Lendlease

1 Triton Square

Ground Contamination Risk Assessment and Remediation Strategy

Longford Place

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Background

Ove Arup and Partners (Arup) has been commissioned by Lendlease to provide consultancy services for the 1 Triton Square development located at Regent's Place, London, NW1 3DX.

1 Triton Square is being developed by British Land Ltd and the development area has been divided into three areas to reflect the phasing of the works. The scheme includes a commercial element (1 Triton Square), a residential element (St Anne's) and Longford Place which is an area of largely hard landscaping. This report specifically relates to the redevelopment of the Longford Place site.

Arup previously prepared a contamination desk study and programme of investigation for the site which presented a preliminary risk assessment based on a conceptual site model (CSM). The desk study highlighted the potential presence of belowground fuel tanks in the eastern part of the site. The desk study report was submitted to the London Borough of Camden (LBC) and approved allowing discharge of part (e) of condition 12. The objective of this report is to enable the discharge of part (f) of planning condition 12.

Ground investigation

An intrusive ground investigation was carried out by Concept Ltd between 12 and 15 January 2018 and comprised two cable percussion boreholes, installed as groundwater monitoring wells, in the eastern part of the site and three shallow hand dug pits in the centre and western part of the site. The investigation was intended to characterise the soil and groundwater conditions at the site including identifying any indication of impact to groundwater as a result of leaks from the onsite tanks.

Two rounds of groundwater sampling and monitoring were completed in the two newly installed wells and the one existing well, installed during the 1 Triton Square investigation.

Results

The findings of the investigation are summarised below:

- concentrations of metals in soils were generally very low. Concentrations of lead exceeded the assessment criteria in three samples;
- TPH concentrations in soils were below the detection limit in four samples and well below the assessment criteria in the remaining samples;
- Low concentrations of asbestos (chrysotile fibres) were identified in three soil samples within the Made Ground;

- Total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH) and benzene, toluene, ethylbenzene and xylene (BTEX) concentrations in groundwater samples were below the detection limit; and
- concentrations of ammoniacal nitrogen and manganese in groundwater were higher than screening levels but are common in an urban environment and are not considered to represent contamination related to the site.

Conclusions

The contamination ground investigation and assessment confirmed that the site has not been impacted by significant contamination. The below ground fuel tanks are believed to remain in place but are thought to be concrete filled. The environmental sensitivity has been identified as low due to the low sensitivity of the shallow aquifer and lack of other receptors and the development sensitivity is low as it comprises hard and soft landscaped public realm with no buildings.

Based on the risk assessment for the proposed development, risks to human health and the environment have been assessed as either low, very low or negligible (without mitigation). Proposed mitigation measures will reduce any residual risk to very low or negligible (with mitigation). A summary of the risk assessment is provided below:

Summary of risk assessment

Description	Classification
Risk assessment	
Risk of harm to human health during construction	Very low (with mitigation)
Risk of harm to human health during operation	Very low (with mitigation for maintenance workers)
Risk of pollution to groundwater	Very low
Risk of pollution to surface water	Negligible
Risk to construction materials and services	Very low (with mitigation)
Risk to designated ecological receptors	Negligible
Risk to planting in landscaped areas	Very low

Recommendations

There is no requirement for a specific phase of remediation based on the findings of the ground investigation and risk assessment. Mitigation measures, including clean cover layers, a marker layer and a watching brief, are described within the report and should be put in place/made available for deployment during the construction work to minimise potential exposure of receptors during the construction and operation phases.

A verification report should be prepared following completion of the works in order to demonstrate that the requirements of the remediation strategy have been achieved. This report sets out the information which is typically included within a verification report.

1 Introduction

1.1 General

Ove Arup and Partners (Arup) has been commissioned by Lendlease to provide consultancy services for the 1 Triton Square development located at Regent's Place, London, NW1 3DX. The site location is shown on Figure 1.

The 1 Triton Square redevelopment is being undertaken by British Land Ltd and the development area has been divided into three areas to reflect the phased nature of the works, as shown on Figure 2. The scheme includes a commercial element (1 Triton Square), a residential element (St Anne's) and Longford Place which is an area of largely hard landscaping to the north of 1 Triton Square.

This report specifically relates to the redevelopment of the Longford Place site. Following development, the area will comprise hard landscaping and high quality soft landscaped public realm areas, as shown in Table 1 in Section 2. There are no proposed buildings or enclosed spaces.

1.2 Planning background

Planning permission for the 1 Triton Square development has been granted by London Borough of Camden (LBC) (reference 2016/6069/P) which was implemented on 7 March 2018 following a Section 106 legal agreement.

