



Ashley House & Cannon Factory, Ashley Road South, Tottenham Hale, London

Supplementary Ground Investigation - Interpretive Report

May 2023

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Comments

Comments

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Executive Summary

Objectives

Waterman were instructed on behalf of Notting Hill Genesis to undertake supplementary ground investigation to fill gaps in information and reduce uncertainties with respect to previously recorded hydrocarbon contamination at two sites, Ashley House and Cannon Factory located at Ashley Road South, Tottenham Hale, London (hereafter referred to separately as “Ashley House” and “Cannon Factory”).

Site Setting

Current Use	The sites comprise two separate plots, Ashley House and Cannon Factory, both located on Ashley Road. Both sites are vacant with empty former works and industrial units on both. Areas not covered by vacant building are covered with concrete hard standing. Land around both plots has been largely recently redeveloped for a residential led use.
History	Historically the Ashley House Site was a farm between 1850 – 1898 prior to becoming occupied by multiple factories in 1913. In 1936 the Ashley House Site was occupied by a printing ink and varnish factory which included various tanks chimneys and a water-cooling tower. From 1972 to present there has been little change to the Site layout. The Cannon Factory Site was undeveloped until the 1940's when warehouses and a rubber factory occupied the site. From 1970 to present partial redevelopment to the large warehouse in the northern Site portion has occurred.
Ground Conditions	Both sites are covered by concrete hardstanding underlain by made ground which is subsequently underlain by the Enfield Silt Member, Kempton Part Gravel and the London Clay formation. Impacted soil as a results of the site's previous use were encountered during the ground investigation.
Controlled Waters	Groundwater levels at Cannon Factory ranged from 2.43m bgl to 2.80m bgl and in Ashley House 2.52m bgl to 2.78m bgl. Groundwater was locally impacted with hydrocarbons however detailed assessment of the contamination confirmed a risk to controlled water receptors was not present.
Ground Gas Regime	The ground gas and vapour regime was confirmed as not pose a risk to the future development.

Conceptual Model

Potential contaminant linkages identified for the Site are as follows:

- Future Site users in areas of proposed soft landscaping, and construction workers may come into direct contact with shallow contaminants;
- Off-site users may be exposed to contaminated dust and fibres during redevelopment of the Site;
- Risk of chemical attack on buried foundations or services;
- Plant uptake of contaminants in shallow soils and groundwater;
- Impacts to groundwater are present on site both Ashley Road and the Cannon Factory however have been confirmed not to pose a risk to off site controlled water receptors. However betterment remedial works will take place at Cannon Factory.
- Buried tanks are known to be present on Ashley Road these will be removed as part of redevelopment. Other potentially contaminative infrastructure may exist on site, this will also be removed as part of the redevelopment of the sites.
- Piling through low permeability Enfield Silt Member and London Clay Formation may present a potential risk to Secondary A Aquifers and Principal Aquifer at depth.

Conclusions

Given the proposed end use the overall risk rating for the Site is **Medium**, however following implementation of remedial measures are set out the Remediation Strategy (WIE16248-100-S-1-2-1.RS the risk will be **Low**.

Recommendations

- A Remediation Strategy has been prepared (Report ref. WIE16248-100-R-1-2-1-RS) detailing remedial measures to be carried out as part of the site redevelopment. The Remediation Strategy should be fully consulted prior to works commencing to ensure the requirements of the Remediation Strategy are understood and can be adequately planned and accounted for.
- Soft landscaping areas will require capping layers of at least 600mm certified clean materials to break potential contaminant pathways between contaminants in soils and future Site users. A colour marker is also required. Soil in soft landscaping areas should be suitable for a residential end-use;
- Clean service corridors, physically separated from residual contaminated soils and groundwater, should be provided for new services to ensure a preferential pathway is not created for contamination to migrate off-site.
- Barrier pipes are recommended for water supply pipes to be placed into Site soils. This approach would need to be agreed with Thames Water;
- Potentially hazardous chemicals should be appropriately stored, banded and sited away from surface waters;
- Import criteria for soils are presented in the Remediation Strategy and should be adhered to for all material imported to site.
- Construction workers should utilise appropriate PPE when undertaking handling soils and groundwater. If required, dampening down of material should take place during excavation works. Construction workers will adhere to good practice hygiene and safety measures, and the Control of Asbestos Regulations 2012.
- Asbestos fragments and fibres in soil have been encountered and construction workers should be asbestos awareness trained and works should be undertaken in accordance with the APoW. Appropriate measure should be in place to prevent fibre release and corresponding monitoring;
- Entry to confined spaces should be carried out in line with the Confined Space Entry Regulations 1997;
- The risk of chemical attack to buried concrete can be mitigated by selecting a concrete class appropriate for the ground conditions in accordance with BRE-Special Digest 1;
- Classification of waste soils in accordance with WM3 (in particular Appendix D on waste sampling) to confirm the findings of the Preliminary Waste Classification Assessment. Most of the soil samples did not return hazardous properties. Natural uncontaminated soils may be acceptable as inert waste without testing at some landfills;
- A Foundation Works Risk Assessment should be carried out to confirm piling carried out will not pose a risk to controlled water receptors.
- Uncontaminated concrete may be recovered for reuse on-site subject to compliance with the WRAP Quality Protocol for Production of Aggregates from Inert Waste or recovered as inert waste subject to acceptance at an appropriately permitted facility;
- Verification Report(s) should be prepared following phases of work as required demonstrating works were carried out in line with the agreed Remediation Strategy

1. Introduction

1.1 Objectives

Notting Hill Genesis instructed Waterman Infrastructure & Environment Limited (“Waterman”) to undertake supplementary ground investigation to fill gaps in information and reduce uncertainties with respect to previously recorded hydrocarbon contamination at two adjacent sites, Ashley House and Cannon Factory, Ashley Road South, Tottenham Hale, London (hereafter referred to separately as “Ashley House” and “Cannon Factory”).

A Site Location Plan is presented in Appendix A.

This assessment follows on from and should be read in conjunction with the following reports:

- Ashley House & Cannon Factory, Ashley Road South, Tottenham Hale, London. Factual and Interpretative Report on Ground Investigation. Ref. D8061-18, August 2019. Socotec UK Limited (hereafter “the Socotec report”);
- Ashley Road Regeneration – Ashley Gardens. Preliminary Risk Assessment – Land Quality. Ref. 70022931-GB1, April 2017. WSP Parsons Brinckerhoff (hereafter “the WSP report”);
 - Land subject to report located off-site, immediately to the north;
- Ashley House, Tottenham Hale. Geo-Environmental Site Assessment. Ref. 27663 R01 (00), February 2015. RSK Environment Ltd (hereafter “the RSK Ashley House report”);
- Cannon Factory, Ashley Road, Tottenham Hale, London N17 9LH. Environmental Site Assessment. Ref. 27782R01 (00), April 2015. RSK Environment Limited (hereafter “the RSK Cannon Factory report”).

A number of third parties (RSK and Socotec) have completed ground investigation at the two Sites and recorded hydrocarbon contamination in both the soils and groundwater. Waterman were provided the above reports together with planning consultation feedback from Haringey Council for review.

This report has been prepared to address comments received from Haringey Council Pollution Officer by email on 22 February 2023 following submission of the Socotec report to discharge Planning Condition 25 Part A (Land Contamination) of Planning Permission HGY/2016/4165 and to provide the findings of the supplementary Ground Investigation (GI) carried at Ashley Road and the Cannon Factory Sites, which will inform preparation of the Remediation Strategy which is reported under a separate cover.

This report should be submitted to facilitate discharge Condition 25 Part A (Land Contamination) of Planning Permission HGY/2016/4165.

1.2 Regulatory Status

It is understood that the above referenced RSK report was first submitted to Haringey Council in pursuit of discharge of planning condition 25 Part A. A second round of ground investigation by Socotec was undertaken and further comments from Haringey Council received. For clarity the comments received are detailed below.

Each comment from Haringey Council Pollution Officer on the Socotec report is reproduced below:

“Groundwater:

a. Sub-section 8.31 (Controlled Water Risk Assessment Screening) indicates that four groundwater samples were recovered on 24th April 2019. However, it is unclear on the method of groundwater sampling used. Given the potential for chlorinated solvents and petroleum hydrocarbons we would expect the groundwater samples to have been taken using low flow techniques minimising the volatile contaminant loss. This is consistent with best practice. Clarification is therefore required

- b. The Socotec UK Limited report mentions the potential impact of offsite sources to be the cause of hydrocarbon contamination at Ashley House. No assessment has been undertaken to determine if this is the case. **The sites impact on the groundwater regime should be determined** by assessing the groundwater flow direction (via groundwater levels) and comparison of contaminant concentrations up hydraulic gradient and down hydraulic gradient of the site.
- c. We agree with the conclusions drawn in Subsection 8.31 of the Socotec UK limited report that Ashley House represents an unacceptable risk to controlled ground waters and that further investigation and risk assessment is required. **As a minimum we would expect that an additional groundwater sampling round utilising all monitoring wells is completed.**
- d. We disagree with the conclusion that the risk of Cannon Factory causing unacceptable pollution of controlled waters is considered to be low. Given the concentrations recorded in BH02 and the oily sheen observed during sampling, we would consider that a potentially unacceptable risk is present. **We would therefore require additional sampling to be undertaken at Cannon Factory in line with points b and c above.**
- e. The bioavailable contaminants (zinc, lead, nickel, copper, manganese) threshold criteria have not been calculated using the EA M-BAT tool and therefore are highly conservative.

Ground Gas:

- f. Section 9 (Ground Gas) does not provide a review of the potential sources of ground gas. **We would expect an assessment of the potentially significant source offsite sources as well as onsite sources, using ground condition information obtained by the RSK investigations.**
- g. Section 9.2 (Gas Monitoring Assessment) indicates that “each monitoring pipe response zone was saturated by groundwater, which can influence gas readings”. As per best practice guidance the ground gas monitoring wells should be installed within the unsaturated zone to avoid interference from small quantities of organic material in the water column. Therefore, the ground gas regime for both Ashley House and Cannon Factory need to be reassessed with unrepresentative ground gas monitoring results identified and removed from consideration.”

Soil:

- h. From a review of the soil sampling results it is noted that samples BH4, PH1A and BH3 are deviant laboratory results due to the holding time being exceeded. **These results would not be accepted as the exceeded holding time can affect the measured concentrations, particularly the volatile compounds. Further soil testing is therefore required.**

The applicant will need to provide us with an updated Ground Investigation Report covering the above issues before we can recommend the discharge of the above condition.”

1.3 Proposed Development

Outline planning permission (ref. HGY/2016/4165) was granted May 2018 for demolition of the existing buildings at Ashley House and Cannon Factory and erection of three buildings to provide up to 3,600sqm of commercial floorspace (GEA) (Class A1/A3/B1/D1), up to 265 residential units (Class C3), new public realm, landscaped amenity space, car and cycle parking and all associated works. (Outline planning application).

The proposed layout is included in Appendix A.

The proposed Development aims to regenerate two existing brownfield sites in Tottenham Hale as three high quality, successful mixed use buildings.

The development will produce a new commercial and residential destination, which will provide more jobs and housing for locals and the wider community. The project looks to improve and increase the efficiency of the site by offering the following:

- 255 units for housing;
- 3,100 square metres of commercial space;
- 1,500 square metres of residential amenity space within the buildings;
- Childrens Play Space;
- 19 Car Parking Spaces.

The development comprises a total Residential NIA of 17,313m².

Both sites have an approximate plan area of 1.03 Hectares.

Building 2, adjacent to Down Lane Park to the west of the Ashley House Site, is four storeys above ground and includes commercial space at Ground Floor with three storeys of residential over.

Building 2A, between Building 2 and Ashley Road is between four and seven storeys above ground. The Ground Floor includes commercial space, plant rooms, bin stores, bike stores and residential areas. Above ground floor the building is residential with a shared roof terrace and green/brown roof areas.

Building 3, located at the Cannon Factory Site is between nine and seventeen storeys above ground. The Ground Floor includes commercial space, plant rooms, bin stores, bike stores, car parking and residential entrances. The First Floor is primarily commercial space, with a shared external residential amenity space, including a children's play park. Above first floor the building is residential with a shared roof terrace and green/brown roof areas.

2. Procedures

This Generic Quantitative Environmental Risk Assessment has been undertaken in general accordance with the Land contamination: risk management guidance (LCRM – Environment Agency, April 2021). The report includes the following:

- review and confirmation of the overall site objectives
- GQRA objectives
- outline Conceptual Model for the Site
- results of Intrusive Ground Investigation
- confirmation of Generic Assessment Criteria used to assess risks
- assessment of results against Generic Assessment Criteria
- formulation of a new Conceptual Model for the Site
- identification of potentially unacceptable risks
- record of findings and recommendations for further action.

This report forms a decision record for the contaminant linkages identified, the generic assessment criteria used to assess risks, the unacceptable risks identified and the proposed next steps in relation to the site. The report also provides an explanation of the refinement of the outline conceptual model following the ground investigation, the selection of criteria and assumptions, an assessment of uncertainties and limitations, the evaluation of potential risks and the basis for the decision on what happens next.

3. Outline Conceptual Model

The following section presents a summary of the site settings established by RSK and Socotec to date.

3.1 Ground Conditions

3.1.1 Geology

The geological sequences encountered at the Ashley House and Cannon Factory Sites by Socotec are summarised in Tables 1 and 2.

Table 1: Geological strata encountered by Socotec – Cannon Factory Site

Soil Type	Depth of Top of Stratum (m bgl)	Thickness (m)	Typical Description
Made Ground	0.00	0.25 – 2.17	Sub-base underlain by a silty gravelly sand
Enfield Silt Member	0.50 – 2.10	0.70 – 1.60	Orangish/yellowish brown slightly sandy gravelly clay
Kempton Park Gravel Member	2.10 – 2.20	3.20 – 4.60	Orangish brown very gravelly sand to very sandy gravel.
London Clay Formation	5.40 – 6.70	15.80 – 16.30	Grey and dark brown clay
Lambeth Group	21.70 – 22.50	>17.45	Clay underlain by silty sand

Table 2: Geological strata encountered by Socotec – Ashley House Site

Soil Type	Depth of Top of Stratum (m bgl)	Thickness (m)	Typical Description
Made Ground	0.00	0.59 – 1.20	Concrete slab 0.15 to 0.30m thick. A second concrete slab 0.08 – 0.15m thick at depths of between 0.22 to 0.90m bgl. Sub-base underlain by a sandy gravelly clay with fragments of brick, concrete
Enfield Silt Member	0.59 – 1.20	1.10 – 1.27	Orangish/yellowish brown slightly sandy gravelly clay.
Kempton Park Gravel Member	1.86 – 2.30	>1.14 – 3.50	Orangish brown very gravelly sand to very sandy gravel.
London Clay Formation	5.30 – 5.70	>2.50	Grey and dark brown clay.

3.1.2 Hydrogeology

Groundwater monitoring at the Cannon Factory Site recorded ground water levels ranging between 2.19 and 2.47m bgl (i.e. within the Kempton Park Gravel Member).

Groundwater monitoring at the Ashley House Site recorded ground water levels ranging between 2.39 and 2.59m bgl (i.e. within the Kempton Park Gravel Member).

3.1.3 Recorded Visual and Olfactory Evidence of Contamination

The Socotec investigation recorded the following visual and olfactory evidence of contamination.

Cannon Factory Site

- Potential asbestos containing materials in Made Ground in PH3 at 0.90 m bgl;
- Potential asbestos containing materials in Made Ground in PH3a at 0.15 m bgl;
- Moderate to strong hydrocarbon odours in Made Ground and Kempton Park Gravel Member in BH02 at 0.80 to 4.50 m bgl, and weak hydrocarbon odour in Kempton Park Gravel Member 4.50 to 6.80m bgl;

The Socotec report also notes the following observations were made in RSK Cannon Factory report:

- Black staining adjacent to electricity substation in SW part of the Cannon Factory site;
- Chrysotile cement-board in the Made Ground in PH1 at 0.80m bgl

Ashley House Site

- Hydrocarbon odour in Made Ground in PH1a at 0.65 to 2.90 m bgl.

The Socotec report also notes the following observations were made in RSK Ashley House report:

- Local black staining and hydrocarbon odour in Made Ground at WS102 and WS111;
- Local black staining and hydrocarbon odour in the Kempton Park Gravel Member at WS101, WS103, WS105, and WS109;
- Strong hydrocarbon odour and black discolouration of groundwater in one borehole (WS107) (although no free product - LNAPL);
- Local fibrous material, possibly asbestos, in the Made Ground in WS102 at 1.00m bgl.

3.2 Potentially Significant Pollution Linkages

The conceptual site model set out in Table 13 of the Socotec report is summarised in Tables 3 and 4 below.

Table 3: Socotec Revised Conceptual Site Model – Ashley House Site

Receptor	Potential sources	Pathways	Risk	Justification
Human Health				
Future site occupants	On-site historical factory and works: Fuel oils, heavy metals, solvents, lubricating oils, PAHs, asbestos, cyanides. On-site historical and current storage tanks and other point sources (1930s–current): Current two diesel tanks and interceptor – petroleum hydrocarbons (fuels oils) Historical tanks – petroleum hydrocarbons, chlorinated solvents, cyanides, metals. Current warehouses and potential chemical storage onsite: Asbestos, hydrocarbons lube oil, kerosene, trichloroethylene (TCE). Made Ground associated with previous phases of development: Unknown fill material (but potentially including heavy metals, ash, clinker, PAHs, asbestos etc.)	Direct contact (ingestion, dermal contact, dust and fibre inhalation)	High	The results of the laboratory testing programmes indicate numerous exceedances of metals, PAH, TPH and the local presence of asbestos. Remedial action will be required.
		Vapour inhalation	Moderate	The in situ and laboratory test results indicate a generally low risk from vapours in the ground. However, it should be noted that in the Ashley House part of the site the RSK report records the presence of underground diesel tanks (with associated fuel pump), together with an effluent tank and a waste oil tank. These redundant tanks represent enclosed spaced within which vapours or ground gases may have accumulated
		Exposure to ground gases	High	Gas monitoring has demonstrated CS2 at the Ashley House area. Remedial action will be required in the Ashley House part of the site. Due to the distance of the nearest landfill, it is considered unlikely that it represents the source of the ground gas, or the contaminants encountered in the groundwater.
Adjacent site users (commercial)	Off-site current BP filling station to immediate south of site: Petroleum hydrocarbons.	Direct contact (ingestion, dermal contact, dust and fibre inhalation)	Low	The results of the laboratory testing programmes indicate numerous exceedances of metals, PAH, TPH and the local presence of asbestos on-site. It is considered unlikely, however, that these would affect occupants of nearby sites
Adjacent site users (residential)	Off-site historical and current railways: Fuel oils, lubricating oils, heavy metals, PAHs, ash and asbestos.	Exposure to ground gases and vapours	Moderate	Gas monitoring has demonstrated CS2 at the Ashley House Site. Although the gas source has not been determined, it is possible that gases within the ground beneath the site could migrate laterally to neighbouring sites.
	Historical landfill 601m north-east 1955 to 1962: landfill gases, leachate.	Direct contact (ingestion, dermal contact, dust and fibre inhalation)	Low	The results of the laboratory testing programmes indicate numerous exceedances of metals, PAH, TPH and the local presence of asbestos on-site. It is considered unlikely, however, that these would affect occupants of nearby sites
Property				

Receptor	Potential sources	Pathways	Risk	Justification
Potable water supply pipes and buildings	Various current and historic industrial land uses on and off site, tanks, electrical substation, railway land, landfill and made ground from previous phases of development: PAHs, asbestos	Chemical attack on the proposed infrastructure (water supply pipes and buildings)	High	The results of the laboratory testing programmes indicate numerous exceedances of metals, PAH and TPH which can affect potable water supplies and pipework. Appropriate remedial action will need to be considered during the design of any new water supply pipes.
Controlled Waters				
Groundwater beneath the site (shallow Secondary A aquifer in the Kempton Park Gravel Member)	Various current and historic industrial land uses on and off site, tanks, electrical substation, railway land, landfill and made ground from previous phases of development: PAHs, asbestos	Lateral migration	High	The results of the laboratory testing programmes on groundwater samples indicate numerous exceedances of metals, PAH and TPH in the groundwater within the Kempton Park Gravel Member (i.e. shallow aquifer) beneath the site.
Groundwater beneath the site (deep aquifers underlying the London Clay Formation – Lambeth Group Secondary A Aquifer, Thanet Formation, Chalk Group). Source Protection Zone 2.		Vertical and lateral migration	Low	Due to a substantial thickness (20m) of clay strata between the shallow (contaminated) groundwater and the deeper aquifer, migration of contaminants to the deeper aquifer is considered unlikely.
Surface watercourses and SSSI located to the east of the site			Low to Moderate	The results of the laboratory testing programmes on groundwater samples indicate numerous exceedances of metals, PAH and TPH in the groundwater within the Kempton Park Gravel Member (i.e. shallow aquifer) beneath the site. Nevertheless, due to the distance of the nearest surface water feature (360m east of the site) and SSSI site (560m east of the site), the risk of contamination from this site affecting the surface water feature or the groundwater at the SSSI site is considered low to moderate.

