- presence/absence of any impact made ground;
- potential underground storage tanks/interceptors and associated infrastructure of unknown integrity and condition.

Geotechnical considerations include;

- presence of historical/existing buried foundations / substructures;
- proximity of neighbouring properties and associated foundations and,
- deep fill materials around potential underground storage tanks/interceptors.

3.1.3 Holly Road, South

The site is located behind a series of terraced residential properties fronting Holly Road and is currently occupied by tarmac hardstanding used to store a number of vehicles. The site is relatively flat. The western site boundary is defined by a railway cutting.

Potential sources of contaminative activity may include:

- leaks and spills associated with vehicle storage; and,
- presence/absence of any impact made ground.

Geotechnical considerations include:

- proximity of neighbouring properties and associated foundations and,
- railway cutting adjacent the western site boundary.

3.2 Previous reports

It is understood that there is an existing/historical Geo-environmental Report produced by LBH Wembley (Reference: 2377). Salient findings as reported within the CDM Pre-Construction Information, Potter Raper Partnership, dated 26th February 2018 include:

- Historical gravel pit located along the western site boundary of the Business Park;
- Ground conditions comprise a variable and substantial thickness of made ground over nominal River Terrace Deposits and the London Clay Bedrock geology;
- No visual or olfactory evidence of contaminative impact were observed during the intrusive exploratory works;
- Groundwater was encountered both perched within the underlying made ground and with the River Terrace Deposits; and,
- Ground was noted as unstable and it was recommended that shoring/lateral support would be required as part of any future excavation works.

3.3 Ground conditions

3.3.1 Geology

Published records (British Geological Survey, 1998) for the area indicated the geology of the site to be characterised by the succession recorded in Table 2.

Table 2: Geology at the site

Geological unit	Description	Estimated thickness (m)
Superficial Geology - Taplow Gravel Member	Sand and gravel, locally with lenses of silt, clay or peat	5m
Bedrock Geology – London Clay Formation	The London Clay mainly comprises bioturbated or poorly laminated, blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay.	Up to 150m
Source: BGS Geology of Britain viewer: http://mapapps.bgs.ac.uk/geologyofbritain/home.html		

Borehole records were downloaded from the British Geological Survey website to provide further information regarding ground conditions in the vicinity of the site. Copies of these are included in **Appendix D**.

Taking into consideration findings of previous exploratory works, site topography and development history of the subject site, made ground should be expected beneath the all land parcels.

3.3.2 Radon

The environmental database report (Envirocheck report, 159575380_1_1, 16 March 2018) indicates that the site is not located within an 'Affected Area' as defined by the Documents of the National Radiological Protection Board (Radon Atlas of England and Wales, NRPB-W26-2002).

Therefore, the risk of significant ingress of radon into structures on-site is considered to be low and no radon protective measures are required within new dwellings at the site.

On this basis, the risk from radon gas has been omitted from further assessment as part of this report.

3.3.3 Mining and quarrying

Evidence has been sought to identify any mining and quarrying operations, past and present, which have taken place in the vicinity of the site. The sources of information referenced in this element of the desk study include:

- an environmental database report;
- records held by local authority/EA;
- old Ordnance Survey maps and plans; and,
- geological maps.

With reference to the environmental database, there are four (4No.) historically recorded BGS Mineral Sites within 1km of the subject site all relating to open cast quarrying of the underlying Taplow Gravel Formation, the closest if which is located circa 400m north of the subject site (Hampton Hill Gravel Pit).

With reference to available historical mapping data, an old gravel pit is located along the western site boundary of The Business Park presumably open cast and quarrying from the underlying Taplow Gravel Member as elsewhere in the region.

The site is not located within an area affected by coal mining.

3.3.4 Ground stability hazards

The Envirocheck report (159575380_1_1, 16 March 2018) identifies the following information with respect to potential ground stability hazards relating to this site:

- No Hazard: compressible ground, dissolution stability;
- Very Low: collapsible ground; landslide ground; running sand; and,
- Low: Shrinking or swelling clay.

Abounding the western site boundaries of both The Business Park and Holly Road, South sites is a steep sided railway cutting.

3.3.5 Landfilling and land reclamation

Evidence has been sought to identify any landfilling or land reclamation operations, past and present, which have taken place in the vicinity of the site. The sources of information referenced in this element of the desk study include:

- environmental database report;
- records held by local authority/EA;
- old Ordnance Survey maps and plans; and,
- geological maps.

There are no records of landfill sites (former or current) within 250 m of the site (i.e. within the planning consultation zone).

The Envirocheck report (159575380_1_1, 16 March 2018) details three areas of potentially in-filled land within 1/2km of the site. There is potential of unknown in-filled land 391m north of site, mapped in 1985 and a second 439m north west of site, mapped in 1985. Another potentially in-filled ground, detailed as water related, is found 495m south, mapped in 1899.

Taking into consideration the localised nature of landfilling activities and the anticipated age of deposits the risks posed to any future development of the subject site are considered negligible and therefore omitted from any further assessment as part of this report.

On-site however and with reference to the historical data, there have been several phases of construction and demolition on all land parcels within the subject site and therefore the presence of made ground should be expected.

3.4 Hydrogeology

3.4.1 Aquifer characteristics

Based on the published geological map referred to above, the hydrogeology of the site is likely to be characterised by the presence of an unconfined shallow aquifer comprising the Taplow Gravel Member overlying the London Clay Formation – an aquitard.

Confined by the London Clay Formation is a deep aquifer, comprising a sequence of deposits consisting of the lower part of the Lambeth Group and Thanet Sands (Basal Sands) and the White Chalk. These units are expected to be in hydraulic continuity.

The anticipated depth to the groundwater table is in the order of 2-3m below ground level coincidental with the occurrence of the granular Taplow Gravel Formation Strata.

Shallow groundwater in the site area is anticipated to flow either westwards toward the unconfined soils of the abounding railway cutting or more regionally southwards towards Longford River (<100m south) a tributary to the River Thames located ~1.5km south of the subject site.

Shallow and localised perched water is anticipated to be present in the underlying made ground.

The presence of low permeability clay at relatively shallow depths beneath the site, while restricting downwards migration, may increase the potential for lateral migration of shallow groundwater (and therefore mobile contamination, if present).

3.4.2 Vulnerability of groundwater resources

The site has been classified by the EA website to overlie a:

- Principal Aquifer (Taplow Gravel Member): defined as layers of rock or drift deposit that have high intergranular and/or fracture permeability (usually providing a high level of water storage). They may support water supply and/or river base flow on a strategic scale; and,
- 'Unproductive' strata (London Clay Formation): defined as low permeability with negligible significance for water supply or river base flow.

The soils beneath the site are classified as having 'high urban' (HU) leaching potential.

HU - soil information for restored mineral workings and urban areas is based on fewer observations than elsewhere, so a worst-case vulnerability classification is assumed until proven otherwise.

3.4.3 Risk from rising groundwater levels

Rising groundwater levels can affect foundations and structures, and may result in flooding if not controlled properly. In certain areas, groundwater levels are rising owing to reduced groundwater abstraction by industry. London is at particular risk but the situations in Birmingham, Liverpool, Glasgow and Nottingham are also being monitored.

As defined within CIRIA Special Publication 69 (Simpson et al., 1989) the site does not lie within an area defined as 'critical' in the London basin within which exceptional structures

and therefore is not considered at potential at risk from the rising groundwater levels in the deep aquifer.

The rise in groundwater levels started during the mid-1960s as a result of a significant reduction in groundwater abstraction from the Chalk aquifer. Prior to this, the Chalk aquifer had been increasingly exploited as a result of increasing industrialisation throughout the 19th century and early part of the 20th century.

Following the issue of CIRIA Special Publication 69 (Simpson et al., 1989), the Rising Groundwater Level Working Group (GARDIT) was formed in March 1998. This group publicly launched a strategy proposal for controlling rising groundwater beneath London. As a result of the implementation of the GARDIT strategy, groundwater levels are now considered to be stabilising across much of the London Basin and the GARDIT Strategy is considered to have been successful. There will be ongoing monitoring and control of groundwater levels in the London Basin using the abstraction licensing process.

The EA status report issued in 2018 'Management of the London Basin Chalk Aquifer' indicates that the potentiometric surface of the groundwater in the deep aquifer in the site area in January 2015 was at approximately -20 to -30 mAOD, i.e. approximately 40-50m below ground level.

3.4.4 Licensed groundwater abstraction

The Envirocheck report (159575380_1_1, 16 March 2018) report indicates that there are two current licensed groundwater abstractions within a 2km radius of the site, details summarised in Table 3 below.

Table 3: Groundwater abstractions

Reference	Distance and orientation from site	Comment
28/39/31/0172	660m south (down-gradient)	Hampton Pool Ltd – sports ground facilities (general) – single point (anticipated from shallow superficial geology)
Th/039/0031/013	762m west	Hampton School – spray irrigation – single point (anticipated from shallow superficial geology)
Notes: none		

In terms of aquifer protection, the EA generally adopts a three-fold classification of source protection zones (SPZ) for public supply abstraction wells.

- Zone 1 or 'inner protection zone' is located immediately adjacent to the groundwater source and is based on a 50-day travel time from any point below the water table to the source. It is designed to protect against the effects of human activity and biological/chemical contaminants that may have an immediate effect on the source.

- Zone 2 or 'outer protection zone' is defined by a 400-day travel time from a point below the water table to the source. The travel time is designed to provide delay and attenuation of slowly degrading pollutants.
- Zone 3 or 'total catchment' is the area around the source within which all groundwater recharge is presumed to be discharged at the source.

Information available on the EA website indicates that the site does not lie within a currently designated groundwater Source Protection Zone.

3.5 Hydrology

3.5.1 Surface watercourses

The nearest identified surface water feature to the site is the Longford River located <100m southwest of the subject site and a tributary to the River Thames located circa 1.5km south of the subject site.

The EA classification of the water quality in the stretch of the Longford River nearest to the site is Grade B (good). Chemical analysis of the Longford River, obtained from a sampling point location circa 1/4km south of the subject site, indicates a Grade A to Grade B (very good to good) river quality chemistry from early 1990's to 2010.

The base flow of the Longford River is likely to be recharged by groundwater in the shallow aquifer in the site area. A linkage between the river and any ground or groundwater contamination beneath the site may therefore exist.

The Envirocheck report (159575380_1_1, 16 March 2018) report does not detail any record of any authorised discharge consents within a 2km radius of the subject site.

There are two reported pollutant incidents to controlled waters recorded within 2km of the subject site. Limited information is available however; both are reportedly category 3 minor incidents, the closest and more recent of which is located circa 800m north-west of the subject site reported in 1998.

3.5.2 Surface water abstractions

The Envirocheck report (159575380_1_1, 16 March 2018) report indicates there is a single licensed surface water abstraction within a 2km radius of the site, the details of which are summarised in Table 4 below.

Table 4: Surface water abstractions

Reference	Distance and orientation from site	Comment
28/39/M/0002	1,617m – southwest (down-gradient)	Thames Water Utilities – potable water single point
Notes: none		

3.5.3 Site drainage

Surface drainage from the site appears to be via a series of gullies discharging into the underlying Taplow Gravels via on-site (albeit poorly maintained) soakaways connected via three-stage interceptors.

3.5.4 Preliminary flood risk assessment

The indicative floodplain map for the area, published by the EA, shows that the does not lie within an EA defined at risk from flooding from rivers or sea, nor is it situated within an area benefitting from defences nor is it within an intended water storage area.

The Envirocheck report (159575380_1_1, 16 March 2018) report indicates that there is a potential for groundwater flooding of property situated below ground level (BGS flood GFS data).

The central and western extents of the Business Park site are identified as being at risk from a high (30-year return) to medium (100-year return) risk from surface water flooding.

Fluvial models suggest the Longford River, located <100m south of the subject site may be suspectbale to inundation in the event of an extreme flood event.

This report is not intended to replace a full hydrological study and it is recommended that additional specialist studies be conducted to confirm flood risks at the site.

3.6 History of site and surrounding area

The history of the land-use and development of the site and surrounding area has been assessed based on the following sources:

- historical maps within the environmental database from 1869 to present (2018);
- town plans;
- internet search;
- historical maps of London;
- local archives;
- information from the local planning authority; and,
- aerial photography.

Copies of OS and County Series maps are included in the environmental database report in **Appendix E**. Reference to historical maps provides invaluable information regarding the land use history of the site, but historical evidence may be incomplete for the period pre-dating the first edition and between successive maps.

Planning records held by London Borough of Richmond upon Thames Council pertaining to the site date from 1994 – 2015. Subsequent planning consents of note are referenced in Table 5.

Table 5: Planning information

Year	Details
1994	94/2187 – installation of additional windows (Unit 4) – permission granted
1996	96/1322 – change of use to facilitate site access (Business Park)– withdrawn by applicant
1996	96/2437 - change of use to facilitate site access (Business Park)– permission refused
1997	97/1699 – extension of working hours (Unit 6) – withdrawn by applicant
1997	96/3995 - change of use to facilitate site access (Business Park)– permission refused – appealed
1997	96/3994 - change of use to facilitate site access (Business Park)– permission refused – appealed
1998	96/3994 – details of materials pursuant (Business Park) –permission granted
1998	96/3995 - details of materials pursuant (Business Park) –permission granted
1998	96/3994 - details of landscaping (Business Park) –permission granted
1999	99/2846 – installation of two 1st floor windows (Unit 6) –permission granted
1999	98/0786 – redevelopment of part of the site to provide 3 buildings for B1 use and demolition of nos. 9-11 Windmill Road to form new vehicular access to the site
2000	99/3230 – demolition of existing buildings and construction of two and three storey business units (b1).
2001	00/3078 – proposed demolition – with drawn by applicant
2001	00/30177 - demolition of existing buildings and construction of 2 and 3 storey business units and offices (b1) – withdrawn by applicant
2015	15/0621 - The redevelopment of the whole site for a mixed-use scheme comprising demolition and conversion of the St Clare Business Park, Hampton Hill for the erection of up to 116 homes (inclusive of support accommodation) of varying tenure together with up to 1,790 GIA square metres (sq.m) of commercial (Use Class B1) floorspace including care communal accommodation and training, creation of a new vehicular access from Windmill Road, provision of parking and refuse facilities, and associated works – withdrawn by applicant

The development history of the site and surrounding area from the above sources is detailed in Table 6 and summarised below.

Table 6: Summary of historical development

Date	Land use/features on-site	Land use/features in vicinity of site (of relevance to the assessment)
1866	**The Business Park** – largely unoccupied with the exception of an isolated building and tree-line along the east site boundary.	Largely residential fronting Hampton Hill High Street, Windmill Lane, and Holly Road with interspersed and open greenfield.

Date	Land use/features on-site	Land use/features in vicinity of site (of relevance to the assessment)
	The Car Wash – northern extents occupied by a detached building fronting Windmill Lane. **Holly Road, South** – unoccupied greenfield	
1896 – 1915	**The Business Park** – Detached buildings occupying the central eastern site boundary. An old gravel pit is located along the western site boundary. **The Car Wash –** Detached building north is denoted as a Smithy **Holly Road, South** –unoccupied greenfield	Residential development throughout fronting surrounding roads. Railway cutting along the western site boundary clearly defined.
1915 – Mid - 1960s	**The Business Park** – occupied by a nursery with buildings located within eastern and southern extents. Trees occupied central and western boundaries. **The Car Wash –** Additional buildings noted fronting Windmill Lane **Holly Road, South** – unoccupied with some evidence of ground working	**The Business Park** – continued residential development **The Car Wash –** A fire station is situated adjacent the western site boundary **Holly Road, South** – continued residential development with some encroachment of gardens / possibly buildings into southern extents
Mid-1960s – 1970s	**The Business Park** – Nursery and associated buildings no longer present. Site now occupied by a builders yard (south) and 'works (north). Buildings largely are existing and in present configuration **The Car Wash –** No significant change **Holly Road, South** – terraced garages located along south-eastern boundary. Two detached buildings along western site boundary.	**The Business Park** – No significant change **The Car Wash –** Adjacent fire station now denoted a public library **Holly Road, South** – No significant change
1970s – 1990s	**The Business Park** – No significant change other than electrical substation depicted in southern extents (present today) **The Car Wash –** building fronting Windmill Lane now replaced by garages present today **Holly Road, South** –– No significant change	No significant change

Date	Land use/features on-site	Land use/features in vicinity of site (of relevance to the assessment)
1990s – present (2018)	**The Business Park** – No significant change other than the construction of the centrally located building as present today **The Car Wash –** The garage building has extended southwards occupying the footprint evident today **Holly Road, South** – the terrace garages and western buildings are no longer present	No significant change

3.7 Sensitive land uses

The subject site is located circa 100m southeast of the Bushy Park and Home Park sites of special scientific interest (SSSI).