Arup previously prepared a contamination desk study and programme of investigation (2018) [1] for the site which presented a risk assessment based upon a conceptual site model (CSM). The desk study report was submitted to LBC and approved allowing discharge of part 12 (e) of the condition. The remaining parts of condition 12 are as follows:

At least 28 days before development commences on Longford Place:

- *(f) following the approval detailed in paragraph (e), an investigation shall be carried out on land within Longford Place in accordance with the approved programme and the results and a written scheme of remediation measures relevant to that land [if necessary] shall be submitted to and approved by the local planning authority in writing.*
- *Any remediation measures [if necessary] shall be implemented strictly in accordance with the approved scheme(s) and where relevant a written report detailing the remediation for either the commercial element or the residential element shall be submitted to and approved by the local planning authority in writing prior to occupation of that element.*
- *Reporting and management of significant additional contamination. additional significant contamination discovered during development shall be fully assessed and any necessary modifications made to the remediation schemes shall be submitted to the Local Planning Authority for written approval. Before any part of either the commercial element or the residential*

element hereby permitted is occupied, where relevant the developer shall provide written confirmation that all works were completed in accordance with the revised remediation scheme(s) for that element.

1.3 Objectives and scope

The objective of this report is to enable the discharge of part (f) of planning condition 12. To meet the requirements of the condition this report:

- presents the scope of intrusive ground investigation and describes the findings;
- quantitatively assesses the data obtained from the 2018 ground investigation and the risks posed to human health and environmental receptors;
- provides a remediation strategy based upon the results of the quantitative assessment to address any risks identified; and
- presents a verification plan to ensure appropriate data and information is collected to form a verification report.

1.4 Report structure

This report has the following structure:

- Section 2 describes the preliminary conceptual model;
- Section 3 provides the scope of ground investigation undertaken;
- Section 4 describes the findings of the ground investigation and presents the methodology and assessment of the laboratory and monitoring data obtained from the ground investigation;
- Section 5 presents the quantitative risk assessment;
- Section 6 presents the revised conceptual site model;
- Section 7 presents the summary and conclusions; and,
- Section 8 presents a remediation strategy and verification plan.

1.5 Information sources

The following information sources have informed this report:

- Arup (2017), 1 Triton Square Contamination Desk Study and Risk Assessment Report [1].
- Arup (2018), Longford Place Contamination Desk Study and Programme of Investigation [2].
- Concept (2018) Site Investigation report, Longford Place, 1 Triton Square [3] (included in Appendix A);
- Landmark (2015), Envirocheck report (Appendix A of Longford Place desk study [2]).

- London Fire and Emergency Planning Authority (2017), Environmental Enquiry Response, Ref. 02/186354/BCW (Appendix B).

1.6 Limitations

This report has been prepared for use by Lendlease in relation to the approved development of the Longford Place site. It takes into account our client's particular instructions and requirements and addresses their priorities at the time. It is not intended for, and should not be relied upon by any third party and no responsibility is undertaken to any third party in relation to it, except as provided for in Arup's agreement with Lendlease.

Arup has based the site appraisal on the sources of information detailed within the report text and believes them to be reliable, but cannot and does not guarantee the authenticity or reliability of this third party information. Notwithstanding the efforts made by the professional team in undertaking this contamination assessment it is possible that ground and contamination conditions other than those potentially indicated by this report may exist at the site.

This report does not present a survey or assessment of the location, condition or liabilities associated with hazardous materials in building fabric such as (but not limited to) asbestos containing material (ACM), radiological or bacterial substances or lead.

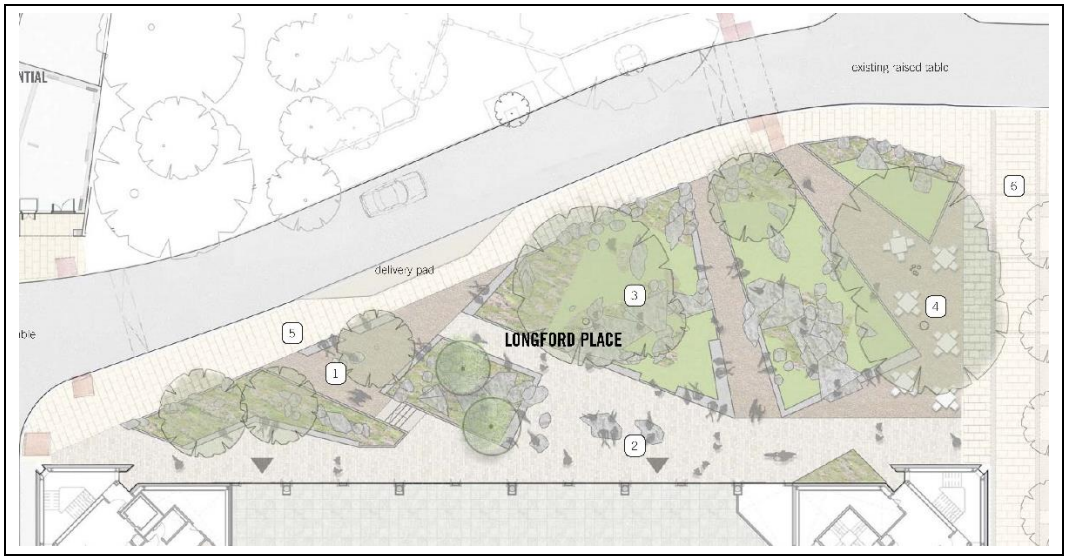
This report has been prepared based on current legislation, statutory requirements, planning policy and industry good practice prevalent at the time of writing. Any subsequent changes or new guidance may require the findings, conclusions and recommendations made in this report to be reassessed in light of the circumstances. Should the approved layout or use of the site change, the assessments and conclusions presented in this report may need to be revised.

