, with the principal measure of risk being whether significant harm (to people, animals, property (including buildings, cattle etc.), or statutory ecological receptors) or pollution of controlled waters (surface water bodies, aquifers, coastal waters, or territorial waters) is being caused, or whether there is a significant possibility of such harm being caused.

The overall risk classification, based on the source-pathway-receptor principle, adopted for this preliminary assessment, is defined as follows:

- ▲ Low risk – issue unlikely to present a liability or cost;
- ▲ Moderate risk – issue may present a liability or cost, but these may be limited; and

▲ High risk – likely that significant liabilities and/or costs exist.

Regulatory Action under Part 2A, EPR or EDR	There is considered to be a Low risk of enforcement action by the regulatory authorities under Part 2A of the Environmental Protection Act 1990, the Environmental Permitting Regulations 2016 or the Environmental Damage Regulations 2015, whilst the Site remains in its current use. However, it should be noted that appropriate works (including additional intrusive investigation) will be required in order to support the future development proposals.
Third Party Liability	The potential for legal action by surrounding landowners based on the potential for contamination to migrate off-Site and result in private or statutory nuisance is considered to be Low .
Investment/Asset Impact	Delta-Simons considers there to be a Low to Moderate risk of impact on the value of the Site from significant contamination issues, in the context of the Site remaining in its current use or for the proposed redevelopment.
Overall Statement of Risk	On the basis of available information, Delta-Simons considers that with regard to potential soil and groundwater contamination issues and associated environmental liabilities, the Site represents an investment opportunity with a Low to Moderate overall risk status in the context of its current use and proposed redevelopment.

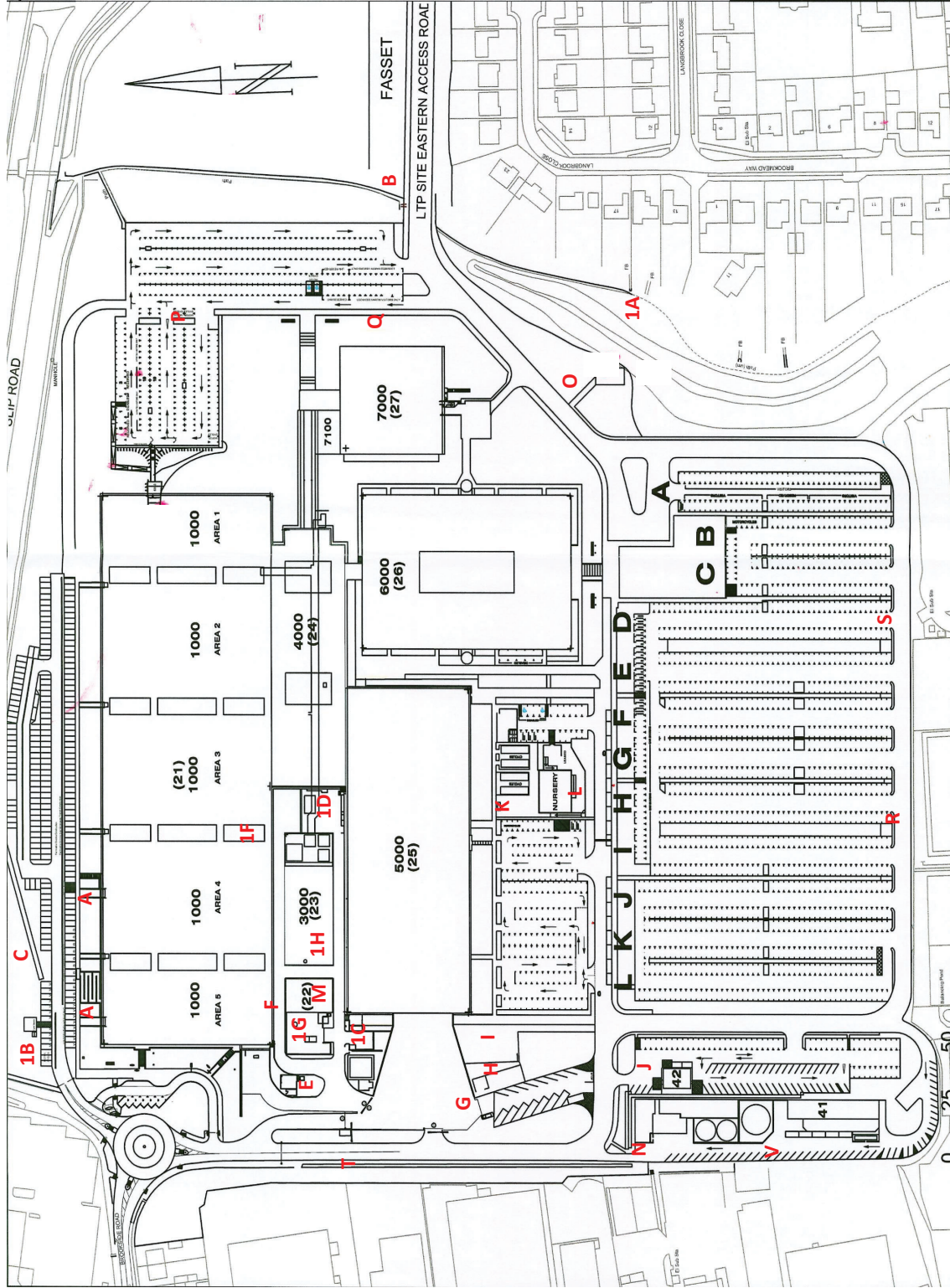
4.3 Flood Risk Advisory

Conclusions & Recommendations	Based on the information reviewed, the majority of the Site is not located within an area considered to be of an elevated risk of fluvial flooding. Several areas of the Site are shown to be at potential risk of surface water flooding, however, no associated issues were reported on-Site with the exception of minor water ingress at Building 1000. Available information indicates that flooding events have occurred at the Site associated with surcharging of the foul system, however, it is understood that a non-return valve was installed at the Site. Whilst a Flood Risk Assessment is available for the current development proposals, it is likely that a further assessment and drainage strategy will be required to support the proposed redevelopment of the Client's masterplan.
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4.4 Other Redevelopment Considerations

Recommendations	Additional environmental surveys were completed and submitted to the Local Planning Authority to support the previous proposed development works, which included those associated with ecology, heritage, air quality, noise and sustainability (BREEAM). These are all likely to require updating for any future planning re-submission.
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Figure 1 – Site Features Plan



Project No. 15-0574.02	Title Langstone Technology Park Figure 1 - Site Features Plan	Scale	Date
		NTS	07-May-18
			Drawn: KH Checked: SUB



Drawing 1 – Proposed Masterplan



GEO-ENVIRONMENTAL APPRAISAL REPORT

**Langstone Technology Park,
Havant,
Portsmouth
PO9 1SA**

**October 2019
Report Ref: 10/1425/001**

Prepared on Behalf of:

AG Langstone B.V.

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GEO-ENVIRONMENTAL APPRAISAL REPORT LANGSTONE TECHNOLOGY PARK, HAVANT, PORTSMOUTH

Report Reference: 10/1425/001

Date: October 2019

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EXECUTIVE SUMMARY

Client	AG Langstone B.V.
Location	The site comprises an approximately rectangular section of land occupying an area of 16Ha. The site is located toward the southern periphery of Havant, approximately 600m south of the Town Centre, and 1.5km south-east of Junction 5 of the A3(M). Vehicular access onto the site is obtained from the west via Brookside Road, and from the east via a dedicated access road (LTP Site Eastern Access Road). The approximate National Grid Reference for the centre of the site is 471300, 105700.
Development	The site is proposed to be partially re-developed comprising the partial demolition and reconfiguration of an existing laboratory and manufacturing unit located toward the north of the site in order to extend parking provision with associated landscaping and the construction of four (4No.) light industrial / commercial units with associated parking across the south of the site with associated car parking.
Site History	Historical OS maps of the area indicate the site was undeveloped until the early 1900s when a large sewage works and engine house occupied the north-eastern section of the site. During the subsequent decades this facility underwent significant expansion. In the mid 1950s, an allotment garden occupied the centre of the site. In the early to mid 1970s, the site had undergone large-scale redevelopment, resulting in the construction of many of the existing commercial / industrial units. In addition, by this time a large building and an electrical sub-station occupied the southern section of the site, within the existing car-parking area. By the early 1990s the building / electricity substation across the south of the site had been replaced by the existing car park and the site is understood to have been in its current configuration. The surrounding area has been a mix of undeveloped, and industrial land uses with mills, sewage works, works and industrial units along with a retail park with associated infrastructure all located / historically located within close proximity to the site.
Unexploded Ordnance	It is considered that there is an overall Medium Risk from German and anti-aircraft UXO at the site. It was also considered that the risk from Allied Ordnance was Low-Medium. It was recommended that a site-specific plan for the management of UXO risk be written for the site, that briefings be given to operatives prior to commencement of intrusive investigation works, and that these briefings be supplemented with UXO specialist engineer attendance during the works, and magnetometer survey of excavation positions.
Geology	The majority of the site is indicated to be underlain by superficial Alluvium Deposits. The western periphery of the site was recorded to be underlain by River Terrace Deposits. A thin, linear band of superficial Head deposits is indicated to be present across the central and southern sections of the site. Bedrock underlying the site is recorded to comprise chalk.
Mining	The site is not located within an area which may be affected by coal mining activity and no BGS recorded mineral sites are within 500m. There is 'very low' or 'no' hazard potential with regard to ground stability issues including, ground dissolution and landslides hazards. The potential hazard associated with collapsible ground, shrinking or swelling clay and running sand was considered 'low'. The potential hazard associated with compressible ground was considered 'moderate'.
Environmental Setting	The nearest identified environmental receptors are the underlying superficial strata which is classified as a Secondary A Aquifer, solid strata classified as a Principle Aquifer and water course immediately to the east of the site though the site is not situated within a Source Protection Zone and no groundwater or surface water abstractions have been identified within 250m of the site.

	The closest identified formal surface water feature is Langstone Mill Channel, which flows north to south past the site immediately beyond the eastern boundary.
Flooding	The site is not within an area susceptible to flooding from rivers or sea without defences however due to the size of the proposed development, a formal Flood Risk Assessment is likely to be required for the site.
Ground Conditions	Made Ground was identified during the intrusive investigation works to depths of up to 3.1m bgl. and generally comprised a variable sequence of either predominantly granular or cohesive materials of various subtypes. Sub-surface hardstanding was encountered in several locations across the site, generally corresponding with the locations of historic / demolished buildings. There remains the possibility that buried structures may be present elsewhere on site which have not been identified during this investigation. The Made Ground was underlain by a sequence of interbedded granular and cohesive strata interpreted to predominantly comprising river terrace deposits and or a highly weathered material derived from the underlying bedrock. These superficial deposits were proven to a maximum depth of between 5.1m and 6.0m bgl. Solid chalk bedrock was encountered below the superficial deposits across the site, proven to a maximum of 24.85m bgl. Groundwater was generally encountered across the site during the fieldwork at depths of between approximately 2.0m to 3.0m.
Soil Contamination	Visual and olfactory evidence of hydrocarbon contamination was recorded in WS2 and WS5 between though chemical testing did not identify any contaminants which exceeded relevant SSVs for commercial / industrial end use in terms of human health and no asbestos fibres or ACMs were encountered during the investigation. Whilst no elevated concentrations of the determinands tested have been recorded in terms of human health, localised concentrations of contaminants not identified / investigated during this investigation may be present in quantities considered harmful in terms of human health. Should during any future investigation / remediation / construction works identify visual or olfactory evidence of contamination, a suitably qualified environmental consultant should be contacted to further assess any potential issues. Additional works may be required to suitably quantify the risk to potential and identified receptors. In respect to controlled waters, chemical testing has identified elevated concentrations of organic contaminants when compared to SSVs for commercial / industrial end use in the locations of WS2 and WS5. Given the presence of controlled waters beneath the site and groundwater identified at approximately 2.0m to 3.0m bgl, it is recommended that further works be undertaken in these areas with the retrieval of soil and groundwater samples to suitably delineate the identified contamination and further assess the risk these contaminants pose.
Concrete Classification	Laboratory testing indicates that sub-surface concrete should be prepared as Design Sulphate Class DS-1 with an ACEC classification of AC-1.
Foundation Recommendations	It is considered that a shallow foundation solution may prove problematic given the very variable nature of the shallow natural strata. If a shallow foundation solution is utilised, excavations may need to over-deepened in areas of deeper Made Ground or very loose / very soft natural strata. Any shallow foundations may span strata of varying characteristics and may be at risk of differential settlement. We would therefore recommend that foundations are reinforced to protect against differential settlement. Given the above, a piled foundation may prove more suitable. Additional advice should be sought from a specialist piling contractor regarding the pile design (i.e. type, length and diameter). If a piled foundation solution is to be utilised, there may be differential settlement between piled structures and the surrounding ground level.