A comprehensive evaluation of ecological receptors is outside the scope of this report.

3.8 Licences and permissions

There are 3No. active contemporary trade directory entries held for the site including a sheet metal work business unit, car repair business, construction services and an air conditioning equipment supplier.

Inactive/past contemporary trade directory entries for the site include business units for garages services, power transmission equipment, printing, tool design and manufacture.

Off-site, there are 4No. local pollution prevention and control currently in place within 2km of the subject site including entries for dry cleaners, petrol filling stations, and a vehicle re-spraying business. The closet entry is a dry cleaner located circa 100m north east of the subject site.

3.9 Local authority environmental health department information

The environmental health department (EHD) of London Borough of Richmond upon Thames has no records of contamination in connection with the site.

Furthermore, the site has not been identified for detailed inspection under Part IIA of the Environmental Protection Act 1990, and the Council is not considering taking any action on a formal or informal basis.

A copy of the response has been included in **Appendix E**.

3.10 Petroleum licensing information

A freedom of information (FOI) requests were been submitted to the London Fire Brigade for information of any ‘known’ petroleum storage across the subject site of the Business

Park and the Car Wash. Letter responses were received on 16th May 2018 and 5th June 2018 respectively (**Appendix R**).

3.10.1 The Business Park

The response from the London Fire Brigade's petroleum environmental search reported two underground fuel storage tanks (USTs) located within The Business Park boundaries. No plans are available to show the locations within the site. However, visual evidence of USTs were identified within the southern extents of The Business Park through the identification of existing vent stacks.

It was reported the tanks held diesel and gas oil with a tank capacity of 4,546 litres and 18,184 litres respectively.

There is currently no licence or Petroleum Storage Certificate in force related to the tanks. It was reported the last licence was issued 1st December 1966 and expired 30th November 1987.

There have been no known records of any leaks or spills relating to the USTs on site. There are no records to indicate the current status of the tanks

3.10.2 The Car Wash

The response from the London Fire Brigade's petroleum environmental search reported two underground fuel storage tanks (USTs) located within The Car Wash boundaries. No plans are available to show the locations within the site.

The two tanks are reported to be single skin steel petrol tanks, both with a capacity of 22,730.

There is currently no licence or Petroleum Storage Certificate in force related to the tanks. It was reported the last licence was issued 1st September 1966 and expired 31th October 1994.

There have been no known records of any leaks or spills relating to the USTs on site. The tanks are reported to have been filled with water in 1983 before the expiration of the licence. There are no current updates to the status of the tanks.

3.10.3 Off site

Hampton Hill Service Station and Tesco Petrol Filling Station (PFS) are located circa 200m and 300m northeast of the subject site respectively.

With reference to the Envirocheck report (159575380_1_1, 16 March 2018) report, there are two fuel station entries within 2km of the subject site, the closest of which relates to an obsolete entry located circa 200m northeast. The second entry is located circa 1km east however; further information is limited.

3.11 Initial conceptual model

The information presented in Sections 2 and 3.1 to 3.10, has been used to compile an initial conceptual model. The identified potential sources of contamination, associated

contaminants and receptors have been considered with plausible pathways that may link them. The resulting potential pollutant linkages are considered in Section 3.11.5.

The risk classification has been estimated in accordance with information in **Appendix F**.

3.11.1 Summary of potential contaminant sources

Potential sources and contaminants of concern are summarised in Table 7.

Table 7: Potential sources and types of contamination

Potential sources	Contaminants of concern
On-site historical	
Impacted made ground: associated with past development history including: ***The Business Park:*** Backfill material of the former gravel pit, former use as a builders yard and historical commercial site-use. ***The Car Wash:*** Former buildings fronting Windmill Lane ***Holly Road, South***: Former garages and buildings on western site boundary	Unknown fill material potentially containing fuel oils, lubricating oils, heavy metals, ash, clinker, sulphates, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), chlorinated and other organic solvents, sulphates, asbestos containing materials (ACM). Possible soil gases including methane and carbon dioxide.
On-site present day	
Impacted made ground: associated with: ***The Business Park:*** Current commercial site-uses (plant rooms, localised fuel/chemical storage, substations and below ground infrastructure of unknown condition and integrity). ***The Car Wash:*** Current commercial site-uses (fuel/chemical storage, and below ground infrastructure of unknown condition and integrity). ***Holly Road, South***: Current vehicular storage (possibility area used for maintenance or storage of vehicles in need of repair)	Possible localised hydrocarbon (PAH/TPH), heavy metals, PCBs, asbestos containing materials (ACM) impact. Possible soil gases including methane and carbon dioxide.
Underground storage tanks and associated infrastructure ***The Business Park:*** Diesel /oil & gas tank on-site of unknown condition/integrity and status ***The Car Wash:*** Underground storage tanks on-site of unknown condition/integrity and status	Possible localised hydrocarbon (PAH/TPH) impact.

Potential sources	Contaminants of concern
Off-site	
The Business Park and Holly Road South: Adjacent railway land defining the western site boundary	Fuel oils, lubricating oils, heavy metals, PAHs, PCBs, ethylene glycol, ash, sulphate, herbicides and asbestos
Petrol filling stations located 200m east and 300m north east of the subject site (all sites)	Hydrocarbons, petroleum spirit, ethylene glycol, methyl tertiary butyl ether (MTBE), oil and waste oil, chlorinated and non-chlorinated solvents, asbestos, sulphuric acid, metal and metal compounds
Dry cleaning premises, 100m east (all sites)	Organic solvents
Gas sources and gas generation potential in line with BS8576	
The Business Park: Landfilling of the former gravel pit on-site onsite (low to moderate gas generation potential but potentially high if disturbed)	Carbon dioxide, methane and trace gases
Impacted made ground: associated with past and present development history (all sites)	Carbon dioxide, methane and trace gases

Note that in the absence of any significant pollutant incidences associated with past/current off-site land uses, the potential for off-site contaminative impact is considered 'low' and therefore omitted from further assessment as part of this report.

3.11.2 Sensitive receptors

Sensitive receptors at this site include:

- future site occupants;
- adjacent site users (local residents and businesses);
- controlled waters:
    - underlying Principal Aquifer (Taplow Gravel Member);
    - nearby surface watercourse (Longford River, <100m south west); and,
- future infrastructure: potable water supply pipes;
- future vegetation; and,
- ecological receptors: Bushy Park and Home Park (SSSI, located 100m south east).

Note that given the proximity of the SSSI to the subject site and the residential land use that separates the two, the SSSI is not considered the primary receptor in this instance, and therefore potential for any site derived contaminative to impact on the SSSI are considered negligible.

In addition, construction workers have also not been identified in the conceptual model as receptors because risks are considered to be managed through health and safety procedures including CDM regulations.

3.11.3 Summary of plausible pathways

The plausible pathways are summarised below:

- direct contact (soil, dust and vegetable ingestion, dermal contact, dust and fibre inhalation);
- ground gas and soil gas inhalation;
- vertical and lateral migration including leaching;
- root uptake; and,
- chemical attack of infrastructure (including water supply pipes) and buildings.

3.11.4 Data gaps and uncertainties

- unknown presence/chemical composition of underlying made ground;
- unknown condition/integrity/capacity and decommissioning status of exiting USTs and associate infrastructure;
- depth to groundwater/condition;
- depth/condition of exiting soakaways;
- extents and nature of backfill associated with the historical gravel pit; and,
- presence/absence of historical foundations/obstructions associated with past development.

3.11.5 Potentially complete pollutant linkages

The outline conceptual model and an estimate of the risk associated with each linkage is summarised in Table 8. The risk classification has been undertaken in accordance with CIRIA C552 (Rudland et al., 2001), a summary of which is included in **Appendix F**.

Table 8: Risk estimation for potentially complete pollutant linkages

Potential Contaminant	Potential receptor	Possible pathway	Likelihood	Severity	Risk and justification
Impacted made ground: associated with past development and current commercial site-use including the presence of USTs of unknown condition/integrity and status.	Future site occupants	Direct contact	Likely	Medium	***Moderate*** – future contact *likely* assuming the proposed development incorporates a degree of soft landscaping and open space. *Medium* severity conservatively assigned given unknown chemical composition of any made ground.
	Adjacent site users		Unlikely	Medium	***Low*** – *unlikely* of future contact assuming construction best practice adopted and adhered to. *Medium* severity conservatively assigned given unknown chemical composition of any made ground.
	Controlled waters – Principal Aquifer of the Taplow Gravel Formation	Vertical and lateral migration including leaching	Likely	Mild	***Moderate/Low*** – conservatively assessed as *likely* given unknowns associated with prevailing ground conditions and asset integrity/condition. *Mild* severity assigned given the site is not located within a SPZ, the absence of any potable water abstractions within 2km and the sensitivity of the nearest abstraction (spray irrigation) located >1/2km south.
	Controlled waters – surface water course –Longford River		Likely	Medium	***Moderate*** – conservatively assessed as *likely* given unknowns associated with prevailing ground conditions and asset integrity/condition. Medium severity assigned given proximity of the surface water body (<100m) and the Grade B status and Grade A/B water quality assigned.

Potential Contaminant	Potential receptor	Possible pathway	Likelihood	Severity	Risk and justification
	Future infrastructure: potable water supply lines	Chemical attack of infrastructure	Likely	Medium	***Moderate*** – future contact *likely* given nature of the development. *Medium* severity conservatively assigned given unknown chemical composition of any made ground.
	Future vegetation	Root uptake	Likely	Mild	***Moderate/low*** – future contact *likely* assuming the proposed development incorporates a degree of soft landscaping and open space. *Mild* severity conservatively assigned given unknown chemical composition of any made ground.
Hazardous Ground Gases associated with landfilling of a former gravel pit and any Impacted made ground: associated with past and present development history	Future site occupants	Ground gas and soil gas inhalation	Low-likelihood	Severe	***Moderate*** – *low-likelihood* given the proposed development will incorporate areas of confining atmosphere (most notably the basement). *Severe* assigned given potential for explosive atmospheres and or asphyxiation.
	Adjacent site users		Unlikely	Severe	***Moderate/low*** – *unlikely* given the surrounding residential properties are unlikely to have needed to include ground gas protection measures . *Severe* assigned given potential for explosive atmospheres and or asphyxiation.
Notes: none					

The potential pollutant linkages with a risk of moderate or above requiring further investigation include:

1. Direct contact of future site occupants with potentially impacted made ground;
2. Vertical/lateral migration of potentially impacted made ground to the underlying Principal Aquifer (Taplow Gravels) and to the proximal surface water course (Longford River);
3. Chemical attack on future infrastructure (potable water supply lines) from potentially impacted soils;
4. Root uptake of contaminants into future vegetation exposed to potentially impacted made ground; and,
5. Inhalation hazardous ground gases by future site occupants and adjacent site users.

4 SITE INVESTIGATION METHODOLOGY

RSK carried out intrusive investigation work on 26th March – 29th March 2018 to confirm the potential pollutant linkages identified in the outline conceptual model and to inform geotechnical constraints.

4.1 Sampling strategy and methodology

4.1.1 Health, safety and environment considerations

Prior to the intrusive works, the available service plans were consulted and a service clearance engineer carried out a utility clearance survey of the site using a ground penetrating radar. A Cable Avoidance Tool (CAT) scan at the investigation locations was also carried out by the RSK supervising engineer.

Prior to commencement, RSK commissioned a Preliminary UXO Risk Assessment for the subject site. Recommendations of the preliminary assessment included the need for further works in the form a Detailed UXO Risk Assessment.

At the request of the Client, RSK commissioned a detailed assessment within which it a UXO watching brief was recommended as part as part of any intrusive works. The watching brief provided included the use of down-hole magnetometer undertaken on all intrusive exploratory positions.

For completeness, copies of both UXO assessments have been presented as **Appendix G** of this report.

4.1.2 Investigation locations

The site work comprised the activities summarised in Table 9 along with a justification for each exploratory hole location.

Note that whilst the locations of each exploratory position were defined by the Clients Agent, RSK have inferred rationale based on an understanding of the prevailing geo-environmental site setting.

The investigation and the soil descriptions were carried out in general accordance with BS5930: 2015 - Code of Practice for Ground Investigations.

The exploratory hole logs and other site work records are presented in **Appendix H**. The locations of the intrusive investigations are shown in **Figure 4**.

Table 9: Exploratory hole and monitoring well location rationale

Investigation Type	Land Parcel	Ref.	Targeted Response zone	Rationale
Deep Borehole (Cable Percussion)	The Business Park	BH4	Shallow – Made Ground Deep – Taplow Gravel	Adjacent 'known' UST/ Adjacent proposed block and basement Shallow: Hazardous ground gases Deep: Groundwater in Aquifer Soil parameters for geotechnical design
Window Sampling (drive-in sampler)	The Car Wash	WS1	None	Adjacent 'known' UST/ Adjacent within proposed access road
		WS2	Shallow – Made Ground	Adjacent 'known' UST/ Adjacent within proposed access road Hazardous ground gases and perched water body
	The Business Park	WS3	None	General site coverage – geotechnical within proposed footprint
		WS4	Shallow – Made Ground	General site coverage – geotechnical within proposed footprint
		WS5	Deep – Taplow Gravels	General site coverage – geotechnical within proposed footprint Deep: Groundwater in Aquifer
		WS6	Shallow – Made Ground	General site coverage – geotechnical within proposed footprint Hazardous ground gases and perched water body
		WS7	None	General site coverage – geotechnical within proposed footprint
		WS8	Shallow – Made Ground	Adjacent existing substation Hazardous ground gases and perched water body
	Holly Road, South	WS9	Shallow – Made Ground	General site coverage – Hazardous ground gases and perched water body
		WS10	None	General site coverage
Hand Excavated Foundation Pit	The Business Park	TP01	None	Foundation pit to confirm profile of existing foundations

Investigation Type	Land Parcel	Ref.	Targeted Response zone	Rationale
Machine excavated Trial Pits		TP02	Taplow Gravels	BRE365 soakage test locations
		TP03		
Note: Boreholes BH1-BH3 and BH5 removed from original scope of works and will be carried out once the site is vacant. TP01 was removed from the scope of works due to inaccessibility of location.				

4.1.3 Soil sampling, in-situ testing and laboratory analysis

Soils collected for laboratory analysis were collected in a variety of containers appropriate to the anticipated testing suite required. Samples were stored in accordance with the RSK quality procedures to maintain sample integrity and preservation and to minimise the chance of cross contamination.

The samples were transported to the laboratory in chilled cool boxes. Laboratory chain of custody forms can be provided if required. The rationale for soil sample chemical analysis is presented in Table 10.

Table 10: Scheduled analysis – soil

Exploratory hole no. and sample depth (m bgl)	Analyte	Rationale
WS2 (0.20-0.80)	Full suite (Heavy metals, hydrocarbons and ACM screen)	Establish prevailing chemistry of underlying Made Ground
WS4 (1.20)	Full suite (Heavy metals, hydrocarbons and ACM screen)	Establish prevailing chemistry of underlying Made Ground
WS5 (0.50 – 1.00)	Full suite (Heavy metals, hydrocarbons and ACM screen)	Establish prevailing chemistry of underlying Made Ground
WS5 (2.80)	Waste classification suite	Establish prevailing chemistry of natural soils within proximity of the proposed basement for future off-site disposal
WS6 (2.50 and 3.50)	Speciated TPH	Location down-gradient of hydrocarbon impacted gravels identified at a similar depth in TP02
WS7 (0.20 – 0.70)	Waste classification suite	Establish prevailing chemistry of made ground within proximity of the proposed basement for future off-site disposal

Exploratory hole no. and sample depth (m bgl)	Analyte	Rationale
WS8 (0.50)	Full suite (Heavy metals, hydrocarbons and ACM screen) plus PCBs	Establish prevailing chemistry of made ground within proximity of existing substation
WS10 (0.45- 1.10)	Full suite (Heavy metals, hydrocarbons and ACM screen)	Establish prevailing chemistry of underlying Made Ground
TP02 (2.90)	Full suite (Heavy metals, hydrocarbons and ACM screen)	Visual / olfactory evidence of hydrocarbon impact
TP02 (3.50)	Speciated TPH	Establish hydrocarbon impact (if any) at greater depth in natural soils
TP02	Asbestos ID	Suspected ACM fragment encountered in made ground
BH4 (0.30)	Full suite (Heavy metals, hydrocarbons and ACM screen)	Establish prevailing chemistry of underlying Made Ground within proximity to 'known' UST
BH4 (1.20 – 1.65) (2.75)	Speciated TPH	Establish hydrocarbon impact (if any) at a depth similar to the anticipated base of the UST and into natural soils at depth
Notes: none		

Standard penetration tests (SPTs) were carried out at regular intervals of approximately 1m, alternated with U100 samples at the same frequency. Test results are given on the borehole records presented in **Appendix H** and within the summary table included within that appendix.