2 Preliminary conceptual model

2.1 Proposed development

The site is a small (90m x 30m) area of existing primarily hard landscaped public realm. The proposed development comprises hard and soft landscaping in the form of a new public garden area including lawns, trees and planting as shown in Table 1. Further details are provided in the Longford Place Desk Study and Programme of Investigation [2].

Table 1 Extract from landscape masterplan



2.2 Preliminary conceptual model

A conceptual site model was set out in the desk based assessment [2]. That described the plausible pollutant linkages (PPL) associated with the construction and operation phases of the development. The report was agreed with LBC. The preliminary conceptual model is reproduced in Table 2 below.

Table 2 Preliminary conceptual site model

Receptors	Pathways	PPL
Human health		
Site workers (during construction)	Ingestion of soils, dust and/or groundwater. Dermal contact with soils, dust and/or groundwater. Inhalation of dust fibres and/or vapours	Yes Workers are likely to come into contact with soil and perched water (if present) when carrying out ground works. Workers may be exposed to gases/vapours if working in confined spaces.
Neighbours (during construction)		Yes Principally due to dust emissions

Receptors	Pathways	PPL
Future site users (during operation)	Ingestion of soils, dust and/or groundwater. Dermal contact with soils and/or groundwater. Inhalation of dust, fibres and/or vapours.	Yes (but limited) The development will comprise hard and soft landscaping within clean imported soils. Dust and fibres will not be released due to new hard/soft landscaping. No buildings will be constructed. Vapour pathways will be limited to outdoor inhalation only.
Controlled waters		
Shallow groundwater (secondary aquifer)	Vertical migration of contamination from Made Ground to the River Terrace Deposits (RTD)	Yes Fuel tanks on site could be a source of hydrocarbon contamination which could migrate to the RTD.
Building materials and services		
New hard landscaping and services	Direct contact with ground and/or groundwater	Yes New services may be in contact with contaminated soils.
Ecological		
Planting within soft landscaped areas	Uptake from contaminated soils or groundwater	Yes (but limited) Made Ground is expected to be present across the site. All new planting will be within clean imported soils.

A ground investigation was proposed within the Longford Place footprint to obtain further information on ground conditions and contaminant concentrations at the site. Previous investigations and the recent ground investigation are described in Section 3.

3 Ground investigation

3.1 Previous adjacent ground investigation

An intrusive ground investigation was completed in 2017 by Concept Ltd over two phases at an adjacent site, within the footprint of the 1 Triton Square building. A full description of the investigation is provided in the 1 Triton Square contamination desk study and risk assessment [1].

The findings of the investigation included:

- A slight hydrocarbon odour was noted within the River Terrace Deposits (RTD) at CH10. No other visual or olfactory observations of potential contamination, elevated PID readings or evidence of potential vapour sources were recorded.
- Results from chemical testing of six soil samples (three from the Made Ground, two from the RTD and one from the London Clay) were generally low and indicated that significant contamination was not present.
- Groundwater levels in BH101 (which was installed in the RTD between 3.4m and 7.5mbgl) were recorded between 5.8mbgl and 5.9mbgl.
- Chemical testing of five groundwater samples (from BH101, CH02 and CH03) did not indicate any significant groundwater contamination. Detectable concentrations of total petroleum hydrocarbons (TPH) (CH02 and CH03) and copper (CH03) concentrations were noted.
- Ground gas levels within BH101 (screened in the Made Ground between 1.0 and 2.4mbgl) gave a maximum GSV of 0.0002, which equates to a characteristic situation (CS) 1 classification and represents a very low risk from ground gas requiring no specific gas protection measures.

3.2 Recent onsite ground investigation

3.2.1 Scope

The recent intrusive ground investigation was carried out by Concept Ltd between 12 and 15 January 2018. The scope of works comprised:

- two cable percussion boreholes (BH201 and BH202) within the eastern part of the site, installed in the RTD to supplement the information provided by BH101 previously installed [1]; and,
- three shallow hand dug pits (HP101-103) in the centre and western parts of the site to depths of between 0.7m and 1.2m to provide information on shallow soils across the site.
- chemical laboratory testing of 12 soil samples (solid and leachable) from five locations for a comprehensive suite of determinands;

- chemical laboratory testing of six groundwater samples from the three monitoring wells (BH101, BH201 and BH202) for a comprehensive suite of determinands;
- two rounds of groundwater (RTD) monitoring in the three monitoring wells.

The locations of the intrusive investigation positions are shown on Figure 3.

3.2.2 Objectives

The presence of belowground fuel tanks was expected in the eastern part of the site based on historical maps. A historical site plan (included in Appendix B) identifies the tanks as decommissioned and concrete filled. Records of the status of the tanks were requested from LBC and London Fire and Emergency Planning Authority as part of the desk study but no further information was available (see Appendix B for response).