Hazardous Ground Gas	Ground gas monitoring was undertaken on 4 occasions and has recorded 7.2% carbon dioxide. No methane has been identified and gas flow rates were typically absent. Based on the gas screening values available, the site can be classified as Characteristic Situation 1 (CS1). According to the current guidance and best practice however, where carbon dioxide concentrations are recorded in excess of 5%, consideration should be given to increasing the classification to CS2. In this instance, given the relatively short monitoring period, the presence of elevated carbon dioxide, depleted oxygen levels, the depth and nature of the filled ground and presence of peat in the local area, we would recommend that the characteristic situation be increased to CS2 and that gas protective measures are installed in all new structures in accordance with guidance provided in BS 8485: 2015 "Code of Practice for the Design of Protective Measures for Methane & Carbon Dioxide Ground Gases for New Buildings".
Soakaway Testing	As part of the investigation, soakaway testing was undertaken in general accordance with the guidance provided in BRE digest 365 'Soakaway Design' in two locations with falling head tests also undertaken in two locations in order to supplement the soakaway data. Recorded infiltration rates suggest that the superficial deposits exhibit marginal to good drainage characteristics, and that soakaway drainage / permeable paving may be suitable subject to design parameters. Infiltration rates within the granular Made Ground also show good drainage characteristics however it should be noted that soakaway drainage in Made Ground is generally not considered acceptable by regulators. Whilst no visual or olfactory evidence of contamination was observed and laboratory test results within this area have not highlighted any elevated concentrations of the determinands tested, further thought should be given to the suitability of this location for the installation of soakaways. Due to the presence of chalk there is a risk of ground dissolution features caused by traditional soakaway structures that concentrate infiltration to a localised area. In low to medium density chalk traditional soakaways must have a minimum of 5-10m separation from buildings and structures to avoid the generation of dissolution features that may impact on building foundations (CIRIA C574 'Engineering in Chalk'). Distributive soakaways such as permeable paving and sub-base infiltration that do not concentrate infiltration avoid the risk of generating groundwater dissolution features.
Further Works	Based on the information available to date we would recommend the following further works are required: • Additional investigations to be carried out in the location of WS2 and WS5 to delineate identified organic contamination with regards to controlled waters. Soil and water samples to be recovered for laboratory testing. • Preparation of a Remediation Strategy following delineation of the organic contamination for approval with the Local Authority. • Gas protective measures to be installed in all new structures in accordance with CS2 conditions. The installation of the protective measures should be independently verified to ensure they are fit for purpose and to assist with planning discharge. • The continued risk of unexploded ordinance should be considered during any future excavations and an EOD engineer may be required on site to brief and support site personnel.

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DRAWINGS

Site Location Plan
Existing Site Layout
Proposed Site Layout
Exploratory Hole Location Plan

APPENDICES

Appendix I	Drawings
Appendix II	Exploratory Hole Logs
Appendix III	Chemical Laboratory Results
Appendix IV	Geotechnical Laboratory Results
Appendix V	Foundation Pit Sections
Appendix VI	Infiltration and Soakaway Test Results
Appendix VII	Gas Monitoring Results

1.0 INTRODUCTION

1.1 Background

Clancy Consulting Limited has been instructed by AG Langstone B.V to carry out a Geo-Environmental Appraisal for Langstone Technology Park, Havant, Portsmouth. Current redevelopment proposals include the partial demolition and reconfiguration of an existing building (Building 1000) located towards the north of the site in order to extend parking provision with associated landscaping, the construction of two new entrance / lobby areas to the existing Building 6000 and the demolition of the existing buildings in the south west of the site to facilitate the construction of four new light industrial buildings comprising twelve units with associated car parking. The newly constructed units will occupy a total area of approximately 12,500m² (use classes B1C, B2 and B8). Additional areas of proposed car parking are also planned in the south east and west of the site.

A Phase 1 Desk Study has been carried out for the site by Delta Simons Environmental Consultants Ltd which should be read in conjunction with this current, site investigation report. Clancy Consulting Ltd have also been provided with a copy of a Detailed UXO Risk Assessment for the site. Both of these documents are referenced below.

- Delta Simons Environmental Consultants Ltd. (May 2019) '*Preliminary Geo-Environmental Risk Assessment*'
- 1st Line Defence Ltd. (May 2019) '*Detailed Unexploded Ordnance (UXO) Risk Assessment*'

The Delta Simons report references two other phases of investigation, the reports of which are referenced below. Clancy Consulting Ltd have not however been in receipt of a copy of these reports.

- WSP (December 2005) '*Phase I Environmental Assessment*'
- Delta-Simons Environmental Consultants Ltd. (September 2018) '*Phase I Environmental Assessment*'

A site location plan and proposed site layout plan are presented in Appendix I.

1.2 Objectives

The objectives of this investigation are summarised below:

- Review and provide a summary of data obtained during a previous Phase 1 geo-environmental site investigation carried out by a third party, inclusive of land use history, environmental setting, geology, hydrology, hydrogeology, mining and potential geotechnical hazards at the site and surrounding area.
- Undertake a ground investigation comprising the excavation of trial pits, window sample and cable percussive boreholes in order to examine the ground conditions present at the site, and the characteristics of existing building foundations.
- Carry out chemical testing of the soils to assess whether any contamination risk exists with regard to the environment and / or human health.

- Undertake testing for the presence of asbestos fibres in soils and any fragments of asbestos containing materials (ACMs) encountered during the site investigation to assess whether any risk exists with regard to human health.
- Carry out a gas risk assessment to investigate the potential risk to end users of the site from hazardous ground gas.
- Refine the Preliminary Risk Assessment and Conceptual Site Model with regard to potential contamination sources, pathways and receptors.
- Carry out geotechnical testing of the soils to further assess their physical characteristics and provide indicative recommendations for foundations.
- Provide recommendations regarding the requirement for further investigations, if required, to satisfy the Local Planning Authority.

1.3 Limitations of the Study

Clancy Consulting Limited cannot be held responsible for any omissions, misrepresentation, errors or inaccuracies with the supplied third-party reporting / information. The report is written in the context of an agreed scope of work and budget and should not be used in a different context. New information or improved practices and changes in legislation may require a reinterpretation of the report in whole or in part.

Clancy Consulting Limited reserves the right to amend either conclusions or recommendations in light of any further information that may become available. The report is provided for the sole use of AG Langstone B.V. for the objectives discussed previously only and is confidential to them.

The report may not be relied upon by any other party without prior written consent of Clancy Consulting Limited. Those using this information in subsequent assessments or evaluations do so at their own risk.

There is a possibility that buried structures may be present beneath the site associated with potential historic buildings which have not been identified during this investigation.

2.0 DESK STUDY

2.1 Sources of Information

The following sections summarise the data presented in the documents referenced above, supplemented by data obtained from statutory and online data sources including those provided by the British Geological Survey (BGS), the Environment Agency, and DEFRA.

2.2 Site Setting and Description

Langstone Technology Park, hereafter referred to as 'the site', comprises an approximately rectangular section of land occupying an area of 16Ha. The site is located toward the southern periphery of Havant, approximately 600m south of the Town Centre, and 1.5km south-east of Junction 5 of the A3(M). Vehicular access onto the site is obtained from the west via Brookside Road and from the east via a dedicated access road (LTP Site Eastern Access Road). The approximate National Grid Reference for the centre of the site is 471300, 105700.

Langstone Technology Park comprises a series of large buildings subdivided into leased units of varying purposes. The largest of the buildings located toward the north of the site and referred to

as 'Building 1000' is a single-storey structure built atop of a man made embankment and understood to contain a number of office, manufacturing and laboratory units with access tunnels running from the car park to the north to beneath the building.

Occupying the centre of the site are a series of buildings including two plant buildings ('Building 2000 and 3000'), offices and amenity complex with associated courtyards ('Building 4000'), a large data and distribution centre ('Building 5000') with waste storage area to the west, and three-storey office buildings ('Building 6000 and 7000'). A small on-site nursery is present to the south of Building 5000.

Toward the south-western corner of the site is a small gymnasium, vehicle washing area (with associated subsurface drainage) storage area and a number of circular historic tank bases. A site walkover undertaken by a third party (Delta Simons) in July 2015 recorded this area to have previously been used as a deionised water production facility, a caustic and buffer chemical storage area, and an effluent treatment plant. Additional information is provided in Section 2.17 below.

Access infrastructure and open landscaping is covering the rest of the site, with engineered slopes within the landscaping areas across the site, suggesting that significant earthworks have previously taken place. The remainder of the site is currently occupied by car parking areas.

The site is bound to the west and south by a series of commercial / light industrial units fronting onto Southmoor Road and Penner Road which run parallel to the site approximately 100m from the respective boundaries. These units are separated from the site by thin, linear sections of heavily vegetated landscaping. Immediately beyond the eastern boundary of the site is a vegetated river corridor associated with Langstone Mill Channel, which runs north to south past the site, eventually flowing into Bridge Lake approximately 500m to the south. Beyond this corridor to the east is a large residential estate.

North of the site, beyond the landscaping areas is the main carriageway of the A27. The associated verges are wooded with a public footpath with forms a site access in the north east of the site. Beyond the A27, approximately 100m to the north is a retail park which includes a Petrol Filling Station.

Open space belonging to Southmoor Nature Reserve is present approximately 250m to the south separating the tidal lakes (Bridge Lake and Storehouse Lake) from the various industrial / commercial concerns located on and in the vicinity of the site.

2.3 Phase 1 Desk Study Findings

2.3.1 Site History

As part of the Phase 1 Desk study undertaken by Delta Simons Environmental Consultants Ltd. available historical Ordnance Survey (OS) maps, and aerial photography were examined in order to assess the development history and previous land uses at the site and in the surrounding area. The findings of this assessment are summarised below.

The first available OS map dated 1867 records the site and immediate surrounds to have been under predominantly agricultural use with several small, unspecified buildings recorded toward the north-western and western peripheries of the site. Havant Corn Mill was recorded approximately 90m north-east of the site. A watercourse was shown flowing north-east to south-west across the northern section, and a series of artificial drainage channels ran west to east across the southern section of the site, associated with the Mill Stream / Channel which was located off-site to the east. By 1897, an aqueduct and sluice were shown in the south-western corner of the site associated with the southern drainage channel.