Dynamic Cone Penetrometer testing was undertaken in 3No. exploratory locations across the subject site in order to determine CBR values for pavement design. Copies of the in-situ test data are given in **Appendix J** of this report and discussed in further detail within Section 5.

Disturbed samples were taken from each stratum encountered for subsequent geotechnical analysis.

4.1.4 Groundwater monitoring and levelling

Depths to groundwater and non-aqueous phase liquid were recorded using an electronic interface probe during return monitoring visits. The monitoring results together with the temporal conditions are contained within **Appendix I** and discussed in more detail in Section 5 of this report.

4.1.5 Groundwater developing, sampling and analysis

During the ground gas monitoring programme RSK retrieved a total of 4No. groundwater samples from WS2, WS5, WS6 and BH4 on the 10th May 2018 to confirm the absence of contamination within the ground water.

In the absence of any visual/olfactory signs of contaminative impact samples were collected via 'conventional' means using sample bailers without full well development having been achieved due to the slow recharge rate of each exploratory location.

In order to collect more representative groundwater samples, a second round of groundwater sampling was completed on 23rd August 2018 using a United States Environment Protection Agency (USEPA) approved low-flow purging and sampling methodology.

Despite using the low-flow methodology, only a single location (BH4) recharged sufficiently to allow the collection of a representative groundwater sample.

All chemical analysis reports are found in **Appendix L**.

4.1.6 Ground gas monitoring

A total of 6No. monitoring wells were installed across all subject sites with response zones targeted the underlying made ground as detailed in Table 9. A total of 6No. monitoring rounds were completed between 5th April 2018 and 23rd August 2018.An infrared gas meter was used to measure gas flow, concentrations of carbon dioxide (CO_2), methane (CH_4) and oxygen (O_2) in percentage by volume, while hydrogen sulphide (H_2S) and carbon monoxide (CO) were recorded in parts per million.

Initial and steady state concentrations were recorded. In addition, during the first monitoring round, all wells were screened with a PID to establish if there are any interferences and cross-sensitivity of other hydrocarbons with the infrared gas meter.

The atmospheric pressure before and during monitoring, together with the weather conditions, was recorded.

All monitoring results together with the temporal conditions are contained within **Appendix I** and discussed in further detail within Section 5.

4.1.7 In-situ hydraulic conductivity/infiltration testing

A trail pit soakage tests in accordance with BRE365 were scheduled to be undertaken within TP02, however due to trail pit instability and the latter identification of potential of hydrocarbon impact, the test was aborted shortly after commencement.

A return site visit was arrange to undertake an additional trial pit (TP03) within an area of potentially more competent ground, however, again due to trail pit instability, the test was aborted shortly after commencement.

An existing soakaway chamber located adjacent TP02 was examined by RSK as a potential location to obtain ground infiltration data, however after filling with a nominal volume of water, no observable infiltration was noted and was attributed to the poor conditions of the silt laden chamber.

Falling head tests were conducted within exploratory locations BH4 (borehole) and WS5 (piezometer), both installed with response zones within the underlying Taplow Gravels.

Results together with the temporal conditions are contained within **Appendix K** and discussed in further detail within Section 5.

5 GROUND CONDITIONS

The results of the intrusive investigation and subsequent laboratory analysis undertaken are detailed below. The descriptions of the strata encountered, notes regarding visual or olfactory evidence of contamination, list of samples taken, field observations of soil and groundwater, in-situ testing and details of monitoring well installations are included on the exploratory hole records presented in **Appendix H**.

5.1 Soil

The exploratory holes revealed that the site is underlain by a variable thickness of made ground over the Taplow Gravel Member of the River Terrace Deposits, with the London Clay Formation encountered at depth. This appears to confirm the stratigraphical succession described within the initial conceptual model. For the purpose of discussion, the ground conditions are summarised in Table 11 and the strata discussed in subsequent subsections

Table 11: General succession of strata encountered

Strata	Exploratory holes encountered	Depth to top of stratum m bgl	Thickness (m)
Made ground	All	G.L.	1.50 - 3.50 (not proven in WS1; WS4 and TP03)
Taplow Gravel Member	BH4, WS2, WS3, WS5 to WS9 and TP02	1.50 – 3.50	1.50 - 1.60 (proven only in BH4 and WS5)
London Clay Formation	BH4 and WS5	4.00 – 4.40	proven to 20mbgl in BH4

5.1.1 Made ground

The made ground (ranging between 1.50m and 3.50m in thickness) was variable in nature and comprised of both granular and cohesive portions. The granular portion generally consisted of a very loose to medium dense, dark brown/ greyish in colour, clayey, slightly to very sandy, gravel. The cohesive proportion comprised of stiff to firm, dark brown/ greyish in colour with varying amounts of gravel and sand clays.

Within both the granular and cohesive portions the sand was fine to coarse and the gravel was fine to coarse. The gravel was described as rounded to angular gravel comprising of brick, concrete, flint, clinker, with other anthropogenic material such as glass, oyster shells and a shoe. Occasionally cobbles sized concrete and brick fragments were found within the made ground.

A suspected fragment of asbestos containing cement was identified within TP02 and was confirmed by laboratory testing to contain chrysotile.

Included within the made ground were varying ground level surface conditions. Locations WS1, WS2, WS3, WS9 and WS10 had a thin layer of tarmac (0.05 – 0.20m) followed by

a red brick sub-base (0.80 – 0.20m). Locations WS6, WS7 and TP03 have concrete at ground level (0.20 – 0.50m thick), while WS4 and WS5 are in the area of reinforced concrete surface (0.10 – 0.15m thick). Locations WS8 and TP02 were located within an area of soft landscaping with vegetation and topsoil found at ground level.

5.1.2 Taplow Gravel Member

This stratum was encountered beneath the made ground at depths of between 1.50m and 3.50m below ground level and varies between 1.50m and 1.60m in thickness. Based on the site descriptions and in-situ tests carried out (SPT 'N' values of 14 to >50), this layer can be described predominately as a medium dense to dense (locally very dense), orangish brown, very gravelly sand.

Sand was described as fine to coarse. The gravel was described as fine to coarse, rounded to angular comprising of flint and sandstone and rare shell fragments.

5.1.3 London Clay Formation

The London Clay was encountered at a depths of 4.00m to 4.40m below ground level to the full depth of investigation. Based on the site descriptions and in-situ and laboratory testing carried out this stratum can be described as a stiff to very stiff, high to very high strength, poorly laminated bluish grey clay, with increased silt content towards the base of the borehole.

A summary of the in-situ and laboratory test results in this stratum is presented in Table 12 or the in-situ and laboratory test results can be found in **Appendix H** and **Appendix M**.

Table 12: Summary of in-situ and laboratory test results for London Clay

Soil parameters	Range	Reference
Liquid limit (%)	61 - 90	**Appendix M**
Plasticity limit (%)	29 - 43	
Plasticity index (%)	32- 47	
Plasticity term	High to Very High (CH to MV)	
Moisture content (%)	20 - 31	
Consistency index	0.94 – 1.49	-
Consistency term	Stiff to Very Stiff	
SPT 'N' values	28 - 32	**Appendix H**
Undrained shear strength inferred from SPT 'N' values (kN/m^2)	118 to 134	-
Undrained shear strength measured by triaxial testing (kN/m^2)	81 to 177	**Appendix M**
Undrained shear strength measured by shear vane testing (kN/m^2)	146 to 236	
Strength term	High to Very High (locally Extremely High)	-

5.1.4 Groundwater

Groundwater was encountered during the investigation as detailed in Table 13.

TP03 had a slow water seepage at 2.20m

Table 13: Groundwater results during investigation

BH/TP	Stratum	Strike (m bgl)	Rise (m)
BH4	Made ground/ Taplow Gravel interface	2.50	2.40
TP02	Taplow Gravel	3.20	NA
TP03	Made Ground	2.20	NA
WS1	Made Ground	1.30	NA
WS2	Made Ground	2.90	2.80
WS3	Made Ground	1.80	2.10
WS4	NA	DRY	NA
WS5	Made Ground	2.30	1.86
WS6	Made Ground	2.00	NA
WS7	Made Ground	2.50	2.50
WS8	NA	DRY	NA
WS9	Taplow Gravel	3.50	NA
WS10	NA	DRY	NA

The minimum and maximum results of the subsequent groundwater monitoring and well surveying exercise are summarised in Table 14.

Table 14: Groundwater monitoring data (5th April 2018 to 23rd August 2018)

Monitoring well	Depth to groundwater (m bgl)
BH4	Dry - 1.75
WS2	Dry – 2.38
WS4	Dry
WS5	2.11 - 1.46
WS6	2.47 - 1.49
WS8	Dry
WS9	3.40 - 2.85

It should be noted that groundwater levels might fluctuate for a number of reasons including seasonal variations.

5.1.5 Results of hydraulic conductivity testing

The results of the falling head tests are summarised in Table 15.

Table 15: Rising/falling head test results

Borehole/ monitoring well	Saturated geological unit	Hydraulic conductivity (m/sec)
BH4	Taplow Gravel	6.20×10^{-5} to 7.06×10^{-5}
WS5		6.20×10^{-5}

5.1.6 Visual/olfactory evidence of soil and groundwater contamination

Visual/olfactory evidence of contaminative impact was identified within TP02. An oily sheen was noted on the water and on the soil at the interface between the made ground and underlying natural Taplow Gravel.

5.2 Ground gas regime

The results of the ground gas monitoring and testing carried out are given in **Appendix I**. The minimum and maximum results are recorded in Table 16.

Table 16: Summary of ground gas monitoring results (5th April 2018 to 23rd August 2018)

Borehole	Response zone	Methane (%)	Carbon dioxide (%)	Oxygen (%)	Flow rate (l/hr)	Atmospheric pressure (mbar)
BH4 (Pipe 1)	3.00 – 4.00	0.0	1.5 – 4.8	13.9 – 20.0	0.0	1011 - 1026
BH4 (Pipe 2)	0.50 – 2.00	0.0	0.8 – 2.4	19.2 - 20.5	0.0	1011 - 1026
WS2	0.65 – 6.35	0.0	4.8 – 15.3	1.5 - 11.8	0.0	1011 - 1026
WS4	0.30 – 1.30	0.0	0.0 – 4.9	14.4 – 19.8	0.0 – 0.1	1011 - 1026
WS5	2.00 – 3.00	0.0	0.6 – 4.2	13.0 – 19.7	0.0	1011 - 1026
WS6	1.00 – 3.00	0.0	0.0 – 1.0	17.9 – 19.2	-0.1 - 0.0	1011 - 1026
WS8	1.00 – 2.50	0.0	0.1 – 2.4	17.8 – 20.7	0.0	1011 - 1026
WS9	0.70 – 4.00	0.0	1.6 – 20.8	0.2 – 18.8	0.0	1011 - 1026

5.3 Refinement of the initial conceptual site model

The investigation generally confirmed the desk-based assessment and outlined conceptual site model as discussed within the PRA and summarised in Section 3.

Visual evidence of contamination identified during the site work was an oily sheen on the water and on the soil at the interface between the made ground and underlying natural Taplow Gravel at the location of TP02 along with the presence of single a visible asbestos fragment within the Made Ground.

The maximum thickness of the Made Ground was recorded to be 3.5m, which is considered to be potential generator of ground gas (methane/carbon dioxide).

6 QUANTITATIVE RISK ASSESSMENT

In line with CLR11 (EA, 2004), there are two stages of quantitative risk assessment, generic and detailed. The GQRA comprises the comparison of soil, groundwater, soil gas and ground gas results with generic assessment criteria (GAC) that are appropriate to the linkage being assessed. This comparison can be undertaken directly against the laboratory results or following statistical analysis depending upon the sampling procedure that was adopted.

6.1 Linkages for assessment

Section 5 presents the refined conceptual model which identified the linkages that required assessment after the findings of the site investigation had been considered. These linkages together with the method of assessment are presented in Table 17.

Table 17: Linkages for generic quantitative risk assessment

Potentially relevant pollutant linkage	Assessment method
1. Direct contact with impacted soil by future residents	Human health GAC presented in **Appendix N** for a proposed residential end use with private gardens since proposed end use includes residential gardens. Statistical analysis was not undertaken owing volume of sampling data available at this stage of exploratory works.
2. Inhalation exposure of future residents to asbestos fibres	
3. Uptake of contaminants by vegetation potentially impacting plant growth	Comparison of soil data to phytotoxic GAC presented in **Appendix O**
4. Contaminants permeating potable water supply pipes	Comparison of soil data to GAC presented in A**ppendix P** for plastic water supply pipes using UKWIR (2010) guidance.
5. Leaching of soil contaminants and subsequent migration to Principal aquifer (Taplow Gravels) and Longford River	Comparison of groundwater data to GAC for controlled waters Table 1 of **Appendix N** for secondary aquifer. Freshwater EQS were adopted owing to the proximity of the nearest surface water body (<100m southwest) vs the nearest groundwater abstraction (660m south) and not located within an EA defined SPZ. Where EQS values are absent more conservative UK DWS were adopted.
6. Concentrations of methane and carbon dioxide in ground gas entering and accumulating in: depressions and excavations that could affect workers enclosed spaces or small rooms in new buildings, which could affect future residents.	Gas screening values (GSV) have been calculated using maximum methane and carbon dioxide concentrations with maximum flow rates recorded at the site. The GSV have been conservatively assessed using generic Traffic Lights, as presented within the NHBC ground gases guide (Boyle and Witherington, 2007) and the aforementioned CIRIA report C665, owing to the development comprising an element of low-rise housing with suspended

Potentially relevant pollutant linkage	Assessment method
In the case of methane this could create a potentially explosive atmosphere, while death by asphyxiation could result from carbon dioxide.	floors. In addition, the gas regime is considered within the context of a conceptual model as required by both aforementioned guidance documents and BS8576. **Appendix I**
Notes: None	

6.2 Methodology and results

The methodology and results of the GQRA are presented for each relevant pollutant linkage in turn.

6.2.1 Direct contact with impacted soil by future residents

The analytical results have been subjected to an initial 'screening' assessment against the appropriate generic assessment criteria (GAC) values derived by RSK using CLEA software v1.06 and supporting UK guidance. Where available, published soil guideline values (SGV) were used as the adopted GAC.

As a conservative approach, 1% soil organic matter has been assumed. The GACs are appended to this report and considered to be the most suitable guidelines to protect the most critical targets from contaminants via all possible exposure routes.

6.2.1.1 The Business Park

Determinants exceeded the adopted GACs for human health have been summarised in Table 18 below.

Table 18: Soil exceedances of the adopted Human Health GAC: The Business Park

Determinant	GAC (mg/kg)	Exceedances
Lead	200	WS4 at 1.20m – made ground (537mg/kg) WS5 at 0.50-1.00m – made ground (287mg/kg) WS7 at 0.20-0.70m – made ground (2014mg/kg) WS8 at 0.50m – made ground (662mg/kg) TP02 at 2.90m – made ground (237mg/kg) BH4 at 0.30m – made ground (311mg/kg)
Benzo(b)fluoranthene	2.6	BH4 at 0.30m – made ground (3.17mg/kg)
Dibenzo(ah)anthracene	0.24	WS4 at 1.20m – made ground (0.26mg/kg) BH4 at 0.30m – made ground (0.48mg/kg)
Asbestos	0.001%w/w	WS4 at 1.20m – made ground (Amosite & Chysotile loose fibres and cement board of 0.053%w/w) TP02 – made ground (Crysotile board – bulk fibre 40%w/w)

6.2.1.2 *The Car Wash*

Determinants exceeded the adopted GACs for human health have been summarised in Table 19 below.

Table 19: Soil exceedances of the adopted Human Health GAC: The Car Wash

Determinant	GAC (mg/kg)	Exceedances
Lead	200	WS2 at 0.20-0.80m - made ground (446mg/kg)
Benzo(b)fluoranthene	2.6	WS2 at 0.20-0.80m - made ground (3.86mg/kg)
Dibenzo(ah)anthracene	0.24	WS2 at 0.20-0.80m - made ground (0.50mg/kg)
Asbestos	0.001%w/w	WS2 at 0.20-0.80m - made ground (Chysotile loose fibres and cement board of 0.017%w/w)

6.2.1.3 *Holly Road, South*

None of the determinands were detected above the adopted GACs in any of the tested samples.