As a result, the ground investigation was intended to identify any indication of impact to groundwater as a result of historical leaks from the tanks and characterise the shallow soils across the remainder of the site. The investigation, and previous work, results in a sampling density of approximately 21m centres which is sufficient given the low sensitivity of the site and development.

3.2.3 Monitoring installations

Groundwater monitoring wells were installed in BH201 and BH202. Table 3 provides a summary of the installation details of the exploratory holes.

Table 3 Exploratory hole depth and installation details

Hole	Type	Depth (m)	Installation
BH201	CP	8.15	Groundwater well screened within RTD from 4.2m to 7.2m bgl
BH202	CP	8.15	Groundwater well screened within RTD from 4.0m to 7.0m bgl
Key CP – Cable Percussion, HP – Hand Pit, N/A - Not Applicable			

3.2.4 Monitoring

Two rounds of groundwater sampling and monitoring were completed in BH101, BH201 and BH202 on 27th February 2018 and 6 March 2018. The in situ groundwater monitoring included the assessment of non-aqueous phase liquids (NAPL) and groundwater testing of controlled waters in the secondary aquifer (RTD); and,

There are no proposed buildings or enclosed spaces. No ground gas monitoring was undertaken as part of the investigation as no plausible pollutant linkages (PPLs) were identified in the conceptual site model (CSM) [2].

3.2.5 Chemical analysis

The soil (including leachability) and groundwater chemical analysis undertaken as part of the ground investigation is described below. The testing was conducted by i2 Analytical Environmental Science laboratory, to UKAS and MCERTS accredited methods, where appropriate and available.

Soil

12 soil samples were collected from the five locations and submitted for laboratory analysis. 10 samples from the Made Ground, one sample from the RTD and one sample were the London Clay were tested for a range of contaminants. These included metals, detailed quantified asbestos analysis (two stage by initial stereo-binocular/PLM and quantitative phase contrast microscopy assessment), speciated total petroleum hydrocarbons (TPHCWG carbon banding), MTBE, speciated PAH, BTEX, volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) (including cresols), phenols, cyanide, polychlorinated biphenyls (PCBs), plus other inorganic compounds. Soil leachability testing was also undertaken.

Groundwater

Six groundwater samples were collected from the three boreholes onsite (BH101, BH201 and BH202) with screened sections in the RTD and scheduled for a similar suite of analysis to the soil samples (no asbestos analysis but additional testing for hardness, ammoniacal nitrogen, chloride, dissolved organic carbon, calcium, manganese).

3.2.6 Geology and stratigraphy

The ground conditions encountered during the 2018 investigation are summarised in Table 4**Error! Reference source not found.**. The exploratory hole logs are included in the factual report presented in Appendix A.

Table 4 Summary of the depths and composition of encountered strata

Formation	Elevation of top of stratum (mOD)	Thickness (m)	Description
Surface cover	+28.27 to +28.02	0.01 – 0.2	Pavement slab (0.08m)/ yellow sand/ rubber surfacing (0.01m)/ reinforced concrete (Ø6mm rebar mesh)
Made Ground	+28.32 to +27.77	0.92 (np) – 2.25	Silty gravelly sand with rootlets and inclusions of flint, brick ceramic, concrete and plastic, glass and metal fragments. Plastic membrane at 0.28m.
RTD	+26.12 to +25.52	4.30 - 4.70	Silty sandy gravel
London Clay	+21.42 to +21.22	1.25 – 1.35 (np)	Slightly micaceous clay
Notes: np – not proven			

Made Ground was encountered in all five locations. Unproven thicknesses were recorded in the hand pits in the centre and west of the site which ranged from 0.7m to 1.2m. The boreholes in the east of the site recorded Made Ground thicknesses of 2.2 and 2.5m. The Made Ground was reported to include various anthropogenic materials such as plastic, glass, metal and ceramic fragments. A plastic membrane was recorded at 0.28m depth in BH202 and 0.2m in HP102.

3.2.7 Groundwater

Groundwater levels for BH101, BH201 and BH202 were recorded on 27th February 2018 and 6th March 2018. Monitoring was previously completed at BH101 between 26th April 2017 and 18th May 2017. The results of the groundwater level monitoring are summarised in Table 5.

Table 5 Summary of groundwater levels recorded in the RTD

Location	Monitoring rounds	Response zone (m bgl)		Water level (m bgl)	
		Top	Bottom	Max	Min
BH201	2	4.20	7.20	5.70	5.68
BH202	2	4.00	7.00	5.53	5.53
BH101	6	3.40	7.85	5.85	5.72

3.2.8 Observations of contamination

The results of PID headspace testing ranged from 0ppm to 0.1ppm, indicating no significant hydrocarbon vapours are present in the materials monitored. No visual or olfactory observations of potential contamination (such as odours, colours or evidence of hydrocarbons) were recorded during the ground investigation.

4 Data assessment

4.1 Assessment criteria

4.1.1 Rationale

The assessment criteria have been selected based upon the preliminary conceptual site model including a consideration of the proposed development.