Table 4: Socotec Revised Conceptual Site Model – Cannon Factory Site

Receptor	Potential sources	Pathways	Risk	Justification
Human Health				
Future site occupants	Various current and historic industrial land uses on and off site, tanks, electrical substation, railway land, landfill and made ground from previous phases of development: PAHs, asbestos	Direct contact (ingestion, dermal contact, dust and fibre inhalation)	High	The results of the laboratory testing programmes indicate numerous exceedances of metals, PAH, TPH and the local presence of asbestos. Remedial action will be required.
		Vapour inhalation	Low	The in situ and laboratory test results indicate a generally low risk from vapours in the ground
		Exposure to ground gases	Low	Gas monitoring has demonstrated CS1 at the Cannon Factory Site.
Adjacent site users (commercial)		Direct contact (ingestion, dermal contact, dust and fibre inhalation)	Low	The results of the laboratory testing programmes indicate numerous exceedances of metals, PAH, TPH and the local presence of asbestos on-site. It is considered unlikely, however, that these would affect occupants of nearby sites
Adjacent site users (residential)		Exposure to ground gases and vapours	Low	Gas monitoring has demonstrated CS1 at the Cannon Factory Site.
		Direct contact (ingestion, dermal contact, dust and fibre inhalation)	Low	The results of the laboratory testing programmes indicate numerous exceedances of metals, PAH, TPH and the local presence of asbestos on-site. It is considered unlikely, however, that these would affect occupants of nearby sites
Property				
Potable water supply pipes and buildings	Various current and historic industrial land uses on and off site, tanks, electrical substation, railway land, landfill and made ground from previous phases of development: PAHs, asbestos	Chemical attack on the proposed infrastructure (water supply pipes and buildings)	High	The results of the laboratory testing programmes indicate numerous exceedances of metals, PAH and TPH which can affect potable water supplies and pipework. Appropriate remedial action will need to be considered during the design of any new water supply pipes.
Controlled Waters				
Groundwater beneath the site (shallow Secondary A aquifer in the Kempton Park Gravel Member)	Various current and historic industrial land uses on and off site, tanks, electrical substation, railway land, landfill and made ground from previous phases of development:	Lateral migration	High	The results of the laboratory testing programmes on groundwater samples indicate numerous exceedances of metals, PAH and TPH in the groundwater within the Kempton Park Gravel (i.e. shallow aquifer) beneath the site.

Receptor	Potential sources	Pathways	Risk	Justification
Groundwater beneath the site (deep aquifers underlying the London Clay Formation – Lambeth Group Secondary A Aquifer, Thanet Formation, Chalk Group). Source Protection Zone 2.	PAHs, asbestos	Vertical and lateral migration	Low	Due to a substantial thickness (20m) of clay strata between the shallow (contaminated) groundwater and the deeper aquifer, migration of contaminants to the deeper aquifer is considered unlikely.
Surface watercourses and SSSI located to the east of the site		Migration of chemicals through the shallow unsaturated zone and lateral migration in the groundwater	Low to Moderate	The results of the laboratory testing programmes on groundwater samples indicate numerous exceedances of metals, PAH and TPH in the groundwater within the Kempton Park Gravel Member (i.e. shallow aquifer) beneath the site. Nevertheless, due to the distance of the nearest surface water feature (360m east of the site) and SSSI site (560m east of the site), the risk of contamination from this site affecting the surface water feature or the groundwater at the SSSI site is considered low to moderate.

4. Rationale and Specific Objectives

The objective of this supplementary investigation is to fill gaps in information and reduce uncertainties with respect to contamination at the Ashley House and Cannon Factory Sites.

Specific objectives include:

- Address comments received from Haringey Council Pollution Officer by email on 22 February 2023 pertaining to the Socotec report;
- Refine the conceptual site models, identify potentially unacceptable risks to receptors, and inform a Remediation Strategy.

5. Methodology

The intrusive investigation work was undertaken in general accordance with the Code of Practice for Ground Investigation BS 5930 (2015) and the Code of Practice for the Investigation of Potentially Contaminated Sites BS 10175 (2017).

5.1 Design of Investigation

The ground investigation was designed to fill gaps in information, reduce uncertainties and address comments from Haringey Council Pollution Officer.

Prior to commencement of the ground investigation, Waterman provided the Haringey Council Pollution Officer with a short technical note (Ref. WIE16248-100.R.2.2.1.TN, March 2023) detailing how the works would address each of their comments, proposed ground investigation location plans and a schedule of proposed exploratory hole locations and rationales.

The responses provided to each of the Pollution Officers comments are summarised in Table 5.

Following review of the technical note, email correspondence received from the Pollution Officer on 26 April 2023 stated they were satisfied with the proposed ground investigation and raised two queries on the detailed ground gas assessment presented in Appendix C of the technical note. The queries and Waterman responses are presented in [Table 6](#)

The rationale/target features of the exploratory hole locations are set out in [Table 7](#) and [Table 8](#).

Table 5: Waterman Responses to Pollution Officer Comments

Haringey Council Pollution Officer Comment	Waterman Response
<i>a. Sub-section 8.31 (Controlled Water Risk Assessment Screening) indicates that four groundwater samples were recovered on 24th April 2019. However, it is unclear on the method of groundwater sampling used. Given the potential for chlorinated solvents and petroleum hydrocarbons we would expect the groundwater samples to have been taken using low flow techniques minimising the volatile contaminant loss. This is consistent with best practice. Clarification is therefore required.</i>	Groundwater monitoring using low flow techniques will be undertaken as part of the supplementary ground investigation. Groundwater samples will be recovered from newly installed monitoring wells and serviceable existing monitoring wells installed by RSK and Socotec. Site inspection has established that most of the previously installed monitoring wells are serviceable and contain groundwater.
<i>b. The Socotec UK Limited report mentions the potential impact of offsite sources to be the cause of hydrocarbon contamination at Ashley House. No assessment has been undertaken to determine if this is the case. The sites impact on the groundwater regime should be determined by assessing the groundwater flow direction (via groundwater levels) and comparison of contaminant concentrations up hydraulic gradient and down hydraulic gradient of the site.</i>	Additional monitoring wells will be installed at Ashley House and post investigation groundwater reduced level monitoring and groundwater sampling will be undertaken to establish groundwater flow direction and upgradient and downgradient concentrations of contaminants to ascertain potential sources of contamination and risk to groundwater quality.
<i>c. We agree with the conclusions drawn in Subsection 8.31 of the Socotec UK limited report that Ashley House represents an unacceptable risk to controlled ground waters and that further investigation and risk assessment is required. As a minimum we would expect that an additional groundwater sampling round utilising all monitoring wells is completed.</i>	Groundwater monitoring using low flow techniques will be undertaken as part of the supplementary ground investigation. Groundwater samples will be recovered from newly installed monitoring wells and serviceable existing monitoring wells installed by RSK and Socotec. Site inspection has established that most of the previously installed monitoring wells are serviceable and contain groundwater.
<i>d. We disagree with the conclusion that the risk of Cannon Factory causing unacceptable pollution of controlled waters is considered to be low. Given the concentrations recorded in BH02 and the oily sheen observed during sampling, we would consider that a potentially unacceptable risk is present. We would therefore require additional sampling to be undertaken at Cannon Factory in line with points b and c above.</i>	Additional window sample holes will be advanced around BH02 and installed with groundwater monitoring wells. BH02 is serviceable and groundwater will be sampled from this location as part of post investigation groundwater level monitoring and sampling, along with the newly installed monitoring wells.
<i>e. The bioavailable contaminants (zinc, lead, nickel, copper, manganese) threshold criteria have not been calculated using the EA M-BAT tool and therefore are highly conservative.</i>	The supplementary investigation will comprise a revised controlled waters risk assessment using site-specific zinc, lead, nickel, copper, manganese assessment criteria derived using the EA M-BAT tool.
<i>f. Section 9 (Ground Gas) does not provide a review of the potential sources of ground gas. We would expect an assessment of the potentially significant source offsite sources as well as onsite sources, using ground condition information obtained by the RSK investigations.</i>	A detailed ground gas risk assessment has been undertaken which includes a review of on and off site potential sources of ground gas and information obtained by the RSK investigations. A copy of the assessment is presented as Appendix B (of the technical note provided to the Pollution Officer).

g. Section 9.2 (Gas Monitoring Assessment) indicates that “each monitoring pipe response zone was saturated by groundwater, which can influence gas readings”. As per best practice guidance the ground gas monitoring wells should be installed within the unsaturated zone to avoid interference from small quantities of organic material in the water column. Therefore, the ground gas regime for both Ashley House and Cannon Factory need to be reassessed with unrepresentative ground gas monitoring results identified and removed from consideration.

The detailed ground gas risk assessment includes a review of previous ground gas monitoring data, review of the source – pathway – receptor linkages, and a revised risk assessment. A copy of the assessment is presented as Appendix B (of the technical note provided to the Pollution Officer). Should the findings of the supplementary investigation change the findings the Ground Gas Risk assessment it will be updated.

*h. From a review of the soil sampling results it is noted that samples BH4, PH1A and BH3 are deviant laboratory results due to the holding time being exceeded. **These results would not be accepted as the exceeded holding time can affect the measured concentrations, particularly the volatile compounds. Further soil testing is therefore required.***

The supplementary ground investigation will target locations of deviant soils chemical analysis. Soil samples will be recovered from these new locations and submitted for chemical analysis within the appropriate holding times to confirm the chemical status of soils at these locations.

The applicant will need to provide us with an updated Ground Investigation Report covering the above issues before we can recommend the discharge of the above condition.

A ground investigation interpretive report and revised Conceptual Site Model will be prepared and submitted assessing results of previous ground investigation as well as the findings of the supplementary investigation.

Table 6: Waterman Responses to Pollution Officer Comments – Detailed Ground Gas Assessment

Haringey Council Pollution Officer Comment	Waterman Response
1. The report concludes that Ground gas protection measures would not be required in the completed developments and that no significant gas generating sources are present on-site. The report attributes the high concentrations of methane identified in WS101 to “black oil is identified in the sandy pockets” at 1.2-1.8m bgl but argues that “there is no significant risk in the long term (because the volumes of gas are typically small)”. However, this is an on-site source of ground gas that is likely to remain on-site due to its depth. The report also notes that that CO2 concentrations of 5.2% were identified in BH3. Calculating the GSVs using these gas concentrations would place the site in ‘Characteristic Situation’ 2 (low hazard) in Table 8.5 of CIRIA 665 – requiring some level of ground gas protection.	In accordance with BS8485:2015 (2019), where methane and/or carbon dioxide are reported at concentrations >1% and 5% respectively, consideration has been given to whether an increase to Characteristic situation 2 (CS2) is appropriate. Concentrations of methane and/or carbon dioxide recorded above these values do not automatically require an increase to CS2 and the purpose of the detailed assessment is to ascertain if the increase to CS2 is required. An increase to CS2 is identified as not required for the following reasons: - Petroleum hydrocarbons degrade and produce methane at very slow rates such that hazardous rates of surface emissions are unlikely in the long term. The absence of high flow rates in WS101 and on-site is further evidence the methane is being produced at a very slow rate. The volume of methane produced is also low. This is evidenced by the decrease in methane concentrations over the monitoring periods which identifies a methane source with a small reservoir of readily degradable material rather than a large methane source as would be present at a landfill for example which would have large reservoir of readily degradable material+ - As identified in the CL:AIRE 2012 RB17 guidance document and CIRIA C665, ground gases only pose a risk to developments when the following can be satisfied: • An accumulation of a large volume of gas in the ground in or near the buildings (source). Large volume of gas is absent. Therefore, source is absent. • A pathway that allows gas to migrate through and/or out of the ground into a building or other structure sufficiently quickly to allow it to build up inside the building (pathway). Low gas flow rates. Therefore, rapid gas build up will not occur. Therefore, pathway is absent. • A confined space within the building or structure where gas can build up to unacceptable levels (receptor). Confined spaces potentially present. However, source and pathway are absent. Therefore, linkage is broken. - The methane recorded in WS101 is unrepresentative of the ground gas regime on-site and is not evidence of a long term of high surface emissions risk; Ground gas monitoring data is consistent with the microbial respiration of organic materials in soil (as identified by ground gas ternary plots), in which a low flow and low volume of ground gas is present. Therefore, in accordance with 2018 EPG Ternary Plot Guidance, where the carbon dioxide is likely caused by biological

respiration of small quantities of organic matter as present on-site the increase in characteristic situation (CS1 to CS2) is only required should a high gas risk scenario be present; landfill, coal mining, volcanic activity, or acidic mine water. None of which are present at the site or surrounding area.

2. It is noted that "The proposed Development will incorporate a 250mm thick cast in-situ ground bearing reinforced floor slab with minimal penetrations. The ground floor slab will be tanked with a waterproof membrane with a minimum 200 gauge thickness". I presume this is supposed to be 250mm?

Correct, it should state 250mm cast in-situ ground bearing reinforced floor slab with minimal penetrations. The 250mm thick cast in-situ ground bearing floor slab would restrict the vertical migration of residual ground gas into the building, and a built structure which would inherently restrict the migration of ground gases into the proposed Development.

5.1.1 Strategy for Selection of Exploratory Hole Locations

A summary of the investigation locations and features investigated is presented in Table 7 and Table 8.

Table 7: Ground Investigation Strategy – Cannon Factory

Exploratory Hole	Rationale	Monitoring Well Installation Details
Window Sample Holes		
WWS01	Provide additional site coverage within accessible internal areas. Target Kempton Park Gravel Member. Obtain environmental soil samples.	None
WWS02	Provide additional site coverage within accessible internal areas. Target Kempton Park Gravel Member. Obtain environmental soil samples. Install groundwater monitoring well to assess groundwater flow direction and collect groundwater samples potentially downgradient of hydrocarbon contamination identified in BH02.	Screening Enfield Silt Member and Kempton Park Gravel Member 1.00 – 3.00m bgl
WWS03	Provide additional site coverage in the south of the Site. Target Kempton Park Gravel Member. Obtain environmental soil samples. Note: position moved and drilled through WTP02 to the north due to obstructions at original proposed location. Trial pit (WTP11) advanced at original proposed location of WWS03.	Screening Kempton Park Gravel Member 2.00 – 3.00m bgl
WWS10	Additional window sample hole advanced between WTP03 in the north-east and WWS02 in the south-east following identification of hydrocarbon contamination in the Kempton Park Gravel Member at these locations Target Kempton Park Gravel Member. Obtain environmental soil samples. Install groundwater monitoring well in the Kempton Park Gravel Member.	Screening Kempton Park Gravel Member 2.00 – 4.00m bgl
WWS11	Target Kempton Park Gravel Member. Additional window sample hole advanced through WTP03 to install a monitoring well in the north-east of the Site	Screening Kempton Park Gravel Member 2.00 – 3.00m bgl
Trial Pits		
WTP01	Investigate location of previously identified asbestos containing materials below the concrete slab in PH3 and PH3A. Target Made Ground. Collect environmental soil samples adjacent to PH3 and PH3A where deviating laboratory results were reported.	N/A
WTP02	Provide additional site coverage within accessible internal areas. Target Made Ground. Obtain environmental soil samples.	N/A
WTP03	Provide additional site coverage within accessible internal areas. Target Made Ground. Obtain environmental soil samples.	N/A
WTP11	Replacement for original proposed location of WWS03, which was moved due to shallow obstructions. Target Made Ground. Expose obstructions and obtain environmental soil samples.	N/A

Table 8: Ground Investigation Strategy – Ashley House

Exploratory Hole	Rationale	Monitoring Well Installation Details
Window Sample Holes		
WWS04	Provide site coverage within accessible internal areas. Target Kempton Park Gravel Member Obtain environmental soil samples.	Screening Kempton Park Gravel Member 2.00 – 3.50m bgl
WWS05	Provide site coverage within accessible internal areas. Target Kempton Park Gravel Member Obtain environmental soil samples.	None
WWS06	Target Made Ground / Kempton Park Gravel Member Collect environmental soil samples adjacent to BH03 where deviating laboratory results were reported. Install a groundwater monitoring well adjacent to BH03 due to this well not being serviceable.	Screening Kempton Park Gravel Member 2.00 – 3.50m bgl
WWS07	Target Kempton Park Gravel Member. Obtain environmental soil samples in area of previously identified hydrocarbon contamination. Install groundwater monitoring well to assess groundwater flow direction and groundwater chemical analysis potentially upgradient of previously identified hydrocarbon contamination at BH04 and WS107.	Screening Made Ground and Kempton Park Gravel Member 1.00 – 3.00m bgl
WWS08	Target Kempton Park Gravel Member. Obtain environmental soil samples in area of previously identified hydrocarbon contamination. Install groundwater monitoring well to assess groundwater flow direction and groundwater chemical analysis potentially downgradient of previously identified hydrocarbon contamination in groundwater at BH04 and WS107.	Screening Kempton Park Gravel Member 2.00 – 3.50m bgl
WWS09	Provide additional site coverage in the west of the Site. Target Kempton Park Gravel Member. Obtain environmental soil samples.	None
Trial Pits		
WTP04	Collect environmental soil samples adjacent to PH1A where deviating laboratory results were reported. Target Made Ground	N/A
WTP05	Provide additional Site coverage in the west of the Site. Investigate potential obstructions. Target Made Ground. Obtain environmental soil samples.	N/A
WTP06	Investigate location of WS102 where potential asbestos containing materials encountered. Target Made Ground. Obtain environmental soil samples.	N/A
WTP07	Collect environmental soil samples adjacent to BH04 where deviating laboratory results were reported. Target Made Ground/ Enfield Silt Member	N/A
WTP08 to WTP10	Investigate proposed location of drainage run and establish the presence and location of underground diesel tanks and associated fuel lines.	N/A

Target Made Ground.
Obtain environmental soil samples.

5.1.2 Sampling Strategy

Soils

Discrete environmental soil samples were collected every 0.5m in Made Ground, every 1.0m in natural soils, at the interface between strata and where visual and/or olfactory evidence of contamination was encountered.

Each environmental soil sample for subjected to headspace testing by Photoionisation Detector (PID) to monitor for volatile compounds and inform scheduling of laboratory analysis.

Groundwater

Groundwater samples were obtained from monitoring wells using low flow sampling (peristaltic pump) to minimise disturbance of the groundwater column and potential for volatile contaminant loss.

Groundwater samples were recovered from newly installed monitoring wells. In addition, groundwater samples were also collected from serviceable monitoring wells in and around locations where uncertainties in groundwater analysis were identified previously.

Groundwater samples were recovered from the following existing monitoring wells screening the Kempton Park Gravel Member:

- BH01 (Cannon Factory). Sample recovered using low-flow techniques due to uncertainties pertaining to Socotec groundwater sampling methodology;
- BH02 (Cannon Factory). Previously identified hydrocarbon contamination at this location and uncertainties pertaining to Socotec groundwater sampling methodology;
- BH04 (Ashley House). Previously identified hydrocarbon contamination at this location and nearby at WS107 (which is no longer present), and uncertainties pertaining to Socotec groundwater sampling methodology;
- BH101-shallow (Ashley House). Potentially representative of groundwater quality flowing off-site (based on anticipated groundwater flow direction);
- BH102-shallow (Ashley House). Potentially representative of groundwater quality flowing onto the Site (based on anticipated groundwater flow direction);
- BH103-shallow (Ashley House). Previously identified hydrocarbon contamination at BH04 and WS107. Potentially downgradient of BH04 and WS107 (based on anticipated groundwater flow direction);
- WS109 (Ashley House). Potentially upgradient of BH04 (based on anticipated groundwater flow direction) where hydrocarbon contamination was previously identified.

5.2 Quality Control

The samples were despatched in batches on a daily basis under a chain of custody procedure to i2 Analytical who are a UKAS accredited laboratory, for subsequent chemical analysis. Where appropriate, samples were stored within cool boxes containing ice packs.

All contractors, including laboratories, used during this project have been approved by Waterman as a part of in-house Integrated Management System (BS ISO 9001, BS ISO 14001) procedure. This requires all third parties to demonstrate competence and a high standard of work during a regular audit scheme.

6. Site Activities

Details of the ground investigation activities undertaken are shown in Table 9.

Table 9: Summary of fieldwork activities

Phase of Work.	Activity	Date
Ground Investigation	Service clearance comprising: Review of buried services plans, ground penetrating radar (GPR) survey of proposed exploratory hole locations, lifting inspection covers, and tracing service runs. Hand dug inspection pits to 1.2m bgl at each window sample hole location.	20 April 2023
	11No. Window sample holes (5No. at Cannon Factory to a max. depth of 5.00m bgl and 6No. at Ashley House to a max. depth of 5.00m bgl) Soil logging and sampling for environmental purposes.	20 – 21 April and 24 April 2023
	9No. Trial pits (4No. at Cannon Factory to a max. depth of 2.5m bgl and 5No. at Ashley House to max. depth of 2.6m bgl) Soil logging and sampling for environmental purposes.	20 – 21 April and 24 April 2023
	UXO Engineer Supervision	20 – 21 April and 24 April 2023
	3No. Falling head tests WWS03: 2.00 – 3.00m bgl (Kempton Park Gravel Member) WWS04: 2.50 – 3.50 m bgl (Kempton Park Gravel Member) WWS11: 2.50 – 3.50m bgl (Kempton Park Gravel Member)	21 and 24 April 2023
	Installation of groundwater monitoring wells in 8No. window sample holes (4No. at Cannon Factory and 4no. at Ashley House)	20 – 21 April and 24 April 2023
	Collection of groundwater samples from newly installed and existing monitoring wells. Recording groundwater levels. Collection of a surface water sample from Pymmes Brook to inform M-BAT tool assessment.	2 and 16 May 2023
Scheduling of Laboratory Analysis	Scheduling of soils and groundwater analysis	21 April – 16 May 2023

6.1 Window Sample Holes

6.1.1 Cannon Factory

Five window sample holes were advanced to depths of between 1.20m and 5.00m bgl (7.81m AOD and 4.05m AOD).