6.2.1.4 *Summary of results*

The results of the assessment indicate that this pollutant linkage may exist on both, The Business Park and The Car Wash parcels of land however; is likely to be absent on the Holy Road, South site.

6.2.2 Uptake of contaminants by vegetation potentially inhibiting plant growth

6.2.2.1 *The Business Park*

Determinants exceeded the adopted GACs for phytotoxicity have been summarised in Table 20 below.

Table 20: Soil exceedances of the adopted Phytotoxic GAC: The Business Park

Determinant	GAC (mg/kg)*	Exceedances
Lead	300	WS4 at 1.20m - made ground (537mg/kg) WS8 at 0.50m – made ground (662mg/kg) BH4 at 0.30m – made ground (311mg/kg)
Mercury	1	WS8 at 0.50m – made ground (1.81mg/kg)
*GAC for pH >8 adopted		

6.2.2.2 *The Car Wash*

Determinants exceeded the adopted GACs for phytotoxicity have been summarised in Table 21.

Table 21: Soil exceedances of the adopted Phytotoxic GAC: The Car Wash

Determinant	GAC (mg/kg)*	Exceedances
Lead	300	WS2 at 0.20-0.80m - made ground (446mg/kg)
*GAC for pH >8 adopted		

6.2.2.3 Holly Road, South

None of the determinands were detected above the adopted GACs in any of the tested samples.

6.2.2.4 Summary of results

The results of the assessment indicate that this pollutant linkage may exist on both, The Business Park and The Car Wash parcels of land however; is likely to be absent on the Holy Road, South site.

6.2.3 Impact of organic contaminants on potable water supply pipes

For initial assessment purposes, the results of the investigation have been compared with the GAC presented in **Appendix P** for this linkage, which are reproduced from *UKWIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (UKWIR, 2010).

6.2.3.1 Summary of results

The results indicate that this pollutant linkage may exist on both, The Business Park and The Car Wash parcels of land.

Detectable concentrations of TPH were encountered within WS2 (0.20-0.80m), WS4 (1.20m), WS5 (2.80m), WS7 (0.20-0.70m), TP02 (2.90m and 3.90m), and BH4 at 0.30m, and therefore pollutant polyethylene (PE) water supply pipes are expected to be unsuitable for use on the development unless remedial measures are implemented that mitigate the risk. Polyvinyl chloride (PVC) pipes are likely to be suitable for use.

It should be noted that at the time of this investigation the future routes of water supply pipes had not been established, hence the investigation and sampling strategy may not be fully compliant with UKWIR recommendations.

Consequently, a targeted investigation and specific sampling/analytical strategy may be required at a later date once the route(s) of the supply pipe(s) are known. In addition, it is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements for assessment, which may not necessarily be the same as those recommended by UKWIR.

6.2.4 Leaching of contaminants to groundwater in principal aquifer and subsequent migration to surface watercourse

6.2.4.1 The Business Park

Determinants exceeded the adopted GACs for controlled waters have been summarised in Table 22 below.

Table 22: Groundwater exceedences of the adopted Controlled Waters GAC: The Business Park

Determinant	GAC (ug/l)	Exceedances
Aliphatic C8 – C10	300	WS6 – 480ug/l
Aromatic C10 – C12	90	WS6 – 150ug/l
Aromatic C12 – C16	90	WS6 – 126ug/l
Aromatic C16 – C21	90	WS6 – 675ug/l
Aromatic C21 – C35	90	WS6 – 15,200ug/l
Anthracene	0.1	WS6 – 0.23ug/l
Benzo(a)pyrene	0.00017	WS5 – 0.36ug/l WS6 – 1.04ug/l
Benzo(b)fluoranthene	0.1	WS5 – 0.45ug/l WS6 – 1.36ug/l
Benzo(ghi)perylene	0.1	WS5 – 0.23ug/l WS6 – 0.88ug/l
Benzo(k)fluoranthene	0.1	WS5 – 0.18ug/l WS6 – 0.47ug/l
Fluoranthene	0.0063	WS5 – 0.78ug/l WS6 – 1.91ug/l
Indeno(123-cd)pyrene	0.1	WS5 – 0.24ug/l WS6 – 0.83ug/l

6.2.4.2 The Car Wash

Determinants exceeded the adopted GACs for controlled waters have been summarised in Table 23 below.

Table 23: Groundwater exceedances of the adopted Controlled Waters GAC: The Car Wash

Determinant	GAC (ug/l)	Exceedances
Lead	10	WS2 – 14ug/l
Nickel	20	WS2 – 81ug/l
Aromatic C21-C35	90	WS2 – 281ug/l
Benzo(a)pyrene	0.00017	WS2 – 0.29ug/l

Determinant	GAC (ug/l)	Exceedances
Benzo(b)fluoranthene	0.1	WS2 – 0.37ug/l
Benzo(ghi)perylene	0.1	WS2 – 0.18ug/l
Benzo(k)fluoranthene	0.1	WS2 – 0.15ug/l
Fluoranthene	0.0063	WS2 – 0.64ug/l
Indeno(123-cd)pyrene	0.1	WS2 – 0.19ug/l

6.2.4.3 Holly Road, South

No groundwater samples were taken for subsequent laboratory analysis from the installed exploratory position WS9 as part of this phase of investigation.

6.2.4.4 Summary of results

Elevated concentrations of individual hydrocarbon speciations were identified in exploratory locations WS2 and WS6. Hydrocarbon concentrations within exploratory location BH4 largely remained at or below the laboratory detection limited.

Marginally elevated SVOCs (PAHs) were identified within exploratory locations WS2, WS5 and WS6.

Isolated elevated heavy metal Lead and Nickel was identified within exploratory location WS2.

6.2.4.5 Commentary

Despite the aforementioned exceedances it is important to note that all samples in exceedance were collected via 'conventional' means using sample bailers without full well development and therefore can often over-estimate the concentrations of contaminants present.

In terms of hydrocarbon impact, visual/olfactory evidence of contaminative impact was limited to TP02 oily sheen noted on the water at the interface between the made ground and underlying natural Taplow Gravels. TP02 is located within close proximity WS6 where elevated hydrocarbon concentrations have been reported. However; collection of a more representative groundwater sample using 'low flow' methodology was not achievable due to insufficient groundwater recharge.

Marginally elevated concentrations of 'heavy-end' aromatics (C21-C35) were recorded within WS2 located south of 'known' underground fuel storage tanks (UST's). Again, collection of a more representative groundwater sample using 'low flow' methodology was not achievable due to insufficient groundwater recharge.

No elevated hydrocarbon concentrations were reported within exploratory location BH4, adjacent to a 'known' UST's. These findings were supported by subsequent 'low-flow' sampling an analysis.

Whilst localised hydrocarbon impact has been identified on-site (notably WS6 and marginally WS2), given the absence of any contaminative impact within any of the surrounding exploratory positions, and the insufficient groundwater recharge rates stifling the collection of more representative groundwater samples, the impact identified is

unlikely to represent a significant contaminative source with the potential to adversely affect any underlying and surrounding Controlled Waters.

Elevated hydrocarbon concentrations or any visual/olfactory signs of contaminative impact were notably absent from telltale soil horizons (2-3mbgl anticipated tank base horizon) within exploratory locations targeting the 'know' USTs and associated infrastructure (BH4).

With reference to the soil chemical analysis completed to date, exceedances of generic assessment criteria are largely limited to heavy metal Lead and rare individual speciations of poly aromatic hydrocarbons (PAHs).

Although localised marginal exceedances of lead, nickel and PAH were recorded within groundwater collected from WS2, they are not considered to represent a significant contaminative source but rather indicative of leachable concentrations within isolated pockets of Made Ground.

Based on the data collected to date, the results of this quantitative assessment indicate that this pollutant linkage is unlikely to exist.

It is important to note however; that whilst hydrocarbon impact is understood to be localised and limited in extent, in pursuance of a Duty of Care and betterment approach the requirement for limited and localised removal of impacted soils/groundwater should be allowed for and in particular within areas around existing infrastructure (USTs, soakaways and associated pipe work).

6.2.5 Ground gas assessment

The results have been assessed in accordance with the guidance provided in BS8576, NHBC guidance and *CIRIA Report C665*. In the assessment of risks and selection of appropriate mitigation measures, both reports highlight the importance of the conceptual model.

6.2.5.1 General

CIRIA C665 identifies two types of development, termed Situation A (modified Wilson and Card method), and Situation B (National House-Building Council, NHBC) only appropriate to traditional low-rise construction with ventilated sub-floor voids.

Situation A relates to all development types except low-rise housing and, by combining the qualitative assessment of risk with the gas monitoring results, provides a semi-quantitative estimate of risk for a site. The method uses both gas concentrations and borehole flow rates to define a characteristic situation for a site based on the limiting borehole gas volume flows for methane and carbon dioxide. Having calculated the worst case GSVs for methane and carbon dioxide, the Characteristic Situation is then determined from Table 8.5 of CIRIA C665.

Situation B is a characterisation system developed by the NHBC (Boyle and Witherington, 2007), which relates only to low rise housing development constructed with a clear ventilated underfloor void. The system provides a risk-based approach that is designed to allow an identification of the required gas protection measures for low-rise housing by comparing the measured gas emission rates to generic "Traffic Lights". The Traffic Lights include typical maximum concentrations that are provided for initial screening purposes

and risk-based GSVs for situations where the typical maximum concentrations are exceeded. Based on the typical maximum gas concentrations and the GSVs, the appropriate Traffic Light, ranging from Green through Amber 1 and Amber 2 to Red, is determined from Table 8.7 of CIRIA C665.

Both methods are based on calculations of the limiting borehole gas volume flow for methane and carbon dioxide, renamed as the gas screening value (GSV). The GSV (litres of gas per hour) is calculated by multiplying borehole flow rate (litres per hour) and gas concentration (percent by volume).

In both situations, it is important to note that the GSV thresholds are guideline values and not absolute. The GSV thresholds may be exceeded in certain circumstances, if the site conceptual model indicates it is safe to do so. Similarly, consideration of additional factors such as very high concentrations of methane, should lead to consideration of the need to adopt a higher risk classification than the GSV threshold indicates.

6.2.5.2 Summary of results

The Business Park

All concentrations of methane (CH4) in all exploratory positions remained below the limit of detection (<0.1%v/v).

Concentrations of carbon dioxide (CO2) in all exploratory positions ranged from 0.3 to 4.9%v/v.

All flow rates in all exploratory positions remained below the limit of detection (<0.1l/hr).

The Car Wash

All concentrations of methane (CH4) in all exploratory positions remained below the limit of detection (<0.1%v/v).

Elevated concentrations of CO2 (5.5 to 15.3%v/v) were recorded in exploratory location WS2 located within the southern extents of the Car Wash site.

All flow rates in all exploratory positions remained below the limit of detection (<0.1l/hr).

With reference to the exploratory log data, WS2 comprised 3.50m of varied granular made ground. A slight hydrocarbon odour was noted within the shallow made ground. WS2 is situated adjacent a ‘known’ underground storage tank within the southern extents.

Holly Road, South

All concentrations of methane (CH4) in all exploratory positions remained below the limit of detection (<0.1%v/v).

Elevated concentrations of CO2 (14.4 to 20.8%v/v) were recorded in exploratory location WS9 located within the northern extents of the Holly Road, South site.

With reference to the exploratory log data, WS9 comprised 3.20m of varied granular made ground however; contaminative impact was limited to anthropogenic inclusions alone.

All flow rates in all exploratory positions remained below the limit of detection (<0.1l/hr).

6.2.5.3 *Assessment of data*

The Business Park

The site is to be redeveloped with both low and medium-rise residential dwellings/commercial units and therefore falls under both Situation A and B.

- Situation A: Maximum GSVs of <0.01l/hr for both CH4 and CO2 resulting in Characteristic Situation 1 – no ground gas protection measures required; and,
- Situation B: Maximum GSVs of <0.01l/hr for both CH4 and CO2 resulting in Green scenario – no ground gas protection measures required.

The Car Wash

The site is be redeveloped as an access road to the main development site (The Business Park) only however; owing to its location abound by predominantly residential housing, Situation B assessment has been applied.

- Situation B: Maximum GSVs of <0.01l/hr for both CH4 and CO2 resulting in Green scenario – no ground gas protection measures required. However, given the elevated concentrations of CO2 above the trigger concentration of 5% this portion of the site should be reclassified as Amber 1.

Holly Road, South

At present the development proposals are unknown however; owing to its location abound by predominantly residential housing, Situation B assessment has been applied.

- Situation B: Maximum GSVs of <0.01l/hr for both CH4 and CO2 resulting in Green scenario – no ground gas protection measures required. However, given the elevated concentrations of CO2 above the trigger concentration of 10% this portion of the site should be reclassified as Amber 2.

6.2.5.4 *Commentary*

Based on the monitoring data collected to date indicates that this pollutant linkage is absent on the Business Park site and therefore no ground gas protection measures would be required as part of any future development proposals on this parcel of land.

The elevated concentrations of carbon dioxide in two locations WS9 (Holly Road, South) and WS2 (Car Wash) elevate these sites to an Amber 1 and Amber 2 scenarios respectively and the need for ground gas protection measures will be required on these parcels of land.

However, with reference to the proposed development and assuming no buildings are to be constructed, no ground gas protection measures would be required for the proposed access road on the Car Wash site.

The requirement for ground gas protection measures on the Holly Road, south site would only need to be considered should future development plans include for buildings (be it residential or commercial).

It should be noted that gas monitoring was not undertaken during low (<1000mb) atmospheric pressure conditions, albeit in the absence of low pressure conditions RSK targeted a ‘falling’ pressure round (defined as a pressure change of 1.6 to 3.5hPa in the

preceding three hours) in order to capture worst case conditions for ground gas generation.

Given the absence of a low atmospheric pressure round (<1000mb) additional monitoring may be required by the local planning authority to confirm the findings to date.

6.3 Summary of findings

6.3.1 The Business Park

The relevant pollutant linkages that will require future mitigation include:

1. Direct contact of future site occupants with impacted made ground; and,
2. Chemical attack on future infrastructure (potable water supply lines) from potentially impacted made ground.

6.3.2 The Car wash

The relevant pollutant linkages that will require future mitigation include:

1. Chemical attack of future infrastructure (potable water supply lines) from potentially impacted made ground.
2. Future ground gas protection measures may be required if buildings are included on the proposed development within this parcel of land.

6.3.3 Holly Road, South

No potentially complete pollutant linkages were identified as part of this geo-environmental assessment however; the requirement for any future ground gas protection measures may need to assessed once development plans are made available.

7 GEOTECHNICAL SITE ASSESSMENT

7.1 Engineering considerations

It is understood that the proposed development will comprise the demolition of the existing buildings of the Business Park, to provide room for high-density purpose built mixed commercial and residential units, comprising 11No. houses and 100No. flats in blocks up to five-storeys high. A single-storey basement is also understood to be proposed beneath the central building on The Business Park site.

Currently there is no information on the proposals for the Holly Road South site. Furthermore, no specific information relating to the proposed structures and building loads has been provided.

7.2 Geotechnical hazards

A summary of commonly occurring geotechnical hazards is given in Table 22 together with an assessment of whether the site may be affected by each of the stated hazards.