The OS map dated 1909 showed a large sewage works and engine house occupying the north-eastern corner of the site. During the subsequent decades this facility underwent significant expansion. The OS Map dated 1932 showed several large filter beds within the treatment complex.

By 1954 a number of tanks and sludge beds were identified within the sewage works complex and an allotment garden occupied the centre of the site. OS Maps dated 1962 and 1963 record the sewage works simply as 'works', however the orientation of infrastructure within the complex suggests ongoing operation of the facility. By this time, small scale residential development had occurred to the west, and to a greater extent to the east beyond Langstone Mill Channel, and a larger sewage works complex had been constructed approximately 200m to the south-west.

The A27 Havant bypass had been constructed to the north of the site by 1966 resulting in the demolition and removal of Havant Corn Mill. Industrial premises were recorded approximately 50m north-west of the site at this time.

OS maps dated 1972-1975 show the large-scale redevelopment of the site, resulting in the construction of commercial / industrial units occupying the approximate footprints of existing Buildings 1000, 3000, 5000, 4000, 6000 and 7000. In addition, by this time a large building and an electrical sub-station occupied the southern section of the site, within the existing car-parking area. The entire complex was referred to as 'works'. Additional works / industrial units were recorded immediately west of the site, and the retail park located north of the A27 had also been constructed by this time. The sewage works to the south-west had undergone expansion.

By 1990 the building / electricity sub-station across the south of the site had been replaced by a car-park. A number of tanks and an electricity sub-station were recorded across the southwest of the site. Additional industrial units had been constructed immediately west of the site.

By 1993 the site is understood to have been in its current configuration, and by 2000 the industrial units currently located immediately beyond the southern site boundary had been constructed.

A number of potential sources of contamination were identified by Delta Simons within 150m of the site, including:

- The sewage works present on-site between 1909 until circa 1972, and later industrial / commercial activity undertaken at the site following redevelopment including tanks and sub-stations, and prior to the current site use.
- Havant Mill, located approximately 90m north-east of the site between 1867 and ca. 1966.
- The sewage treatment facility shown approximately 200m southwest of the site between 1962 and the present day.
- An unspecified works unit shown approximately 50m north-west of the site between 1966 to present day.
- Unspecified works shown immediately west of the site between 1972 and present day.
- Other various works including a depot and tanks which were recorded at or in excess of 150m from the site to the north-west and north, but which were not specifically described by Delta Simons within the summary text.

2.3.2 Unexploded Ordnance (UXO) Risk Assessment

The review of historical mapping for the area does not show any significant building damage or demolition which would likely be associated with bomb damage. However, a site-specific assessment of risk with regard to Unexploded Ordnance (UXO) was undertaken by 1st Line Defence in May 2019 on behalf of Delta Simons in support of the Phase 1 Desk Study produced for the site.

The 1st Line Defence UXO assessment considered that there is an overall **Medium Risk** from German and anti-aircraft UXO at the site. It was also considered that the risk from Allied Ordnance was **Low-Medium**.

It was recommended that a site-specific plan for the management of UXO risk be written and briefings be given to operatives prior to commencement of intrusive investigation works. These briefings should be supplemented with UXO specialist engineer attendance during any intrusive works to undertake a magnetometer survey of excavation positions.

2.3.3 Geology

The 1:50,000 British Geological Survey (BGS) scale map for the area (Sheet No. 316, Fareham) indicates that the majority of the site is underlain by superficial Alluvium deposits, with River Terrace deposits underlying the western periphery of the site.

A thin, linear band of superficial Head deposits (clay, sand and gravel) is indicated to be present across the central and southern sections of the site.

Bedrock underlying the site is recorded to comprise chalk of the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation (undifferentiated) of Cretaceous age. These materials are biogenic and detrital, generally formed by shallow marine processes involving the deposition of carbonate material (coccoliths) forming distinctive beds of chalk.

The BGS do not record the site to be underlain by artificial ground, however given the setting and development history which includes possible large-scale earthworks and reconciliation of former sludge beds, some Made Ground would be expected. Artificial ground associated with the construction of the A27 is identified by the BGS immediately north-east of the site.

The environmental search undertaken as part of the Delta Simons report identified eight records of potentially infilled land (water) located on-site, which were presumed to be associated with the drainage channels/aqueduct shown on historical maps. An additional seven areas of infilled land (water) were recorded off-site, within 250m.

Twelve historical British Geological Survey (BGS) boreholes were recorded within the site boundaries, excavated in 1966 as part of a 'proposed development at Brookside Road'. Recorded ground conditions generally comprised topsoil to a depth of approximately 0.8m bgl overlying superficial deposits consisting of clay, silt, gravel and occasional peat layers. Chalk bedrock comprising cobbles in a matrix of 'firm putty chalk' with flints was encountered below the superficial deposits and recorded to a maximum depth of approximately 5.60 m bgl.

2.3.4 Mining & Ground Stability

According to Coal Authority records, the site is not located within an area which may be affected by coal mining activity. The BGS consider that 'no hazard' is present at the site with regard to 'non-coal' mining (underground) and there are no recorded mineral sites within 500m.

There is a 'very low' or 'no' hazard potential at the site with regard to ground stability issues including, ground dissolution and landslides hazards. The potential hazard associated with collapsible ground, shrinking or swelling clay and running sand was considered 'low'. The potential hazard associated with compressible ground was considered 'moderate'.

'Moderate' hazard with regard to ground dissolution was recorded approximately 97m north of the site.

2.3.5 Hydrogeology

According to Environment Agency groundwater vulnerability maps, the various superficial deposits recorded across the site have been classified as a Secondary (A) Aquifer, whilst the underlying chalk bedrock is classified as a Principal Aquifer.

The site is not located within a groundwater Source Protection Zone (SPZ), however an SPZ Zone 1 (inner protection zone) is located 173m north-east of the site.

There are three groundwater abstraction licences recorded within 500m of the site, all of which relate to the abstraction of water for potable use from a borehole located approximately 461m north of the site.

No groundwater discharge consents have been recorded within 500m of the site.

2.3.6 Hydrology

The nearest identified formal surface water feature is Langstone Mill Channel, which flows north to south past the site immediately beyond the eastern boundary. Historical mapping has identified additional drainage channels which were previously present across the north-eastern and southern sections of the site. The current status of these former channels is unknown.

A series of tidal waterways, referred to as Bridge Lake, Storehouse Lake, Chalkdock Lake, North Lake and South Lake, which collectively make up a saline estuary are located approximately 500m south of the site.

No surface water abstraction points have been recorded within 500m of the site.

Sixty-six surface water discharge consents have been recorded within 500m. Two of these entries were recorded as being on site and were related to the discharge of 'other matter-surface water' resulting from the manufacture of computers / electronics / optical products. The receiving water was not supplied, however, based on the location of the site and adjacent watercourses is anticipated to be Langstone Mill Channel. The consent was originally issued in April 1978 to Xyratex Ltd. and superseded in March 1995 with a similar authorisation issued to Fasset Ltd. The latest iteration of the consent is understood to be active.

Four pollution incidents to controlled waters were recorded within 250m. The closest recorded incident occurred on March 1995 approximately 82m east of the site, involving the release of 'unknown oils / related products' into an undisclosed watercourse. This was considered to be a Category 3 (minor) incident. An additional Category 2 (significant) incident occurred on January 1997 approximately 94m north-east of the site, involving the release of 'diesel oil' into an undisclosed watercourse.

A prosecution relating to controlled waters has been recorded within 250m. This incident involved 'tipping brick rubble onto land without a waste management license' in February 2005.

2.3.7 Flood Risk

According to Environment Agency records, the majority of the site is located in Flood Zone 1 and is therefore not within an area susceptible to flooding from rivers or sea without defences. The eastern periphery of the site, immediately adjacent Langstone Mill Channel is located within Flood Zone 2 (Fluvial Models). With the exception of a small section of the LTP Site Eastern Access Road, no on-site infrastructure is impacted by this designation. Zone 3 (Fluvial Models) is located immediately east of the site.

Due to the size of the proposed development (>1Ha), a formal Flood Risk Assessment is likely to be required.

An area benefitting from flood defences is recorded approximately 70m west of the site. No flood storage areas have been recorded within 250m.

The site is located within a BGS Groundwater Flooding Susceptibility Area where there is potential for groundwater flooding to occur at surface.

2.3.8 Radon Risk Potential

The Radon Guidance on protective measures for new dwellings indicates that the site is located within an area where between 3% and 5% of homes are above the National Radiological Protection Board (NRPB) recommended action level.

As a result, basic radon gas protective measures are likely to be required in new buildings at the site.

It is recommended that a site-specific radon risk assessment be obtained.

2.3.9 Landfill and Waste Management Sites

A historic landfill facility has been recorded within 500m of the site, which was used to dispose of household waste and was located approximately 191m south-west. The rate of input, date of operation / closure, and the size of the facility have not been recorded.

One landfill site has been recorded by the Local Authority within 500m, located 201m to the south-west, off Southmoor Lane and was operated by Havant Borough Council. The facility was authorised to accept household, commercial and acidic waste. No further information was available regarding maximum input rate, size, or last date of input, however, the site is understood to have closed.

Seven historic waste treatment, transfer and disposal facilities were recorded within 500m of the site with one of these entries located on-site. Teleplan Ltd are authorised to operate an electronics (WEEE) treatment facility within the current site boundary; no further detail have been provided, however the authorisation is understood to be active. The closest off-site entry relates to a household, commercial and industrial transfer station which was located 302m west of the site. Authorisation to operate was issued in September 1997 and was surrendered in October 2010.

Two additional registered (EA) waste transfer facilities have been recorded within 500m and the closest is located 281m west of the site and is authorised to accept concrete and brick rubble, construction and demolition wastes and soils. The remaining facility is located approximately 369m west, and is authorised to accept batteries, degradable commercial and household waste, inert materials, metal waste and special waste. Both facilities are understood to be active.

Three registered waste treatment / disposal sites have been identified within 500m. The closest entry relates to a scrapyard located approximately 248m north of the site and the accepted waste was restricted to scrap metal, and associated vehicle wastes. The license lapsed or was cancelled in August 1990. The remaining treatment facilities were located in excess of 350m from the site.

2.3.10 Industrial Land Uses

Seventy-six contemporary trade directory entries have been recorded within 250m of the site, of which eighteen are currently active. Three entries (all inactive) have been recorded on site.

The inactive on-site entries relate to printing activities undertaken by Diamond Print and Mail Centre Ltd., computer manufacture (Xyratex Ltd.) and general engineering (Saacke Combustion Services Ltd.).

Active off-site trade directory entries include; tool design and manufacturers, blind awning and canopy manufacture, domestic appliance servicing and repair, domestic cleaning services, air conditioning and refrigeration contractors, spray painting/coating, precision engineering, marine electrical services, petrol filling stations, garage services, electrical engineers, metal finishing services and pallet manufacture.

Potentially contaminative inactive entries included; fireplace and mantelpiece manufacture, air conditioning and refrigeration contractors, domestic cleaning services, general engineering, commercial vehicle repair, car body repairs, precision engineering, aviation engineering, crane hire, printers, electronic component manufacture and distribution, pest and vermin control, marine engineering, case manufacturers, hospital, road haulage services, packaging manufacturers, waste disposal services, tyre dealers, distribution services, plastic injection moulding, sheet metal work, screen printing, car component manufacture, garage services, dry cleaners, boatbuilding, metal finishing, builders merchants, plastic product manufacture and lighting manufacture.