Window samples WWS02, WW03, WWS10 and WWS11 were installed with a 50mm internal diameter (ID) High Density Polyethylene (HDPE) monitoring standpipe with gas tap and bung and finished at surface with a lockable flush cover. Monitoring standpipes targeted the Kempton Park Gravel Member.

WWS01 was terminated at 1.2m bgl within the upper horizons of the Enfield Silt Member on the advice of the UXO engineer following detection of a metallic anomaly signal. The soils were logged and environmental soil samples collected from Made Ground and the Enfield Silt Member to fill gaps in information on shallow soils in this part of the Site. An alternative location was not selected due to the close proximity of WTP01, WTP02, and WWS03.

The proposed location of WWS03 was originally in the south of the Site. However, due to the presence of shallow obstructions encountered in the hand dug inspection pit, this location was advanced as a trial pit (WTP11) to expose and log the obstruction. WWS03 was moved north, drilled through WTP02 and

installed with a monitoring well targeting the Kempton Park Gravel Member to provide information for the Controlled Waters risk assessment.

WWS10 and WWS11 are additional boreholes drilled to assist with delineation of hydrocarbon impacted Kempton Park Gravel Member which was encountered in WWS02 in the south-east and WTP03 in the north-east. WWS11 was drilled through WTP03 and installed with a monitoring well following identification of hydrocarbon impacted soils in the groundwater smear zone at this location. WWS10 was also installed with a monitoring well to provide information for the Controlled Waters risk assessment.

Generally, the window samples were terminated due to refusal in dense sand and gravel of the Kempton Park Gravel Member.

6.1.2 Ashley House

Six window sample holes were advanced to depths of between 0.5m and 5.0m bgl (elevations of between 8.80m AOD and 3.92m AOD).

Window samples WWS04, WW06, WWS07 and WWS08 were installed with a 50mm internal diameter (ID) HDPE monitoring standpipe with gas tap and bung and finished at surface with a lockable flush cover. Monitoring standpipes targeted the Kempton Park Gravel Member.

WWS05 was terminated at 0.50m bgl due to the presence of a second concrete slab. The soils were logged and environmental soil samples collected from Made Ground to fill gaps in information on shallow soils in this part of the Site. An alternative location was not selected due to vertical and lateral space constraints. However, WTP04 and previous RSK locations WS103 and WS104 were all advanced in the vicinity of WWS05 and provided a record of ground conditions down to the Kempton Park Gravel Member. Therefore, the potential gap in information with respect to ground conditions at WWS05 is not considered to be significant.

Generally, the window samples were terminated due to refusal in dense sand and gravel of the Kempton Park Gravel Member.

6.1.3 In-situ Tests

Falling Head Tests

Three falling head tests were undertaken in the Kempton Park Gravel Member at depths of between 2.00 and 3.50m bgl to provide a record of its permeability. Two tests were undertaken at Cannon Factory (in WWS03 and WWS11) and one test undertaken at Ashley House (in WWS04).

It is considered that due to the proximity of the Sites, the three values provide a robust assessment of the characteristics of the Kempton Park Member in the local area.

Standard Penetration Tests (SPTs)

SPT tests were undertaken at 1m intervals in window sample holes to provide information on soil geotechnical properties.

6.2 Trial Pits

All trial pits were advanced using a wheeled mechanical excavator with a backactor following breaking out of hardstanding.

6.2.1 Cannon Factory

Four trial pits were advanced to depths of between 0.60m bgl and 2.5m bgl (8.39m AOD and 6.54m AOD). WTP01 was terminated at 0.60m bgl in Made Ground due to the presence of asbestos cement fragments embedded in the base of a second concrete slab which was present 0.18 to 0.40m bgl. Loose

asbestos cement fragments were also encountered on Made Ground directly below this slab. A soil sample was collected from the Made Ground underlying the concrete slab then the trial pit was backfilled with the asbestos cement impacted materials first followed by the other arising as encountered. The surface of the trial pit was reinstated with concrete to avoid potential disturbance of the arisings. The information regarding the presence of asbestos at this location has been passed to the client team including the contractor due to undertake work at the Site in the near future.

As the purpose of WTP01 was to investigate the presence of asbestos and recover environmental soil samples adjacent to PH3 and PH3A where deviating laboratory results were reported the aims of this trial pit were achieved and an alternative location was not required.

WTP11 was advanced in the original proposed location of WWS3 due to the presence of shallow obstructions preventing WWS3 from being drilled. WTP11 exposed the obstructions and shallow soil samples were recovered from Made Ground and the upper horizon of the Enfield Silt Member to fill gaps in information in this part of the Site.

All trial pits achieved their aim of gathering information on Made Ground across the Site. In addition, WTP02 and WTP03 gathered information on the Enfield Silt Member and upper horizons of the Kempton Park Gravel Member.

6.2.2 Ashley House

Five trial pits were advanced to depths of between 0.61m bgl and 2.60m bgl (8.54m AOD and 6.40m AOD).

WTP05 was terminated at 1.20m bgl due to the presence of an unrecorded gas main at 1.1m bgl. Environmental soil samples were collected from the Made Ground then the trial pit was backfilled. Whilst the thickness of Made Ground was not proven, an alternative location was not advanced as samples of the Made Ground had been recovered for analysis and WTP04 close to the north, proved the thickness of Made Ground.

WTP08 to WTP10 were combined into a single trial pit (WTP08-10) due to space limitations in the anticipated location of the underground diesel tanks including drainage runs, a small wooden shed, a trailer, wooden pallets, and parts of a boat. WTP08-10 exposed a second concrete slab at 0.61m bgl. The slab was not broken out as a precaution due to uncertainty of the location of the tanks and fuel lines and potential risk of damage to these. Notwithstanding, a sample of shallow Made Ground was obtained for chemical analysis prior to backfilling the trial pit.

An inspection cover lifted to the west of to the north-west of WTP08-10 (to the west of WWS08) exposed fill points and fuel lines. Therefore, it is expected that the underground diesel tanks remain in-situ.

All trial pits achieved their aims of gathering information on Made Ground across the Site and collecting samples in locations of previously reported deviating samples. In addition, WTP04 gathered information on the Enfield Silt Member and upper horizons of the Kempton Park Gravel Member. WTP06 also gathered information on the Enfield Silt Member.

6.3 Groundwater Monitoring

Groundwater level monitoring and sampling were undertaken on 3 May 2023. Groundwater levels were recorded newly installed monitoring wells and together with the serviceable monitoring wells installed by RSK and Socotec.

Groundwater levels were recorded using a dip meter and the presence of free product inspected using an oil interface probe.

Groundwater sampling was undertaken using low-flow sampling (peristaltic pump) in combination with a multi-parameter monitor. Samples were collected following stabilisation of water parameters including dissolved oxygen, temperature, total dissolved solids, pH, redox potential, and conductivity. A

submersible bailer was also used to recover a surface water sample from Pymmes Brook about 300m west of the Cannon Factory and Ashley House Sites. Pymmes Brook is anticipated to be ultimately downgradient of groundwater flow from the Sites.

A second visit was undertaken on 16 May 2023 following receipt of data from the first monitoring round to augment the existing dataset.

6.3.1 Cannon Factory

Of the newly installed monitoring wells, groundwater samples were recovered from WWS02 and WWS10 only. Groundwater samples were also recovered from BH01 and BH02.

The columns of water present in WWS03 and WWS11 were insignificant (0.16m and 0.03m) and could not be recovered by the peristaltic pump or submersible bailer. However, no evidence of hydrocarbon contamination was encountered during drilling of WWS03 or excavation of WTP02.

6.3.2 Ashley House

Of the newly installed monitoring wells, groundwater samples were recovered from WWS06 and WWS08 only. Groundwater samples were also recovered from BH04, BH101, BH102, BH103, and WS109.

WWS04 was dry. However, no evidence of hydrocarbon contamination was encountered during drilling at this location and a groundwater sample was recovered from WS109, which is anticipated to be downgradient of groundwater flow from WWS04.

WWS07 was dry. However, no evidence of hydrocarbon contamination was encountered during drilling at this location and groundwater samples were recovered from WWS08, WS109, and BH04 nearby.

6.4 Laboratory Scheduling

6.4.1 Soils

Table 10 and Table 11 provide summaries of soils chemical analysis undertaken at Cannon Factory and Ashley Road.

Cannon Factory

A total of twenty soils samples were analysed from Cannon Factory. These included eight samples of Made Ground, four samples of Enfield Silt Member, and eight samples of Kempton Park Gravel Member.

Hydrocarbon contamination analysis was undertaken on soil samples obtained from exploratory holes targeting locations of previously reported deviating samples. Including: WTP01 - 0.50m bgl targeting Socotec locations PH3 and PH3A.

Table 10: Summary of Soil Chemical Analysis – Cannon Factory

Chemical Analysis	No. of Samples Analysed and Stratum
Soil properties (organic matter, total organic carbon, pH, moisture content, fraction of organic carbon)	18No. (8No. Made Ground, 4No. Enfield Silt Member, 6No. Kempton Park Gravel Member)
Soil properties (fraction of organic carbon only)	2No. Kempton Park Gravel Member
Metals Suite (As, W/S B, Cd, Cr, Cr VI, Cu, Hg, Pb, Ni, Se, V, Zn)	7No. (6No. Made Ground, 1No. Kempton Park Gravel Member)
Total Petroleum Hydrocarbons (TPH-CWG C5-C44, plus BTEX and MTBE)	16No. (6No. Made Ground, 4No. Enfield Silt Member, 6No. Kempton Park Gravel Member)

Chemical Analysis	No. of Samples Analysed and Stratum
Hydrocarbons (Speciated PAHs-16)	10No. (4No. Made Ground, 2No. Enfield Silt Member, 4No. Kempton Park Gravel Member)
Volatile Organic Compounds	4No. (1No. Made Ground, 1No. Enfield Silt Member, 2No. Kempton Park Gravel Member)
Semi-volatile Organic Compounds	2No. (1No. Made Ground, 1No. Kempton Park Gravel Member)
Asbestos Screen (quantification if positive ID)	7No. Made Ground

Ashley House

A total of twenty-seven soils samples were analysed from Ashley House. These included sixteen samples of Made Ground, four samples of Endfield Silt Member, and seven samples of Kempton Park Gravel Member.

Organic contamination analysis was undertaken on soil samples obtained from exploratory holes targeting locations of previously reported deviating samples. Including: WWS06 – 0.30, 1.5, and 3.5m bgl targeting Socotec location BH03; WTP04 – 1.00, 2.00, and 2.60m bgl targeting Socotec location PH1A; WTP07 – 1.00 and 2.00m bgl targeting Socotec location BH04.

Table 11: Summary of Soil Chemical Analysis – Ashley House

Chemical Analysis	No. of Samples Analysed and Stratum
Soil properties (organic matter, total organic carbon, pH, moisture content, fraction of organic carbon)	26No. (16No. Made Ground, 4No. Enfield Silt Member, 6No. Kempton Park Gravel Member)
Soil properties (fraction of organic carbon only)	1No. Kempton Park Gravel Member
Metals Suite (As, W/S B, Cd, Cr, Cr VI, Cu, Hg, Pb, Ni, Se, V, Zn)	9No. (8No. Made Ground, 1No. Kempton Park Gravel Member)
Total Petroleum Hydrocarbons (TPH-CWG C5-C44, plus BTEX and MTBE)	22No. (13No. Made Ground, 3No. Enfield Silt Member, 6No. Kempton Park Gravel Member)
Hydrocarbons (Speciated PAHs-16)	13No. (10No. Made Ground, 3No. Kempton Park Gravel Member)
Volatile Organic Compounds	3No. (1No. Made Ground, 2No. Enfield Silt Member)
Semi-volatile Organic Compounds	3No. (1No. Made Ground, 2No. Enfield Silt Member)
Asbestos Screen (quantification if positive ID)	15No. Made Ground

6.4.2 Groundwater

A total of six and groundwater samples were analysed from Cannon Factory and Ashley House respectively.

Sample were analysed for the suite detailed in Table 12.

Table 12: Summary of Groundwater Chemical Analysis

Chemical Analysis	No. of Samples Analysed
Water properties (pH, total hardness, dissolved organic carbon, total organic carbon)	14No. (6No. from Cannon Factory, 8No. from Ashley House)

Metals Suite (dissolved: As, Cd, Ca, Cr (total and dissolved), Cr VI, Cu, Hg, Pb, Ni, Se, Zn, Mn)	4No. (4No from Cannon Factory, 4No. from Ashley House)
Total Petroleum Hydrocarbons (TPH-CWG C5-C44, plus BTEX and MTBE)	12No. (4No. from Cannon Factory, 8No. from Ashley House)
Hydrocarbons (Speciated PAHs-16)	12No. (4No. from Cannon Factory, 8No. from Ashley House)
Volatile Organic Compounds	10No. (3No. from Cannon Factory, 7No. from Ashley House)
Electron Acceptors and Metabolic by-products (NO ₃ and NO ₂ , SO ₄ and S ₂ , Cl, total inorganic carbon, Fe(II) and Fe(III), Mn(II) and Mn(IV))	11No. (4No. from Cannon Factory, 7No. from Ashley House)

In addition to the groundwater samples, the surface water sample recovered from Pymmes Brook was analysed for dissolved organic carbon and the metals suite.

7. Results

Detailed logs of the strata encountered, together with records of the samples taken during both trial pitting and borehole installation and PID readings, are provided in Appendix B. A summary of the geological strata and manmade underground structures encountered is presented below.

7.1 Geological Strata

Geological strata encountered at Ashley House and Cannon Factories are summarised in Table 13 and Table 14. The geological sequence encountered generally mirrors that encountered by previous investigations by Socotec and RSK.

Table 13: Geological strata encountered – Cannon Factory

Soil Type	Depth of Top of Stratum (m bgl)	Thickness (m)	Typical Description
Hardstanding	0	0.13 – 0.30	Grey reinforced concrete with medium gravel inclusions of quartzite
Made Ground	0.13 – 0.30	0.64 – 1.35	Sand and gravel of varying proportions. With quartzite, brick, and concrete. Locally silty and clayey.
Enfield Silt Member	0.80 – 1.55	0.60 – 1.00 (where proven)	Sandy gravelly silt and/or clay.
Kempton Park Gravel Member	1.80 – 2.30	Not proven	Sand and gravel of varying proportions. Locally silty and clayey.

Hardstanding covers about 20% of the Cannon Factory Site, with the rest of the Site occupied by a two-storey office building along the western boundary, adjoining warehouses along the northern and eastern boundaries.

Table 14: Geological strata encountered – Ashley House

Soil Type	Depth of Top of Stratum (m bgl)	Thickness (m)	Typical Description
Hardstanding	0	0.20 – 0.24	Grey reinforced concrete with medium gravel inclusions of quartzite
Made Ground	0.20 – 0.24	0.46 - 2.27 (where proven)	Gravelly sand. With quartzite, brick, and concrete. Locally silty and clayey.
Enfield Silt Member	0.70 – 2.40 (where encountered)	Absent to 0.80 (where proven)	Sandy silt and/or clay. Locally gravelly.
Kempton Park Gravel Member	2.00 – 2.90	Not proven	Sand and gravel of varying proportions. Locally clayey.

Hardstanding covers about 60% of the Ashley House Site with the remaining areas occupied by a two-storey office building along the western boundary and warehouse along the northern boundary. Perimeter planting is present around the east and south of the two-storey office building and numerous raised planter beds are present in the central portion of the Site.

7.2 Underground Structures and Obstructions

Numerous obstructions were encountered during the works as follows:

Cannon Factory

- WWS01
 - Buried reinforced concrete slab 0.18 – 0.41m bgl;
 - 1.20m bgl: metallic anomaly detected by the UXO engineer. Window sample hole terminated as a precaution;
- WWS02
 - Buried reinforced concrete slab: 0.23 – 0.38m bgl.
- WTP01
 - Buried reinforced concrete slab 0.18 – 0.40m bgl.
- WTP11
 - Linear concrete features encountered at 0.80 and 1.50m bgl (potentially historical footings and/or foundations).

Ashley House

- WWS05
 - Buried reinforced concrete slab 0.40 - ≥0.50m bgl.
- WTP05
 - Unrecorded low-pressure gas main at 1.1m bgl.
- WTP08-10
 - Buried concrete structure at 0.60m bgl.

7.3 Chemical Analysis

The laboratory test results are presented in Appendix D.

7.4 Visual and Olfactory Observations of Contamination

Visual and olfactory evidence of contamination encountered during advancement of exploratory holes and subsequent groundwater monitoring is summarised below.

The nature of visual and olfactory contamination observed was consistent with previous investigations by RSK and Socotec.

Cannon Factory

Soils

- WWS02
 - Moderate hydrocarbon odour 2.20 to 3.00m bgl (Kempton Park Gravel Member);
 - Dark grey staining 2.80 to 3.00m bgl (Kempton Park Gravel Member).
- WWS10
 - Moderate hydrocarbon odour with dark grey staining 2.10 to 2.40m bgl (Kempton Park Gravel Member);
 - Moderate hydrocarbon odour with dark grey staining 3.70 to 4.00m bgl (Kempton Park Gravel Member).

- WWS11
 - Moderate hydrocarbon odour 2.30 to 2.60m bgl (Kempton Park Gravel Member).
- WTP01
 - Asbestos cement embedded within the base of the buried concrete slab 0.40m bgl (Made Ground);
 - Asbestos cement fragments in Made Ground 0.40 to 0.60m bgl (Made Ground).
- WTP11
 - Localised areas of multicoloured clay 0.55m bgl (Made Ground).

PID headspace monitoring recorded a maximum VOC concentration of 2.6ppm in WWS10 at 2.20m bgl corresponding with a moderate hydrocarbon odour with dark grey staining in the Kempton Park Gravel Member.

PID headspace readings were generally below the instrument's limit of detection (<0.1ppm).

Groundwater

The following visual/olfactory observations of contamination were made during groundwater monitoring:

- BH01
 - Hydrocarbon-like odour
- BH02
 - Slight Hydrocarbon-like odour
- WWS02
 - Slight hydrocarbon-like odour
- WWS10
 - Slight hydrocarbon-like odour

Non-aqueous phase liquid was not recorded in the monitored wells. No hydrocarbon sheens were observed on the recovered groundwater.

Ashley House

Soils

- WWS09
 - Slight hydrocarbon odour 1.30 to 1.50m bgl (Made Ground).
- WTP04
 - Moderate hydrocarbon odour 0.60 to 1.80 (Made Ground).

PID headspace monitoring recorded a maximum VOC concentration of 1.5ppm in WTP04 at 1.00m bgl corresponding with a moderate hydrocarbon odour in Made Ground.

Most PID headspace readings were below the instrument's limit of detection (<0.1ppm).

Groundwater

The following visual/olfactory observations of contamination were made during groundwater monitoring:

- BH04
 - Slight solvent-like odour
- BH103
 - Slight hydrocarbon odour

Non-aqueous phase liquid was not recorded in the monitored wells. No hydrocarbon sheens were observed on the recovered groundwater.

7.5 Controlled Waters

Groundwater monitoring records (groundwater levels, monitoring observations, and multiparameter readings) are presented in Appendix C. Permeability testing and groundwater strike records are presented in the Ground Investigation Factual Report in Appendix B.

7.5.1 Groundwater Levels and Flow Direction

The following groundwater strikes were recorded at Cannon Factory:

- WWS02 – 2.80m bgl (6.25m AOD);
- WWS03 – 3.00m bgl (6.04m AOD);
- WWS10 – 3.00m bgl (6.04m AOD);
- WWS11 – 3.00m bgl (6.05m AOD);

The following groundwater strikes were recorded at Ashley House:

- WWS04 – 3.40m bgl (5.85m AOD);
- WWS06 – 2.50m bgl (6.40m AOD);
- WWS07 – 2.80m bgl (6.34m AOD);
- WWS08 – 2.50m bgl (6.61m AOD);
- WWS09 – 2.90m bgl (6.04m AOD).

All of the groundwater strikes were recorded in the Kempton Park Gravel Member.

Monitored groundwater levels at Cannon Factory ranged from 2.43m bgl (BH02) to 2.80m bgl (WWS03). Groundwater elevations ranged from 6.19m AOD (BH01) to 6.49m AOD (WWS10).

Monitored groundwater levels at Ashley House ranged from 2.52m bgl (BH103) to 2.78m bgl (WS101). Groundwater elevations ranged from 6.36m AOD (WWS06) to 6.62m AOD (WS109).

Groundwater elevation contour plotting, presented in Appendix A, indicates groundwater at the Cannon Factory and Ashley House Sites is flowing west, contrary to anticipated groundwater flow direction towards Pymmes Brook about 300m east.