Table 24: Summary of main potential geotechnical hazards that may affect site

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
Sudden lateral changes in ground conditions	✓	Likely to be present given the inherent variability of the made ground, and the depth to the surface of the Taplow Gravel		Likely to affect ground engineering and foundation design and construction
Shrinkable clay soils			✓ London Clay Formation at depths not affecting the proposed development	Design to NHBC Standards Chapter 4 or similar
Highly compressible and low bearing capacity soils, (including peat and soft clay)			✓	Likely to affect ground engineering and foundation design and construction
Silt-rich soils susceptible to loss of strength in wet conditions	✓	London Clay with variable silt content		Likely to affect ground engineering and foundation design and construction
Running sand at and below water table		✓	Likely to be present for excavations below the water table	Likely to affect ground engineering and foundation design and construction

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
Karstic dissolution features (including 'swallow holes' in Chalk terrain)			✓	May affect ground engineering and foundation design and construction – refer to Section 4.1.2
Evaporite dissolution features and/or subsidence			✓	May affect ground engineering and foundation design and construction
Ground subject to or at risk from landslides		✓	Railway cutting at the western boundary may be affected by the development	Likely to require special stabilisation measures
Ground subject to peri-glacial valley cambering with gulls possibly present			✓	Likely to affect ground engineering and foundation design and construction
Ground subject to or at risk from coastal or river erosion			✓	Likely to require special protection/stabilisation measures
High groundwater table (including waterlogged ground)			✓	May affect temporary and permanent works
Rising groundwater table due to diminishing abstraction in urban area			✓	May affect deep foundations, basements and tunnels
Underground mining	✓	Great thickness of made ground, possibly due to in-filled gravel pits		Likely to require special stabilisation measures
Existing sub-structures (e.g. tunnels, foundations, basements, and adjacent sub-structures)	✓	Evidence of USTs; possible remains of historic structures on the site		Likely to affect ground engineering and foundation design and construction
Filled and made ground (including embankments, infilled ponds and quarries)	✓	Made ground with variable thickness across the entire site		Likely to affect ground engineering and foundation design and construction
Adverse ground chemistry (including expansive slags and weathering of sulphides to sulphates)	✓	See Section 7.7		May affect ground engineering and foundation design and construction
Note: Seismicity is not included in the above table as this is not normally a design consideration in the UK.				

7.3 Foundations

7.3.1 General suitability

The ground conditions beneath the site comprise variable and locally significant (up to 3.5m) thickness of made ground, over 1.5m to 1.6m thick layer of medium dense to dense, sand and gravel of the Taplow Gravel Member, with high to very high strength, silty clay of the of the London Clay Formation at depth. Groundwater was generally at the interface between the made ground and the Taplow Gravel, with highest recorded 'resting' level at 1.45mbgl.

Given the significant depth of made ground and the relatively high anticipated loading from the proposed structures, it is considered that traditional spread foundations are unlikely to be appropriate foundation solution, and consideration should be given to piled foundations. Reinforced concrete rafted foundation can also be considered, especially under the proposed basement, transferring anticipated loading over a greater area, thus reducing the risk of potential differential movements.

The sub-structure design and construction will be primarily determined by the proposal to construct a basement beneath the majority of the Business Park area. Given the inherent instability of the granular Taplow Gravel deposits, it will be necessary to form an effective perimeter wall taken sufficiently deep for stability purposes and to control the water ingress in the excavation. Adoption of interlocked sheet piles or secant bored piled wall should overcome this issue.

The excavation of the new basement will be accompanied by immediate elastic and long-term swelling heave of the underlying clay soils. The amount of heave movement will be a function of the depth and breadth of excavation and period of time that elapses between excavation and subsequent construction.

7.3.2 Basement Raft

Based on the ground conditions encountered, the proposed single-storey basement formation level is likely to be at the boundary between the made ground and the Taplow Gravel Member.

For preliminary design purposes, a net safe bearing pressure in the order of 150kN/m^2 (safety factor F_s=3.0) is considered suitable for a raft foundation, although it will be necessary to check that the associated movements related to the removal of overburden to form the basement structure (heave), and subsequent settlements following the construction of the new structure are acceptable to the proposed structure and surrounding buildings.

Based on the groundwater monitoring records, the proposed basement formation level will be below groundwater level, and therefore dewatering will be required during the construction. The falling head test undertaken in BH04 and WS5 indicate a coefficient of permeability 'k' value of approximately 6.20×10^{-5} to 7.06×10^{-5} m/s, however, it should be stressed that the ground conditions within the Taplow Gravel were relatively variable across the site and further, targeted permeability testing should be undertaken to confirm these values. The basement raft should also be deigned to withstand the uplift hydrostatic pressures acting at the underside of the slab.

The basement structure will need to incorporate suitable waterproofing measures and reference should be made to BS 8102:2009 'Code of practice for protection of below ground structures against water from the ground' for further guidance.

7.3.3 Piled foundations

Recommendations for the design and construction of pile foundations in relation to the ground conditions are set out in Table 25.

Table 25: Design and construction of piled foundations

Design/construction considerations	Design/construction recommendations	
Pile type and possible constraints	The construction of both bored and driven piles is considered technically feasible at this site. Given the close proximity of the site to a residential area it is considered possible that the vibration/noise associated with pile driving may not be acceptable. Furthermore, driven piles may reach premature set within the locally very dense Taplow Gravel. Given potential for isolated contaminative impact of the made ground at the site it may not be cost effective to adopt bored piles at the site as disposal of arisings will be costly.	
Temporary casing	Given the presence of groundwater strikes within the non-self supporting made ground and Taplow Gravel, bored piles will require temporary casing throughout their depth. Alternatively, the use of continuous-flight-auger (CFA) injected bored piles or driven piles usually overcomes this issue.	
Man-made obstructions	The presence of buried sub-structures or other obstructions within made ground may lead to some difficulty during piling. It is recommended that once the proposed pile layout has been determined, pre-pile probing be carried out at each of the pile positions. Where buried obstructions are encountered, it will be necessary to either relocate the pile(s) or make allowance for removing the obstruction	
Soft superficial deposits	For the purpose of assessing preliminary pile capacities the made ground has been presumed not to contribute to the load-carrying capacity for the piles.	
Hard strata	An allowance should be made for chiselling thin 'rock' bands (claystone, limestone or cemented sandstone) within the London Clay or Reading Formation	
Pile design parameters for Taplow Gravel	Shaft friction factor ($k_s \times \tan \delta$)	0.1
Pile design parameters for London Clay Formation	Undrained shear strength c_u (kN/m^2)	50+9.67z; z – depth of the London Clay
	Adhesion factor α	0.5
	Bearing capacity cactor N_c	9.0
General parameters	Global margin of safety	2.6

Design/construction considerations	Design/construction recommendations	
	Limiting shaft friction (kN/m^2)	110 kN/m^2
	Limiting concrete stress (kN/m^2)	7.5 N/mm^2
Special precautions relating to bored pile shafts and bases	Bored pile concrete should be cast as soon after completion of boring as possible and in any event the same day as boring. Prior to casting the base of the pile bore should be clean, otherwise a reduced safe working load will be required. Similarly, if the pile bore is left open the shaft walls may relax/soften, leading to a reduced safe working load.	

The design procedure for piles varies considerably, depending on the proposed type of pile. However, for illustrative purposes Table 26 gives likely working pile loads for traditional bored, cast-in-situ concrete piles of various diameters and lengths, based on the design parameters given in Table 25.

Table 26: Illustration of typical pile working loads for bored cast-in-situ piles

Typical pile working loads (kN)				
Depth of pile below proposed basement level (m)	Pile diameter			
	300 mm	450 mm	600 mm	750 mm
5.0	74	127	191	266
10.0	188	307	443	595
15.0	346	553	782	1035
20.0[1)]	529	830	1155	1505

[1)] pile toe below final depth of investigation

It should be stressed that the above capacities do not take into consideration pile group effects which is more pronounced for a large number of closely spaced piles.

7.4 Floor slabs

The site is generally underlain by more than 600 mm of existing made ground. National House-Building Council (NHBC) standards require that ground floor slabs should be suspended in areas where made ground is greater than 600 mm in thickness. Alternatively, consideration could be given to removing the made ground and replacing it with well compacted, suitable granular fill.

7.5 Basement retaining wall design parameters

In order to facilitate basement construction it may be necessary to construct some form of retaining wall suitable for the site conditions. On the basis of the ground investigation information the following soil parameters in Table 27, are recommended for retaining wall design purposes.

Table 27: Retaining wall design parameters

Soil type	C_U (kN/m^2)	SPT 'N' value	Unit weight (kN/m^3)	Short Term Characteristics		Long Term Characteristics	
				C_U (kN/m^2)	ϕ (°)	c' (kN/m^3)	ϕ' (°)
Made ground	-	1 to 14	18	-	22[1)]	-	22[1)]
Kempton Park Gravel	-	N_{min}=14	20 (moist) 21 (saturated)	-	32	-	32
London Clay Formation	50 at surface; 200 at 20mbgl	12 to 32	19.5	50+9.7z where z-depth into clay	-	2[2)]	23[2)]

[1)] estimated values based on predominantly granular in nature
[2)] presumed values – no drained analysis undertaken

Groundwater was encountered at the interface of the made ground and the Taplow Gravel, with the highest resting level at 1.45mbgl, above the proposed basement formation level, therefore temporary groundwater control will be necessary to allow construction of the basement, and there will be hydrostatic pressures acting behind retaining structures.

The new basement construction must be designed to be fully sealed to prevent any future groundwater ingress unless allowance is made for an effective drainage system.

7.6 Roads, hardstanding and drainage

In the 1 m to 1.5 m below the proposed finished ground level the exploratory holes have revealed a soil profile comprising variable made ground.

In pavement design terms, the groundwater conditions are anticipated to comprise a intermediate water table, i.e. between 300 mm and 1000 mm of the pavement formation level.

The results of in-situ testing on the near surface soils are summarised in Table 28.

Table 28: Summary of CBR values derived from in-situ DCP tests

Test location	Material type	Minimum CBR value
WS1	Made ground	2%
WS4		7%
WS9		2%

The sub-grade soils may be susceptible to improvement by rolling with conventional compaction plant.

The recommended sub-grade soil CBR value for road pavement design is therefore 2%. This value assumes that during construction the formation level will be carefully compacted and any soft spots removed and replaced with well-compacted granular fill.

The sub-grade soils can be regarded as non-frost-susceptible, based upon the criteria given in Appendix 1 of TRRL (1970) Report Road Note 29. When the sub-grade is frost-susceptible the thickness of sub-base must be sufficient to give a total thickness of non-frost-susceptible pavement construction over the soil of not less than 450 mm.

7.7 Chemical attack on buried concrete

This assessment of the potential for chemical attack on buried concrete at the site is based on *BRE Special Digest 1: Concrete in aggressive ground*, which represents the most up-to-date guidance on this topic currently available in the UK.

The desk study and site walkover indicate that, for the purposes of assessing the aggressive chemical environment of the site, the site should be considered as comprising natural ground likely to contain pyrite

As the site is considered likely to contain pyrite, the characteristic percentage of oxidisable sulphide (OS) in the soil has been calculated as 1.62%, which is above the 0.3% limit set in *BRE Special Digest 1*. As such, the soil can be considered pyritic.

Based on the characteristic water-soluble sulphate and total potential sulphate concentrations in the soil of 227mg/l (SO_4) and 1.27% (SO_4), the Design Sulphate (DS) Class for the London Clay Formation is DS3, as determined from Table C1 of *BRE Special Digest 1*. However, it is important to note that the sulfide content of the ground depends of the concrete exposure to disturbed ground which might be vulnerable to oxidation. Simply cutting through ground without opening up the ground beyond the cut face (eg. piling operations) does not generally result in disturbed ground. On that basis, a reduced Design Sulphate (DS) Class for the London Clay Formation of DS2 can be adopted.

Based on the mobile groundwater conditions and the characteristic pH values measured in the London Clay Formation, the aggressive chemical environment for concrete (ACEC) is AC-2.

7.8 Soakaways

With reference to the available data, the infiltration rate of the underlying Taplow Gravels ($k=10^{-5}$) is considered representative of low to medium permeability, and good drainage conditions.

However, the occurrence of both significant thickness of unsuitable strata (Made Ground) and the underlying high groundwater table is likely to influence the suitability of pit soakaways.

Whilst it is noted that there are numerous soakaway chambers currently on-site, there number may be indicative of a drainage strategy designed to overcome the aforementioned constraints.

8 REUSE OF MATERIALS AND WASTE

8.1 Reuse of suitable materials

Under the Waste Framework Directive, naturally occurring soils are not considered waste if reused on the site of origin for the purposes of development.

In accordance with the definition provided in the Waste Framework Directive, materials are only considered waste if 'they are discarded, intended to be discarded or required to be discarded, by the holder'. Thus, soils that are not of clean and natural origin, i.e. made ground (whether contaminated or not) and other materials such as recycled aggregate, do not become waste until the aforementioned criteria are met.

The Definition of Waste: Development Industry Code of Practice (CL:AIRE, 2011) (CoP) was developed in consultation with the Environment Agency and development industry to enable the re-use of materials under certain scenarios and subject to demonstrating that specific criteria are met. The current reuse scenarios covered by the CoP comprise

- reuse on the site of origin (with or without treatment)
- direct transfer of clean and natural soils between sites
- use in the development of land other than the site of origin following treatment at an authorised Hub site (including a fixed soil treatment facility).

The importation of made ground soils (irrespective of contamination status) or crushed demolition materials is not permitted currently under the CoP and requires either a standard rules environmental permit or a U1 waste exemption (see below).

In the context of excavated materials used on sites undergoing development, four factors are considered to be of particular relevance in determining if the material is a waste or when it ceases to be waste:

- the aim of the Waste Framework Directive is not undermined, i.e. if the use of the material will create an unacceptable risk of pollution of the environment or harm to human health it is likely to be waste
- the material is certain to be used
- the material is suitable for use both chemically and geotechnically
- only the required quantity of material will be used.

The CoP requires the preparation of a materials management plan (MMP) that confirms the above factors will be met. This plan needs to be reviewed by a 'Qualified Person' (QP) who will then issue a declaration form to the EA. As the project progresses, data must be collated and on completion a verification report produced that shows the MMP was followed and describes any changes.

The MMP establishes whether specific materials are classified as waste and how excavated materials will be treated and/or reused in line with the CoP. The MMP is likely to form part of the site waste management plan.

The site has been developed previously and the investigation has confirmed the presence of made ground. Therefore, before any excavation works begin on-site, an MMP will need to be prepared, reviewed by a QP; and a Declaration lodged with the EA.

As noted above, under the Waste Framework Directive naturally occurring soils are not considered waste and therefore arisings of clean natural soils, e.g. from foundation and drainage excavations, may be reused on the site. However, it is important that these soils should be stockpiled separately and not become cross-contaminated with made ground / contaminated soils or construction wastes.

If it were proposed to import clean and naturally occurring soils direct from another site, the receiving site's MMP would need to be updated in advance of importation.

8.2 Treatment to meet suitable-for-use criteria

Where materials do not meet the suitable for use criteria, it may be possible to treat them under an environmental permit (mobile treatment licence) to enable them to be reused on-site.

To enable the treatment options to be determined, an options appraisal and a remediation strategy document will be necessary to support discussion of the issues with regulators and third parties.

8.3 Reuse of waste materials

If material is discarded as waste then its reuse on site may still be possible. Waste soils and recycled aggregate can be reused on site under a standard rules environmental permit or a U1 waste exemption from the Environmental Permitting (England and Wales) Regulations 2010 provided that they are suitable for the proposed use, i.e. not cause harm to human health or the environment. However, it should be noted that these have strict limits on the quantity of material that can be reused.

8.4 Wastes for landfill disposal

Wastes require pre-treatment prior to disposal at landfill. Pre-treatment must be a physical, thermal, chemical or biological process (including sorting) that changes the characteristics of the waste to reduce its volume, reduce its hazardous nature, facilitate its handling and enhance its recovery.

The latest edition of the EA's 'Technical Guidance WM3' (2015), Guidance on the classification and assessment of waste, requires that within a mixed waste the separately identifiable wastes are assessed separately. Mixing of different types of hazardous waste and hazardous waste with other waste substances is prohibited under the Waste Framework Directive. Wastes that have been mixed must be separated whenever possible.

It is best practice to provide your waste carrier (or the disposal site) with details of how the waste has been treated. Your waste carrier may provide a pre-treatment confirmation form or space on the waste transfer note to detail the pre-treatment.

The classification of waste soil is a two-stage process, the first being an assessment of whether the soil is considered hazardous or not following the guidance within Technical Guidance WM3. For off-site disposal to landfill the results of Waste Acceptance Criteria

(WAC) testing must then be reviewed to establish if the soil is acceptable at the relevant class of landfill or requires pre-treatment to reduce specific hazardous properties.

8.4.1 Waste acceptance criteria

All inert, stable non-reactive hazardous and hazardous wastes have limit values (waste acceptance criteria) set out in legislation that must be met before that class of landfill can accept the waste. Currently, no WAC are in place for non-hazardous waste.

Soil and other materials that are found not to be hazardous may be classified as either non-hazardous or inert. In order to determine whether they can be classed as inert the soil must be tested and found to be below the inert waste acceptance criteria.

8.4.2 Waste sampling plan

Technical Guidance WM3 sets out in Appendix D requirements for waste sampling. It is a legal requirement to correctly assess and classify waste. The level of sampling should be proportionate to the volume of waste and its heterogeneity. At this stage, RSK consider that the level of soil sampling is/is not sufficient to categorise the material robustly/fully.