The evaluation of ground investigation data has been carried out in accordance with the risk assessment methodology outlined in Appendix C and following CIRIA C552 [4] and CLR11 [5]. Appendix C describes the background and context of the assessment and defines the criteria used to assess soils and groundwater, which are further discussed below.

4.1.2 Human health soil criteria

The UK statutory guidance [6] suggests that generic soil quality guideline values may be used for an initial screening of soil contamination results in regard to human health risk assessment. Generic assessment criteria (GAC provide an indication of concentrations in soil below which the long-term human health risks for various generic land-use scenarios are considered to be minimal. Concentrations above GAC do not necessarily indicate that significant contamination is present, but rather that further assessment or risk management measures may be warranted.

A generic residential public open space end use ($POS_{(resi)}$) has been considered in the assessment to provide an initial appraisal of the results. The $POS_{(resi)}$ end use assumes a predominantly grassed area adjacent to high density housing or as a central green area around which houses are located. It is based on assessing risks to a female child using the site on a regular basis (1 hour at a time for 170 days a year). Soil organic matter (SOM) content in the soil samples collected ranged from <0.1% to 8.28% with an average of 2.03%. Criteria based on the lowest SOM level available (1%) have been used in the first instance.

Category 4 Screening Levels (C4SLs), released by Defra for some determinands including lead, have been used within this assessment. C4SLs are only available for six contaminants.

Arup has derived GAC, using CLEA v1.07, which use C4SL exposure parameters but maintain the traditional minimal risk toxicological benchmarks. Input data for the toxicological effects, physical characteristics and contaminant fate and transport parameters for the determinands have been taken from sources published by the Environment Agency and other industry sources (including LQM/CIEH and the European Food Safety Authority (EFSA)).

4.1.3 Controlled waters quality standards

Groundwater and soil leachability results have been compared to the appropriate water quality standards (WQS). As outlined in Appendix C, a hierarchy of water

quality standards (WQS) has been used in the assessment of groundwater and leachability chemical data. Environmental Quality Standards (EQS) set out in the Water Framework Directive (2000) have been used where available. Where these values are not available other relevant UK EQS for surface water and drinking water have been used.

Results above the WQS do not necessarily indicate significant contamination but may require further assessment. The values are set relatively low as they are protective of a sensitive water environment, whereas in this case inner London groundwater is being assessed. Concentrations above the WQS have been reviewed for unusually high concentrations which may be indicative of other issues (free product or primary sources such as tanks) and might warrant further intervention.

The conceptual model indicates the site has a low sensitivity with no PPL associated with surface water and the principal aquifer underlying the site.

4.2 Results

Laboratory analytical certificates are presented in the factual report in Appendix A and the results of a comparison of the concentrations against the relevant assessment criteria is presented as Appendix D.

4.2.1 Soil

The measured concentrations of contaminants in soil were generally very low. A summary of the results is as follows:

- The concentrations of metals were generally very low. Concentrations of lead exceeded assessment criteria in three samples (HP101 at 1.0m, HP103 at 0.3m and HP103 at 0.7m) with a maximum of 750mg/kg which is above the GAC of 630mg/kg. By comparison it is below the GAC for a public open space park end use of 1,300mg/kg. Further assessment is provided later in this report.
- TPH concentrations were below the detection limit in four samples and where recorded were generally low at between 17mg/kg and 130mg/kg. Higher concentrations were recorded in HP102 with the sample from 0.3m recording a total hydrocarbon concentration of 1,240mg/kg and the sample from 1.0m containing 580mg/kg. These were heavier end carbon fractions with the majority in the aliphatic and aromatic $>C_{21}$ to C_{44} carbon bands. The concentrations of the individual speciated hydrocarbon carbon bands were all well below the GAC for the POS_{resi} end use.
- PAH were detected at very low concentrations (marginally above the laboratory detection limit). No concentrations were measured above the relevant GAC and the results were very low.
- Concentrations of PCBs and MTBE were all recorded below the laboratory method detection limit (MDL).

- Asbestos (chrysotile loose fibres) was identified in three samples (BH201 at 0.3m, BH202 at 0.3m and HP102 at 1.0m) within the Made Ground at concentrations ranging from <0.001 to 0.002%.
- |All concentrations of phytotoxic elements (zinc, copper and nickel) were below the thresholds given in BS3882 [7] apart from one concentration of copper in BH202 (0.3m).

4.2.2 Controlled waters

Groundwater

The groundwater data was assessed initially by comparison to WQS and are presented in Appendix D. In general, the concentrations recorded in groundwater were very low and below the respective WQS with most recorded at concentrations below the MDL.

TPH, PAH and BTEX was measured in all six samples. All samples reported concentrations of these hydrocarbons below the detection limit. The three samples taken during the first monitoring round were also tested for VOC and SVOCs and all recorded concentrations were below the MDL.

All concentrations of metals and inorganics were below the respective WQS apart from manganese (discussed below).