Recent development (Berol Yard) to the immediate south of Cannon Factory comprises a basement with a finished floor level of 3.7m AOD. Therefore, this basement will be intercepting groundwater in the Kempton Park Gravel Member. It is also known that recent development (Ashley Gardens) adjacent north of Ashley House comprises a basement with a finished floor level of 4.1m AOD. Basements are also known to be present at the Berol Yard development on the opposite side of Ashley Road to the east with finished floor levels of basements ranging from 6.0m AOD to 3.7m AOD. Therefore, basements in the surrounding area are most likely intercepting groundwater in the Kempton Park Gravel Member and interfering with its natural flow direction at a local level.

Notwithstanding the above, it also cannot be discounted that current and relic foundations at both Cannon Factory and Ashley House are intercepting groundwater in the Kempton Park Gravel Member resulting in localised fluctuations in groundwater elevations. This is particularly apparent on the groundwater contour plot for Ashley House where a steep dip in groundwater elevation at BH04 is shown – likely caused by the buried diesel tanks located between BH103 and BH04.

Groundwater in the wider area is expected to flow towards Pymmes Brook. However, as evidenced by the groundwater contour plotting, its route will be affected by numerous subsurface structures along its flow path increasing its travel time and route.

7.5.2 Permeability Testing

The falling head test results are as follows:

- WWS03: 2.00 – 3.00m bgl (Kempton Park Gravel Member) = $1.80\text{E-}07$ (0.00000018) m/s
- WWS04: 2.50 – 3.50 m bgl (Kempton Park Gravel Member) = $1.32\text{E-}06$ (0.00000132) m/s
- WWS11: 2.50 – 3.50m bgl (Kempton Park Gravel Member) = $5.32\text{E-}08$ (0.0000000532) m/s.

8. Generic Assessment Criteria

The information requirements for generic quantitative risk assessment will depend on:

- The substance being assessed;
- The receptors being considered;
- The pathways being considered; and
- The complexity of the site.

Potential contaminant linkages identified in Table 3 have been investigated and the results assessed against generic assessment criteria. The generic assessment criteria selected for each potential contaminant linkage are summarised in Table 15.

Table 15: Generic assessment criteria

Source	Pathway	Receptor	Generic Assessment Criteria	Justification/ Site Specific Information used to Support the Generic Risk Assessment
Contamination in Site Soils	Direct contact (ingestion, dermal contact, dust and fibre inhalation)	Future Site occupants	GAC for residential land use without plant uptake ($RESI_{WOPU}$) for soils with 1% SOM. GAC derived from Category 4 Screening Levels (C4SLs), LQM/CIEH S4ULs (Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3060. All rights reserved).	The development comprises commercial and residential uses with residential amenity space. The most sensitive use is residential and amenity space will be present. Therefore, the GAC for residential land use without home-grown produce has been selected. 1% SOM, for organic contaminants has been selected. 1% was selected as a conservative and consistent approach across the Site and was based on the lowest SOM % identified in the soils.
	Direct contact (ingestion, dermal contact, dust and fibre inhalation)	Adjacent site users (commercial and residential users)	Semi-quantitative Risk Assessment using soils GAC.	The Site is in an area of residential and commercial uses. Therefore, risks to off-site residents and users will be assessed through analysis of soils on-site.
	Chemical attack on the proposed infrastructure (water supply pipes and buildings)	Potable water supply pipes and buildings	Qualitative Risk Assessment. BRE Special Digest 1: 2005 Concrete in Aggressive Ground. UKWIR Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites.	The risk to buried structures was assessed in accordance with the guidelines included within BRE Special Digest 1:2005 Concrete in Aggressive Ground. The risk to water supply pipes was assessed in accordance with the UKWIR Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites.
Contamination in Site soils and shallow groundwater	Vapour Inhalation	Future Site occupants	Quantitative assessment of groundwater against the Society of Brownfield Risk Assessment (SoBRA) derived GAC_{GWVAP} for residential end-use. Semi-quantitative risk Assessment for vapours utilising PID measurements alongside soil and groundwater contamination results in accordance with CIRIA C682 and BS8576: 2013.	The risk from vapours to human health receptors will be determined quantitatively through assessment of the groundwater concentrations against the GAC_{GWVAP} as derived by SoBRA. Based on the ground conditions on-site this quantitative assessment builds in the following precautionary assumptions; - No biodegradation is occurring between the source term, and the receptor; - The groundwater is at 0.65mbgl; - The geology on-site is a sandy stratum; and - The omission of capillary fringe between the saturated and unsaturated zones.

Source	Pathway	Receptor	Generic Assessment Criteria	Justification/ Site Specific Information used to Support the Generic Risk Assessment
Ground gases in Site soils	Exposure to Vapours	Adjacent Site users (commercial and residential)	Semi-quantitative Risk Assessment using ground gas and vapour monitoring data. Quantitative assessment of groundwater against the Society of Brownfield Risk Assessment (SoBRA) derived GAC _{GWVAP} .	The quantitative risk assessment will therefore be inherently conservative in its approach. A semi-quantitative approach will be used to assess risks from vapours in soils accordance with CIRIA C682. Soil headspace testing has been used along with analysis for VOCs and SVOCs in soil samples.
		Future Site occupants	Gas Screening Value determination and assessment in accordance with CIRIA C665 and BS8485:2015+A1:2019. CL:AIRE Research Bulletin RB17 (2012)	Risks to off-site residents and users will be assessed through analysis of soil, groundwater, and vapour concentrations on-site, assessment of the hydrogeological regime at the Site and potential for off-site migration of contamination and vapour.
	Exposure to ground gases	Adjacent Site users	Semi-quantitative risk assessment using findings from the assessment of risks to future Site occupants	The potential risk arising from ground gas to the development will be assessed using the approach recommended in CIRIA C665, BS 8485:2015+A1:2019, BS 8576: 2013, and guidance presented in CL:AIRE Research Bulletin RB17 (2012). Risks to off-site residents and users will be assessed through characterisation of the ground gas regime at the Site and the potential for off-site migration of ground gas
Contamination in Site soils and shallow groundwater	Lateral migration	Groundwater beneath the site (shallow aquifer – Kempton Park Gravel Member)	Environmental Quality Standards (EQS) for freshwater and EQS _{bioavailable} .	The Kempton Park Gravel Member is a Secondary A Aquifer. The closest surface water feature is Pymmes Brook, some 300m east. Given its distance away and inferred groundwater flow directions at both Ashley House and Cannon Factory, Pymmes Brook is unlikely to be a receptor of contamination at the Site. However, there is likely to be hydraulic continuity between the Kempton Park Gravel Member and Pymmes Brook. Therefore, EQS has been selected as conservative assessment criteria. The Kempton Park Gravel Member is unlikely to have hydraulic continuity with the River Lee Navigation as this surface water feature is canalised.
	Vertical and lateral migration	Groundwater beneath the site (deep aquifers underlying the London Clay)	Semi-quantitative Risk Assessment using soils and groundwater analysis and monitoring and, screening of groundwater from shallow groundwater.	Aquifers at depth are overlain by cohesive deposits of the London Clay Formation and a significant portion of the Lambeth Group also comprises cohesive deposits. A such, downward vertical migration of shallow contamination is restricted.

Source	Pathway	Receptor	Generic Assessment Criteria	Justification/ Site Specific Information used to Support the Generic Risk Assessment
		Formation – Lambeth Group Secondary A Aquifer, Thanet Formation, Chalk Group). Source Protection Zone 2.		Notwithstanding, the development is likely to comprise piled foundations. Therefore, a semi-quantitative approach will be used to assess potential risks to the aquifers at depth using soils and groundwater analysis.
Contaminated soils and shallow groundwater	Migration of chemicals through the shallow unsaturated zone and lateral migration in the groundwater	Surface watercourses and SSSI located to the east of the site	Environmental Quality Standards (EQS) for freshwater and EQS _{bioavailable} . Quantitative Risk Assessment using soils analysis	Given its distance away (some 300m east) and inferred groundwater flow directions at both Ashley House and Cannon Factory, Pymmes Brook is unlikely to be a receptor of contamination at the Site. However, there is likely to be hydraulic continuity between the Kempton Park Gravel Member and Pymmes Brook. Therefore, EQS has been selected as conservative assessment criteria. The Kempton Park Gravel Member is unlikely to have hydraulic continuity with the River Lee Navigation as this surface water feature is canalised. The SSSI is some 500m east. Therefore it is highlight unlikely to be a receptor of contaminated groundwater at the Site.

The generic assessment criteria used in this report are included in Appendix I.

9. Quantitative Environmental Risk Assessment – Risk Estimation

The potential contaminant linkages identified in Section 3.2 have been evaluated using the Generic Assessment Criteria described in Section 8 and Appendix I. The results of this evaluation are reported below:

9.1 Risk to Human Health

A summary of GAC exceedances reported at Cannon Factory and Ashley House are presented in Table 16.

Table 16: Summary of generic quantitative risk assessment for human health

Contaminant	Location, depth (m bgl)	Concentration (mg/kg)	Stratum	Generic Assessment Criteria (mg/kg)
Cannon Factory				
Lead	WWS01 – 0.50	1,700	Made Ground	310
	WTP11 – 0.50	1,300	Made Ground	
Mercury	WTP11 – 0.50	2.30	Made Ground	1.20*
TPH Aromatic C21-35	WWS02 – 2.80	2,100	Kempton Park Gravel Member	1,900
	WWS10 – 2.20	2,800	Kempton Park Gravel Member	
	WTP11 – 3.00	2,600	Kempton Park Gravel Member	
	WTP03 – 2.50	3,300	Kempton Park Gravel Member	
Di-benzo(a,h.)anthracene	WTP03 – 0.50	0.37	Made Ground	0.31
Ashley House				
Lead	WWS09 – 0.50	610	Made Ground	310
	WTP10 – 0.50	340	Made Ground	
Mercury	WWS09 – 0.50	1.70	Made Ground	1.20*
Naphthalene	WTP07 – 1.00	4.00	Made Ground	2.30
Benzo(a)anthracene	WTP05 – 1.00	13.00	Made Ground	11
Benzo(b)fluoranthene	WWS08 – 1.00	7.30	Made Ground	3.90
	WTP07 – 1.00	7.30	Made Ground	
	WTP05 – 1.00	11.00	Made Ground	
Benzo(a)pyrene	WWS08 – 1.00	4.80	Made Ground	3.2
	WTP07 – 1.00	5.00	Made Ground	
	WTP05 – 1.00	11.00	Made Ground	
Di-benzo(a,h.)anthracene	WWS08 – 1.00	0.61	Made Ground	0.31
	WTP07 – 1.00	0.68	Made Ground	
	WTP05 – 1.00	0.89	Made Ground	

*The GAC for elemental mercury, which the inhalation of vapours indoor exposure pathway contributes significantly to the overall exposure in the residential and commercial land uses¹, is 1.20mg/kg. The GAC for inorganic mercury can normally be compared with chemical analysis for total mercury content because the equilibrium concentrations of elemental and methylmercury compounds are likely to be very low. Elemental mercury is unlikely to form in natural near-surface soils. However, consideration should be given to whether elemental mercury could be been introduced to the Site by anthropogenic activity². The GAC for inorganic mercury is 56mg/kg for residential land use without plant uptake. The dominant pathway in this scenario is ingestion of soil and indoor dust. Mercury is considered likely to be in its inorganic form in soils on-site. Historical uses of the Site are considered not to be a source of elemental mercury, which is associated with processes that used amalgams such as millinery or chloralkali production². Comparison of mercury concentrations against the GAC for inorganic mercury (56mg/kg) returns no exceedances.

9.1.1 Asbestos Screening

Cannon Factory

Suspected asbestos cement fragments were encountered embedded in the base of a buried concrete slab present 0.18 and 0.40m bgl at WTP01. Suspected asbestos cement fragments were also encountered in Made Ground underlying the buried concrete slab at this location. None of the Made ground samples screened for asbestos by the laboratory (seven in total) identified the presence of asbestos. However, the presence of asbestos fibres in Made Ground has been confirmed by previous investigations by RSK and Socotec.

ACMs have also been reported in Made Ground below the concrete slab by RSK and Socotec at locations PH1 (RSK), PH3, and PH3A. It is, therefore, apparent that there are pockets of ACMs present underlying the existing units at Cannon Factory. The absence of ACMs at other exploratory hole locations suggests the contamination is localised.

Ashley House

ACMs were not observed in soils during advancement of the exploratory holes at Ashley House. However, the RSK investigation identified a suspected ACM (fibrous material) in WS102 at 1.00m bgl. Subsequent asbestos identification and quantification on this sample confirmed the presence of chrysotile and amosite and reported an asbestos concentration of 6.265%. WTP06 which targeted this area did not record any visual evidence of ACMs but did report asbestos in Made Ground samples from 0.30m bgl and 0.50m bgl at concentrations of <0.001% and 0.005% respectively.

A summary of Made Ground samples identified as containing asbestos fibres at part of this investigation is presented in Table 17.

Table 17: Summary of Made Ground Samples Containing Asbestos Fibres – Waterman Investigation

Location, Depth (m bgl)	Asbestos Type	Concentration (%)
WTP06 – 0.30	Amosite loose fibres	<0.001
WTP06 – 0.50	Chrysotile and Crocidolite loose fibres and loose fibrous debris	0.005
WTP04 – 1.00	Chrysotile and Crocidolite loose fibres and loose fibrous debris	0.063
WWS05 – 0.30	Amosite loose fibres	<0.001
WWS08 – 2.00	Chrysotile and Amosite loose fibres	<0.001
WTP10 – 0.50	Chrysotile and Amosite loose fibres	<0.001

¹ Nathanail, C.P., McCaffrey, C., Gillett, A.G., Ogden, R.C. and Nathanail, J.F. 2015. The LQM/CIEH S4UIs for Human Health Risk Assessment. Land Quality Press, Nottingham.

² Environment Agency (2009). (Withdrawn). Soil Guideline Values for mercury in soil (Science Report No. SC050021 / Mercury SGV). Environment Agency (Bristol, UK)

WTP05 – 1.00

Amosite loose fibres

<0.001

Asbestos fibres have been identified in Made Ground across Ashley House. In light of this, and the presence of an ACM encountered by RSK at WTP06, there is potential for localised pockets of ACMs to be present across Ashley House.

9.1.2 Risk From Soils Contamination at Cannon Factory

Future Site Users

Isolated GAC exceedances of lead were reported in shallow Made Ground at WWS01 and WTP11. A marginal exceedance of di-benzo(a,h.)anthracene was also reported in shallow Made Ground at WTP03. The lead exceedance at WTP11 may be associated with some localised multicoloured clay (potentially lead paint) that was encountered in Made Ground at this location and depth.

Four slight exceedances of TPH Aromatic C21-35 were reported in samples taken from exploratory holes in the east of Cannon Factory. The samples were taken from the Kempton Park Gravel Member at depths of between 2.20 and 3.00m bgl and the exceedances correspond with locations of dark grey staining and hydrocarbon odours. However, given the depth of the exceedances in the Kempton Park Gravel Member, this contamination will present a low risk to future Site users.

The contamination recorded to be elevated at the Site is of low volatility within the subsurface. The proposed development will either comprise buildings or associated hardstandings indicating the potential risk of contact with the underlying soils is low. Areas of soft landscaping will be incorporated into the development which will require an engineered cover system to ensure the end-user remains isolated from the underlying soils.

The nature of contamination reported in shallow soils is similar to that reported by Socotec and RSK (asbestos and speciated PAHs). Furthermore, asbestos containing materials (ACMs) have been identified in Made Ground by this investigation and those undertaken previously by RSK and Socotec. Therefore, it has been confirmed that capping layers will be required in proposed soft landscaping areas to break the direct contact (ingestion, dermal contact, dust and fibre inhalation).

The absence of ACMs in site-won concrete needs to be confirmed prior to any processing for recycled aggregates.

Off-site Users (Residential and Commercial)

Potential risks to off-site users from elevated contaminants in Made Ground and shallow natural soils include inhalation of contaminated dusts and fibres during groundworks. These risks can be mitigated using standard techniques employed during construction works such as dust suppression, dampening down of exposed surfaces and covering of stockpiles. These measures would be typically implemented and managed through a Construction Environmental Management Plan (CEMP).

Construction Workers

Construction and maintenance workers should wear appropriate Personal Protective Equipment (PPE) during any below ground works in order to mitigate potential effects from direct contact, dermal absorption, inhalation, and ingestion of contaminants in soils and groundwater and asbestos in soils. The requirements included within the Confined Space Regulations 1997 should be adhered to also.

All construction workers should be subject to mandatory health and safety requirements under the Construction, Design and Management (CDM) Regulations 2018 and Control of Substances Hazardous to Health (COSHH) Regulations 2002 and Control of Asbestos Regulations 2012 (CAR 2012).

Asbestos has been identified in Made Ground and embedded in the underside of buried concrete slabs. Therefore, construction workers should be asbestos awareness trained. An Asbestos Risk Assessment and Plan of Work should also be prepared in accordance with CAR 2012 prior to work commencing.

9.1.3 Risk from Soils Contamination at Ashley House

Future Site Users

Isolated GAC exceedances of lead were reported in shallow Made Ground at WWS09 and WTP10. Exceedances of several speciated PAHs were also reported in shallow Made Ground at WTP05, WTP07, and WWS08. Exceedances are generally marginal. Asbestos fibres have also been identified in Made Ground at several locations across the Site.

The contamination recorded to be elevated at the Site is of low volatility within the subsurface. The proposed development will either comprise buildings or associated hardstanding indicating the potential risk of contact with the underlying soils is low. Areas of soft landscaping will be incorporated into the development which will require an engineered cover system to ensure the end-user remains isolated from the underlying soils.

The nature of contamination reported in soils is similar to that reported by Socotec and RSK (asbestos, arsenic, lead, nickel, speciated PAHs, and TPHs). Furthermore, ACMs have been identified in Made Ground at WS102 at 1.00m bgl by the RSK investigation. It is further confirmed that capping layers will be required in proposed soft landscaping areas to break the direct contact (ingestion, dermal contact, dust and fibre inhalation).

Off-site Users (Residential and Commercial)

Potential risks to off-site users from elevated contaminants in Made Ground and shallow natural soils include inhalation of contaminated dusts and fibres during groundworks. These risks can be mitigated using standard techniques employed during construction works such as dust suppression, dampening down of exposed surfaces and covering of stockpiles. These measures would be typically implemented and managed through a CEMP.

Construction Workers

Construction and maintenance workers should wear appropriate PPE during any below ground works in order to mitigate potential effects from direct contact, dermal absorption, inhalation, and ingestion of contaminants in soils and groundwater and asbestos in soils. The requirements included within the Confined Space Regulations 1997 should be adhered to also.

All construction workers should be subject to mandatory health and safety requirements under the CDM Regulations 2018, COSHH Regulations 2002, and CAR 2012.

Asbestos has been identified in Made Ground. Therefore, construction workers should be asbestos awareness trained. An Asbestos Risk Assessment and Plan of Work should also be prepared in accordance with CAR 2012 prior to work commencing.

9.1.4 Risk from Vapours

Cannon Factory

Exceedances of soil GAC for contaminants with a significant vapour phase were not identified. Furthermore, soils headspace analysis reported negligible concentrations of VOCs.

Assessment of groundwater chemical analysis against (SoBRA) derived GAC_{GWVAP} for residential end-use also reported no exceedances. Therefore, a significant vapour regime is not inferred at the Cannon Factory Site and the risk to future site users and off-site users is low and the assessed risk is consistent with conclusions made in the Socotec report.

Ashley House

Exceedances of soil GAC for contaminants with a significant vapour phase were limited to a slight exceedance of naphthalene in WTP07 at 1.00m bgl. Given the exceedance is marginal and isolated, this is not indicative of a significant vapour regime in soils at the Ashley House Site. Furthermore, an exceedance is no longer reported if the GAC is adjusted to 5.60mg/kg to account for the 2.5% organic matter content of the sample. Soil headspace analysis also reported negligible concentrations of VOCs.

Assessment of groundwater chemical analysis against (SoBRA) derived GAC_{GWVAP} for residential end-use also reported no exceedances. Therefore, a significant vapour regime is not inferred at the Ashley House Site and the risk to future site users and off-site users is low and the assessed risk is consistent with conclusions made in the Socotec report.

9.2 Risk to Controlled Waters

9.2.1 Shallow Aquifer and Surface Waters

A summary of freshwater EQS exceedances reported at Cannon Factory and Ashley House from this investigation are presented in Table 18.

Table 18: Summary of generic quantitative risk assessment for controlled waters

Contaminant	Location	Concentration (ug/l)	Generic Assessment Criteria (EQS) (ug/l)	Comments
Cannon Factory				
Dissolved chromium	WWS10	8.5	4.70	Low-level isolated exceedance. Chromium reported as below the laboratory limit of detection (<0.2ug/l) in BH02 downgradient of groundwater flow.
Dissolved lead	WWS10	16	11.80*	Low-level isolated exceedance. Lead reported as below the laboratory limit of detection (<0.2ug/l) in BH02 downgradient of groundwater flow.
Dissolved manganese	WWS10	3,600	701.43*	Metabolic by-product indicative of biodegradation of organic compounds in the groundwater. ³
	WWS02	8,300		
	BH02	2,500		
Anthracene	BH02	0.28	0.10	Low-level exceedance typical of former brownfield Sites. Anthracene has low mobility in groundwater. ⁴
Fluoranthene	BH02	0.24	0.0063	Low-level exceedance typical of former brownfield Sites. Fluoranthene has low mobility in groundwater. ⁴
Ashley House				

³ Guidance on the Assessment and Monitoring of Natural Attenuation of Contaminants in Groundwater. R&D Publication 95. Environment Agency. 2000.