RSK recommends that a Sampling Plan be prepared to support any waste classifications and hazardous waste assessments, prior to development.

8.4.3 Preliminary waste assessment

Given the level of data obtained, scale of the development and heterogeneity of the site soils, the following assessment should be considered indicative and further assessment should be undertaken following the preparation of a waste sampling plan.

Envirolab, an RSK company, has developed a waste soils characterisation assessment tool (HASWASTE), which follows the guidance within Technical Guidance WM3. The analytical results have been assessed using this tool for potential off-site disposal of materials in the future (**Appendix Q**). The results are presented in Table 28.

Table 29: Results of waste soils characterisation assessment (HASWASTE)

Sample location	Waste classification
BH4	Non Hazardous
TP02	Non Hazardous
TP02	Non Hazardous
WS2	Non Hazardous
WS4	Non Hazardous
WS5	Non Hazardous
WS6	Non Hazardous
WS7	Non Hazardous
WS8	Non Hazardous
WS10	Non Hazardous
Notes: See Section 8.4.4 Asbestos within waste soils, below	

None of the samples were classified as hazardous waste. Therefore to determine whether waste might be classified as inert or non-hazardous WAC testing will need to be undertaken prior to any off-site disposal.

8.4.4 Asbestos within waste soils

The latest edition of Technical Guidance WM3 requires that within a mixed waste the separately identifiable wastes be assessed separately. For instance, where waste soil contains identifiable pieces of asbestos (visible to the naked eye) the asbestos should, where feasible, be separated from the soil and classified separately.

A sample from TP02 of potential asbestos containing material was collected from site and analysed for the presence of asbestos, the results of which are presented in **Appendix L** and **Appendix Q**. Analysis confirmed that asbestos is present within the sample. Visible asbestos containing material should, where feasible, be separated from soils and classified as stable, non-reactive hazardous waste, which can then be disposed of within a stable non-reactive hazardous waste landfill or a special cell in a non-hazardous waste landfill.

Samples from WS2, WS4, WS5, WS7, WS8 WS10, BH4 and TP02 have been analysed for percentage asbestos fibres by weight, the results of which are presented in **Appendix L** and **Appendix Q**. Analysis confirmed the presence of asbestos fibres within WS2 and WS4, however, the percentage of asbestos fibres were less than 0.1% by weight and therefore the waste can be disposed of within a non-hazardous waste landfill.

8.5 Landfill tax

Waste producers disposing of material to landfill are required to pay landfill tax by HM Revenue and Customs.

The tax is chargeable by weight (tonnage) and two rates apply, either standard or lower rate. The lower rate only applies to those less polluting wastes as set out in the Landfill Tax (Qualifying Material) Order 2011, which include naturally occurring rock and soil, concrete, some minerals, some furnace slags and ash, and some low-activity organic compounds. Evidence confirming that the waste qualifies for the lower rate will be required, and standard rate tax will apply for the whole waste load for any loads of mixed waste.

Currently (since 1 April 2017), standard rate landfill tax is £86.10 per tonne.

The lower rate of landfill tax applicable to less polluting wastes (i.e. ‘inert’ wastes) remains at £2.70 per tonne.

Material disposed of at a soil treatment centre will not be subject to landfill tax.

8.6 Groundwater

When there is an intention to discard groundwater, chemical test results will indicate the appropriate disposal options. This could include disposal to treatment facility, via consent (issued by the water authority) to foul sewer or via consent (issued by the EA) to a watercourse or land.

8.7 Recommendations

RSK recommends that consideration as to how potentially waste soils will be dealt with as part of this development/remediation is given as early in the project planning process as possible. Such planning can lead to cost savings where potentially waste soils are viewed as a resource and retained on-site as part of the development. We also recommend, where off-site disposal is being considered, that appropriate facilities are identified and discussions initiated to confirm suitability of the facility to take the material. Potentially, these may include soil treatment facilities as well as landfills.

RSK can provide specialist advice to assist in this process, which can be complex and subject to regular regulatory change.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Environmental

The relevant pollutant linkages that will require future mitigation (based on current development proposals) include:

1. Direct contact of future site occupants with impacted made ground on The Business Park site; and,
2. Chemical attack of on future infrastructure from potentially impacted made ground on both The Business Park site and The Car Wash.

9.1.1 Conclusions

With reference to both the aforementioned soil laboratory results there will the requirement for a suitable 'clean' capping layer on the Business Park site to mitigate future risks to human health.

Assuming the Car Wash site remains a future access road, the requirement for suitable capping layer would be omitted through the use of hardstanding however; the appropriate decommissioning of any underground infrastructure (USTs) and removal of any residual/localised impact in accordance with a Duty of Care and betterment approach would still need to be considered. The same would apply for the any underground infrastructure of The Business Park site.

Whilst exceedences are absent on the Holly Road, South site, depending on the intended end-use, the requirement to install a suitable capping layer and or removal of the shallow made ground may be driven by the presence of undesirable anthropogenic inclusions and or future geotechnical considerations.

Elevated hydrocarbon concentrations or any visual/olfactory signs of contaminative impact were notably absent from telltale soil horizons within exploratory locations targeting the 'know' USTs and associate infrastructure however; localised removal of residual soil/groundwater impact cannot be ruled out entirely and should be allowed for.

Whilst phytotoxic exceedences were identified, the risks posed to future vegetation are likely to be mitigated through the importation of a suitable growing medium (including root bowls) as part of the final landscaping solution. Taking this into consideration in addition to the requirement for a suitable 'clean' capping layer to mitigate future risks to human health, this pollutant linkage is considered absent and therefore omitted from any further assessment and or any specific remedial measures.

Isolated/localised detectable concentrations of TPH were encountered on both The Business Park and car Wash sites and therefore pollutant polyethylene (PE) water supply pipes are expected to be unsuitable for use on the development unless remedial measures are implemented that mitigate the risk. Polyvinyl chloride (PVC) pipes are likely to be suitable for use.

Whilst the risks to controlled waters are considered 'low', the occurrence of localised soil/groundwater impact cannot be ruled out entirely.

With reference to the proposed basement – it is anticipated that dewatering activities will be required to some extent. Appropriate management, mitigation and disposal of groundwater (impacted or otherwise) will need to be considered at an early stage and the necessary consents/licenses obtained.

With regards to hazardous ground gases, based on the monitoring data collected to date ground gas protection measures may be required depending upon the future development proposals (if any) for the Car Wash and Holly Road, South.

9.1.2 Recommendations

A site Remediation Strategy will need to need to be drafted and approved by the Local Authority and their statutory consultees at the Environment Agency.

Remedial measures are likely to be limited to the incorporation of a 'clean' cap typically 600mm in private gardens and 450mm within public open space within The Business Park site.

The Remediation Strategy will also need to provide details on the decommissioning and verification works to be undertaken on existing below ground infrastructure (USTs/soakaways/pipe work); as well as an outline as to the procedures in place should previously unforeseen contaminative impact be discovered during the development phases of works.

Should a piled foundations solution be decided upon, despite the risks to Controlled Waters being considered low, owing to the presence of the shallow Principal Aquifer (Taplow Gravels), it is recommended that a Piling Risk Assessment is completed prior to commencement.

Owing the sites location within a predominately residential area, impacts of any development to adjacent site users will need to closely managed and as such there may be the requirement for a Construction Environmental Management Plan (CEMP).

With reference to the preliminary flood risk assessment (Section 3.5.4) and the identification of potential hydrological constraints, specialist studies may need to be conducted to confirm flood risks at the site.

With reference to potable water supply lines, it is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements for assessment.

Note that the assessment has been conducted with reference to the proposed development and the intended end-use understood at the time of drafting. Should any of the development plans change, it recommended that the assessment is re-visited.

RSK recommends early engagement with the local authority, following issuance of this report.

9.2 Reuse of materials and waste

9.2.1 Conclusions

The results of the preliminary waste assessment indicate none of the samples analysed would not be classified as hazardous waste.

Most notably the occurrence of other isolated asbestos containing materials such as that encountered within TP02 cannot be ruled out entirely.

The abundance of anthropogenic inclusions within the underlying made ground is likely to result in a non-hazardous waste classification rather than 'inert'. Underlying natural and un-impacted soils are likely to be classified as 'inert'.

9.2.2 Recommendations

RSK recommends that consideration as to how potentially waste soils will be dealt with as part of this development/remediation is given as early in the project planning process as possible.

More specifically, RSK recommends that a Site Waste Management Plan inclusive of a Sampling Plan be prepared to support any waste classifications and hazardous waste assessments, prior to development.

9.3 Geotechnical

The site investigation has confirmed the site to be underlain by variable thickness of made ground (up to 3.5m thick), medium dense to dense sand and gravel of the Taplow Gravel, with high to very high strength, silty clay (London Clay Formation) proven to the terminal depth of investigation at 20mbgl. Groundwater was encountered at the interface between the made ground and the Taplow Gravel, at the highest level of 1.45m below ground level.

The formation level of the new basement is estimated to lie at around 3.50m below existing ground level, within the Kempton Park Gravel and below the current groundwater level.

Piles or reinforced concrete basement raft are considered to be preferred foundation solution for the proposed development.

The presence of buried sub-structures or other obstructions within made ground may lead to some difficulty during piling. It is recommended that once the proposed pile layout has been determined, pre-pile probing be carried out at each of the pile positions.

Given the granular nature of the Taplow Gravel, it will be necessary to form an effective perimeter wall taken sufficiently deep for stability purposes and to control the water ingress in the excavation. Adoption of an interlocked sheet piles or secant bored piled wall should overcome this issue.

Allowance should be made for the resulting hydrostatic pressures acting underneath the raft and behind the basement retaining walls.

The basement structure will need to incorporate suitable waterproofing measures and reference should be made to BS 8102:2009 'Code of practice for protection of below ground structures against water from the ground' for further guidance.

The recommended sub-grade soil CBR value for road pavement design is 2%. This value assumes that during construction the formation level will be carefully compacted and any soft spots removed and replaced with well-compacted granular fill. The sub-grade soils can be regarded as non-frost-susceptible.

Should the ground conditions will not be significantly disturbed during the construction phase of construction, and the concrete is not into contact with the London Clay soils, the

Design Sulphate Class for the site DS-2 with an Aggressive Chemical Environment for Concrete classification of AC-2 can be adopted for the proposed development.

Infiltration rates of the underlying Taplow Gravels ($k=10^{-5}$) is considered representative of low to medium permeability, and good drainage conditions however; the presence of a significant thickness of unsuitable strata and a shallow water table are likely constraints to the suitability of pit soakaways.

BIBLIOGRAPHY

AGS Interim Guidance (2013), 'Site investigation and asbestos risk assessment for the protection of site investigation and geotechnical laboratory personnel', February.

Baker, K., Hayward, H., Potter, L., Bradley, D. and McLeod, C. (2009), *CIRIA Report C682. The VOCs Handbook. Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination* (London: CIRIA).

Barton, N. J. (1992), *The Lost Rivers of London: A Study of Their Effects Upon London and Londoners, and the Effects of London and Londoners on Them* (London: Historical Publications).

Boyle, R. A. and Witherington, P. J. (2007), 'Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present', National House-Building Council and RSK Group.

British Standards Institution (BSI) (1990), 'BS 1377:1990. Methods of test for soils for civil engineering purposes'.

British Standards Institution (2015), 'BS 5930:2015. Code of practice for ground investigations'.

British Standard Institution (BSI) (2015), 'BS 8485:2015. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings '.

British Standards Institution (2013), 'BS 10175:2013. Investigation of potentially contaminated sites: Code of practice'.

British Standards Institution (2013), BS8576:2013. Guidance on investigations for ground gas – permanent gases and volatile organic compounds (VOCs)

Building Research Establishment (BRE) (2001), *BRE Report 414. Protective measures for housing on gas-contaminated land* (London: BRE).

Building Research Establishment (2005), *BRE Special Digest 1: Concrete in aggressive ground* (London: BRE).

Building Research Establishment (2016) *BRE Digest 365. Soakaway design* (London: BRE).

Card, G. B. (1995), *CIRIA Report 149. Protecting development from methane* (London: CIRIA).

Chandler R. J. and Forster A., (2001) CIRIA Report C570, Engineering in Mercia Mudstone.

Chartered Institute for Environmental Health and Land Quality Management (2009), 'The LQM/CIEH Generic Assessment Criteria for Human Health', second edition.

Chartered Institute of Environmental Health (CIEH) and CL:AIRE (2008), *Guidance on Comparing Soil Contamination Data with a Critical Concentration* (London: CIEH).

CIRIA (2014). Good practice on the testing and verification of protection systems for buildings against hazardous ground gases

CL:AIRE (2009), *Soil Generic Assessment Criteria for Human Health Risk Assessment* (London: CL:AIRE).

CL:AIRE (2011), *CL:AIRE Code of Practice. The Definition of Waste: Development Industry Code of Practice, Version 2* (London: CL:AIRE).

Dangerous Substances Directive (76/464.EEC).

Department for Environment, Food and Rural Affairs (2010), *The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010* (London: HMSO).

Department of the Environment (1996), *Code of Practice for Agricultural Use of Sewage Sludge* (London: HMSO).

Environment Agency (2015), 'Technical Guidance WM3. Guidance on the classification of and assessment of waste. 1st Edition.

Environment Agency (2004), *Model Procedures for the Management of Contaminated Land. Contaminated Land Report Number 11 (CLR11),* September (Bristol: Environment Agency).

Environment Agency (2004b), 'Policy Number 199_04, dated 9 March 2004, Part IIA – Detailed Quantitative Assessment of Chronic Risks to Human Health from Contaminated Soils'.

Environment Agency (2006a), 'Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination'.

Environment Agency (2006b), 'The Knotweed Code of Practice – managing Japanese Knotweed on development sites'.

Environment Agency (2008), *Science Report SC050021/SR7. Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values* (Bristol: Environment Agency).

Environment Agency (2009a), Contaminated Land Exposure Assessment (CLEA) software, version 1.06.

Environment Agency (2009b), *Human health toxicological assessment of contaminants in soil. Science Report – Final SC050021/SR2*, January (Bristol: Environment Agency).

Environment Agency (2009c), 'Science Report SC050021/benzene SGV, toluene SGV, ethylbenzene SGV, xylene SGV, mercury SGV, selenium SGV, nickel SGV, arsenic SGV, cadmium SGV, phenol SGV, dioxins, furans and dioxin like PCBs SGVs', 'Supplementary information for the derivation of SGV for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', and 'Contaminants in soil: updated collation of toxicological data and intake values for humans: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', March 2009, May 2009 and September 2009.

Environment Agency (2009d), *Science Report – SC050021/SR3. Updated technical background to the CLEA model* (Bristol: Environment Agency).

Environment Agency (2010a), 'GPLC1 – Guiding Principles of Land Contamination', 'GPLC2 – Frequently Asked Questions, Technical Information, Detailed Advice and References', and 'GPLC3 – Reporting Checklists', all March.

Environment Agency (2010b), 'Horizontal Guidance Note H1 - Environmental risk assessment for permits'.

Environment Agency (2010c), 'Status Report: Management of the London Basin Chalk Aquifer'.

Environment Agency (2011) Chemical Standards Database.

Environment Agency (no date) Freshwater environmental quality standards.

Environment Agency www.environment-agency.gov.uk/.

Environmental Permitting (England and Wales) Regulations 2010 (London: HMSO).

Hartless, R. (1991), 'BRE Report 212: Construction of new buildings on gas-contaminated land', Building Research Establishment.

Hazardous Waste Regulations 2005 (London: HMSO).

Knipp, C. V., Lloyd, J. W., Lerner, D. N. and Greswell, R. (1993), *CIRIA Special Publication 92. Rising groundwater levels in Birmingham, and their engineering significance* (London: CIRIA).

Landmark Information Group (2018), 'Envirocheck report reference 159575380_1_1', dated 16th March.

Lord, J. A., Clayton, C. R. I. and Mortimore, R. N. (2002), *CIRIA Report C574 Engineering in chalk* (London: CIRIA).

National House-Building Council (1999), 'Chapter 5.2: Suspended Ground Floors' in *NHBC Standards*, revised September 1999, effective January 2000.

Norbury, D. (2010), *Soil and Rock Description in Engineering Practice* (Caithness: Whittles).

Office of the Deputy Prime Minister (2004), *Planning Policy Statement 23: Planning and Pollution Control* (London: The Stationery Office).

Part IIA of the Environmental Protection Act (Contaminated Land Regulations (England) 2002 (London: HMSO).