Two petrol filling stations (PFS) are recorded within 250m. The closest (Havant Lorry Park) is located approximately 137m north of the site. This facility is recorded to be obsolete. An additional active PFS (Tesco Havant Extra) is recorded approximately 141m north.

Twelve industrial manufacturing points of interest were recorded on-site. These records include manufacturing businesses (Fasset Ltd, Havant International Ltd.) and nine unspecified tanks. An additional fourteen manufacturing points of interest (predominantly 'works' facilities) are recorded off-site within 250m.

2.3.11 Environmental Permits, Incidents and Registers

Two Integrated Pollution Control (IPC) consents and three Integrated Pollution Prevention and Control (IPPC) authorisations have been issued within 500m of the site according to the database search undertaken as part of the Delta Simons Phase I Desk Study. Two of these entries (both IPC) were recorded on-site, authorising 'processes involving halogens within the chemical industry' by Adflex Solutions Ltd. The initial authorisation was issued in March 1995 and varied (non-substantially) in January 1997. Authorisation was subsequently revoked, however no associated date has been supplied. The remaining recorded IPPC authorisations were located in excess of 350m from the site, and related to the combustion of waste derived fuel, and landfilling activities.

Fifteen Local Authority Pollution Prevention and Control permits are recorded within 500m, one of which is located on-site. The on-site authorisation is held by Teleplan and White Electronics Ltd. and relates to 'unspecified' Part B activities. Additional authorised processes within 150m of

the site include 'coating of metal and plastic' at a site located 29m to the south-west, and 'respraying of motor vehicles' at facilities located 45m, 76m, 78m, and 119m south-west, and 121m west. The majority of these authorisations remain active.

Six authorisations under the Radioactive Substances Act for the keeping, use and disposal of radioactive substances have been issued within 500m. These authorisations are all held by Apollo Fire Detectors Ltd. at premises located between 44m and 126m north-west of the site.

2.3.12 Sensitive Land Uses

The site is situated within a Nitrate Vulnerable Zone for surface waters.

An area of outstanding natural beauty (Chichester Harbour) has been designated by Natural England approximately 406m to the south-east. In addition, Chichester and Langstone Harbours, recorded approximately 306m to the south have been designated a RAMSAR site.

A Site of Special Scientific Interest (Langstone Harbour) has been designated by Natural England approximately 306m south of the site.

According to historicengland.org.uk there is one area of heritage interest located within 100m. This feature is a Grade II Listed Building known as Langstone Hotel.

2.3.13 Planning

A search of the Havant Borough Council Planning Portal was undertaken by Delta Simons on 13th May 2019 in order to identify any applications on, or in the vicinity of the site pertinent to the proposed development.

Several applications were identified, the majority of which are understood to relate to minor external changes or changes in use of on-site buildings.

The following specific applications were identified:

- Demolition of existing steel-clad building and two portacabins to make way for a single storey timber framed building to house a nursery school with capacity for 52 pupils (ref. APP/10/00272, dated August 2010)
- Construction of Waste Compactor Housing and Consumables store (ref. APP/11/00168, dated February 2011)
- Installation of 2 no. roof mounted condenser units and associated chiller pipework to support 2 no. additional internal computer room air conditioning units (ref. APP/15/01225, dated October 2015)

Delta Simons state that no additional potentially contaminative activities or other information pertinent to the assessment was identified from the historical planning records.

2.4 Summary of Other Previous Investigations

As part of the Preliminary Geo-Environmental Risk Assessment Report, Delta Simons provided a summary of previous investigation works undertaken at the site. An overview of these investigations is provided below.

2.4.1 WSP Phase I Environmental Assessment December 2005

Investigations were undertaken in December 2005 by WSP Ltd ('Phase I Environmental Assessment – Langstone Technology Park') though we have not been in receipt of a copy of this report.

Potentially contaminative activities identified during a site walkover undertaken as part of the investigation were limited to the storage of diesel fuel in two above ground storage tanks and the storage of waste materials.

During the investigation the Contaminated Land Officer at Havant Borough Council was contacted. According to WSP, the Officer stated that based on the historical and neighbouring land uses, and the use of good quality hardstanding, the site was not considered to pose a concern with regard to human health given its continued use as a technology park. It was noted that in the case of redevelopment, further intrusive investigations would be required.

The following third-party reports were also reviewed as part of WSP's assessment, however, were not provided to Delta Simons:

- A 1999 Environmental Monitoring Program undertaken by Casella Ltd. The report is understood to have detailed results of effluent monitoring, industrial emissions monitoring, ground water monitoring, surface water monitoring and building fabric monitoring. WSP indicated that the Casella Ltd. report reviewed a number of intrusive and non-intrusive investigations previously undertaken at the site, and identified potential issues associated with; elevated, but relatively low concentrations of toluene and hydrocarbons recorded during effluent monitoring for Building 2000, groundwater contamination associated with chlorinated solvents; and copper contamination 'within a concrete slab'. It was noted by WSP that the effluent treatment facility had subsequently been decommissioned, that the identified groundwater contamination was outside the current Site boundary and that the concrete slab had since been remediated.
- A 1999 Phase I Environmental Audit undertaken by WSP Environmental.
- A 1999 Initial Ground Investigation by Soil Consultants Limited, which was understood to have identified potential issues associated with elevated concentrations of cadmium in soil samples taken from two boreholes excavated at the site, and elevated levels of arsenic, lead, copper, zinc and mercury within samples taken from a single borehole. It was noted by WSP that the soil guidance values used for comparison at that time were no longer applicable.
- A 2003 and 2004 'Addendum Site Investigation Report' undertaken by STATS Ltd. WSP indicated that the report identified potential issues associated with elevated concentrations of ground gases within Made Ground at the site. This report was, however based on a single monitoring visit and did not record flow rate.

WSP stated within the report that based upon the information obtained the contamination issues identified did not represent a significant risk with regard to the continued commercial use of the site. It was noted, however that the potential presence of residual contamination, which may require remediation in the event of redevelopment, could not be discounted.

Given the ground gas concentrations identified in a previous investigation at the site, it was considered that the presence of ground gas could not be discounted, as such, further ground gas testing was recommended.

2.4.2 Delta-Simons Phase I Environmental Assessment September 2015

Delta Simons produced a Phase I Environmental Assessment, dated September 2015 though we have not been in receipt of a copy of this report. The report was undertaken as an appraisal of 'inground' environmental risks and liabilities, as part of a pre-divestment assessment of the site. It was undertaken in the context of the site remaining under commercial/ industrial use.

As part of the investigation a site walkover was undertaken. At the time of the investigation, the site was occupied by offices, laboratories, light manufacturing/ engineering, a gym, and a nursery.

The following potential sources of contamination were identified during the Site Walkover carried out on 29th July 2015:

- Waste storage areas were identified toward the east and west of the site. The Site Facilities Manager stated that the western waste storage area had been used by the former tenant (IBM) for chemical storage and processing. Associated plant remained present, including two above ground storage tanks. The plant was understood to include air and chemical extraction systems, solvent recovery equipment, carbon absorption tanks, and chemical storage which included hydrochloric acid, sodium hypochlorite, xylene, nitrogen and cyanide.
- Further general waste storage areas were observed to the west and south-west of Building 5000 (comprising vegetation, metal cardboard, domestic waste, vehicle tyres and drums)
- Beneath Building 1000 in north-western corner of the site, was a chemical drum store. The drums were located within an area of secondary containment;
- Electricity sub-stations were identified in the south-western corner and the centre of the site
- A back-up generator was located between Building 3000 and Building 4000 (central section of the site)
- In the south-west corner of the site, a deionised water production plant and caustic storage area were recorded, in addition to an effluent treatment plant and buffer holding tanks. It was understood that this area had undergone previous intrusive investigation works, however, no further information was available. Used engines/ motors were noted to be stored on pallets externally in this area.
- It was noted that Asbestos Containing Materials were present within the fabric of the buildings on-site, managed via an Asbestos Register. No evidence of leakages/ spillages was observed during the walkover and no significant issues of potential environmental concern (aside from the potential sources listed above) were identified.

The following additional anecdotal information was obtained during the walkover:

- It was understood that surface water pooling occurs in car park areas during periods of increased precipitation.
- Delta Simons was informed by the Facilities Manager that a pollution incident which required remediation works had taken place in 1984, however, no further details were available. Delta Simons did not consider this to represent a significant cause for concern in the context of the current commercial / industrial use of the site.

- Two oil interceptors were recorded within the eastern car parking area.
- Two tunnel entries (into an embankment) were present within the northern elevation of Building 1000 toward the north-western corner of the site.
- A surface water pump house was observed to the east of Building 6000.

2.5 Desk Study Conclusions / Recommendations

Based on the data presented above, Delta Simons Environmental Consultants Ltd. carried out a Preliminary Risk Assessment in accordance with the guidance established in Environment Agency document CLR 11 'Model Procedures for the Management of Land Contamination'. identifying and evaluating potential sources of contamination, possible receptors following redevelopment, and potential contaminant linkages.

The site was considered by Delta Simons to represent 'moderate' environmental sensitivity based on the presence of the underlying superficial Secondary A Aquifer, the Principal bedrock aquifer, and the commercial / industrial use of the site and surrounding area.

The following potential contaminant sources were considered significant:

On-site:

- Potential sources of contamination at the site are considered to include; limited quantities of fuel and chemical storage associated with the current site use(s), chemical storage and activities associated with the site's former uses (electronics manufacture), and historical use of the north-eastern section of the site as a sewage works between 1909 and ca.1972.

Off-site:

- Delta Simons considered significant potential historical off-site sources of contamination (within 150m) to include; a mill, a sewage works, factories, an engineering works, a warehouse, a boatbuilding works / works, a plastics factory and a pumping station with a tank.
- Current potential off-site sources of contamination were considered to include; vehicle respraying processes, metal coating processes, a landfill, a fuel station and facilities for tool design, precision engineering, aviation engineering and engineering services.

Given that the proposed redevelopment requires the partial demolition of existing on-site buildings in the northeast of the site and the construction of new buildings in the south-west, it was recommended that an intrusive site investigation be undertaken to assess uncertainties / data gaps identified in the preliminary Conceptual Site Model.

3.0 SITE INVESTIGATION

3.1 Investigation Design & Objectives

Based on the findings and recommendations presented in the Delta Simons Environmental Consultants Ltd. Preliminary Geo-Environmental Risk Assessment, an intrusive investigation was designed and undertaken by Clancy Consulting Ltd. The design was provided by the appointed Clancy Consulting Ltd Structural Engineer and approach based on guidance provided in BS 10175 Code of Practice for Investigation of Potentially Contaminated Land (2011).

The aim of the investigation was to provide initial characterisation of ground conditions at the site, in order to produce and refine a representative Conceptual Site Model, to carry out contamination and geotechnical assessments to inform civil and structural design and to ensure that the site is suitable for the proposed end-use.

An additional objective of the investigation was to examine the geotechnical competence of materials at the site, including an examination of the existing structure's foundations, in order to provide indicative foundation solutions and to support future detailed geotechnical design.