⁴ CL:AIRE, 2017. Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies. CL:AIRE, London

Contaminant	Location	Concentration (ug/l)	Generic Assessment Criteria (EQS) (ug/l)	Comments
Anthracene	WWS06	0.23	0.1	Low-level exceedance typical of former brownfield Sites. Anthracene has low mobility in groundwater. ⁴
Fluoranthene	WWS06	1.11	0.0063	Low-level exceedance typical of former brownfield Sites. Fluoranthene has low mobility in groundwater. ⁴
Benzo(a)pyrene	WWS06	0.35	0.00017	Low-level exceedance typical of former brownfield Sites. Benzo(a)pyrene has very low mobility in groundwater. ⁴
Benzo(b)fluoranthene	WWS06	0.51	0.00017	Low-level exceedance typical of former brownfield Sites. Benzo(b)fluoranthene has very low mobility in groundwater. ⁴
Benzo(k)fluoranthene	WWS06	0.2	0.00017	Low-level exceedance typical of former brownfield Sites. Benzo(k)fluoranthene has very low mobility in groundwater. ⁴

⁴EQS_{bioavailable} calculated for copper, lead, nickel, manganese, and zinc using the Water Framework Directive UK Technical Advisory Group (WFD-UKTAG) Metal Bioavailability Assessment Tool (M-BAT) using the following parameters from Pymmes Brook surface water sampling: DOC: 9.83mg/l, pH: 7.4, calcium: 130mg/l. An Ambient Background Concentration (ABC) for dissolved zinc of 3.3µg/l has been used, corresponding to the Lee area/region⁵.

The exceedances reported in Table 18 are not indicative of significant groundwater contamination at the Cannon Factory and Ashley House Sites. Slightly elevated concentrations of speciated PAHs in groundwater are typical of urban and brownfield Sites. Furthermore, the PAHs reported are of low and very low mobility and, therefore, significant migration will not occur and the risk to the Kempton Park Gravel Member Secondary A Aquifer is low.

Isolated slightly elevated concentrations of chromium and lead have been reported at Cannon Factory. However, these were not detected in BH02 downgradient. Therefore, significant attenuation is occurring and the risk to the Kempton Park Gravel Member Secondary A Aquifer from lead and chromium in groundwater at Cannon Factory is low.

Given the distance to Pymmes Brook and inferred groundwater flow direction, the risk to surface waters from these slightly elevated concentrations of metals and PAHs is low.

The elevated concentrations of manganese are indicative of biodegradation of organic compounds in the groundwater. This is discussed further below.

Whilst there are no freshwater EQS for TPH, the WHO have produced a health-based risk assessment for drinking waters with regard to TPH⁶ aliphatic bands C8-C10, C10-C12, and C12-C16, and aromatic bands C8-C10, C10-C12, C12-C16, C16-C21, and C21-C35. These values have been used as conservative reference criteria to screen groundwater TPH concentrations against. A summary of exceedances is presented in Table 19. Further discussion on TPH concentrations in groundwater is presented in Section 9.2.3.

⁵ Water Framework Directive – United Kingdom Advisory Group (WFD-UKTAG). July 2014. UKTAG Guide to the Metal Bioavailability Assessment Tool (M-BAT).

⁶ World Health Organisation - Petroleum Products in Drinking Waters, Background document for development of WHO Guidelines for Drinking-water Quality. Ref. WHO/SDE/WSH/05.08/123, 2008.

Table 19: Summary of WHO drinking water standards exceedances

TPH-CWG Banding	Location	Concentration (ug/l)	Drinking Water Standard (DWS) (ug/l)
Cannon Factory			
Aliphatic			
>C12-C16	WWS10	1,300	300
Ashley House			
Aromatic			
>C10-C12	BH04	120	90

9.2.2 Evidence of Biodegradation of Organic Compounds

Evidence of biodegradation of organic contamination has been identified in groundwater sampled from Cannon Factory and Ashley House.

Oxygen is the most favoured electron acceptor for microbes in the biodegradation of organics and micro-organisms will generally use electron acceptors in the following order of preference: oxygen, nitrate, Manganese IV, iron III, sulphate, CO₂. Low concentrations of dissolved oxygen are typical in groundwater where biodegradation of organic compound is taken place and metabolic by-products from nitrate, manganese IV, iron III, and sulphate reduction are anticipated, including: nitrite, manganese II, iron II, and sulphide. A potential increase in concentrations of inorganic carbon and chloride could also indicate biodegradation of organic compounds.³

The evidence that biodegradation is occurring at Cannon Factory and Ashley House is summarised in Table 20. The highest concentrations of metabolic by-products were reported in locations where TPH contamination has been reported in groundwater by the Waterman investigation or from groundwater analysis previously undertaken by Socotec.

Table 20: Groundwater parameters indicating biodegradation of organic contamination

Screening Factor	Reported Groundwater Results	Lines of Evidence ^{4,7} / Comments
pH	Cannon Factory: 6.9 – 7.1 Ashley House: 7.0 – 7.5	Optimal pH range for microbial degradation lies between approximately 6 and 8.5.
Dissolved Oxygen (electron acceptor) (Stabilised Readings)	Cannon Factory: <0.01 – 0.16 mg/l Ashley House: 0.18 – 3.38 mg/l	Highest energy-yielding electron acceptor for biodegradation of organic constituents. Dissolved oxygen concentrations <1.0mg/l are indicative of anaerobic conditions. Anaerobic degradation is unlikely to occur at dissolved oxygen concentrations >0.5mg/l, and does not occur at concentrations greater than 1mg/l. A decrease in dissolved oxygen concentration is a trend associated with biodegradation. Most recorded dissolved oxygen concentrations indicate anaerobic conditions at Cannon Factory and Ashley House. Aerobic conditions reported in WWS06 (3.38 mg/l) and BH103 (3.1 mg/l) at Ashley House favours ongoing biodegradation by aerobic respiration.
Nitrate (electron acceptor)	Cannon Factory: 0.10 – 4.99 mg/l Ashley House: 0.09 – 14.8	Decrease in concentration is evidence of biodegradation. Thermodynamically next favourable electron acceptor after oxygen for microbial degradation of organics. Depletion indicates (denitrification) anaerobic degradation of organics. Cannon Factory: Lowest concentration reported in BH02. Ashley House: Lowest concentration reported in BH04.
Nitrite (metabolic by-product from biodegradation)	Cannon Factory: <1.0 – 200 ug/l Ashley House: <1.0 – 220 ug/l	Cannon Factory: Highest concentration reported in BH02. Ashley House: Highest concentration reported in WWS06.
Manganese IV (electron acceptor)	Cannon Factory: <0.02 – 1.34 mg/l Ashley House: <0.02 – 0.77 mg/l	May act as an electron acceptor during anaerobic degradation of contaminants where more thermodynamically favourable electron acceptors are absent. Cannon Factory: Lowest concentration reported in BH01. Ashley House: Lowest concentration (<0.02mg/l) reported in BH102, BH04, BH101, BH103.
Manganese II (metabolic by-product from biodegradation)	Cannon Factory: 0.03 – 6.34 mg/l Ashley House: 0.06 – 1.89 mg/l	Indicator of anaerobic degradation of organics, where manganese (IV) acts as an electron acceptor. Cannon Factory: Highest concentration reported in WWS02. Ashley House: Highest concentration reported in WWS06.

⁷ Lines of evidence as detailed in *Guidance on the Assessment and Monitoring of Natural Attenuation of Contaminants in Groundwater*. R&D Publication 95. Environment Agency. 2000.

Screening Factor	Reported Groundwater Results	Lines of Evidence ^{4,7} / Comments
Iron (III) (electron acceptor)	Cannon Factory: <0.20 mg/l Ashley House: <0.20 mg/l	Biologically available Fe (III) can act as an electron acceptor during anaerobic degradation of organics. Cannon Factory: Reported as below the laboratory limit of detection in BH01, BH02, WWS02, and WWS10. Ashley House: Reported as below the laboratory limit of detection in BH102, BH04, BH101, BH103, WWS06, WS109.
Iron (II) (metabolic by-product from biodegradation)	Cannon Factory: <0.20 – 0.92 mg/l Ashley House: <0.20 – 0.82 mg/l	Indication of iron (III) reduction during microbial degradation of organic compounds in the absence of oxygen, nitrate and manganese (IV). Cannon Factory: Highest concentration reported in WWS10. Ashley House: Highest concentration reported in BH04.
Sulphate (electron acceptor)	Cannon Factory: 40.4 – 174 mg/l Ashley House: 89.2 – 390 mg/l	Used as an electron acceptor in biodegradation of organic constituents. Reduced to form sulphide. Cannon Factory: Lowest concentration reported in BH01. Ashley House: Lowest concentration reported in WWS08
Sulphide (metabolic by-product from biodegradation)	Cannon Factory: <5.0 – 4,200 ug/l Ashley House: <5.0 ug/l	Microbially reduced form of sulphate. Indicates reduced conditions. Cannon Factory: Highest concentration reported in WWS10. Ashley House: Reported as below the laboratory limit of detection in BH102, BH04, BH101, BH103, WWS06, WWS08, WS109.
Inorganic Carbon	Cannon Factory: 38.8 – 97.1 mg/l Ashley House: 46.6 – 121 mg/l	Increases due to biodegradation of organic compounds. Cannon Factory: Highest concentration reported in WWS10. Ashley House: Highest concentration reported in WWS06 and WWS08
Chloride	Cannon Factory: 15 – 67 mg/l Ashley House: 43 – 350 mg/l	Cannon Factory: Highest concentration reported in BH02. Ashley House: Highest concentration reported in WWS06.

9.2.3 TPH in Groundwater

Cannon Factory

Elevated concentrations of TPH were reported in groundwater samples from WWS02 and WWS10 in the east of the Cannon Factory Site. Reported concentrations of total TPH-CWG (C5-44) in these samples were 25mg/l and 160mg/l respectively. All of the TPH in groundwater sampled from WWS02 and WWS10 was reported in aliphatic carbon bands, mostly in carbon bands C21-C35.

A summary of the groundwater TPH-CWG analysis is presented in Table 21.

Table 21: Summary of TPH-CWG analysis at Cannon Factory

	BH01	BH02	WWS02	WWS10
TPH-CWG Banding (ug/l)				
Aliphatic				
>C5-C6	<1.0	<1.0	<1.0	<1.0
>C6-C8	<1.0	<1.0	<1.0	<1.0
>C8-C10	<1.0	<1.0	<1.0	<1.0
>C10-C12	<10	<10	<10	<10
>C12-C16	<10	<10	<10	1,300
>C16-C21	<10	<10	3,800	38,000
>C21-C35	<10	<10	20,000	120,000
>C35-C44	<10	<10	340	370
Total Aliphatics (C5-C44)	<10	<10	25,000	160,000
Aromatic				
>C5-C7	<1.0	<1.0	<1.0	<1.0
>C7-C8	<1.0	<1.0	<1.0	<1.0
>C8-C10	<1.0	<1.0	<1.0	<1.0
>C10-C12	<10	<10	<10	<10
>C12-C16	<10	<10	<10	<10
>C16-C21	<10	<10	<10	<10
>C21-C35	<10	<10	<10	<10
>C35-C44	<10	<10	<10	<10
Total Aromatics (C5-C44)	<10	<10	<10	<10

Made Ground and shallow soils encountered during the ground investigation at the Cannon Factory did not indicate visual or olfactory signs of TPH contamination and correspondingly the Made Ground soils subject to laboratory testing recorded concentrations that were below the GACs. An obvious shallow soil source has therefore not been identified to date.

The recorded geology at the Site indicates a silt / clay layer overlying the Kempton Park Member, which would provide a low permeability layer inhibiting potential vertical migration of contamination.

However, visual and olfactory evidence of hydrocarbon contamination was identified in natural soils at depth (beneath the low permeability clay /silt layer) associated with the Kempton Park Gravel Member at or around the level of groundwater in the east of Cannon Factory (exploratory holes WWS02, WWS10, and WWS11).

Laboratory analysis of the natural soils reported total speciated TPH (C5-C44) concentrations of up to 15,300mg/kg (reported in WWS02 at 2.80m bgl). The Socotec investigation also recorded hydrocarbon odours in the Kempton Park Gravel Member at BH02. However, RSK exploratory holes PH2, PH4, PH5, PH6, and Socotec exploratory holes PH3C and PH3B, also in the east of the Site, did not record visual or olfactory evidence of hydrocarbon contamination in Made Ground, Enfield Silt Member, or the Kempton Park Gravel Member and reported negligible concentrations of PAHs and TPHs in analysed soils (up to 1.5m bgl).

The vast majority of the TPH in samples of Kempton Park Gravel Member from WWS02, WWS10, WWS11, and BH02 has been reported in aliphatic and aromatic carbon bands C21-C35. Furthermore, laboratory interpretation of the groundwater and soils TPH analysis suggested the contamination is lubricating oil.

The apparent absence of current potential sources of the TPH, such as existing tanks or gross contamination in Made Ground soils indicates the contamination is from a historic source, potentially relating to the Site's former use for rubber manufacturing around the mid-1900s. Furthermore, historical maps dated 1961 and 1977, presented in the RSK Cannon Factory report, show potential small tanks in the north-east of the Site.

Assessment of Risk

A shallow soil source has not been identified to date in the Made Ground, however, it is recognised that the Site is a former industrial premises with a former potential tank recorded in the north-east of the Site. Site conditions indicate a low permeability layer overlying the permeable Kempton Park Member, with TPH present beneath this layer associated with the smear zone soils and within the shallow groundwater.

As part of the redevelopment it will be recommended that the impacted smear zone soils will be removed and disposed of off-site. In addition, a Watching Brief will be recommended to address unexpected visual and olfactory evidence of contamination recorded during earthworks, together with inspection of the former tank area.

The direction of groundwater migration has been inferred east to west, with elevated TPH concentrations recorded in the groundwater at boreholes (WWS02, WWS10) and soils in the groundwater smear zone in WWS11) at the east, but not in boreholes BH01 and BH02 west of these locations. The migration of contamination is considered to be limited across the Site for a number of reasons. The majority of the contamination recorded in the groundwater is contained in carbon bands aliphatic C21-C35, indicated as lubricating oil, which typically has a low mobility in the environment and does not readily migrate. In addition, the falling head tests completed at the Site demonstrate a low hydraulic conductivity of the gravel at both sites which indicates further a limited potential for migration. The qualitative lines of evidence indicate the risk from the Site to the surrounding environment is low.

To further confirm the low risk a Controlled Waters Detailed Quantitative Risk Assessment (DQRA) was undertaken for the Cannon Factory site using the EA Remedial Targets Methodology (RTM). The derivation methodology of the physical and chemical input parameters together with the sensitivity analysis and model outputs is presented in the Appendix E sub-section I.

Based on the low mobility of the identified contaminants, limited hydraulic gradient and low hydraulic conductivity recorded within the Kempton Park Gravels the derived Remedial Target Values (RTVs) at a 50m compliance point identifies no exceedances in the groundwater, A summary of the output of the RTM model is provided in Table 22: Summary of RTM model results Cannon Factory .

Table 22: Summary of RTM model results Cannon Factory

Contaminant	Initial Concentration (mg/l)	Target Concentration (mg/l)	RTV at Compliance Point (mg/l)	Groundwater Exceedances
Fluoranthene	2.8×10^{-4}	6.3×10^{-6}	3.18×10^7	None
Benzo(b)fluoranthene	1×10^{-5}	1.7×10^{-7}	5.78×10^3	None
Benzo(k)fluoranthene	1×10^{-5}	1.7×10^{-7}	1.38×10^{-2}	None
Aromatic >C05-C06 (Benzene)	1×10^{-5}	0.01	8.06×10^{11}	None
Aromatic >C08-C10 (Xylenes)	1×10^{-5}	0.03	2.24×10^{19}	None
Aromatic >C10-C12	1×10^{-3}	0.09*	1.99×10^{27}	None
Aromatic >C12-C16	1×10^{-3}	0.09*	2.19×10^{11}	None
Aromatic >EC16-EC21 (anthracene)	1×10^{-5}	1.0×10^{-4}	2.43×10^8	None
Aromatic >EC16-EC21	0.01	0.09*	1.20×10^4	None
Aromatic >EC21-EC35 (benzo[a]pyrene)	1×10^{-5}	1.7×10^{-7}	4.49×10^4	None
Aromatic >EC21-EC35	0.01	0.09*	1.20×10^4	None
Aliphatic >C5-C6	1×10^{-3}	15*	9.19×10^3	None
Aliphatic >C12-C16	1.3	0.3 *	1.84×10^2	None
Aliphatic >C16-C21	38	0.3 *	1.84×10^2	None
Aliphatic >C21-C35	120	0.3 *	1.84×10^2	None
Aliphatic >C35-C44	0.37	0.3 *	1.84×10^2	None

* World Health Organization (WHO) guide values for TPHCWG fractions in drinking water

The RTM model therefore confirms hydrocarbon contaminants are not posing a risk to controlled water receptors. The RTM worksheets are presented in Appendix E sub-section III.

The multiple lines of evidence including geology, hydraulic conditions, contamination mobility together with the quantitative assessment indicate the risk from the groundwater at the Site to the surrounding environment is low.

Ashley House

Reported concentrations of total speciated TPH (C5-C44) in groundwater at Ashley House range from <10 to 4,000ug/l. However, total speciated TPH concentrations in four of the seven monitoring wells (BH101, BH102, BH103, and WWS08) were all below the laboratory limit of detection (10ug/l).

A summary of groundwater TPH-CWG results reported above the laboratory limit of detection is presented in Table 23.

Table 23: Summary of TPH-CWG analysis results above the laboratory limit of detection at Ashley House

	BH04	WWS06	WS109
TPH-CWG Banding	Concentration (ug/l)		
Aliphatic			
>C5-C6	130	<1.0	26
>C6-C8	<1.0	<1.0	<1.0
>C8-C10	<1.0	<1.0	<1.0
>C10-C12	<10	<10	<10
>C12-C16	<10	48	<10
>C16-C21	<10	560	<10
>C21-C35	<10	3,100	<10
>C35-C44	<10	230	<10
Total Aliphatics (C5-C44)	130	4,000	26
Aromatic			
>C5-C7	<1.0	<1.0	<1.0
>C7-C8	<1.0	<1.0	<1.0
>C8-C10	<1.0	<1.0	<1.0
>C10-C12	120	<10	<10
>C12-C16	20	<10	<10
>C16-C21	20	<10	<10
>C21-C35	<10	<10	<10
>C35-C44	<10	<10	<10
Total Aromatics (C5-C44)	160	<10	<10

WS109 reported a total speciated TPH concentration of 26ug/l (all of which was reported in aliphatic band C5-C6), and BH04 reported 290ug/l (reported mostly in aliphatic band C5-C6 and aromatic band C10-C12). WWS06 is about 50m downgradient of groundwater flow from WS109 and BH04. However, concentrations of TPH in aliphatic band C5-C6 and aromatic band C10-C12 at this location were reported as below the laboratory detection limits of <1.0ug/l and <10 respectively. Therefore, significant attenuation, and biodegradation (as evidenced in Table 19) is inferred.

The TPH concentration of 4,000ug/l in WWS06 was reported entirely in aliphatic carbon bands ranging from C12-C44 which have a very low mobility⁴. The absence of aromatics and lighter chain TPH suggests a heavily degraded historical contamination source. Groundwater analysis from BH03 (adjacent north-east of WWS06) undertaken by Socotec reported a total speciated TPH concentration of 55ug/l. This was reported entirely in low to very low mobility carbon bands of C16-C35. Therefore, is apparent the contamination reported WWS06 is localised. The localised nature of the contamination was further demonstrated by a second round of groundwater analysis which reported TPH-CWG (C5-44) as below the laboratory limit of detection (<10ug/l).

Evidence of hydrocarbon contamination was not recorded during drilling of WWS06 or BH03 and TPH concentrations in soils analysed from depths of between 0.30 and 3.50m bgl in WWS06 were below the laboratory limit of detection (<10mg/kg). BH03 reported low levels of speciated TPH (<100mg/kg) in soil samples analysed from depths of between 0.40 and 2.3m bgl. The TPH identified in groundwater at

WWS06 may be associated with historical above ground tanks that were situated around this location when the Site operated as a printing ink and varnish works from around the 1930s to around the 1960s.

Assessment of Risk

Potential sources of contamination exist at the Ashley House Site in the form of underground diesel tanks in the east of the Site that remain in-situ. Furthermore, historical tanks were present on-site during its operation as a printing ink and varnish works from around the 1930s to around the 1960s. The presence of these potential contaminant sources likely resulted in entry of hydrocarbon contamination to soils and groundwater.

As part of the redevelopment it will be recommended that tanks remaining in-situ are decommissioned and removed along with surrounding impacted soils. In addition, a Watching Brief will be recommended to address unexpected visual and olfactory evidence of contamination recorded during earthworks, together with inspection of the former tank areas.

A Controlled Waters Detailed Quantitative Risk Assessment (DQRA) was undertaken for the Ashley House site using the EA Remedial Targets Methodology (RTM) to confirm the identified risks remain low at the site. The derivation methodology of the physical and chemical input parameters together with the sensitivity analysis and model outputs is presented in the Appendix E sub-section IV.