The samples overall showed elevated concentrations of:

- ammoniacal nitrogen ranging from 36µg/l to 680µg/l; and,
- manganese ranging from 2µg/l to 170µg/l, which is above the EQS.

The slightly elevated concentrations of ammoniacal nitrogen and manganese identified within groundwater samples are commonly observed in an urban environment. In fact, both are typically identified at higher concentrations than observed on this site.

The results of all the testing, therefore, indicate the groundwater in this area is relatively high quality given the environmental setting (a shallow aquifer in central London). There was no significant hydrocarbon impact identified and hydrocarbons results were all below detection limit, indicating that the underground tanks discussed in the desk study do not appear to have resulted in significant contamination of the groundwater.

Soil leachability

The soil leachability data were screened against relevant WQS and are presented in Appendix D. In general, the soil leachability concentrations were low and below their respective EQS, except for copper as summarised in **Error! Reference source not found.**.

Table 6 Leachability results for copper exceeding EQS

Determinand	EQS (mg/l)	Min (mg/l)	Max (mg/l)	Mean (mg/l)	No. above WQS
Copper	0.001	0.001	0.030	0.012	11

The maximum concentration of copper (0.03mg/l) was recorded in BH201 at 7.3m. Although above the very low EQS value (set to protect sensitive aquatic organisms in rivers) the concentrations of leachable copper in the soil were well below drinking water standards by two orders of magnitude. Therefore, the leachable copper concentrations in soils at the site are not considered significant.

5 Risk assessment

5.1 Risk classification definitions

The potential risks to various receptors have been considered in the context of the conceptual site model in accordance with the current UK approach to contaminated land assessment. The method for risk evaluation has been based on a qualitative assessment taking into consideration the magnitude of the potential severity of the risk as well as the probability of the risk occurring. The risk characterisations provided below have been assessed using a scale from very high to very low based on the CIRIA guidance C552 [4]. A brief summary of each risk classification is provided in Table 7.

Table 7 Risk classification

Risk classification	Description of risk
Very high	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, or there is evidence that severe harm to a designated receptor is currently happening. The risk, if realised, is likely to result in substantial liability. Remediation is likely to be required.
High	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Remedial works may be necessary
Moderate	It is possible that harm could arise to a receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Some remedial works may be required.
Low	It is possible that harm could arise to a receptor from an identified hazard but it is likely that this harm, if realised, would typically be mild.
Very low	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised the consequence would at worst be mild.
Negligible	There is no plausible pollutant linkage due to the absence of a pathway or receptor (without any intervention).

5.2 Site sensitivity

5.2.1 Environmental sensitivity

The secondary undifferentiated shallow aquifer within the RTD is expected to be of relatively low sensitivity since it will be truncated by existing basements particularly to the south. The deeper principal aquifer within the Chalk is overlain by a significant thickness of London Clay which will provide significant protection. There are no source protection zones, surface water receptors, abstractions, environmentally sensitive areas or historic or current landfills in the vicinity of the site. The environmental sensitivity of the site is consequently considered to be **low**.

5.2.2 Development sensitivity

The development comprises hard and soft landscaped public realm areas. The site will be used by adults and children and therefore sensitive receptors are expected to use the site, albeit for relatively short periods, potentially on a regular basis given the proximity of residential properties. Hard landscaped areas are considered **low** sensitivity because direct contact pathways will not be active. There is the potential for dermal contact and ingestion in soft landscaped areas. However, the proposed planting and grassed area will be high quality landscaped areas with a significant thickness of clean imported soils and tree pits. These areas are also considered to be **low** sensitivity.

5.3 Summary of results

Most soil results were below the protective initial GAC used in the assessment. Three samples (25%) reported slightly elevated lead and three reported low concentrations of chrysotile fibres.

The results of all the testing indicates the groundwater in this area is relatively high quality given the environmental setting (a shallow aquifer in central London). There was no significant hydrocarbon impact identified and hydrocarbons results were all below detection limit, indicating that the underground tanks discussed in the desk study do not appear to have resulted in significant contamination of the groundwater.

The soil leachability results were very low and below either EQS or DWS.

5.4 Human health risk assessment

5.4.1 During construction

There is a PPL between contaminated Made Ground soils and dusts and site workers (including visitors) and neighbours during anticipated shallow earthworks. Made Ground was identified in all five exploratory locations to depths of between 2.2m and 2.5m bgl. Contaminant concentrations in Made Ground soils were generally low with regard to risks to construction workers.

Asbestos as chrysotile loose fibres was identified in three samples (0.2m in BH201, 0.3m in BH202 and 1.0m in HP102) at concentrations of between <0.001% and 0.002% (HP102). There are no specific thresholds for safe levels of asbestos fibres in soils but the risks associated with these low levels can be managed during construction with enhanced health and safety measures.

Based on the findings of the ground investigation the risk of harm to human health during construction of the development is assessed to be **low** and principally related to concentrations of lead and asbestos.

With mitigation comprising appropriate control measures and risk management during construction the risk of harm to construction workers is **very low**. Recommendations are presented in Section 7.