3.2 Exploratory Fieldwork

The ground investigation works were carried out between 17th and 25th July 2019 and comprised the following works:

- Excavation of 8 No. window sample boreholes (WS1 to WS8) to a maximum depth of 5.45m bgl.
- Hand excavation of 4 No. trial pits (HTP1 to HTP4) to a maximum depth of 1.4m bgl.
- Excavation of 4 No. cable percussive boreholes to a maximum depth of 24.85m bgl.
- Excavation of 2 No. trial pits using a mechanical excavator to depths of between 2.05m and 2.10m bgl to enable soakaway testing in accordance with BRE 365.
- Indicative infiltration testing (falling head) within selected window sample boreholes (WS2 and WS6).

Soil samples for chemical and geotechnical laboratory testing were collected at regular intervals from each exploratory hole location and sealed in appropriate plastic and glass containers provided by the laboratory.

The exploratory locations were positioned within areas proposed for redevelopment with a targeted approach towards locations of potential contamination, proposed structures and infrastructure.

WS1 and BH1/1A were located to the south of Building 6000. These excavations were positioned so as to identify ground conditions in this area to aid in structural design. In addition, HTP1 and HTP2 were excavated immediately adjacent to Building 6000 in order to examine the construction characteristics of the existing building foundations.

WS3, WS4 and BH2 were positioned to the north and south of the existing main car park, within the footprints of two of the proposed new buildings. The purpose of excavations was to examine the ground conditions, geotechnical competence and contaminative status of the ground in this area. HTP3 was excavated within the existing car park between these buildings in order to provide general coverage of the site with regard to soil sampling / chemical testing and to assess the build-up of the existing car park.

WS5 and BH3 were excavated within the footprint of the westernmost of the proposed new buildings in order to provide geotechnical data to enable foundation design. These locations examine the potential for contamination to be present as a result of the previous operation of a deionised water plant, caustic tanks, effluent treatment plant and vehicle wash identified in this area during the Delta Simons Report.

WS2 was located toward the centre / west of the site within a proposed car park area, adjacent to an existing electricity sub-station on site. In addition to establishing geotechnical characteristics

the objective of this excavation was to determine the chemical quality of soils in this area, which has previously also been established as historically being used for the temporary storage of waste.

WS6, WS7, WS8, BH4, HTP4 were excavated toward the north-east of the site, within the area that was historically occupied by a sewage treatment works, and which is to be redeveloped (partial demolition of Building 1000 and the construction of a new vehicle parking area). HTP4 was excavated adjacent to the existing building in order to examine the existing building foundations and assist with future design work.

SA1 and SA2 were excavations undertaken to enable soakaway testing and were positioned toward the south and north of the site to examine the permeability of the subsurface within areas where the installation of drainage is currently under consideration. Falling head tests were also undertaken in WS2 and WS6 for this purpose.

An exploratory hole location plan is provided in Appendix I as Drawing No. 10/1425/002.

3.3 Ground Conditions

Details of the ground conditions encountered, along with records of the soil samples taken are presented on the exploratory hole records in Appendix II with a summary of the ground conditions provided below.

3.3.1 Made Ground

Made Ground was encountered in all exploratory hole locations to depths of between 0.65m and 3.1m bgl. However, HTP1 to HTP4, SA2, WS7 and WS8 were terminated within Made Ground and therefore did not prove the base of the material.

Tarmac hardstanding was encountered at surface in nine of the excavations with thicknesses of between 0.1m and 0.25m. The tarmac hardstanding was commonly underlain by sub-base type materials of sandy gravel of limestone to a maximum depth of 0.65m or sandy gravel of flint to a maximum depth of 0.35m bgl. In WS5, HTP1 and HTP2, this was directly underlain by concrete with a thickness of between 0.05m (WS5) and 0.19m (HTP1 and HTP2). In HTP1 and HTP2 the concrete was steel reinforced with 8mm rebar.

In the locations of BH1, BH1A, WS2, WS6 to WS8 and SA1 to SA2, the Made Ground was found to be topped by grass and occasionally topsoil type materials.

The composition of the underlying Made Ground was highly variable, reflecting the variability of infrastructure and land use across the site.

In the locations of BH1, BH1A, WS7, WS8, SA1 and SA2 (where historic structures were found to be present), the Made Ground was found to comprise a mix of granular deposits with gravel and cobbles of brick and concrete and (in the location of SA2) occasionally fragments of pottery and slate to a maximum depth of 2.45m bgl. These deposits are consistent with soils derived from the demolition process and reworking of demolition type materials.

Elsewhere on site, the Made Ground comprised a mix of granular and cohesive deposits with gravels often including flint, concrete and occasionally brick and chalk proven to a maximum depth of 1.6m bgl.

Fragments of organic material including decaying wood, rootlets and grass were noted between 1.0m and 1.25m in WS2, in WS6 between 1.5m and 3.1m bgl and in HTP1 between 0.24m and 1.4m,

Visual and olfactory evidence of hydrocarbon contamination was identified in WS2 and WS5 between the depths of 0.95m to 1.6m and 2.5m to 3.45m respectively, spanning both Made Ground and natural stratas.

Subsurface Structures / Obstructions

Subsurface hardstanding / obstructions were encountered in WS3, WS5, BH1, BH1A, HTP1 and HTP2 and SA2.

In WS3 a layer of 0.1m thick tarmac was encountered at a depth of 0.35m bgl, underlain by layer of concrete, recorded to a depth of 0.65m bgl. This represented the base of the Made Ground in this excavation.

A thin layer of tarmac was also recorded toward the middle of the Made Ground profile in WS5 between 0.35m and 0.40m bgl.

A layer of in-situ concrete was encountered in BH1 and BH1A at a depth of 1.0m and recorded to 1.15m bgl. A small void was recorded immediately below the concrete between 1.15m and 1.30m bgl. This concrete may represent the floor / hardstanding associated with the historic buildings in this location.

Buried structures were encountered in SA2 in the form of a historic building foundation and drainage, proven to the depth of 2.1m bgl.

It is noteworthy that it is possible that buried structures / basements may present in other areas of the site which have not been identified during this investigation.

3.3.2 Superficial Strata

River Terrace Deposits/Brickearth

A variable, alternating sequence of predominantly granular and cohesive strata potentially consistent with materials described by the BGS as River Terrace Deposits or Brickearth (depending on the publication) was encountered below the Made Ground, or topsoil in each of the excavations.

The BGS indicate that these deposits are likely to be restricted to the western periphery of the site, however intrusive investigation works suggest that the deposits extend across much of the, as far east as SA1.

In general, where encountered, these materials comprised one of three different types.

- A cohesive material typically described as very soft to soft light brown / brownish white / grey occasionally silty, slightly sandy to sandy, slightly gravelly to very gravelly clay. The gravel component was described as rounded to sub-angular, fine to coarse of flint.
- Predominantly granular material described as very loose to medium dense brown / light brown clayey, sandy gravel. The gravel was described as angular to rounded, fine to coarse of flint.
- Firm brown very sandy slightly gravelly clay. Gravel was described as sub-rounded, fine to coarse of flint. This material was characterised by the presence of frequent wood fragments.

In addition to the above, in WS4 a band of greenish grey silt underlain by greenish grey clay with sand lenses was encountered from 2.5m to the base of the borehole at 5.45m bgl.

Underlying the Made Ground in BH4 was a layer of very soft plastic brown amorphous very silty peat, which was recorded between 1.0m and 1.6m bgl. This was the only significant organic deposit recorded during this investigation.

Weathered Chalk Bedrock

Materials consistent with weathered bedrock were encountered across the site underlying the superficial horizons described above and located above intact chalk rock (where encountered).

The degree of weathering varied substantially across the site, and at various locations this material was described as an extremely weathered predominantly cohesive material (very soft to firm occasionally sandy gravelly clay), or a de-structured predominantly granular material described as medium dense clayey, sandy gravel. In both cases the gravel component was described as angular to rounded, fine to coarse of chalk and flint.

The cohesive strata was recorded in WS1, BH1A and BH2 between a minimum of 2.6m and proven to a maximum of 5.45m. The granular material was encountered in WS2, BH1A, BH3, BH4 between a minimum of 2.5m proven to a maximum of 6.0m. Where both types were encountered within the same excavation, the cohesive material was located above the granular.

3.3.3 Chalk Bedrock (Undifferentiated)

Chalk was recorded in BH1A to BH4 below the superficial and weathered materials described above. The chalk was encountered at depths of between 5.1m and 6.0m bgl and recorded to a maximum depth of 24.85m bgl.

In general, where encountered, this material was described as structureless chalk (Grade Dm) composed of uncompacted brownish/light brownish / yellowish / greyish cream slightly sandy slightly gravelly occasionally cobbly silt. The gravel / cobble component was described as sub-angular to sub-rounded very weak chalk and black flint.

An exception was encountered in BH4 between 15.0m and 16.50m bgl where a slightly less weathered horizon was recorded. This material was described as structureless chalk (Grade Dc) composed of uncompacted light greyish cream sandy, silty sub-angular to sub-rounded medium to coarse gravel. This material was underlain by the Grade Dm chalk described above.

3.4 Groundwater

Groundwater was encountered across the site during the fieldwork at depths of between 1.9m and 6.0m rising to between 1.8m and 3.7m. Groundwater was not recorded in WS2 or WS6 due to the undertaking of falling head tests in these locations. The soils were however noted to be 'wet' from 3.5m and 4.8m respectively.

Groundwater was not encountered with any of the trial pits or within WS7 and WS8.

Subsequent monitoring visits are to be undertaken on four occasions over the coming months in the locations of BH1A, BH3, WS3 and WS4. The results will be reported upon completion of the monitoring works.

3.5 Laboratory Chemical Testing

Selected soil samples were recovered at regular intervals and submitted to a UKAS / MCerts accredited laboratory for a general and targeted suite of analysis.

Nine samples of Made Ground and six samples of underlying natural soils were submitted for chemical testing.

Testing included analysis of some or all of the following determinands: *arsenic, beryllium, cadmium, chromium (VI), copper, lead, mercury, nickel, selenium, vanadium, zinc*.

Selected soil samples were also tested for *speciated PAH, speciated TPH, asbestos identification, speciated PCBs, Total Organic Carbon, pH and water-soluble sulphate*.

Copies of the laboratory test certificates are presented in Appendix III.

4.0 TIER 1 CONTAMINATION ANALYSIS

4.1 Soil Guidelines

At a Tier 1 stage the long-term human health toxicity of the soil has been assessed with reference to the LQM / CIEH S4ULs for Human Health Risk Assessment and CL:AIRE Category 4 Screening Levels (C4SLs). The proposed development will comprise the partial demolition of an existing laboratory and manufacturing unit located toward the north of the site in order to extend parking provision, the construction of four (4No.) light industrial / commercial units with associated adjacent parking provision across the southern section and additional parking in the east and west of the site. The newly constructed parking area toward the north of the site will include provision for peripheral ornamental landscaping, however following redevelopment, the majority of the site will remain under hardstanding.

On this basis, chemical test results have been compared against Site Screening Values (SSVs) for a commercial / industrial end use.

Where appropriate the statistical significance of the chemical test results has been assessed by reference to the CIEH & CL:AIRE publication "Guidance on Comparing Soil Contamination Data with a Critical Concentration" (2008).

For the purpose of this report a 'planning scenario' has been applied which aims to demonstrate that there is a 95% probability that the true population mean falls below the critical concentration (soil screening value).

4.2 Inorganic Contamination

Nine samples of Made Ground and six samples from the natural strata were submitted for chemical testing for inorganic determinands. Statistical analysis of the test results has been carried out for the Made Ground with individual analysis of the natural soil samples.

The test result and statistical analyses of the Made Ground samples indicate that all 95%^{ile} concentrations for the inorganic determinands tested fell below their respective SSVs when compared to values generated for commercial end use.