Based on the low mobility of the identified contaminants, limited hydraulic gradient and low hydraulic conductivity recorded within the Kempton Park Gravels the derived Remedial Target Values (RTVs) at a 50m compliance point identifies no exceedances in the groundwater. The RTM model therefore identifies hydrocarbon contaminants as not posing a risk to controlled water receptors. The RTM worksheets are presented in Appendix E sub-section VI., a summary of the out put is provided in Table 24

Table 24: Summary of RTM model results Ashley House

Contaminant	Initial Concentration (mg/l)	EQS (mg/l)	RTV at Compliance Point (mg/l)	Groundwater Exceedances
Aromatic >C5-C6 (Benzene)	0.03	0.01	8.57x10 ³	None
Aromatic >C8-C10 (Xylenes)	1.35	0.03	5.25x10 ⁷	None
Aromatic >C10-C12	0.12	0.09*	6.05x10 ¹¹	None
Aromatic >C12-C16	0.02	0.09*	1.49x10 ⁴	None
Aromatic >EC16-EC21 (anthracene)	2.3x10 ⁻⁴	1.0x10 ⁻⁴	16.6	None
Aromatic >EC16-EC21	0.02	0.09*	7.66	None
Aromatic >EC21-EC35 (benzo[a]pyrene)	3.5x10 ⁻⁴	1.7x10 ⁻⁷	9.99x10 ⁻³	None
Aromatic >EC21-EC35	0.01	0.09*	7.66	None
Aliphatic >C5-C6	0.13	15*	1.44x10 ²	None
Aliphatic >C12-C16	0.048	0.3*	2.89	None
Aliphatic >C16-C21	0.56	0.3*	2.89	None
Aliphatic >C21-C35	3.1	0.3*	2.89	1 (WWS06)

Aliphatic >C35-C44	0.23	0.3*	2.89	None
* World Health Organization (WHO) guide values for TPHCWG fractions in drinking water				

These exceedance for WWS106 is not consider significant for the following reasons. WWS06 is approximately 20m fro the west boundary of the site and the model shows that within 54 m the RTV is greater than the concentration measure at WWS06. The second round of sampling from WWS06 did not detect C21 to C35 above the limit of detection confirming the contamination detected is not representative of wide spread contamination at this location. Also using the WHO DWS as the assessment criteria is conservative as the water in the aquifer being assessed will not and is not abstracted from for drink water.

The multiple lines of evidence including geology, hydraulic conditions, contamination mobility together with the quantitative assessment indicate the risk from the groundwater at the Site to the surrounding environment is low.

Underground diesel tanks in the east of the Ashley Road site remain in-situ and will require removal as part of redevelopment works.

9.2.4 Deep Aquifers

The Sites are underlain by about 20m of cohesive deposits of the London Clay Formation and Lambeth Group. Therefore, downward migration of shallow contamination is prevented. However, developments at Ashley House and Cannon Factory are expected to utilise piled foundation solution. Therefore, there is potential for hydrocarbon contamination to be driven downwards and, if foundations are to founded below cohesive deposits of the Lambeth Group, created a preferential pathway for contamination to impact on the aquifers at depth.

The risks from creating preferential pathways from piling can be mitigated by undertaking a Foundation Work Risk Assessment and use of appropriate piling methods.

9.3 Risk to Structures

9.3.1 Buried Concrete

The risk of chemical attack to buried concrete can be mitigated by selecting a concrete class appropriate for the ground conditions in accordance with BRE-Special Digest 1.

Assessment of the appropriate concrete class is presented in the Socotec report (Ref. D8061-18, August 2019).

9.3.2 Water Supply Pipes

Drinking water supply pipes are to be placed into clean service corridors using barrier pipe. The UKWIR project steering group decided that barrier pipes would provide sufficient protection for the supply of drinking water in all Brownfield site conditions. This approach would need to be agreed with Thames Water.

9.4 Risk from Ground Gas

A detailed ground gas risk assessment has been undertaken which includes a review of on and off-site potential sources of ground gas and information obtained by the RSK investigations. The detailed ground gas risk assessment includes a review of previous ground gas monitoring data, review of the source – pathway – receptor linkages, and a revised risk assessment. The assessment concludes that ground gas protection measures are not required for the developments at Cannon Factory and Ashley House. Additional commentary on how this conclusion was reached is presented in Table 6 in Section 5 above.

A copy of the assessment is presented as Appendix F.

Made Ground encountered as part of this investigation is consistent with the investigations undertaken by RSK and Socotec. Significant quantities of potentially putrescible materials were not encountered. Therefore, the conclusions of the detailed ground gas risk assessment remain relevant and the assessment does not require revisiting.

10. Conclusions and Risk Evaluation

Following the implementation of the ground investigation, the Socotec Conceptual Site Model has been re-evaluated and reclassified in relation to the additional information obtained, using the risk rating matrix presented in Appendix G and Assessment criteria in Appendix I. The results of the reassessment are summarised in Table 25 and Table 26.

The supplementary ground investigation and subsequent risk assessment has filled information gaps and addressed comments from the Haringey Council Pollution Officer through the following actions:

- Targeting Socotec ground investigation locations (PH1A, PH3, PH3A, BH03, and BH04) to recover and analyse soil samples for hydrocarbon analysis where deviating results were previously reported;
- Targeting gaps in area coverage;
- Installation of additional groundwater monitoring wells to establish groundwater flow direction, establish up and downgradient concentrations of contaminants, identify sources of contamination and risk to groundwater quality;
- Additional investigation locations around BH02 at Cannon Factory to identify and delineate the source of previously identified contamination at BH02;
- Additional groundwater level monitoring and groundwater sampling to inform controlled waters risk assessment;
- Use of low flow groundwater sampling techniques to minimise potential loss of volatile contaminant during sampling;
- Controlled water risk assessment using site-specific zinc, lead, nickel, copper, manganese assessment criteria derived using the EA M-BAT tool;
- A revised ground gas risk assessment;
- A revised controlled waters risk assessment;
- A revised Conceptual Site Model.

Table 25: Revise Conceptual Site Model – Ashley House

Receptor	Potential sources	Pathways	Risk	Justification
Human Health				
Future site occupants	On-site historical factory and works: Fuel oils, heavy metals, solvents, lubricating oils, PAHs, asbestos, cyanides. On-site historical and current storage tanks and other point sources (1930s–current): Current two diesel tanks and interceptor – petroleum hydrocarbons (fuels oils) Historical tanks – petroleum hydrocarbons, chlorinated solvents, cyanides, metals. Current warehouses and potential chemical storage onsite: Asbestos, hydrocarbons lube oil, kerosene, trichloroethylene (TCE).	Direct contact (ingestion, dermal contact, dust and fibre inhalation)	Medium	Ground investigations have reported elevated concentrations of metals, PAHs, and TPHs in shallow soils. ACM fragments and asbestos fibres have also been recorded in Made Ground. Clean capping layers will be required in soft landscaping areas to break the contaminant pathways and reduce the risk to low.
		Vapour inhalation	Low	A Significant vapour risk has not been identified and vapour protection measures are now required. Underground diesel tanks and associated fill points and fuel links remain in-situ. The underground diesel fuel tanks, fill points and fuel lines will require decommissioning and removal as part of redevelopment works along with any surrounding impacted soils.
		Exposure to ground gases	Low	Detailed ground gas risk assessment shows a significant ground gas regime at the Site is not present and ground gas protection measures are not required for the development.
Adjacent site users (commercial)	Made Ground associated with previous phases of development: Unknown fill material (but potentially including heavy metals, ash, clinker, PAHs, asbestos etc.) Off-site current BP filling station to immediate south of site: Petroleum hydrocarbons. Off-site historical and current railways: Fuel oils, lubricating oils, heavy metals, PAHs, ash and asbestos.	Direct contact (ingestion, dermal contact, dust and fibre inhalation)	Low	Ground investigations have reported elevated concentrations of metals, PAHs, and TPHs in shallow soils. ACM fragments and asbestos fibres have also been recorded in Made Ground. It is considered unlikely, however, that these would affect occupants of nearby sites. Notwithstanding, risks to off-site users can be mitigated using standard techniques employed during construction works such as dust suppression, dampening down of exposed surfaces and covering of stockpiles. These measures would be typically implemented and managed through a Construction Environmental Management Plan (CEMP).
Adjacent site users (residential)	Historical landfill 601m north-east 1955 to 1962: landfill gases, leachate.	Exposure to ground gases and vapours	Low	Detailed ground gas risk assessment shows a significant ground gas regime at the Site. A significant vapour regime has not been identified at the Site. Therefore, the risk to off-site users from ground gas and vapour is low.

Receptor	Potential sources	Pathways	Risk	Justification
		Direct contact (ingestion, dermal contact, dust and fibre inhalation)	Low	Ground investigations have reported elevated concentrations of metals, PAHs, and TPHs in shallow soils. ACM fragments and asbestos fibres have also been recorded in Made Ground. It is considered unlikely, however, that these would affect occupants of nearby sites. Notwithstanding, risks to off-site users can be mitigated using standard techniques employed during construction works such as dust suppression, dampening down of exposed surfaces and covering of stockpiles. These measures would be typically implemented and managed through a Construction Environmental Management Plan (CEMP). Works will also proceed in line with CAR 2012.
Property				
Potable water supply pipes and buildings	Various current and historic industrial land uses on and off site, tanks, electrical substation, railway land, landfill and made ground from previous phases of development: PAHs, asbestos	Chemical attack on the proposed infrastructure (water supply pipes and buildings)	Medium	Potential risks to water supply pipes from contaminants in soils can be mitigated by installation of barrier pipes and clean service corridors. Potential risk to buried concrete can be mitigated by selecting a concrete class appropriate for the ground conditions in accordance with BRE-Special Digest 1. These measures will ensure the risks to potable water supply pipes and buried concrete are low.
Controlled Waters				
Groundwater (shallow Secondary A aquifer in the Kempton Park Gravel Member)	Various current and historic industrial land uses on and off site, tanks, electrical substation, railway land, landfill and made ground from previous phases of development: PAHs, asbestos	Lateral migration	Low	The revised controlled waters risk assessment demonstrates a low risk to controlled waters from contamination in the Kempton Park Gravel Member Secondary A Aquifer. However, current potential sources of contamination including underground diesel fuel tanks, fill points, and fuel lines will require decommissioning and removal as part of redevelopment works along with any surrounding impacted soils to reduce the risk to low.
Groundwater (deep aquifers underlying the London Clay Formation – Lambeth Group Secondary A Aquifer, Thanet Formation, Chalk)		Vertical and lateral migration	Low	Due to a substantial thickness (20m) of clay strata between the shallow (contaminated) groundwater and the deeper aquifer, migration of contaminants to the deeper aquifer is considered unlikely. The risks from creating preferential pathways from piling can be mitigated by undertaking a Foundation Work Risk Assessment and use of appropriate piling methods.

Receptor	Potential sources	Pathways	Risk	Justification
Group). Source Protection Zone 2.				
Surface watercourses and SSSI located to the east of the site			Low	The revised controlled waters risk assessment demonstrates a low risk to controlled waters from contamination in the Kempton Park Gravel Member Secondary A Aquifer. Given their distances from the Site, and groundwater flow path, the risk to surface watercourses and the SSSI is low.

Table 26: Revise Conceptual Site Model – Cannon Factory

Receptor	Potential sources	Pathways	Risk	Justification
Human Health				
Future site occupants	Various current and historic industrial land uses on and off site, tanks, electrical substation, railway land, landfill and made ground from previous phases of development: PAHs, asbestos	Direct contact (ingestion, dermal contact, dust and fibre inhalation)	Medium	Ground investigations have reported elevated concentrations of metals, PAHs, and TPHs in shallow soils. ACM fragments and asbestos fibres have also been recorded in Made Ground. Clean capping layers will be required in soft landscaping areas to break the contaminant pathways and reduce the risk to low.
		Vapour inhalation	Low	A Significant vapour risk has not been identified and vapour protection measures are now required.
		Exposure to ground gases	Low	Detailed ground gas risk assessment shows a significant ground gas regime at the Site is not present and ground gas protection measures are not required for the development.
Adjacent site users (commercial)		Direct contact (ingestion, dermal contact, dust and fibre inhalation)	Low	Ground investigations have reported elevated concentrations of metals, PAHs, and TPHs in shallow soils. ACM fragments and asbestos fibres have also been recorded in Made Ground. It is considered unlikely, however, that these would affect occupants of nearby sites. Notwithstanding, risks to off-site users can be mitigated using standard techniques employed during construction works such as dust suppression, dampening down of exposed surfaces and covering of stockpiles. These measures would be typically implemented and managed through a Construction Environmental Management Plan (CEMP).
Adjacent site users (residential)		Exposure to ground gases and vapours	Low	Detailed ground gas risk assessment shows a significant ground gas regime at the Site. A significant vapour regime has not been identified at the Site.

Receptor	Potential sources	Pathways	Risk	Justification
				Therefore, the risk to off-site users from ground gas and vapour is low.
		Direct contact (ingestion, dermal contact, dust and fibre inhalation)	Low	Ground investigations have reported elevated concentrations of metals, PAHs, and TPHs in shallow soils. ACM fragments and asbestos fibres have also been recorded in Made Ground. It is considered unlikely, however, that these would affect occupants of nearby sites. Notwithstanding, risks to off-site users can be mitigated using standard techniques employed during construction works such as dust suppression, dampening down of exposed surfaces and covering of stockpiles. These measures would be typically implemented and managed through a Construction Environmental Management Plan (CEMP).
Property				
Potable water supply pipes and buildings	Various current and historic industrial land uses on and off site, tanks, electrical substation, railway land, landfill and made ground from previous phases of development: PAHs, asbestos	Chemical attack on the proposed infrastructure (water supply pipes and buildings)	Medium	Potential risks to water supply pipes from contaminants in soils can be mitigated by installation of barrier pipes and clean service corridors. Potential risk to buried concrete can be mitigated by selecting a concrete class appropriate for the ground conditions in accordance with BRE-Special Digest 1. These measures will ensure the risks to potable water supply pipes and buried concrete are low.
Controlled Waters				
Groundwater beneath the site (shallow Secondary A aquifer in the Kempton Park Gravel Member)	Various current and historic industrial land uses on and off site, tanks, electrical substation, railway land, landfill and made ground from previous phases of development: PAHs, asbestos	Lateral migration	Low	The revised controlled waters risk assessment demonstrates a low risk to controlled waters from lateral migration of contamination in the Kempton Park Gravel Member Secondary A Aquifer due to its very low mobility. However, contamination in the smear zone will be delineated and removed to achieve a betterment of subsurface conditions.
Groundwater beneath the site (deep aquifers underlying the London Clay Formation – Lambeth Group Secondary A)		Vertical and lateral migration	Low	Potential risks to water supply pipes from contaminants in soils can be mitigated by installation of barrier pipes and clean service corridors. Potential risk to buried concrete can be mitigated by selecting a concrete class appropriate for the ground conditions in accordance with BRE-Special Digest 1.

Receptor	Potential sources	Pathways	Risk	Justification
Aquifer, Thanet Formation, Chalk Group). Source Protection Zone 2.				These measures will ensure the risks to potable water supply pipes and buried concrete are low.
Surface watercourses and SSSI located to the east of the site		Migration of chemicals through the shallow unsaturated zone and lateral migration in the groundwater	Low	The revised controlled waters risk assessment demonstrates a low risk to controlled waters from lateral migration of contamination in the Kempton Park Gravel Member Secondary A Aquifer due to its very low mobility. Given their distances from the Site, and groundwater flow path, the risk to surface watercourses and the SSSI is low.

11. Recommendations

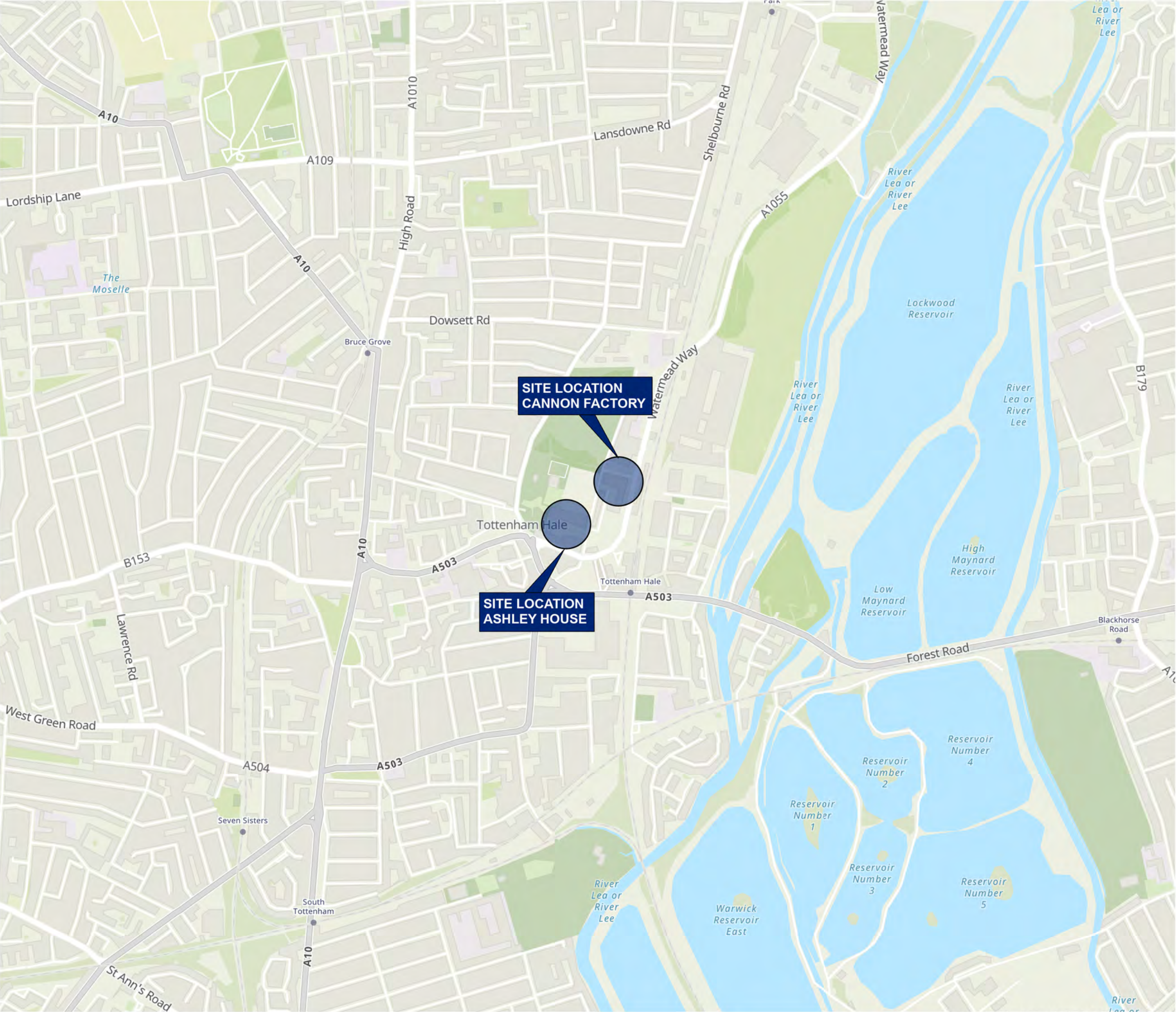
The following actions are recommended to address the potentially unacceptable risks that remain:

- A Remediation Strategy has been prepared (Report ref. WIE16248-100-R-1-2-1-RS) detailing remedial measures to be carried out as part of the site redevelopment. Remedial measures include, amongst others, removal of impacted material from the smear zone at the Cannon Factory following a delineation exercise. This is required to achieve betterment of subsurface contamination conditions. Removal of buried tanks are required at Ashley House. The Remediation Strategy also includes requirements where unforeseen or uncharted contaminants or buried potentially contaminative infrastructure is encountered. The Remediation also includes other requirements beyond these stated above. The Remediation Strategy should be fully consulted prior to works commencing to ensure the requirements of the Remediation Strategy are understood and can be adequately planned and accounted for.
- Soft landscaping areas will require capping layers of at least 600mm certified clean materials to break potential contaminant pathways between contaminants in soils and future Site users. Soils in soft landscaping areas should be suitable for a residential end-use;
- Clean service corridors, should be provided for new services to ensure a preferential pathway is not created for contamination to migrate off-site.
- Barrier pipes are recommended for water supply pipes to be placed into Site soils. This approach would need to be agreed with Thames Water;
- Potentially hazardous chemicals should be appropriately stored, banded and sited away from surface waters;
- Validation, import criteria for soils are presented in the Remediation Strategy and should be adhered to for all material imported to site.
- Construction workers should utilise appropriate PPE when undertaking handling soils and groundwater. If required, dampening down of material should take place during excavation works. Construction workers will adhere to good practice hygiene and safety measures, and the Control of Asbestos Regulations 2012.
- Asbestos fragments and fibres in soil have been encountered and construction workers should be asbestos awareness trained and works should be undertaken in accordance with the APoW. Appropriate measure should be in place to prevent fibre release and corresponding monitoring;
- Entry to confined spaces should be carried out in line with the Confined Space Entry Regulations 1997;
- The risk of chemical attack to buried concrete can be mitigated by selecting a concrete class appropriate for the ground conditions in accordance with BRE-Special Digest 1;
- Classification of waste soils in accordance with WM3 (in particular Appendix D on waste sampling) to confirm the findings of the Preliminary Waste Classification Assessment. Most of the soil samples did not return hazardous properties. Natural uncontaminated soils may be acceptable as inert waste without testing at some landfills;
- A Foundation Works Risk Assessment should be carried out to confirm piling will not pose a risk to controlled water receptors.
- Uncontaminated concrete may be recovered for reuse on-site subject to compliance with the WRAP Quality Protocol for Production of Aggregates from Inert Waste or recovered as inert waste subject to acceptance at an appropriately permitted facility;
- Verification Report(s) should be prepared following phases of work as required demonstrating works were carried out in line with the agreed Remediation Strategy