5.4.2 During operation

After development the main receptors at the site will be site users and maintenance workers. Site users will include adults and children that visit the landscaped areas for short periods, potentially on a regular basis.

The results of the ground investigation have identified generally low concentrations of contaminants in the ground. Concentrations of lead above the GAC for public open space and asbestos fibres have been identified but direct contact and fibre inhalation pathways for future users will be limited due to the presence of hard landscaping and soft landscaping which will include a suitable thickness of clean cover. Consequently, potential risks to future site users are assessed to be **very low** assuming the soft landscaping is managed during operation.

There is the potential for maintenance workers to be exposed to underlying Made Ground soils if the hard and/or soft landscaping is penetrated during future maintenance works. Mitigation in the form of a marker layer and safety controls are described in Section 7. Assuming this is implemented, the risk of harm to human health after development is assessed to be **very low**.

5.5 Controlled waters

The conceptual model identified that controlled waters receptors are limited to the shallow RTD secondary A aquifer. The aquifer is of low sensitivity based on the lack of SPZs and abstractions, and it will be truncated by existing basements in this inner London setting, particularly to the south.

The development is expected to involve limited excavation and little disturbance of the ground. Works will include the removal of the existing hard landscaping and replacement with new areas of hard and soft landscaping. The net effect of the development is expected to be a small increase in infiltration of water into the ground.

The results of the ground investigation have identified no significant contamination onsite within the groundwater and low concentrations of leachable contaminants. The risk of pollution to the shallow aquifer as a result of the development is therefore considered to be **very low**.

5.6 Risk to building materials

Building materials normally identified as being at risk on contaminated sites are concrete, plastic and metals. The results of the ground investigation have not identified significant contamination onsite. No buildings are proposed within the development, which is limited to hard and soft landscaping. Some concentrations of heavier end hydrocarbons have been identified at HP102. If new services or utilities are to be installed at the site these should be designed appropriately for the ground conditions. Based on the above the risks to building materials and services are assessed to be **very low.**

5.7 Risk to ecological receptors

The site is not located in an area of ecological importance and the risks of harm to designated ecological receptors from contaminated ground are therefore **negligible**.

The principal (non-designated) ecological receptors identified are new landscaping (grass, trees and shrubs etc.) which form part of the development. A single concentration of copper at 0.3m depth in BH202 was found to exceed phytotoxic thresholds for topsoil. A suitable thickness of clean imported landscaped soils will be provided within the development and site won soils will not be reused.

The risk of harm to new planting is therefore considered to be **very low**.

6 Revised conceptual site model

The preliminary conceptual model has been updated based on the findings of the ground investigation and the risk assessment. Table 8 presents the revised conceptual model based on assessment of the PPLs for the site.

Table 8 Revised conceptual model

PPL	Summary	Mitigation measures	Risk
Construction workers (including visitors) via dermal contact, ingestion and inhalation of soils, soil-derived dust and vapours.	Generally low levels of contamination identified. Low concentrations of chrysotile asbestos fibres identified in three locations. Lead identified above public open space (residential and park) criteria. Potential for other unexpected contamination.	Enhanced construction practices, material management, dust control measures and PPE. Watching brief during excavation works.	Very low
Site neighbours via inhalation of soils, soil-derived dust and vapours			
Future site users via dermal contact, ingestion and inhalation of soils and soil-derived dust.	Hard and soft landscaping in clean soils across the entire site. No direct contact with underlying soils if managed well.	None (assuming mitigation for maintenance implemented))	Very low
Future site maintenance workers via dermal contact, ingestion and inhalation of soils and soil-derived dust.	Low concentrations of asbestos fibres and elevated concentrations of lead identified.	Marker layer below clean soils. Services laid in clean material	Very low
Secondary A aquifer (RTD).	Low levels of contamination in soils and leachable contaminants. Small increase in infiltration.	None	Very low
Construction materials and services	No significant contamination identified in soil and groundwater.	Materials to be appropriately specified.	Very low
Planting within soft landscaped areas	No significant contamination identified in soil and groundwater	Planting in suitable thickness of clean imported material	Very low

7 Conclusions and recommendations

7.1 Conclusions

The contamination ground investigation and assessment confirmed that the site has not been impacted by significant contamination. The site was previously developed as a petrol filling station prior to 1982 which was no longer present in 1993. The belowground fuel tanks are believed to remain in place but are understood to be concrete filled.

Soil and groundwater contamination levels at the site were generally very low. Concentrations of lead above the GAC were reported in three soil samples from two locations at shallow depths. Low concentrations of chrysotile asbestos fibres were reported in three soil samples (25%) from three locations. TPH and PAH concentrations were below the POS_{resi} assessment criteria.

A preliminary assessment of the soil and leachability results indicates one sample could be classified as hazardous waste based on the TPH concentration and potentially carcinogenic content and one sample could be classified as non-hazardous waste as it exceeds the inert waste acceptance criterion (WAC) for selenium. The remaining samples (over 80%) are likely to be classified as inert.