Statistical outliers were recorded for beryllium and water soluble boron in WS2 at 1.1m with respective recorded concentrations of 1.1 mg/kg and 2.6 mg/kg compared to the respective SSV

of 12 mg/kg and 240000 mg/kg. As neither of the concentrations recorded exceed the respective SSVs, these records are not considered significant.

A statistical outlier was recorded for cadmium in SA1 at 0.6m with a concentration of 1.8 mg/kg compared to the SSV of 190 mg/kg. As the record does not exceed the SSV, it is not considered significant.

No exceedances were recorded for any of the natural samples tested when compared to values generated for commercial end use.

The results of the chemical analyses of inorganic contaminants indicate that both the Made Ground and underlying natural soils are uncontaminated in regard to human health when compared with the appropriate published Soil Screening Value.

4.3 Organic Contamination

Visual and olfactory evidence of hydrocarbon contamination was recorded in the Made Ground and natural soils in WS2 along within the natural soil in WS5. Potentially impacted samples from both of the excavations were subsequently recovered and scheduled to chemical analysis for organic determinands. Additional samples were recovered from across the site for laboratory testing to determine background concentrations.

Nine samples of Made Ground and six samples of the underlying natural soils were scheduled for speciated PAH analysis. One sample of Made Ground, and three samples of natural materials were also scheduled for speciated TPH analysis with one sample of the Made Ground tested for PCB analysis.

No elevated concentrations of the 16 PAH compounds or TPH fractions tested were recorded within the Made Ground or natural soils when compared to SSVs generated for a commercial end use.

A statistical outlier was recorded for the PAH compound naphthalene in WS2 at 1.1m with a recorded concentration of 0.29 mg/kg compared to the SSV of 190 mg/kg. As the concentration does not exceed the SSV, the record is not considered significant.

Despite the above, in the location of WS2 at 1.1m and WS5 at 2.6m where visual and olfactory evidence of hydrocarbon contamination was observed during the investigation works, concentrations of TPH fractions Ali C10-C12, Ali C12-C16 and Aro C12-C16 have been recorded in excess of Water Screening Values (WSVs).

The concentration recorded for TPH fraction Ali C10-C12 in WS2 at 1.1m was 242 mg/kg and in WS5 was at 2.6m was 89 mg/kg compared to the WSV of 48 mg/kg. For Ali C12-C16 the concentrations were recorded as 2210 mg/kg and 318 mg/kg respectively compared to the WSV of 24 mg/kg. The concentrations of Aro C12-C16 were recorded as 1830 mg/kg and 218 mg/kg respectively compared to the WSV of 169 mg/kg.

Given the presence of the superficial Secondary A and Principal bedrock Aquifers beneath the site and that groundwater has been identified between approximately 2.0 to 3.0m bgl, it is considered that a viable pathway may exist through which identified contaminants may migrate into the controlled waters. In the location of WS5 at 2.6m bgl, the sample was taken below the ground water level.

It is noteworthy that samples from WS2 at 2.4m and WS5 at 3.9m were retrieved and tested to establish the extent of any vertical migration of these identified contaminants. Both samples did not record any elevated concentrations of the determinands tested.

PCBs

One sample, taken from WS2 at a depth of 1.1m bgl was scheduled for speciated PCB analysis.

Individual PCB species (PCB105, PCB118, PCB156 and PCB167) were recorded above laboratory levels of detection. The sum recorded concentration of these contaminants was 0.148 mg/kg, which whilst elevated did not exceed the adopted SSV of 0.240 mg/kg for the 'sum of dioxin-like PCBs' on commercial/industrial sites taken from Environment Agency Science Report SC050021 'Soil Guideline Values for dioxins, furans and dioxin-like PCBs in soil'

Total Organic Carbon

Seven samples (one from the shallow natural and six from the underlying chalk bedrock) from across the site were retrieved and sent to a UKAS accredited laboratory to be tested for total organic carbon (TOC).

The TOC content of the shallow natural sample was 1.08% with the TOC in the chalk bedrock ranging from 1.69% to 4.67%.

To derive the percentage of soil organic matter (SOM), in accordance with CLEA guidance the TOC must be divided by 0.58.

As such, the shallow natural soil sample has a SOM of 1.86% with the chalk bedrock recording SOMs ranging from 2.91% to 8.05%.

4.4 Asbestos Contamination

Seven soil samples taken from the Made Ground were screened using microscopy for the presence of asbestos fibres.

None of the samples tested proved the presence of asbestos fibres, or asbestos containing materials in excess of qualitative levels of detection.

5.0 CONTAMINATION ASSESSMENT

5.1 General

Based on the information obtained during the preliminary ground investigation and laboratory testing, a 'Conceptual Site Model' (CSM) has been amended accordingly. The conceptual Site Model is used as a basis to identify contamination sources, pathways and receptors and is subject to constant refinement as more information becomes available.

5.2 Environmental Setting & End Use

Made Ground was identified during the intrusive investigation works to depths of up to 3.1m bgl. and generally comprised a variable sequence of either predominantly granular or cohesive materials of various subtypes.

The Made Ground was underlain by a sequence of interbedded granular and cohesive strata and / or a highly weathered material derived from the underlying bedrock. These superficial deposits were proven to a maximum depth of 6.0m bgl.

Solid bedrock was encountered below the superficial deposits across the site and proven to 24.85m bgl.

Visual and olfactory evidence of hydrocarbon contamination was recorded in WS2 between 1.0m and 1.25m and 1.6m spanning Made Ground and natural soils along with the natural strata in WS5 between 2.5m and 4.0m bgl.

Groundwater was encountered at approximately 2.0m to 3.0m across the site.

Whilst a complex distribution of lower and higher permeability horizons has been proven within these units, the overall hydrogeological character of the geology underlying the site is not considered to be substantially different from the preliminary risk assessment; comprising a sequence of moderately permeable (Secondary A Aquifer) superficial strata, underlain by highly permeable (Principal Aquifer) bedrock. As such, the environmental setting remains of 'moderate' sensitivity.

5.3 Revised Conceptual Site Model

In accordance with CLR11 "Model Procedures for the Management of Land Contamination" (2004) and BSI 10175 "Code of Practice for Investigation of Potentially Contaminated Land" (2011), a Preliminary Conceptual Site Model was developed to identify potential contamination sources, migration pathways and receptors within the study area.

Chemical testing undertaken during the site investigation did not identify any contaminants which exceeded relevant SSVs for commercial / industrial end use in terms of human health. No asbestos fibres or ACMs were encountered during the investigation.

Whilst no elevated concentrations of the determinands tested have been recorded in terms of human health, localised concentrations of contaminants not identified / investigated during this investigation may be present in quantities considered harmful in terms of human health.

Site workers involved in excavations for foundations, roads, sewers etc. may come into direct shallow Made Ground soils which have not been identified during this investigation. As any Made Ground does represent a potential risk, we would therefore recommend that simple precautionary measures be adopted during the construction phase i.e. good personal hygiene, provision of welfare facilities and basic personal protective equipment i.e. gloves and safety glasses. Should during any future investigation / remediation / construction works identify visual or olfactory evidence of contamination, a suitably qualified environmental consultant should be contacted to further assess any potential issues. Additional works may be required to suitably quantify the risk to potential and identified receptors.

In respect to controlled waters, chemical testing has identified elevated concentrations of organic contaminants when compared to SSVs for commercial / industrial end use with the following contamination sources have been identified within the Made Ground and natural soils in WS2 and natural soils in WS5.

- Elevated concentrations of TPH fractions Ali C10-C12, Ali C12-C16 and Aro C12-C16 in WS2 at 1.1m and WS5 at 2.6m.

WS2 was positioned in the location of a historic waste storage area and also adjacent to an existing electricity sub-station with WS5 adjacent to the historic tanks in the west of the site which are likely to be the source of contamination in these locations. Given the presence of controlled waters beneath the site and groundwater identified at approximately 2.0m to 3.0m bgl, it is recommended that further works be undertaken in these areas with the retrieval of soil and groundwater samples to suitably delineate the identified contamination and further assess the risk these contaminants pose.

Further thought should be given in these areas to any proposed hardstanding design and the use of permeable surfaces / soakaways as the introduction of water into these soils may increase the risk of the identified contaminants mobilising and migrating into controlled groundwaters.

6.0 HAZARDOUS GAS ASSESSMENT

6.1 General

Made Ground was identified during the intrusive investigation works to depths of up to 3.1m bgl. and generally comprised a variable sequence of either predominantly granular or cohesive materials of various subtypes with fragments of putrescible materials noted in two locations. Visual and olfactory evidence of hydrocarbons was also noted in two locations which can be a source of hazardous ground gasses. A review of historical maps of the area has identified historic sewage works with associated engine house and filter beds on site with industrial buildings historically occupying the south of the site. Within the surrounding area, another sewage works, mills, industrial units and infilled land / landfill have also been identified which could be viewed as sources of filled ground and potentially organic materials with the potential to generate hazardous ground gases.

Natural strata beneath the site and within the surrounding area including alluvium and river terrace deposits are indicated to potentially contain peat and other organic materials with peaty soils and fragments of decaying wood / grass identified within the natural soils on site. The chalk bedrock could also be viewed as being a potential source of ground gasses, with samples retrieved for TOC testing recording organic concentrations up to 8.05%.

6.2 Scope of Works

In view of the above, four gas monitoring wells were installed in BH1, BH3, WS3 and WS4 with response zones set in the Made and natural strata. An initial gas monitoring programme was scheduled to comprise four monitoring visits over a minimum one month period in general accordance with CIRIA Report C665.

6.3 Monitoring Results

Monitoring has been undertaken on four occasions between 12th September and 30th September 2019 with atmospheric pressures recorded ranging between 1009mb and 1027mb. Falling atmospheric pressure was recorded on two occasions.

Copies of the results are presented in Appendix VII and summarised in the table below.

Table 1 – Gas Monitoring Results

Hole ID	Methane (%v/v)	Carbon Dioxide (%v/v)	Flow Rate (l/hr)	Gas Screening Value (l/hr)
BH1A	0.0	4.7	0.7	0.0329
BH3	0.0	4.8	0.1	0.0048
WS3	0.0	7.2	0.1	0.0072
WS4	0.0	0.0	0.1	0.0000

The monitoring results have not recorded any methane concentrations and maximum carbon dioxide concentration of 7.2%. Gas flow rates were found to be generally absent with the maximum flow rate recorded of 0.7 l/hr. Based on the monitoring results, the worst-case Gas Screening Value (i.e. 7.2% carbon dioxide and 0.7 l/h flow) is 0.0504 l/hr.

In addition to the above, depleted oxygen was recorded in WS3 on one occasion with oxygen recorded at 10.9%.

6.4 Discussion

Based on the available results and the worst-case gas screening value of 0.0504 l/hr recorded, the site can be classified as Characteristic Situation 1 (CS1).

According to the current guidance and best practice however, where carbon dioxide concentrations are recorded in excess of 5%, consideration should be given to increasing the classification to CS2. In this instance, given the relatively short monitoring period, the presence of elevated carbon dioxide, depleted oxygen levels, the depth and nature of the filled ground and presence of peat in the local area, we would recommend that the characteristic situation be increased to CS2 and that gas protective measures are installed in all new structures in accordance with guidance provided in BS 8485: 2015 "Code of Practice for the Design of Protective Measures for Methane & Carbon Dioxide Ground Gases for New Buildings".