Rudland, D. J., Lancefield, R. M. and Mayell, P. N. (2001), *CIRIA C552. Contaminated Land Risk Assessment: A Guide to Good Practice* (London: CIRIA).

Simpson, G., Blower, T., Craig, R. N. and Wilkinson, W. B. (1989), *CIRIA Special Publication 69. The engineering implications of rising groundwater levels in the deep aquifer beneath London* (London: CIRIA).

Stone, K., Murray, A., Cooke, S., Foran, J., Gooderham, L., (2009) CIRIA C681, Unexploded Ordnance (UXO). A guide or the construction industry.

The Building Regulations (revised December 2004) 'Approved Document C. Department of the Environment and The Welsh Office'.

The Surface Waters (Abstraction for Drinking Water) (Classification) Regulations 1996 (London: HMSO).

The Surface Waters (Dangerous Substances) (Classification) Regulations 1998 (London: HMSO).

The Water Supply (Water Quality) Regulations 1989, 2000 and 2001 (London: HMSO).

Transport and Road Research Laboratory (1970), 'TRRL Road Note 29 (Appendix 1). Road pavement design'.

Transport and Road Research Laboratory (1984), 'TRRL Report LR1132 (Table C1)'.

UK Water Industry Research (2010) *UKWIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (London: UKWIR).

Water Framework Directive (2000/60/EC).

Wilson, S. A. and Card, G. B. (1999), ‘Reliability and risk in gas protection design’, *Ground Engineering*, February: 33–6.

Wilson, S., Oliver, S., Mallet, H., Hutchings, H. and Card, G. (2007), *CIRIA Report C665: Assessing risks posed by hazardous ground gases to buildings* (London: CIRIA).

World Health Organization (2004), *Guidelines for drinking-water quality*, 3rd edn (Geneva: WHO).

WRc plc (2002), ‘Polycyclic Aromatic Hydrocarbons (PAH): Priorities for Environmental Quality Standard Development, R&D Technical Report P45’.

FIGURES

RSK

18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT
United Kingdom

Tel: +44 (0) 1442 437500
Fax: +44 (0) 1442 437550
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client: NOTTING HILL HOUSING TRUST

Project Title: ST CLAIR BUSINESS PARK, HAMPTON HILL

Drawing Title: SITE LOCATION MAP

Rev	Drawn	Date	Checked	Date	Approved	Date
00	AP	06.04.18	JG	06.04.18	JG	06.04.18

Dimensions	Scale	Original Size
m	1:50,000	A4

Project Number	Drawing File	Drawing Number
29701 - R01 (01)	29701 - SLP.dwg	FIGURE 1

LEGEND

- Site boundary
- Car Wash
- Business Park
- Holly Road South

N

Rev.	Date	Amendment	Drawn	Chkd.	Appd.
P1	09.04.18	FIRST ISSUE	AP	JG	JG

RSK

18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT
United Kingdom

Tel: +44 (0) 1442 437500
Fax: +44 (0) 1442 437550
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client

NOTTING HILL HOUSING TRUST

Project Title

ST CLARE BUSINESS PARK, HAMPTON HILL

Drawing Title

SITE BOUNDARY

Drawn	Date	Checked	Date	Approved	Date
AP	09.04.18	JG	09.04.18	JG	09.04.18

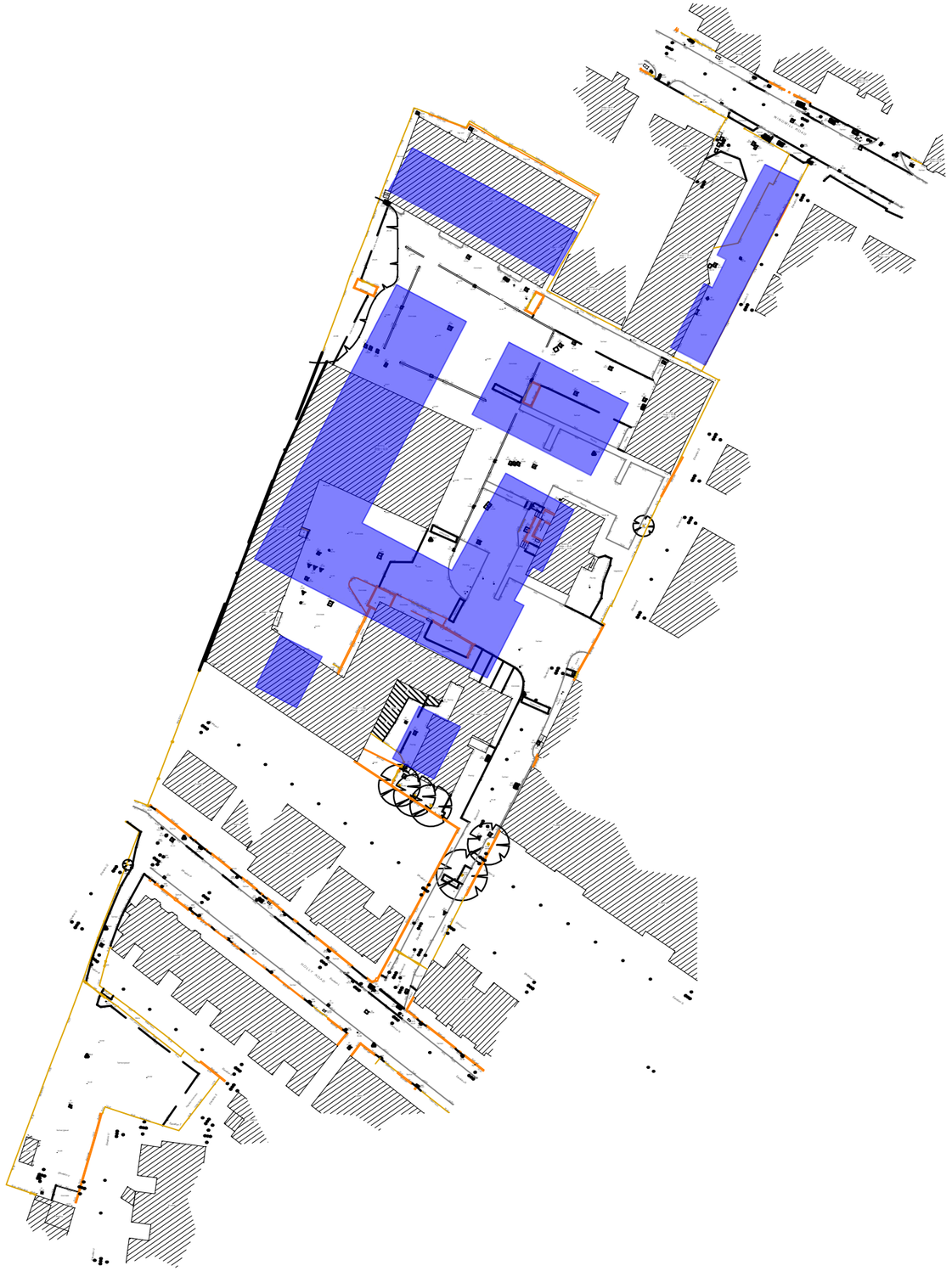
Scale	Orig Size	Dimensions
1:1000	A3	m

Project No.	Drawing File
29701 - R01(01)	29701 - (R01-01).dwg

Drawing No.	Rev.
FIGURE 2	P1

Scale

0 10 20 30 40 50m



LEGEND

Proposed building outline

N

Rev.	Date	Amendment	Drawn	Chkd.	Appd.
P1	09.04.18	FIRST ISSUE	AP	JG	JG

RSK

18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT
United Kingdom

Tel: +44 (0) 1442 437500
Fax: +44 (0) 1442 437550
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client

NOTTING HILL HOUSING TRUST

Project Title

ST CLARE BUSINESS PARK, HAMPTON HILL

Drawing Title

PROPOSED DEVELOPMENT PLAN

Drawn	Date	Checked	Date	Approved	Date
AP	09.04.18	JG	09.04.18	JG	09.04.18

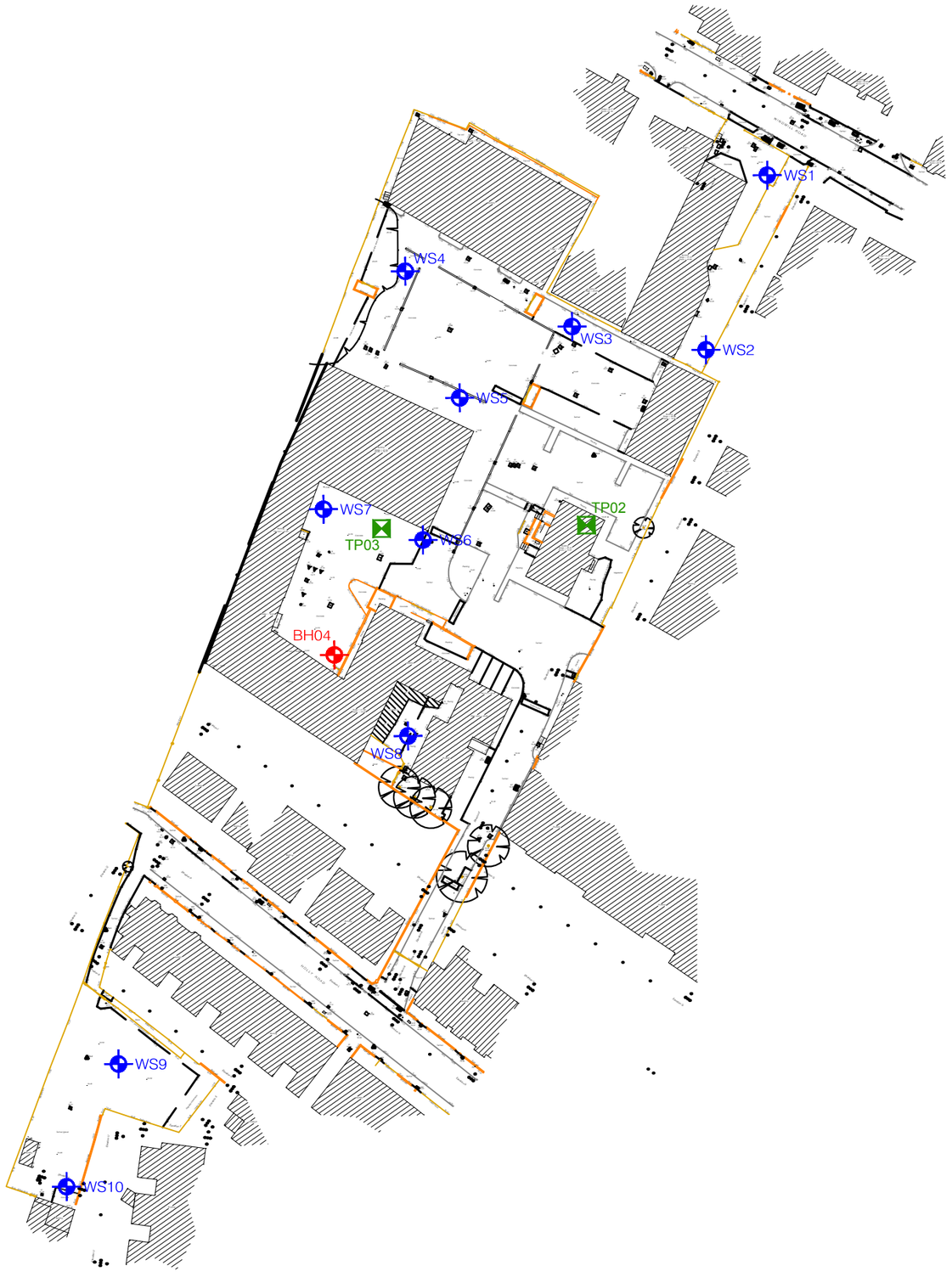
Scale	Orig Size	Dimensions
1:1000	A3	m

Project No.	Drawing File
29701 - R01(01)	29701 - (R01-01).dwg

Drawing No.	Rev.
FIGURE 3	P1

Scale

0 10 20 30 40 50m



LEGEND

- Borehole location
- Window sample location
- Trail pit location

N

Rev.	Date	Amendment	Drawn	Chkd.	Appd.
P1	01.05.18	FIRST ISSUE	AP	JG	JG

RSK

18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT
United Kingdom

Tel: +44 (0) 1442 437500
Fax: +44 (0) 1442 437550
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client

NOTTING HILL HOUSING TRUST

Project Title

ST CLARE BUSINESS PARK,
HAMPTON HILL

Drawing Title

EXPLORATORY HOLE
LOCATION PLAN

Drawn	Date	Checked	Date	Approved	Date
AP	01.05.18	JG	01.05.18	JG	01.05.18

Scale	Orig Size	Dimensions
1:1000	A3	m

Project No.	Drawing File
29701 - R01(01)	29701 - (R01-01).dwg

Drawing No.	Rev.
FIGURE 4	P1

Scale

0 10 20 30 40 50m

APPENDIX A
SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Notting Hill Housing Trust (the "client") in accordance with the terms of a contract between RSK and the "client", dated 12th March 2018 (ref. 29701-T03) and following subsequent e-mail correspondence. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.

2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.

3. Unless otherwise agreed in writing the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**

4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.

5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.

6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.

7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.

8. The intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (boreholes, trial pits etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.

APPENDIX B
SUMMARY OF LEGISLATION AND POLICY RELATING TO CONTAMINATED LAND

Part IIA of the Environmental Protection Act 1990 (EPA) and its associated Contaminated Land Regulations 2000 (SI 2000/227), which came into force in England on 1 April 2000, formed the basis for the current regulatory framework and the statutory regime for the identification and remediation of contaminated land. Part IIA of the EPA 1990 defines contaminated land as 'any land which appears to the Local Authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that significant harm is being caused, or that there is significant possibility of significant harm being caused, or that pollution of controlled waters is being or is likely to be caused'. Controlled waters are considered to include all groundwater, inland waters and estuaries.

In August 2006, the Contaminated Land (England) Regulations 2006 (SI 2006/1380) were implemented, which extended the statutory regime to include Part IIA of the EPA as originally introduced on 1 April 2000, together with changes intended chiefly to address land that is contaminated by virtue of radioactivity. These have been replaced subsequently by the Contaminated Land (England) (Amendment) Regulations 2012, which now exclude land that is contaminated by virtue of radioactivity.

The intention of Part IIA of the EPA is to deal with contaminated land issues that are considered to cause significant harm on land that is not undergoing development (see Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, April 2012). This document replaces Annex III of Defra Circular 01/2006, published in September 2006 (the remainder of this document is now obsolete).

Water Framework Directive (WFD)

The Water Framework Directive 2000/60/EC is designed to:

- enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands that depend on the aquatic ecosystems
- promote the sustainable use of water
- reduce pollution of water, especially by 'priority' and 'priority hazardous' substances
- ensure progressive reduction of groundwater pollution.

The WFD requires a management plan for each river basin be developed every six years.

Groundwater Directive (GWD)

The 1980 Groundwater Directive 80/68/EEC and the 2006 Groundwater Daughter Directive 2006/118/EC of the WFD are the main European legislation in place to protect groundwater. The 1980 Directive is due to be repealed in December 2013. The European legislation has been transposed into national legislation by regulations and directions to the Environment Agency.

Environmental Permitting Regulations (EPR)

The Environmental Permitting (England and Wales) Regulations 2010 provide a single regulatory framework that streamlines and integrates waste management licensing, pollution prevention and control, water discharge consenting, groundwater authorisations, and radioactive substances regulation. Schedule 22, paragraph 6 of EPR 2010 states: 'the regulator must, in exercising its relevant functions, take all necessary measures - (a) to prevent the input of any hazardous substance to groundwater; and (b) to limit the input of non-hazardous pollutants to groundwater so as to ensure that such inputs do not cause pollution of groundwater.'

Water Resources Act (WRA)

The Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009 updated the Water Resources Act 1991, which introduced the offence of causing or knowingly permitting pollution of controlled waters. The Act provides the Environment Agency with powers to implement remediation necessary to protect controlled waters and recover all reasonable costs of doing so.

Priority Substances Directive (PSD)

The Priority Substances Directive 2008/105/EC is a 'Daughter' Directive of the WFD, which sets out a priority list of substances posing a threat to or via the aquatic environment. The PSD establishes environmental quality standards for priority substances, which have been set at concentrations that are safe for the aquatic environment and for human health. In addition, there is a further aim of reducing (or eliminating) pollution of surface water (rivers, lakes, estuaries and coastal waters) by pollutants on the list. The WFD requires that countries establish a list of dangerous substances that are being discharged and EQS for them. In England and Wales, this list is provided in the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. In order to achieve the objectives of the WFD, classification schemes are used to describe where the water environment is of good quality and where it may require improvement.