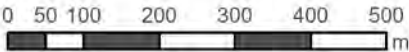
APPENDICES

Appendix A Site Plans

- **Site Location Plan**
- **Ground Investigation Plan – Cannon Factory**
- **Ground Investigation Plan – Ashley House**
- **Ground Investigation Locations – Ashley House (Waterman – 2023, Socotec – 2018, and RSK – 2015)**
- **Ground Investigation Locations – Cannon Factory (Waterman – 2023, Socotec – 2018, and RSK – 2015)**
- **Groundwater Contour Plot – Cannon Factory**
- **Groundwater Contour Plot – Ashley House**



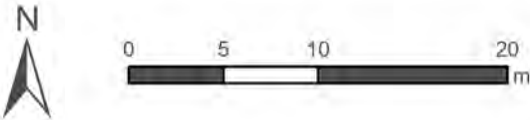
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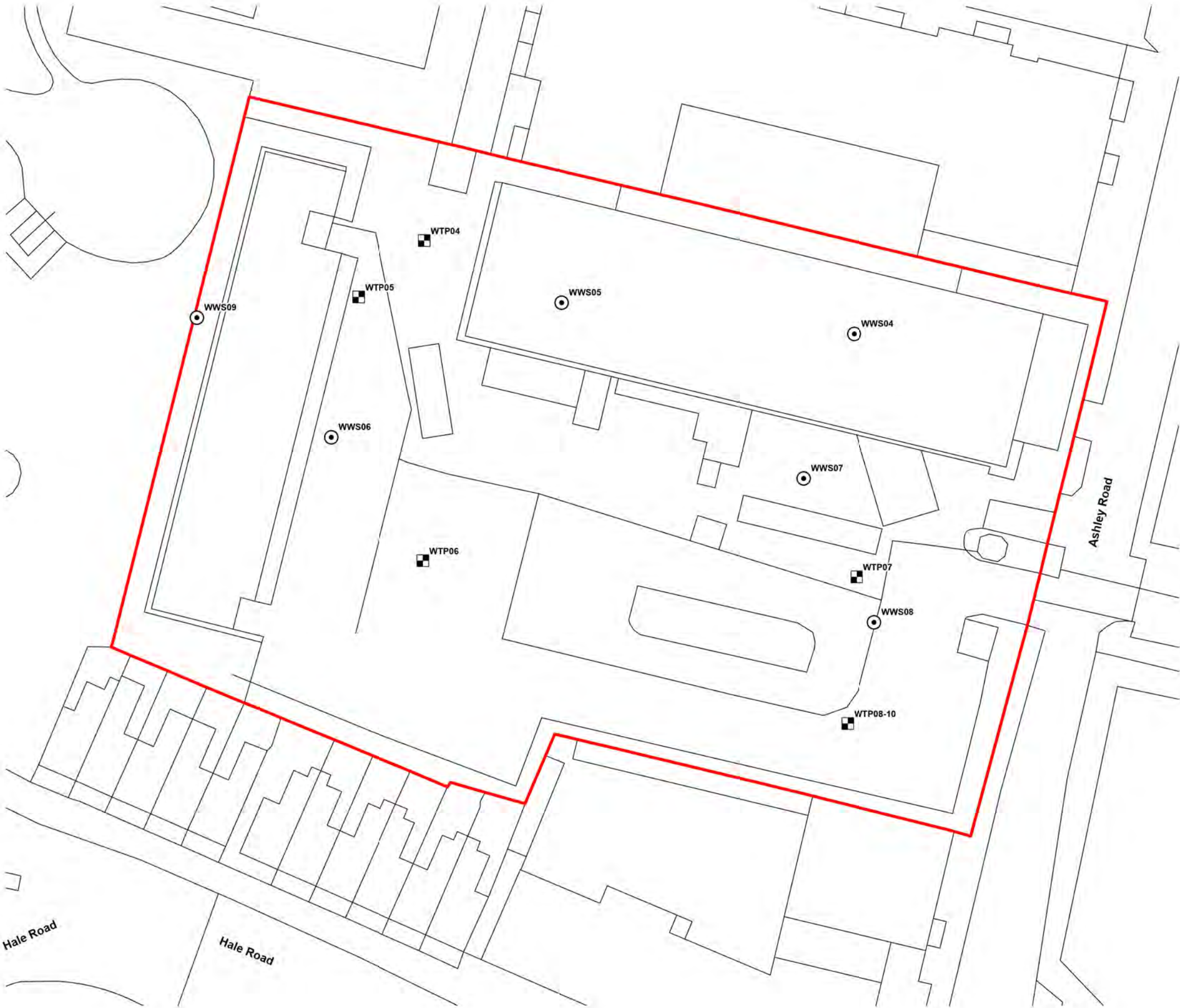
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Figure Ref	WIE16248-100_GIS_GQRA_1A
Date	May 2023
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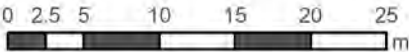
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- Trial Pit
- Window Sample



Project Details	Figure: WIE16248-100: Cannon Factory
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Figure Ref	WIE16248-100_GIS_GQRA_2A
Date	May 2023
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- Site Boundary
- Trial Pit
- Window Sample



Project Details	Figure: WIE16248-100: Ashley House
Figure Title	Figure 3: Ground Investigation Locations – Ashley House
Figure Ref	WIE16248-100_GIS_GQRA_3A
Date	May 2023
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Site Boundary

Waterman GI Locations

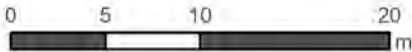
- Trial Pit
- Window Sample

RSK GI Locations

- Probe Hole

Socotec GI Locations

- Borehole
- Window Samples



Project Details	Figure: WIE16248-100: Cannon Factory
Figure Title	Figure 4: Ground Investigation Locations – Cannon Factory (Waterman - 2023, Socotec -2019, and RSK - 2015)
Figure Ref	WIE16248-100_GIS_GQRA_4A
Date	May 2023
File Location	N:\Projects\Figure9_GIS\WIE16248-100_GIS_LOD



Site Boundary

Waterman GI Locations

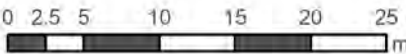
- Trial Pit
- Window Sample

RSK GI Locations

- Deep Borehole Location
- Shallow Window Sample Location

Socotec GI Locations

- Borehole
- Window Sample



Project Details	Figure: WIE16248-100: Ashley House
Figure Title	Figure 5: Ground Investigation Locations – Ashley House (Waterman - 2023, Socotec -2019, and RSK - 2015)
Figure Ref	WIE16248-100_GIS_GQRA_5A
Date	May 2023
File Location	N:\Projects\Figure9_GIS\WIE16248-100_GIS_LOD



Site Boundary

Groundwater Contours

Waterman GI Locations

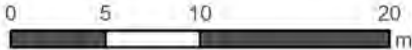
- Trial Pit
- Window Sample

RSK GI Locations

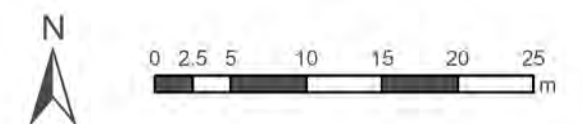
- Probe Hole

Socotec GI Locations

- Borehole
- Window Samples



Project Details	Figure: WIE16248-100: Cannon Factory
Figure Title	Figure 6: Groundwater Contour Plot – Cannon Factory (02/05/2023)
Figure Ref	WIE16248-100_GIS_GQRA_6A
Date	May 2023
File Location	N:\Projects\Figure9_GIS\WIE16248-100_GIS_LOD



Project: Details	Figure: WIE16248-100: Ashley House
Figure Title	Figure 7: Groundwater Contour Plot – Ashley House (02/05/2023)
Figure Ref	WIE16248-100_GIS_GQRA_7A
Date	May 2023
File Location	N:\Projects\Figure\9_GIS\WIE16248-100_GIS_LOD



GROUNDTECH
CONSULTING

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Factory

Report type: Factual Geo-Environmental
Appraisal

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Date: May 2023

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For and Behalf of Groundtech Consulting	
SIGNATURE	
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Plans

<i>Plan Reference</i>	<i>Revision</i>	<i>Title</i>
GRO-23113-P01	-	Project Location Plan
GRO-23113-P02A	-	Exploratory Hole Location Plan – Cannon Factory
GRO-23113-P02B	-	Exploratory Hole Location Plan – Ashley House

1.0 INTRODUCTION

1.1 Project Objectives

Groundtech Consulting Limited have been instructed by Waterman I&E on behalf of Notting Hill Genesis to undertake a Ground Investigation for a site at Ashley House and Cannon Factory in Tottenham.

A main investigation was undertaken in accordance with BS 5930:2015, BS 10175:2013, BS 8576 and BS 22475.

1.2 Proposed Development

Details of the proposed development have not been provided at this stage.

1.3 Limitations

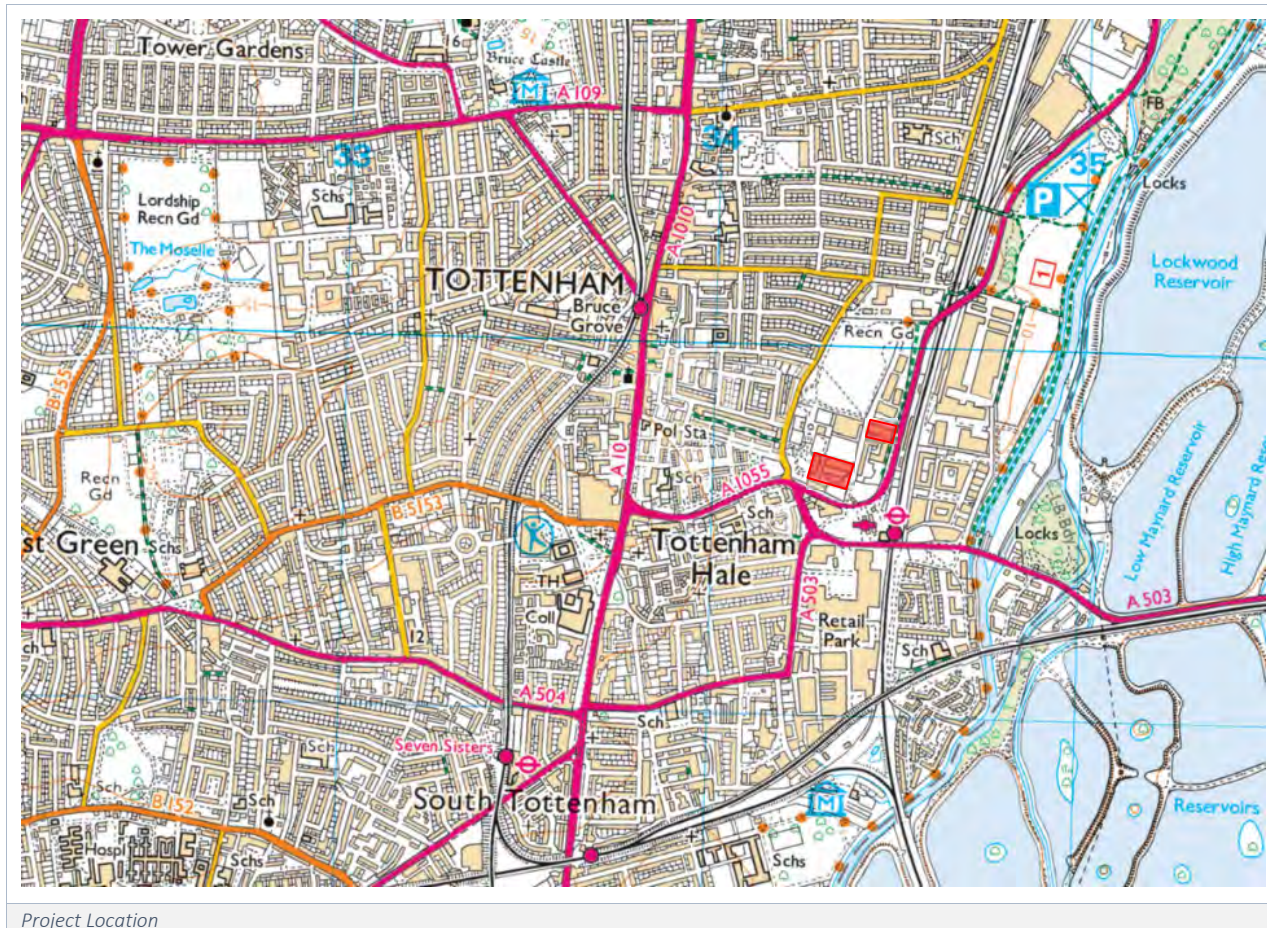
Other conditions may exist on the site that have not been taken into account in this assessment as they are outside the scope of works. Groundtech Consulting are not responsible for these circumstances that are not outlined in the report.

The assessment has been prepared for the exclusive use of the client. No third parties may rely on or reproduce the contents of the report without the written permission of Groundtech Consulting Limited. If any unauthorised third party comes into possession of the report, they rely on it at their own risk and Groundtech Consulting Limited will not be obliged to provide a duty of care.

2.0 SITE SETTING

2.1 Location

The investigation focused on two sites located circa 130m north west and 200 metres north of Tottenham Hale train station, as shown on the Project Location Plan GRO-23113-P01. The northernmost site is approximately centred on National Grid Reference 534454,189771 and the southernmost site is approximately centred on National Grid Reference 534325, 189654.



Access to the site is gained off Ashley Road which bisects the two areas of the site.

2.2 Site Description

The site is formed by two separate parcels of land which are both approximately rectangular in shape and are generally flat lying topographically.

Northern Plot – Cannon Factory

The northern plot is circa 0.25Ha in area and is developed commercially with a disused Cannon factory which occupies the majority of the site. The factory building is predominantly of brick construction with corrugated steel wall cladding. Large sliding doors provide internal access to the warehouse building. The southwestern portion of the site is formed by a concrete surfaced service yard.

A gravel surfaced strip is present along the northern edge of the factory building with several mature trees present and some light vegetation.

The western, northern and eastern site boundaries are formed by Ashley Road, Burdock Road and Watermead Way respectively. The southern boundary is formed by a brick wall and the adjacent commercial/residential premises.

The Cannon Factory is surrounded by the following features/land uses:

- North - *Burdock Road and Secondary School*
- East - *Watermead Way and railway line*
- South - *Residential apartments*
- West - *Ashley Road and residential apartments.*

Southern Plot – Ashley House

The southernmost plot is circa 0.65Ha in area and is currently developed with disused warehouse buildings and an office block. Associated parking, storage, loading yards and some soft landscaping are present. Disused allotment gardens are present in the centre of the site.

The site boundaries are generally formed by a combination of wooden/metal fencing and brick walls.

Ashley House is surrounded by the following features/land uses:

- North - *Residential apartments*
- East - *Ashley Road and residential properties.*
- South - *Residential apartments and houses*
- West - *Public Park.*

Site photographs are presented in *Appendix 2*.

3.0 SCOPE OF INVESTIGATION AND RATIONALE

3.1 Project Objectives

The aim of the fieldwork was to:

Determine the stratification beneath the site.
Maintain a watching brief for visual and olfactory evidence of contamination.
Obtain samples using methodology in current guidance for contamination analysis.
Determine the presence of obstructions and buried structures.
Record details of buried services encountered.
Install standpipes for groundwater monitoring.

3.2 Scope of Works

The following scope of works was completed between 20th April and the 24th April 2023:

- *All exploratory hole locations were cleared by a specialist service clearance team prior to breaking ground including GPR and CAT scanning.*
- *Coring of the concrete hardsurfacing was undertaken at all windowless sample locations.*
- *9 No. Machine dug trial pits (WTP01 to WTP11) were undertaken to a maximum depth of 2.5m bgl.*
- *11 No. Windowless sample boreholes (WWS01 to WWS11) were undertaken to a maximum depth of 5.0m bgl.*
- *Photo Ionisation Detector (PID) screening of all environmental samples.*
- *Surveying of all exploratory hole locations to National Grid and meters Above Ordnance Datum (mAOD).*
- *UXO supervision for the duration of the works.*

The exploratory hole locations are presented on Groundtech Plan GRO-23113-P02, and the exploratory hole logs are presented in *Appendix 3*.

The exploratory hole locations were positioned by Waterman I&E to establish the stratification beneath the site and target areas of concern as set out in the specification. The exploratory holes were logged by a suitably experienced geo-environmental engineer in general accordance with the following current guidance:

- *BS 5930 'Code of Practice for Site Investigations' 2015.*
- *BS EN 14688-1:2002 'Geotechnical Investigation and Testing – Identification and classification of soil'.*
- *BS EN ISO 14689:2002 'Geotechnical investigation and testing – Identification and classification of rock'.*

3.3 Soil Sampling

During the intrusive investigation, representative samples were taken at regular intervals, changes of strata and where evidence of contamination existed. Laboratory analysis was scheduled on the samples obtained.

The samples obtained are summarised in the table below:

Soil Sample	Number
<i>Environmental Sample</i>	<i>93</i>

The samples have been obtained in accordance with current environmental and geotechnical guidance. The sampling plan has been designed to obtain samples from all required strata using the correct methodology.

Disturbed samples of soil for chemical analysis were placed in the correct sampling containers as required by the laboratory in accordance with their MCERTS and UKAS Accreditation. Transportation was arranged in a timely manner and the samples were at the correct temperature.

The sample locations and depths are recorded on the exploratory logs.

3.4 Geo-Environmental Analysis

All testing was scheduled and received by Waterman I&E.

3.6 Groundwater Monitoring

Groundwater monitoring installations were constructed in the boreholes under the instruction of Waterman I&E. The standpipes consisted of high-density polyethylene (HDPE) pipe - a bentonite seal was placed around the plain pipe and a clean gravel pack was placed around the slotted pipe. A summary of the installation construction is presented in the table below:

Location	Depth (m bgl)	Response Zone (m bgl)	Targeted Strata	Reason
WWS02	3.0	1.0 - 3.0	Natural Clay & Sand	Groundwater
WWS03	3.0	2.0 - 3.0	Natural Sand	Groundwater
WWS04	3.5	2.0 - 3.5	Natural Gravel	Groundwater
WWS06	3.5	2.0 - 3.5	Natural Sand	Groundwater
WWS07	3.0	2.0 - 3.0	Made Ground & Natural Sand	Groundwater
WWS08	3.0	2.0 - 3.0	Made Ground & Natural Gravel	Groundwater
WWS10	4.0	2.0 - 4.0	Natural Sand	Groundwater
WWS11	3.5	2.0 - 3.5	Natural Silt & Gravel	Groundwater

Waterman I&E are conducting all the post fieldwork monitoring of the wells for groundwater.

3.7 Vapour Survey - Photo Ionisation Detector

Standard sampling protocol and preservation of samples was undertaken as described in the EA guidance on site investigation. The onsite monitoring was carried out in line CIRIA C665 to aid targeting samples for VOC laboratory analysis.

Soil was collected for onsite testing. A plastic bag was half filled with soil allowing a suitably sized headspace. The bag was sealed and stored for at least 20 minutes before being tested for Total Volatile Organic

Compounds (TVOCs) using a Photo Ionisation Detector (PID). Results of the PID readings are presented in *Appendix 5*.

4.0 GROUND MODEL

4.1 Made Ground

Made Ground was encountered in all exploratory hole locations to a maximum depth of 2.5m bgl in WWS08 in the central area of Ashley House near the USTs.

Surfacing

Concrete surfacing was present at all locations from ground level to a maximum depth of 0.54m bgl. In the Cannon Factory site, the concrete was divided into two slabs separated by a brown grey sandy gravel.

The site can be divided into Cannon Factory in the north, which contains boreholes WWS01 to WWS03 and WWS10 to WWS11 along with trial pits WTP01 to WTP03 and WTP11, and Ashley House in the south containing boreholes WWS04 to WWS09 and trial pits WTP04 to WTP10. WTP08 to WTP10 were combined into one trial pit looking for the underground tank. The ground conditions for the two separate areas of the site are described below.

Cannon Factory (WWS01-WWS03, WWS10, WWS11 & WTP01-WTP03, WTP11)

Made Ground was encountered to depths between 0.6m and 1.55m bgl and comprised two main strata described below:

- Grey brown gravelly fine to coarse sand with minor constituents of quartzite, brick and concrete was encountered in WWS01 to WWS03, WWS10, WTP01 and WTP11 from a minimum depth of 0.13m bgl to a maximum depth of 1.5m bgl.
- Dark grey sandy angular to subangular fine to coarse gravel with minor constituents of brick and concrete was encountered in WTP02 to WTP03, WWS01, WWS03 and WWS11 from a minimum depth of 0.2m bgl to a maximum depth of 1.3m bgl.