There is now a requirement for the installation of gas protective measures to be independently verified in order to achieve discharge of planning conditions relating to contaminated land. Guidance is provided in CIRIA C735 "Good Practice on the Testing and Verification of Protection Systems for Buildings Against Hazardous Ground Gas".

We can advise on the verification procedures to ensure regulatory approval.

7.0 GEOTECHNICAL ASSESSMENT

7.1 General

It should be noted that this Section does not comprise or represent a Geotechnical Design Report (GDR) but instead provides preliminary information and recommendations based on the findings of the Ground Investigation.

The geotechnical section of the ground investigation was designed in general accordance with guidance presented in BS EN 1997-2:2007. The objective of the investigation was to obtain preliminary information in order to assess the geotechnical properties of the ground and provide recommendations for foundation and infrastructure design.

7.2 In Situ Geotechnical Testing

In-situ standard penetration tests (SPTs) were carried out during window sample and cable percussive drilling at approximately 1.0m to 1.5m intervals in order to allow the assessment of ground conditions by establishing soil strength/density characteristics.

7.2.1 Made Ground

SPT 'N' values of between 15 and 40 were recorded within the granular Made Ground. The mean of the recorded 'N' values was 22.75. 'N' values of between 8 and 45 were recorded within the cohesive component with a mean recorded 'N' value of 17.2.

SPT 'N' values in excess of 50 were recorded within the Made Ground in BH1, BH1A and WS8 where obstructions were encountered.

7.2.2 Natural Strata

The SPTs carried out within the shallow natural strata up to 3.45m recorded 'N' values ranging from 1 to >50 indicating these soils to be in a very variable condition.

Beneath this, the SPTs recorded 'N' values ranging from 10 to 28 (with the exceptions of WS4 and BH2 at 4.0m with respective 'N' values of 9 and 4) indicating these soils to be in a medium dense, firm and stiff condition.

7.2.3 Solid Strata

Within the chalk bedrock, the SPT 'N' values generally increased in depth with 'N' values from 6.0m to 13.5m bgl ranging from 6 to 21, 'N' values between 15.0m to 18.0m ranging from 15 to 26 (with the exception of BH3 where an 'N' value of >50 was recorded), from 18.0m to 21.0m ranging from 22 to >50 and from 21.0m proven to a maximum to 24.5m, the SPT 'N' values were all recorded as >50.

In accordance with CIRIA C574 'Engineering in Chalk', the SPT 'N' values indicate that the base of weathering within the chalk bedrock is between 15.0m and 18.0m bgl.

7.3 Laboratory Geotechnical Testing

7.3.1 Triaxial Compression Tests

It was initially intended to recover samples of any cohesive soils for triaxial compression testing in order to provide accurate classification of the soil strength. The clay soils were however found to contain a high sand and gravel content rendering them unsuitable for the recovery of undisturbed samples for laboratory analysis.

Undisturbed samples were recovered from within the chalk however only one (BH1 at 6.0 to 6.45m) was found suitable for triaxial compression testing. The test result recorded a C_u value of 38 kPa.

7.3.2 Plasticity Indices

Four soil samples were recovered from the shallow natural clay deposits from WS1 at 2.5m, WS4 at 2.9m BH4 at 2.1m and SA1 at 1.3m. The four samples were submitted to a UKAS accredited laboratory for Determination of Liquid and Plastic Limits in accordance with BS1377: Part 2: 1990: Methods 3.0, 4.4 and 5.0.

NHBC Standards Chapter 4.2 (Building Near Trees) states that in order to assess the volume change potential of cohesive soils, the Modified Plasticity Index should be calculated. The Modified Plasticity Index is defined as the Plasticity Index of the soils multiplied by the percentage of particles less than 425 μ m.

The results recorded Modified Plasticity Indices ranged from 2.7% in WS1 at 2.5m to 11.7% in WS4 at 2.9m (with the exception of SA1 at 1.3m). Therefore, in accordance with Table 1 of NHBC Standards Chapter 4.2, these soils to be of '**low**' volume change potential.

In SA1 at 1.3m, the Modified Plasticity Index was recorded as 55.0%, indicating these soils to be of '**high**' volume change potential.

7.3.3 Particle Size Distribution

Two soil samples were recovered, one from the shallow Made Ground (HTP3 at 0.15m to 0.2m) and one from the natural granular strata (WS3 at 1.5m) and sent to a UKAS accredited laboratory for particle size distribution testing.

The laboratory test results confirm that these soils are predominantly granular in nature.

7.3.4 CBR Tests

Soil samples from depths between 0.6m and 0.8m bgl were collected from three locations (SA1, SA2 and WS2) and tested by a UKAS accredited laboratory for soaked laboratory CBR tests.

The test results recorded minimum CBR values of 2.7% in SA1 at 0.7m, 1.1% in SA2 at 0.6m and 16.8% in WS2 at 0.6m to 0.8m.

7.3.5 Intact Dry Density of Chalk

Across the site, beneath the superficial deposits, structureless chalk was encountered generally comprising slightly sandy slightly gravelly silt. Fourteen samples were retrieved from WS1 at 4.8m, BH1 at 10.5m to 10.95m, BH2 at 5.0m to 5.45m, 5.6m, 7.5m to 7.95m, 8.0m, and 17.00m to 17.95m, BH3 at 9.0m to 9.45m, 19.0m and 21.0 to 21.45m and from BH4 at 6.5m, 9.1m, 11.5m and 18.9m and submitted to a UKAS accredited laboratory for Saturated Moisture Content and Intact Dry Density testing.

In Accordance with Table 3.2 of CIRIA C574 'Engineering in Chalk', the results recorded for the samples tested are generally consistent with chalk of 'medium density' with areas of 'low density' recorded in BH1 at 10.5m to 10.95m and in BH2 at 5.0m to 5.45m and 7.5m to 7.95m. Areas of 'high density' chalk were encountered in BH4 at 9.1m and 18.9m.

The geotechnical laboratory results are presented in Appendix IV.

7.4 Foundations

7.4.1 Existing Foundations

Three hand excavated trial pits (designated HTP1, HTP2 and HTP4) were excavated alongside the perimeter of existing buildings. The overall objective was to extend these excavations to the base of the foundations in order to determine construction characteristics and founding stratum. HTP1 and HTP2 were excavated adjacent the southern elevation of Building 6000, whilst HTP4 was excavated along the eastern building line of Building 1000.

Building 6000

HTP1 and HTP2 were excavated adjacent to Building 6000 in order to investigate the existing building foundations.

HTP1 was excavated adjacent to a concrete column which extended vertically to a depth of 0.6m bgl, before stepping out horizontally from the column line for a distance of approximately 0.85m. The foundation then extended vertically to a depth of 1.2m, before again stepping out horizontally. At 1.2m depth the foundation extended 1.2m out from the column line before again extending vertically, proven to a depth of 1.4m bgl. The excavation was terminated at 1.4m bgl, at which depth neither the foundation base, nor founding stratum could be proven.

HTP2 was undertaken against a non-loadbearing brick wall, which extended to a depth of 0.3m bgl. A concrete foundation was encountered at this depth which stepped out horizontally by 0.05m, before extending vertically to 0.65m bgl in one half of the trial pit and to the full depth of the excavation at 1.2m bgl in the other half of the trial pit. The foundation base and founding stratum were not exposed.

It is understood from anecdotal evidence that building 6000 is constructed on pad foundations, however the investigation could neither prove or disprove this hypothesis.

Building 1000

HTP4 was excavated to investigate the exist foundations of Building 1000.

The foundation extended vertically to 0.15m bgl where it stepped out horizontally to 0.92m from the building (minus the thickness of the cladding). The foundation then extended vertically to 0.35m bgl before stepping out horizontally to 1.27m from the building. The foundation further extended vertically to 0.5m bgl and was found to be seated within the Made Ground. To confirm that this was the foundation base, the excavation undercut the concrete footing, and was extended to 1.2m bgl.

It is considered that given Building 1000 is situated on a raised mound comprising Made Ground, the foundations encountered may not be representative of the whole building. Given that there are tunnels running beneath the site, deeper foundations may be encountered during demolition.

During the excavation, a metal pipe was encountered adjacent to the concrete footing. The nature and rout of this pie is currently unknown.

Copies of the foundation sections are included in Appendix V, and the exploratory hole logs are provided in Appendix II.

7.4.2 Foundation Recommendations

The following foundation recommendations assume that the proposed development will comprise the partial demolition and reconfiguration of an existing laboratory and manufacturing unit (Building 1000) located toward the north of the site in order to extend parking provision, and the construction of four light industrial / commercial units with associated parking provision across the southern section of the site.

The ground investigation has identified Made Ground across the site to depths up to 3.1m underlain by interbedded granular and cohesive strata and or a highly weathered material derived from the underlying bedrock. These superficial deposits were proven to a maximum depth of between 5.1m and 6.0m bgl and found to be in a very variable condition with SPT 'N' values ranging from 1 to >50.

Solid chalk bedrock was encountered below the superficial deposits across the site. In general, where encountered, this material was described as structureless chalk (Grade Dm) composed of uncompacted slightly sandy slightly gravelly occasionally cobbly silt.

SPT 'N' values obtained from tests conducted within the chalk (Grade Dm) generally increased with depth with un-weathered horizons indicated from between 15.0m to 18.0m bgl. Dry density testing indicates the chalk to generally be of 'medium density' with areas of 'low density' recorded in two locations up to 10.95m bgl.

Groundwater was encountered across the site during this investigation at depths generally between 2.0m and 3.0m bgl.

It is considered that a shallow foundation solution within the superficial deposits encountered may prove problematic, though an allowable bearing capacity of 40 to 50 kN/m² based on a 1m² pad foundation could be assumed in such material. If a shallow foundation solution is utilised, excavations may need to be over-deepened in areas of deeper Made Ground or very loose / very soft natural strata. Any shallow foundations may span strata of varying characteristics and may be at risk of differential settlement. We would therefore recommend that foundations are reinforced to protect against differential settlement.

Given the above, a piled foundation may prove more suitable. Additional advice should be sought from a specialist piling contractor regarding the pile design (i.e. type, length and diameter).

If a piled foundation solution is to be utilised, there may be differential settlement between piled structures and the surrounding ground level.

7.5 Concrete Classification

In accordance with BRE Special Digest 1, the site has been classified as “brownfield” with a mobile groundwater regime.

The concentrations of sulphate in aqueous extractions were determined using the gravimetric method. The pH value of each sample was determined using the electrometric method. Four samples taken from the Made Ground, four from the natural superficial deposits and four from the underlying chalk bedrock were tested for water soluble sulphate content. In addition, ten samples of made ground, six soil samples from the natural superficial deposits and four samples of the chalk bedrock were tested for pH.

Sulphate concentrations did not exceed laboratory level of detection (LOD) of 10 mg/l in any of the samples analysed. The characteristic sulphate value has therefore been set at the laboratory LOD of 10mg/l. The lowest recorded pH was 7.01.

Therefore, in accordance with Table C2 of SD1, sub-surface concrete should be Design Sulphate Class DS-1 with an ACEC classification of AC-1.

7.6 Waste Management

Arisings generated from excavations for foundations and service trenches etc. may be classified as waste and it is the responsibility of the holder of such material to form a view as to whether or not it constitutes waste.

Guidance on how this can be achieved is set out in the Development Industry Code of Practice (CoP) (CL:AIRE, March 2011).

The handling, re-use or disposal of waste materials is regulated by the Environment Agency, who take into account the CoP in determining whether materials are classified as waste. If materials are handled in accordance with the CoP it is considered unlikely that they will be considered waste at the point when they are used during development. This might be because the materials were never formally discarded or because they have been processed as part of a ‘recovery’ operation and therefore ceased to be waste.