Planning Policy

Contaminated land is often dealt with through planning because of land redevelopment. This approach was documented in Planning Policy Statement: Planning and Pollution Control PPS23, which states that it remains the responsibility of the landowner and developer to identify land affected by contamination and carry out sufficient remediation to render the land suitable for use. PPS23 was withdrawn early in 2012 and has been replaced by much reduced guidance within the National Planning Policy Framework (NPPF).

The new framework has only limited guidance on contaminated land, as follows:

- *"planning policies and decisions should also ensure that:*
    - *the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;*
    - *after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and*

- *adequate site investigation information, prepared by a competent person, is presented".*

APPENDIX C
SITE PHOTOGRAPHS AND WALKOVER CHECKLIST

PHOTOGRAPHIC LOG		
Photo no. **1**	**Date:** 26.03.2018	
Direction photo taken: NA		
Description: Entrance to St Clare Business Park		

Photo No. **2**	**Date:** 26.03.2018	
Direction photo taken: NA		
Description: Business Park present land use.		

Photo No.	Date:	
3	26.03.2018	
Direction Photo Taken: NA		
Description: Business Park present land use.		

Photo No.	Date:	
4	26.03.2018	
Direction Photo Taken: NA		
Description: Business Park present land use.		

Photo No.	Date:	
5	26.03.2018	
Direction Photo Taken: NA		
Description: Business Park present land use.		

Photo No.	Date:	
6	26.03.2018	
Direction Photo Taken: NA		
Description: Business Park – Stored unbunded small potential fuels and gas cylinders.		

Photo No.	Date:	
7	26.03.2018	
Direction Photo Taken: NA		
Description: Business Park – Electrical substation located in south-eastern extents		

Photo No.	Date:	
8	26.03.2018	
Direction Photo Taken: NA		
Description: Car wash present land use – active car wash		

Photo No.	Date:	
9	26.03.2018	
Direction Photo Taken: NA		
Description: Car wash present land use – garage		

Photo No.	Date:	
10	26.03.2018	
Direction Photo Taken: NA		
Description: Holly Road, South – Entrance		

Photo No.	Date:	
11	26.03.2018	
Direction Photo Taken: NA		
Description: Holly Road, South present land use to store vehicles (associate with Business Park garage unit)		

Photo No.	Date:	
12	26.03.2018	
Direction Photo Taken: NA		
Description: Holly Road, South – railway cutting on western site boundary		

WALKOVER SURVEY CHECKLIST: GEOSCIENCES

St Clare Business Park, Hampton Hill

These inspections can provide useful information on:

- Potential geotechnical hazards
- Suitable and appropriate locations for investigation
- The groundwater and surface water environments
- Potentially sensitive receptors (targets) including issues that require further investigation, e.g. ecology surveys
- Potential sources of contaminants
- Nature of contamination
- Potential migration routes (pathways)

Mark locations of features described on a map and give them a reference number.

Describe features in as much detail as possible. Continue on the back of the checklist if necessary, using the feature letter for reference. Take photos of site and relevant features in immediate surrounding area.

The walkover survey can also provide information for the environmental consultant in planning the site investigation.

Points that should be addressed in a walkover survey are as follows:

Features	Description	Photo no.	Map ref.
a) Describe materials exposed in nearby road or railway cuttings, in pits and quarries and natural exposures of soils and rocks near to the site. *This will give an indication of the geology beneath the site*	All three sites predominantly covered in hardstanding. A railway cutting is situated east of the Holly Road South.	App C	None
b) Describe surrounding properties/land use and name occupiers. Type of boundary demarcation (if any) on each side. *This will identify any potential sources of contamination from adjacent sites and any sensitive receptors*	Predominantly residential area – boundaries defined by both existing buildings / plots and or palisade fencing	App C	None
c) Describe present land use. Are there areas of hardstanding (if yes describe location, types and condition)? *Especially crops, for consideration of appropriate timing for further investigation, compensation and reinstatement. Also note hardstanding, obstructions etc. Note any old buildings/ivy covered trees as these may be used by owls or bats*	Business Park comprises a number of commercial units ranging from a garage, scaffolders, fabricators, unoccupied and occupied office units. Car wash – north comprises an active carwash facility as wells as a garage Holly Road, South – hardstanding currently used to store vehicles (associate with Business Park garage unit)	App C	None

Features	Description	Photo no.	Map ref.
d) Describe the site in terms of ground slopes and changes in slope. Is there any evidence of subsidence or landslip/slope erosion? *Old scarps or hummocky ground may be evidence of previous landslips that could be reactivated. A terraced appearance may be indicative of superficial solifluction movement or cambering. Trees that are leaning may indicate instability or general slope movement.*	Business Park – slopes to a central low point Car wash – slopes south from road level Holly Road, South – relatively flat – railway cutting on western site boundary	App C	None
e) Describe the types and condition of surface vegetation. *Nettles may indicate an old cesspit for example or unhealthy vegetation may indicate the presence of phytotoxic fill or landfill gas. Note invasive weeds, e.g. Japanese knotweed.*	Business Park – boundary scrub and a single centrally located island of scrub Car wash – limited to boundary scrub Holly Road, South – limited to boundary scrub No invasives identified	App C	None
f) Note the number, location, height and species of trees and hedges. *This is important in terms of shrinking and swelling ground. Trees and hedgerows may be protected; their condition should be noted along with any restrictions they will impose for site access.* *It is important to note any areas with the potential for nesting birds, roosting bats, water voles and badger setts.*	Business Park – trees on western boundary (not identified) Car wash – absent Holly Road, South – absent	App C	None
g) Describe any evidence of animal activity. *For example obvious animal paths or areas of excavations and burrows.*	None	App C	None
h) Describe any damage to existing structures on site or adjacent to the site *For example, cracks in buildings both on the site and in the neighbourhood, and other evidence of settlement or differential settlement.* *Note presence of any suspected asbestos-containing materials (ACM)*	Business Park – ACM roofing suspected on central buildings. Buildings generally noted as dated in moderate to poor condition Car wash – Buildings generally noted as dated in moderate to poor condition Holly Road, South – none	App C	None
i) Note the remains of structures that have been demolished. Look for evidence of remnants of any historical structures. *This will provide valuable information on the location of previous foundations, processes etc.* *Note presence of any suspected asbestos-containing materials (ACM)*	Business Park – none Car wash – none Holly Road, South – none	App C	None

Features	Description	Photo no.	Map ref.
j) Note any abrupt changes in ground level. Is there evidence of Made Ground/fill on site *May indicate that minerals have been worked in surface excavations. May indicate cut and fill.*	Business Park – centrally located low-spot Car wash – none Holly Road, South – none	App C	None
k) Note any surface hollows. *Which may indicate the presence of solution features or swallow holes in rocks such as chalk limestone, gypsum and salt, or collapsed underground workings in these materials. May also indicate badger setts or other wildlife activity.*	Business Park – none Car wash – none Holly Road, South – none	App C	None
l) In areas of country underlain by coal or other minerals note any hummocky ground. *Which may be the remnants of spoil tips and surface depressions that may indicate collapsed shallow workings. Areas of general unevenness may be evidence of waste disposal activities.*	Business Park – none Car wash – none Holly Road, South – none	App C	None
m) Note any evidence of gas from nearby landfill sites *Can be indicated for example by poor vegetation or gas bubbles in water-filled trenches.*	Business Park – none Car wash – none Holly Road, South – none	App C	None
n) Are there any evidence of gas protection measures (gas membrane, gravel filled trenches, venting pipes, cowls etc)	Business Park – none Car wash – none Holly Road, South – none	App C	None
o) Note the location of streams, culverts, ponds, seepages and sinks and signs of previous flooding. Note direction of flow. Note where the stream is accessible for sampling. May need to take dimensions of stream. *If ponds are present on site they may contain great crested newts. Ditches, streams and rivers that border or run through a site may contain water voles, otters or white-clawed crayfish. Presence of water features on site may prompt the need for a survey during a site investigation.*	Business Park – none Car wash – none Holly Road, South – none	App C	None

Features	Description	Photo no.	Map ref.
p) All surface waters should be examined for evidence of contamination. *For example, oil sheen, silt, solid matter, discoloured sediment.*	Business Park – none Car wash – none Holly Road, South – none	App C	None
q) Note site drainage. Are there any drain covers/soakaways (if yes describe locations). Are there any outfalls to surface watercourses? Are there any interceptors/lagoons/effluent treatment plants?	Business Park – surface water soakaway identified on-site. Heavy silted (in need of maintenance). Gullies throughout – in need of maintenance Car wash – none identified – albeit possible interceptors identified at ground level Holly Road, South – none	App C	None
r) Describe storage of fuels and chemicals. Are there any drums/containers (if yes, describe quantity, full/empty, stored on hardstanding/softstanding, bunded)? *Is there evidence of underground fuel tanks (if yes, describe locations, how many, volumes, bunding, used/disused, condition)?*	Business Park – local garage storage on western site boundary on hardstanding – small volumes – unbunded. Gas cylinder store noted centrally. UST vent stack noted in south-western extents. Car wash – none noted but anticipated in small volumes – unbunded Holly Road, South – none	App C	None
s) Note any discoloured ground. *This may provide evidence of contamination.*	Minor isolated incidents of decolourised hardstanding believed to be associated with HC/Oils	App C	None
t) Accidents: In the event of a large spillage would runoff affect any vulnerable watercourses/culverts? *Are emergency procedures/equipment in place?*	Business Park – none Car wash – none Holly Road, South – none	App C	None
u) Waste: Are there any waste skips on site? Are waste storage facilities adequate? Is there any litter/fly-tipped material?	Business Park – unit skips and storage – some fly-tipped materials Car wash – none Holly Road, South – none	App C	None
v) Are there any electricity substations on or adjacent to site?	Business Park – located in south-eastern extents Car wash – none Holly Road, South – none	App C	None

Features	Description	Photo no.	Map ref.
w) Identify any old structures, pipework etc. wherever possible and, if safe, inspect for evidence of stored waste. *Old tanks may contain oil. Old electricity transformers should be noted.* *Asbestos risk should be assessed together with the need for a specialist hazardous materials survey.*	See comments provided above	App C	None
x) Examine surrounding areas for evidence of contamination which could migrate onto the site. *For example a leaking oil tank on an adjacent site.*	Business Park – predominantly residential surrounds – site likely to be source Car wash – predominantly residential surrounds – site likely to be source Holly Road, South – none	App C	None
y) Note the presence of any underground structures, services, mine workings, tunnels etc *From a safety point of view for development of the site and also as they may provide contaminant migration routes.*	Business Park – UST and soakaways. Central building likely to be found on stanchions Car wash – predominantly residential surrounds – site likely to be source Holly Road, South – none	App C	None
z) Note any anecdotal information in past uses of the site. *Local street names etc. can provide indicators of past industry or ground problems*	Business Park – none Car wash – none Holly Road, South – none	App C	None
aa) Description of buildings on site. Is there any evidence of asbestos construction materials, e.g. roofing, insulation materials. Do any of the buildings have basements? Do any of the buildings have a boiler room? (if yes describe fuel type and storage arrangements)	See comments provided above Buildings / units occupied or inaccessible	App C	None
bb) Identify potential access routes to the site for plant for the site investigation *Excavators and drilling rigs may be required for the next stage of the investigation, or if the access is limited window sampling techniques may need to be specified. Note any specific obstructions such as unsafe/unstable ground, protected trees or hedgerows, or protected buildings.*	Business Park – Narrow residential entrance off Holy Road Car wash – vehicle access off Windmill Rd – tight turning circle Holly Road, South – Narrow residential entrance off Holy Road	App C	None

Features	Description	Photo no.	Map ref.
cc) Evidence of buried services (water, gas, electricity, telephone, cable, television, pipelines) *Both for safety considerations and in the case of water as supply for further investigation. As well as danger, there is the question of considerable expense, which can arise from an inadequate knowledge of the location of buried services. The locations and heights of overhead cables may be important when considering the movement of site equipment.*	Business Park – substation / electric / surface water and soakaway / foul network / data. No overheads Car wash – interceptors/ surface water likely foul network and data. No overheads Holly Road, South – none	App C	None

Walkover survey completed: Niki Dubber

Approved: 

N. Dubber

15th April 2018

Notes: none

APPENDIX D
BGS BOREHOLE LOGS

SW 1464 7073

TQ17SW/163
NGR. 1464 7073
B

2 -

TQ17/69

270 317. B

W. S. Ltd. 3,000/7/48.

C. ISLER & Co., LTD.,
ARTESIAN & CONSULTING WELL ENGINEERS
BEAR LANE, SOUTHWARK, S.E.1.

Telegraphic Address: "ISLER, LONDON."
Telephone No.: WATERLOO 7044 (3 lines).

BIRMINGHAM BRANCH: 93, Broad Street.
LEEDS BRANCH: Bardon Chambers, King Street.

CHART

of Borehole at Admiralty Res. Lab. Upper Lodge, Bushy Park, Hampton, Middx.

Bored by H.J.Beak. Date Commenced 15:10:49

Water Levels: Standing 7'6" Pt. Pumping Pt. " Completed 20:10:49

Supply after tubes withdrawn. Galls. per hour. Analysis if made

Lined with 15' Pt. — Ins. of 14" Ins. Tubes Level. Pt. above/below Surface.

Left in both holes for clients to test.
Tubes belonging to clients, supplied by Ministry of Works (Mr. Hatterly)

Boring Stage above/below Ground or Street Level Pt. Height above Sea Level ca. 15 mOD Pt.

TEST BOREHOLE No. 2

Stratum		Thickness.		Total.		Water level. Rods in	Rods out
			5"		5"		
Concrete							
Top Soil.		3'	1"	3'	6"	1.08	
Loam.		1'	0"	4'	6"	1.27	
Sand & Ballast.	TP	6'	9"	12'	3"	4.04	7'6 after tubes withdrn
Brown Clay.	LC (W)	1'	3"	14'	6"	4.29	
Blue Clay.	LC	45'	6"	60'	0"	18.29	

2 Samples of Ballast in Sand Bags, from 5' to 10 ft. and 10' to Clay approx. 13' (as instructed by Mr. Hatterly).

Untouched samples taken as follows:
Brown Clay 14' to 14'6" approx. (Shoe contained Blue)
Blue Clay. 15/16
" " 25/26.
" " 35/36
" " 45/46
" " 59/60

All samples (of Clay) sealed with wax, marked for depth and taken away (Friday Oct. 21) by Mr. Hatterley.
Time sheet signed, allowing 1 day for both holes, putting 13" tube in and filling around steadily.

Sited by Isles on Middlesex 25 NE/W

23.11.49 AN.

TQ 17/69A 270/317A

W. S. Ltd. 3,000/7/48.

C. ISLER & Co., LTD.,
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CHART

of Borehole at Admiralty Res. Lab. (M.O.W) Upper Lodge, Bushy Park, Hampton, Middx.

Bored by R.J.Back. Date Commenced 7:10: 1949

Water Levels: Standing 7 Ft. Pumping ....Ft. ,, Completed 14:10: 1949

Supply ....Galls. per hour. Analysis if made ....

Lined with ....Ft. ....Ins. of ....Ins. Tubes ....Ft. above / below Surface.

TQ 1452 7665

Boring Stage above / below Ground or Street Level ....Ft. Height above Sea Level ....Ft.

TEST **BOREHOLE No. 1**

Stratum	Thickness.		Total.		Water level. Rods in	Rods out
Top Soil.	2'	6"	2'	6"		
Sand & Ballast. (Dirty)	1'	0"	3'	6"		
Seams of Sandy Clay Flints & Stones.	2'	0"	5'	6"		
Sand & Ballast.	7'	6"	13'	0"	S.W.L. 7ft. after tubes withdrawn	
Brown Clay.	1'	6"	14'	6"		
Blue Clay.	45'	6"	60'	0"		

Untouched samples taken in 4" sample tubes at depth of 15/16 ft. driven 1 ft. into solid Blue Clay.
25/26 ft. lose 2" app. by taking cutting shoe.
35/36 ft. off tube each sample = 10" app. sample.
45/46 ft. waxed, sealed in tubes, taken from.
59/60 ft. job by Mr. Hatterly (M.O.W.).

15 ft. of 1½" tube (perforated bottom 2 ft. app). left in hole with debris filled around, for clients use, W.L. etc. Supplied by Ministry of Works (not Islers)

Sited by Isler on Middlesex 25 NE/W - 23.11.49 . A.N -

O.D. +53. [of (a) & (b)] Visited 13.5.63 gmsw.