Locally in WTP11, firm gravelly sandy silty clay was encountered from a depth of 0.5m bgl to 1.55m bgl.



Ashley House (WWS04-WWS09 & WTP04-WTP10)

Made Ground was encountered to a maximum of 2.5m bgl.

The following three main Made Ground populations were encountered up to a depth of 2.5m bgl:

- Grey brown gravelly fine to coarse variably clayey gravelly sand with minor constituents of quartzite, brick and concrete was encountered in WWS04, WWS06 to WWS09 and WTP04 to WTP10 from a minimum depth of 0.2m bgl to a maximum depth of 2.4m bgl.
- Brown grey sandy angular to subangular fine to coarse gravel with minor constituents of brick and concrete was encountered in WWS04 and WWS06 from a minimum depth of 0.22m bgl to a maximum depth of 0.8m bgl.
- Soft and soft to firm brown silty sandy gravelly clay was encountered in WWS07 to WWS09 from a minimum depth of 1.3m bgl to a maximum depth of 2.5m bgl.



Exploratory Hole Locations for Ashley House.

4.2 Natural Ground

Natural strata was observed in the majority of exploratory holes and consisted of brown variably sandy, gravelly, clayey silt and soft to firm variably silty, sandy, gravelly clay from depths of 0.7m bgl to a maximum depth of 2.9m bgl. This was generally underlain by gravelly sand and sandy gravel from depths of 1.8m bgl to the base of the exploratory holes. This confirms the records from the geological maps where the Enfield Silt Member is indicated to rest on the River Terrace deposits of the Kempton Park Gravel Member.

4.3 Bedrock

Bedrock was not encountered during the ground investigation.

4.4 Groundwater

Groundwater was encountered in the majority of the window samples during the investigation at depths between 2.5m and 3.0m bgl. Groundwater strikes are summarised in the table below:

Location	Depth (m bgl)	Strata	Type
WWS02	2.8	Natural Sand	Strike
WWS03	3.0	Natural Sand	Strike
WWS04	3.0	Natural Gravel	Strike
WWS06	2.5	Natural Sand	Strike
WWS07	2.8	Natural Sand	Strike
WWS08	2.5	Natural Gravel	Strike
WWS09	2.9	Natural Gravel	Strike
WWS10	3.0	Natural Sand	Strike
WWS11	3.5	Natural Sand	Strike

4.5 Watching Brief

A watching brief was maintained during the Ground Investigation for visual and olfactory evidence of contamination. The contamination identified is detailed in the table below.

Location	Depth (m bgl)	Strata	Visual Evidence	Olfactory Evidence
WWS02	2.2-3.0	Sand	Hydrocarbon staining	Moderate Hydrocarbon Odour
WWS09	1.3-2.0	Made Ground	-	Moderate hydrocarbon odour
WWS10	2.1-2.4	Sand	Hydrocarbon staining	Moderate hydrocarbon odour
WWS10	3.7-4.0	Sand	Hydrocarbon staining	Moderate hydrocarbon odour
WWS11	2.3-2.6	Gravel	-	Moderate hydrocarbon odour
WTP04	0.6-1.8	Made Ground	-	Moderate hydrocarbon odour
WTP11	0.5-1.55	Made Ground	Multicoloured Clay	-
WTP01	0.4-0.6	Made Ground	Asbestos Cement present	-

4.6 Excavation Stability

Boreholes were cased off to avoid collapse. Trial pits were stable.

4.7 Borehole Progress/Obstructions

Several obstructions were encountered during the investigation or the locations were terminated for the reasons detailed in the table below:

Location	Depth (m bgl)	Obstruction/Termination Reason
WWS01	1.2	Potential UXO
WWS05	0.5	Concrete
WTP11	1.6	Concrete footings
WTP05	1.1	Gas pipe
WTP01	0.4	Asbestos cement
WTP08-10	0.6	Concrete

Second slabs were noted in several window samples boreholes. These are recorded on the exploratory hole logs.

A live low pressure gas pipe was struck in WTP05. The emergency gas teams were notified and the damage was repaired on the same day.

Boreholes that penetrated the Made Ground generally terminated due to sampler refusals in the dense sand and gravel.

4.8 Falling Head Tests

Falling head permeability tests were carried out in the at locations WWS04, WWS03 and WWS11 between depths of 2.5m and 3.5m bgl, within the natural granular soils.

On completion of the drilling, the boreholes were filled with water and the depth of water within the borehole was recorded at regular intervals over a 60-minute period.

Location	Strata	Infiltration Rate (m/s)
WWS03	Gravelly Sand	1.8×10^{-7}
WWS04	Sandy gravel	1.32×10^{-6}
WWS11	Gravelly sand	5.32×10^{-8}

Calculated soil infiltration rates range between 1.32×10^{-6} and 5.32×10^{-8} m/s.

The results of the falling head tests are presented in *Appendix 4*.

5.0 RELEVANT INDUSTRY REFERENCES

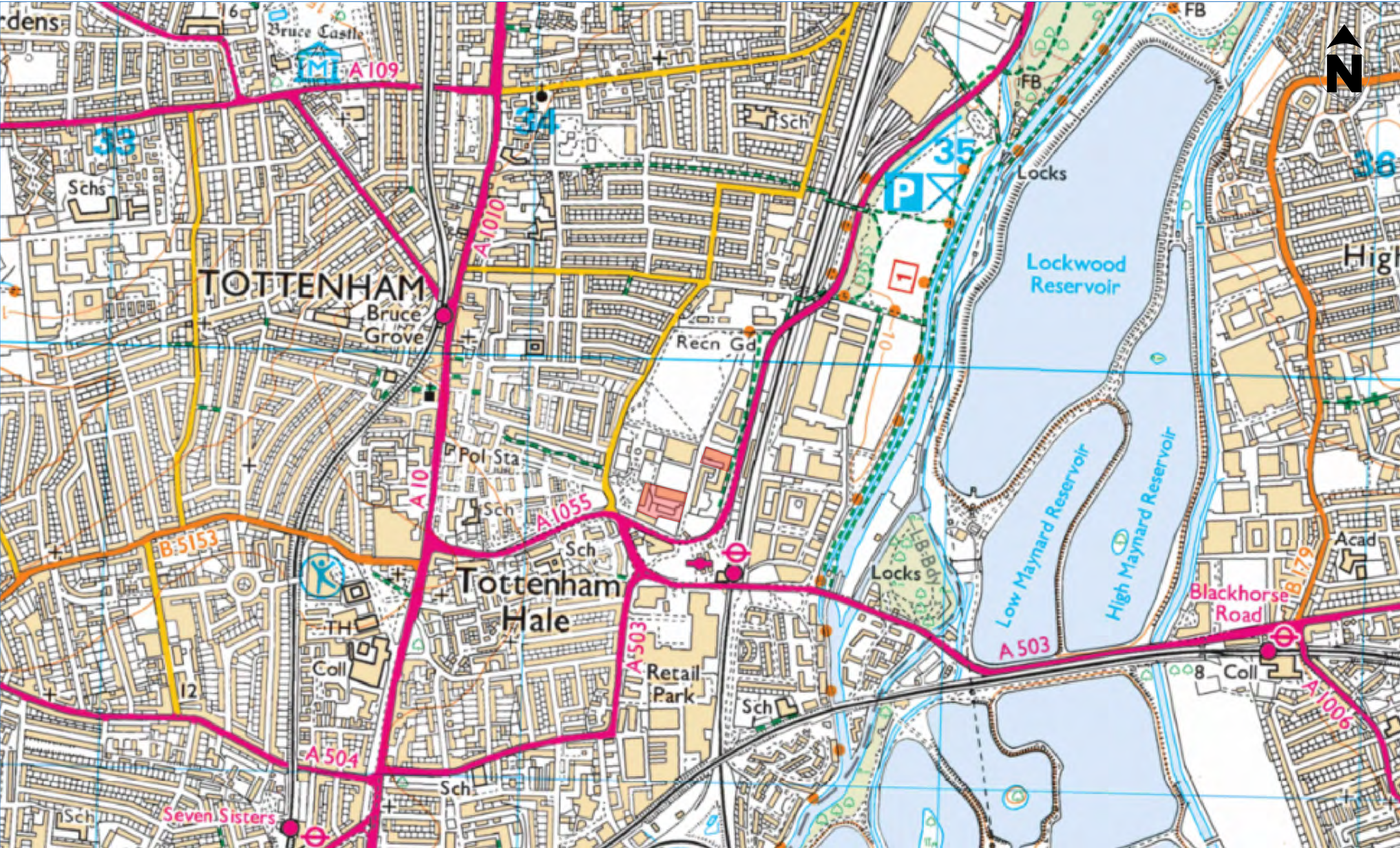
British Standards Institution '*Investigation of Potentially Contaminated sites - code of practice*' BS 10175:2017.

British Standards Institution '*Code of Practice for Site Investigations*' BS 5930:2015

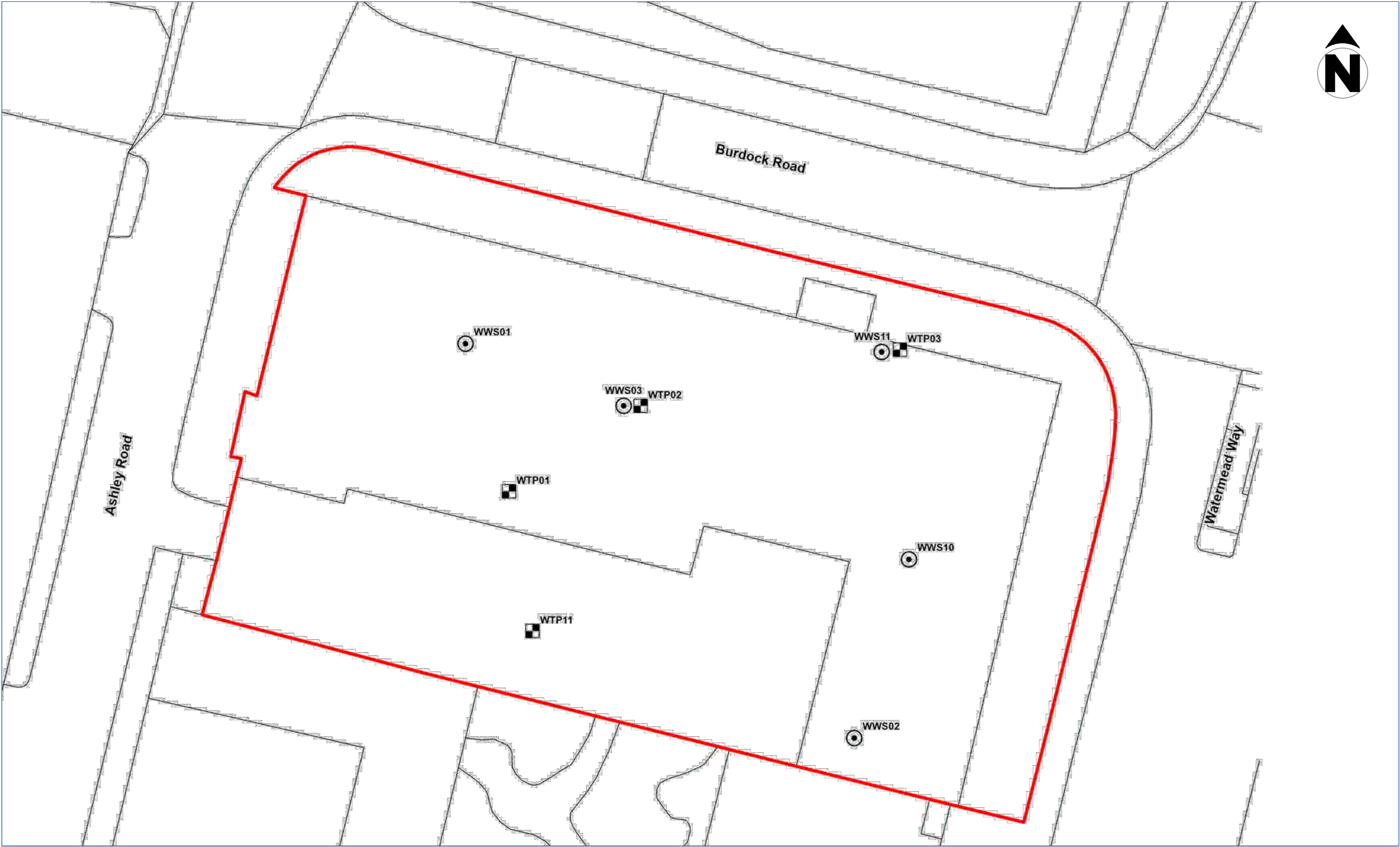
British Standards Institution '*Geotechnical investigation and testing – Identification and classification of soil*' BS EN ISO 14688:2002.

BS EN ISO 14689:2002 '*Geotechnical investigation and testing – Identification and classification of rock*'.

APPENDIX 1 - Plans

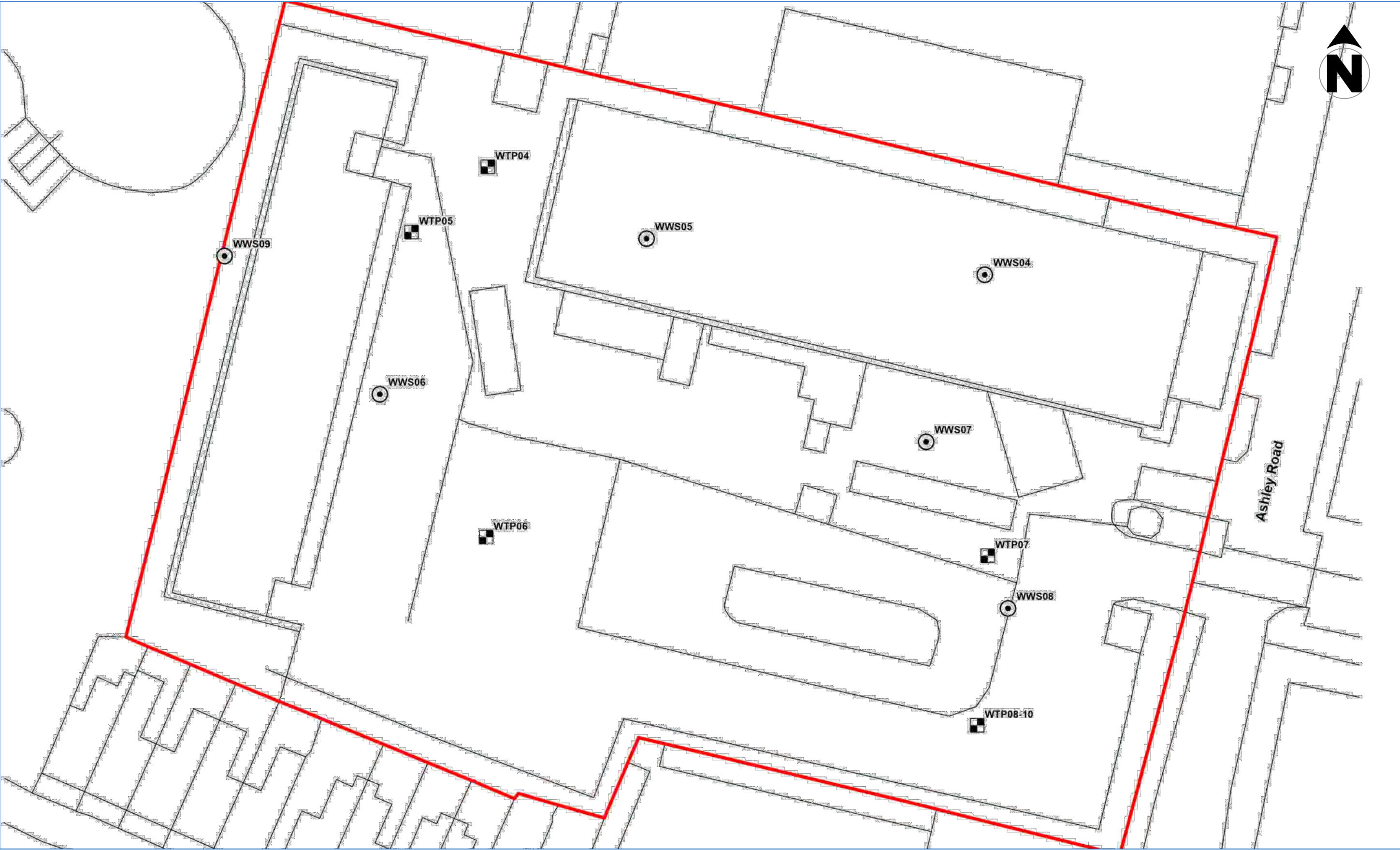


GROUNDTECH CONSULTING 	CLIENT	DATE			Status		Notes Site Location 
	NOTTING HILL GENESIS	APRIL 2023			Preliminary		
	PROJECT TITLE	SCALE			Draft		
	ASHLEY HOUSE AND CANNON FACTORY	NTS			Issued		
	PLAN TITLE	PLAN NUMBER			For Comment		
PROJECT LOCATION PLAN		GRO-23113-P01	Rev.	Details	Date	Approved	



GROUNDTECH CONSULTING	CLIENT	DATE			Status		Notes
	NOTTING HILL GENESIS	MAY 2023			Preliminary		
	PROJECT TITLE	SCALE			Draft		
	ASHLEY HOUSE AND CANNON FACTORY	NTS			Issued		
	PLAN TITLE	PLAN NUMBER			For Comment		
	EXPLORATORY HOLE LOCATION PLAN	GRO-23113-P02A	Rev.	Details	Date	Approved	





GROUNDTECH CONSULTING	CLIENT	DATE			Status		Notes
	NOTTING HILL GENESIS	MAY 2023				Preliminary	
	PROJECT TITLE	SCALE				Draft	
	ASHLEY HOUSE AND CANNON FACTORY	NTS				Issued	
	PLAN TITLE	PLAN NUMBER				For Comment	
	EXPLORATORY HOLE LOCATION PLAN	GRO-23113-P02B	Rev.	Details	Date	Approved	



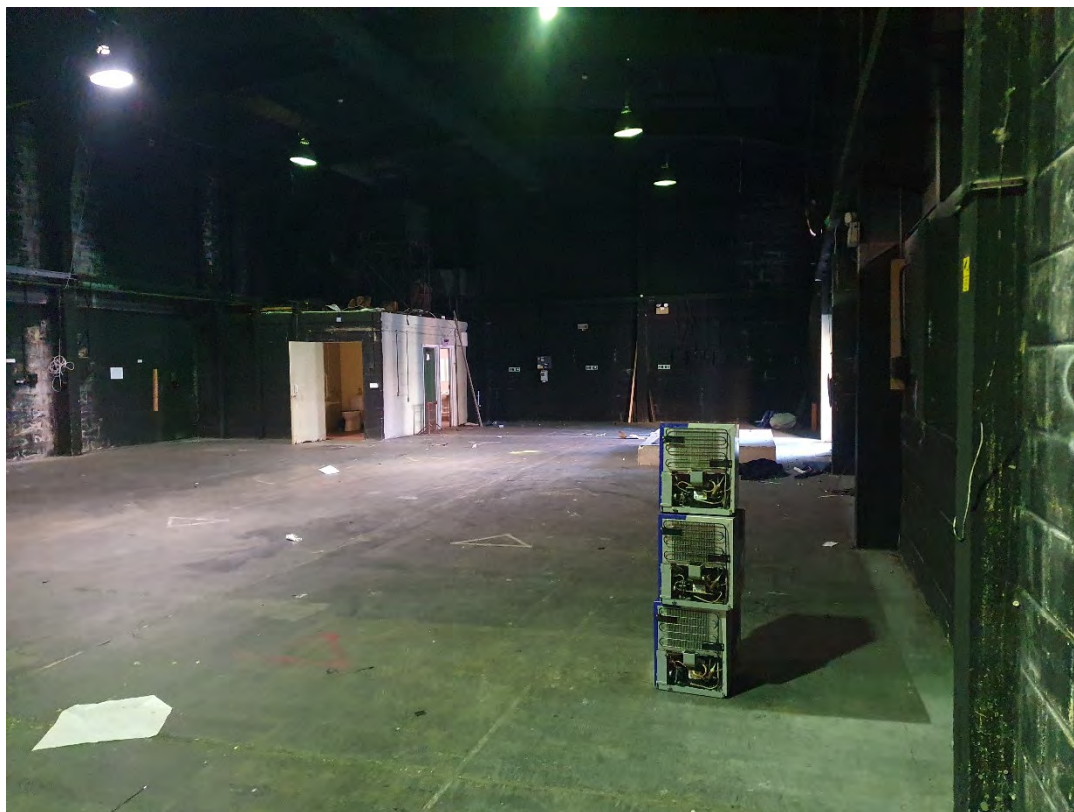
APPENDIX 2 - Site Photographs



Photograph 1 – Internal area of Cannon Factory looking towards WWS01.



Photograph 2 - . Internal area of Cannon Factory looking towards WTP02.



Photograph 3 – Internal area of Cannon Factory looking towards WWS02.



Photograph 4 – Concrete coring and hand pit of WWS01.



Photograph 5 – Hand pit arisings of WWS01.



Photograph 6 – WTP01.