Should site won material be intended for re-use on site a Materials Management Plan will be required from a suitably qualified environmental consultant in order to comply with the CoP.

7.7 Infiltration Tests

7.7.1 Soakaway Testing

Soakaway testing was undertaken in general accordance with the guidance provided in BRE digest 365 'Soakaway Design' in two locations (SA1 and SA2). Mechanically excavated trial pits were undertaken to depths of approximately 2.0m bgl with the vertical sides trimmed and squared before being partially filled with water and the rate of infiltration recorded. Infiltration rates have subsequently been calculated in order to examine soils permeability characteristics and the feasibility of soakaway drainage.

The results of the soakaway tests are presented in Table 2 below. The monitoring certificates are included as Appendix VI.

Table 2 – Soakaway Test Results

Location	Test Depth (m bgl)	Indicative Infiltration Rate (m/s)
SA1 (Test 1)	0.99 – 2.05	4.37×10^{-5}
SA1 (Test 2)	0.95 – 2.05	3.81×10^{-5}
SA1 (Test 3)	0.90 – 2.05	3.95×10^{-5}
SA2 (Test 1)	1.51 – 2.10	6.26×10^{-4}
SA2 (Test 2)	1.50 – 2.10	8.36×10^{-4}
SA2 (Test 3)	1.53 – 2.10	1.04×10^{-3}

Infiltration rates recorded during the tests carried out in SA1 indicate that the natural strata in this location exhibit marginal drainage characteristics and that soakaway drainage / permeable paving may be suitable subject to design parameters.

The infiltration rates recorded within the Made Ground in SA2 indicate good drainage characteristics, however it should be noted that soakaway drainage in Made Ground is generally not considered acceptable by regulators. Whilst no visual or olfactory evidence of contamination was observed and laboratory test results within this area have not highlighted any elevated concentrations of the determinands tested, further thought should be given to the suitability of this location for the installation of soakaways.

Due to the presence of chalk there is a risk of ground dissolution features caused by traditional soakaway structures that concentrate infiltration to a localised area. In low to medium density chalk traditional soakaways must have a minimum of 5-10m separation from buildings and structures to avoid the generation of dissolution features that may impact on building foundations (CIRIA C574 'Engineering in Chalk'). Distributive soakaways such as permeable paving and sub-base infiltration that do not concentrate infiltration avoid the risk of generating groundwater dissolution features.

7.7.2 Preliminary Infiltration Tests

During the intrusive investigation, preliminary infiltration (falling head) tests were carried out in two of the window sample boreholes (WS2 and WS6) in order to examine the feasibility of soakaways as a means of surface water disposal and supplement the above soakaway testing results. The boreholes were excavated to the depth of 2.0m bgl with a response zone set between 1.5m and 2.0m bgl.

An approximate permeability value of 1.80×10^{-4} was calculated within WS2 indicating these soils to have good drainage characteristics. The water in WS6 failed to infiltrate over the duration of the test, indicating these soils to have very poor drainage characteristics.

8.0 CONCLUSIONS AND RECOMMENDATIONS

It is understood that site is proposed to be partially re-developed comprising the partial demolition and reconfiguration of an existing laboratory and manufacturing unit located toward the north of the site in order to extend parking provision with associated landscaping and the construction of four (4No.) light industrial / commercial units with associated parking across the south of the site with associated car parking.

Historical OS maps of the area indicate the site was undeveloped until the early 1900s when a large sewage works and engine house occupied the north-eastern section of the site. During the subsequent decades this facility underwent significant expansion. In the mid-1950s, an allotment garden occupied the centre of the site. In the early to mid 1970s, the site had undergone large-scale redevelopment, resulting in the construction of many of the existing commercial / industrial units. In addition, by this time a large building and an electrical sub-station occupied the southern section of the site, within the existing car-parking area. By the early 1990s the building / electricity substation across the south of the site had been replaced by the existing car-park and the site is understood to have been in its current configuration. The surrounding area has been a mix of undeveloped, and industrial land uses with mills, sewage works, works and industrial units along with a retail park with associated infrastructure all located / historically located within close proximity to the site.

The nearest identified environmental receptors are the underlying superficial strata which is classified as a Secondary A Aquifer, solid strata classified as a Principle Aquifer and water course immediately to the east of the site though the site is not situated within a Source Protection Zone and no groundwater or surface water abstractions have been identified within 250m of the site.

Intrusive site investigation works were carried out between 17th and 15th July 2019 and comprised the excavation of 8 No. window sample boreholes 4 No. Cable Percussive boreholes, 4 No. hand excavated, and 2 No. mechanically excavated trial pits. In addition, indicative infiltration testing (falling head) was carried out within selected window sample boreholes (WS2 and WS6), and soakaway testing was undertaken in the machine excavated trial pits.

Made Ground was identified during the intrusive investigation works to depths of up to 3.1m bgl. and generally comprised a variable sequence of either predominantly granular or cohesive materials of various subtypes.

Sub-surface hardstanding was encountered in several locations across the site, generally corresponding with the locations of historic / demolished buildings. There remains the possibility that buried structures may be present elsewhere on site which have not been identified during this investigation.

The Made Ground was underlain by a sequence of interbedded granular and cohesive strata interpreted to predominantly comprising river terrace deposits and or a highly weathered material derived from the underlying bedrock. These superficial deposits were proven to a maximum depth of between 5.1m and 6.0m bgl. Solid chalk bedrock was encountered below the superficial deposits across the site, proven to a maximum of 24.85m bgl.

Groundwater was generally encountered across the site during the fieldwork at depths of between approximately 2.0m to 3.0m.

Visual and olfactory evidence of hydrocarbon contamination was recorded in WS2 and WS5 between though chemical testing did not identify any contaminants which exceeded relevant SSVs for commercial / industrial end use in terms of human health and no asbestos fibres or ACMs were encountered during the investigation.

Whilst no elevated concentrations of the determinands tested have been recorded in terms of human health, localised concentrations of contaminants not identified / investigated during this investigation may be present in quantities considered harmful in terms of human health.

Site workers involved in excavations for foundations, roads, sewers etc. may come into direct shallow Made Ground soils which have not been identified during this investigation. As any Made Ground does represent a potential risk, we would therefore recommend that simple precautionary measures be adopted during the construction phase i.e. good personal hygiene, provision of welfare facilities and basic personal protective equipment i.e. gloves and safety glasses. Should during any future investigation / remediation / construction works identify visual or olfactory evidence of contamination, a suitably qualified environmental consultant should be contacted to further assess any potential issues. Additional works may be required to suitably quantify the risk to potential and identified receptors.

In respect to controlled waters, chemical testing has identified elevated concentrations of organic contaminants when compared to SSVs for commercial / industrial end use in the locations of WS2 and WS5. WS2 was positioned in the location of a historic waste storage area and also adjacent to an existing electricity sub-station with WS5 adjacent to the historic tanks in the west of the site which are likely to be the source of contamination in these locations. Given the presence of controlled waters beneath the site and groundwater identified at approximately 2.0m to 3.0m bgl, it is recommended that further works be undertaken in these areas with the retrieval of soil and groundwater samples to suitably delineate the identified contamination and further assess the risk these contaminants pose.

Further thought should be given in these areas to any proposed hardstanding design and the use of permeable surfaces / soakaways as the introduction of water into these soils may increase the risk of the identified contaminants mobilising and migrating into controlled groundwaters.

Geotechnical testing of the shallow natural cohesive deposits indicate these soils to be of 'low' volume change potential with the exception of the location of SA1 where a 'high' volume change potential was recorded. That should be taken into consideration for the foundation design.

Laboratory CBR tests carried out in three locations recorded values ranging from 1.1% to 16.8%.

Dry density tests of the chalk bedrock are generally consistent with chalk of 'medium density' with areas of 'low density' recorded in BH1 at 10.5m to 10.95m and in BH2 at 5.0m to 5.45m and 7.5m to 7.95m. Areas of 'high density' chalk were encountered in BH4 at 9.1m and 18.9m.

Ground gas monitoring was undertaken on 4 occasions and has recorded 7.2% carbon dioxide. No methane has been identified and gas flow rates were typically absent. Based on the gas screening values available, the site can be classified as Characteristic Situation 1 (CS1).

According to the current guidance and best practice however, where carbon dioxide concentrations are recorded in excess of 5%, consideration should be given to increasing the classification to CS2. In this instance, given the relatively short monitoring period, the presence of elevated carbon dioxide, depleted oxygen levels, the depth and nature of the filled ground and presence of peat in the local area, we would recommend that the characteristic situation be increased to CS2 and that gas protective measures are installed in all new structures in accordance with guidance provided in BS 8485: 2015 "Code of Practice for the Design of Protective Measures for Methane & Carbon Dioxide Ground Gases for New Buildings".

It is considered that a shallow foundation solution may prove problematic given the very variable nature of the shallow natural strata. An allowable bearing capacity of 40 to 50 kN/m² based on a 1m² pad foundation could be assumed in such material though if a shallow foundation solution is utilised, excavations may need to be over-deepened in areas of deeper Made Ground or very loose / very soft natural strata. Any shallow foundations may span strata of varying characteristics and may be at risk of differential settlement. We would therefore recommend that foundations are reinforced to protect against differential settlement.

Given the above, a piled foundation may prove more suitable. Additional advice should be sought from a specialist piling contractor regarding the pile design (i.e. type, length and diameter). If a piled foundation solution is to be utilised, there may be differential settlement between piled structures and the surrounding ground level.

Laboratory testing indicates that sub-surface concrete should be prepared as Design Sulphate Class DS-1 with an ACEC classification of AC-1.

As part of the investigation, soakaway testing was undertaken in general accordance with the guidance provided in BRE digest 365 'Soakaway Design' in two locations with falling head tests also undertaken in two locations in order to supplement the soakaway data. Recorded infiltration rates suggest that the superficial deposits exhibit marginal to good drainage characteristics, and that soakaway drainage / permeable paving may be suitable subject to design parameters. Infiltration rates within the granular Made Ground also show good drainage characteristics however it should be noted that soakaway drainage in Made Ground is generally not considered acceptable by regulators. Whilst no visual or olfactory evidence of contamination was observed and laboratory test results within this area have not highlighted any elevated concentrations of the determinands tested, further thought should be given to the suitability of this location for the installation of soakaways.

Due to the presence of chalk there is a risk of ground dissolution features caused by traditional soakaway structures that concentrate infiltration to a localised area. In low to medium density chalk traditional soakaways must have a minimum of 5-10m separation from buildings and structures to avoid the generation of dissolution features that may impact on building foundations (CIRIA C574 'Engineering in Chalk'). Distributive soakaways such as permeable paving and sub-base infiltration that do not concentrate infiltration avoid the risk of generating groundwater dissolution features.

Based on the information available to date we would recommend the following further works are required:

- Additional investigations to be carried out in the location of WS2 and WS5 to delineate identified organic contamination with regards to controlled waters. Soil and water samples to be recovered for laboratory testing.
- Preparation of a Remediation Strategy following delineation of the organic contamination for approval with the Local Authority.
- Gas protective measures to be installed in all new structures in accordance with CS2 conditions. The installation of the protective measures should be independently verified to ensure they are fit for purpose and to assist with planning discharge.
- The continued risk of unexploded ordnance should be considered during any future excavations and an EOD engineer may be required on site to brief and support site personnel.

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Appendix I