The environmental sensitivity has been identified to be low because the shallow RTD aquifer is of low sensitivity, the deeper principal aquifer within the Chalk is overlain by a significant thickness of London Clay and there are no source protection zones, surface water receptors or abstractions in the vicinity of the site. The development sensitivity is low as it comprises hard and soft landscaped public realm with no buildings.

Based on the risk assessment for the proposed development, risks to human health and the environment have been assessed as either low, very low or negligible (without mitigation). Proposed mitigation measures including good and enhanced construction practices (e.g. health and safety, environmental controls) and the form of development (hard landscaping and soft landscaped areas in clean imported material) will reduce any residual risk to very low or negligible (with mitigation).

Table 9 below summarises the risk of harm to receptors through the identified PPLs.

Table 9 Summary of risk assessment

Description	Classification
Contaminant sources and site sensitivity	
Environmental sensitivity	Low
Development sensitivity	Low
Risk assessment	
Risk of harm to human health during construction	Very low (with mitigation)

Description	Classification
Risk of harm to human health during operation	Very low (with mitigation for maintenance workers)
Risk of pollution to groundwater	Very low
Risk of pollution to surface water	Negligible
Risk to construction materials and services	Very low (with mitigation)
Risk to designated ecological receptors	Negligible
Risk to planting in landscaped areas	Very low

7.2 Recommendations

Based on the findings of the ground investigation and risk assessment, there is no requirement for a specific phase of remediation. Evidence of contamination related to the underground tanks has not been found. The results therefore do not indicate that remediation in the form of removal of the tanks as part of the development is required.

Mitigation measures are presented in the following sections to be put in place and made available for deployment during the construction work to minimise potential exposure of receptors during the construction and operation phases.

The contractor(s) will need to incorporate the findings of this report applicable to their works as part of their risk assessment process, in order to determine the appropriate level of mitigation and control measures. As with most brownfield sites, there is the potential for conditions different to those identified in this report to exist onsite, for example between investigation locations.

7.3 Site safety and control

The development works should be undertaken in a fashion to prevent the creation of dusts and general PPE and good control of arisings is necessary, where the following may apply:

- The requirements described in Control of Asbestos Regulations (CAR) 2012 [8] and CL:AIRE CAR SOIL [9] guidance should be adhered to where they apply.
- The low levels of asbestos identified by the laboratory during the recent investigation are typical of Made Ground in London. It will not necessarily be identifiable during groundworks so a protective and pragmatic approach will be necessary, primarily through prevention of dust, control of materials, appropriate PPE and asbestos awareness briefings.
- An assessment should be undertaken by a competent assessor (asbestos specialist) in accordance with CAR 2012 and the associated code of practice to determine the likely exposure resulting from the works and the level of protection and management required by CAR 2012.
- Air monitoring may be required which will be advised by the specialist. If the works will take place adjacent to occupied premises (neighbours), a lower

detection limit (than used for occupational monitoring), i.e. 0.00001 f/ml, for air monitoring at the boundary may be appropriate.

- Sufficient hygiene units and PPE should be provided for the works. Suitably competent personnel should advise on and supervise the works and all staff should be briefed on the working methods.

7.4 Clean cover and marker layer

The ground investigation identified elevated lead and asbestos concentrations. The proposed development includes both hard and soft landscaped areas.

It is recommended that a marker sheet and clean cover layer is placed to limit any future contact with potentially contaminated soils. A clean cover layer of a minimum 450mm to 600mm thickness is recommended in soft landscaped areas that should be underlain by a marker layer. The lower thickness would be relevant in low maintenance areas (where digging and similar activities are not expected to occur) and thicker cover where it is. If the landscaping is underlain by an additional hard drainage layer (for instance specified by the landscape architect) then a smaller thickness of soil may be satisfactory. This should be reviewed during construction and recorded in the verification report.

Any services, utilities and other parts of the public realm that may require future maintenance should be provided with a marker layer, denoting the potential presence of asbestos and contamination below that layer and clean backfill provided so that the potential for future exposure is limited.

A record of the installed measures, including depth to marker sheet, should be maintained after completion of the development works as part of the wider management of the Regent's Place area. Any proposed belowground maintenance work should be reviewed to ensure that appropriate measures are taken.

7.5 Underground storage tanks

Underground storage tanks are understood to be present beneath the site as discussed in Section 3.2.2. The available information suggests these tanks are concrete filled and decommissioned. As a result, the objectives of the ground investigation did not include positively locating the tanks but to characterise existing ground and groundwater conditions. No evidence of contamination which would likely be associated with the tanks was identified in soils or groundwater.

The level of the top of the tanks is not known. Whilst the proposed development is expected to involve limited groundworks the final ground levels are not currently known. If the presence of tanks is found to impact the development and they require removal for construction reasons, this should be undertaken in line with Environment Agency guidance [10] and recorded in the verification report.

7.6 Watching brief and unexpected contamination

A watching brief should be maintained during the works for the presence of contamination and to ensure the various recommendations provided are implemented and recorded.

The method for implementing the watching brief should be described in the construction risk assessment method statement (RAMS). The watching brief should be documented, reported on during progress meetings and compiled in the verification report. Specialist personnel will be necessary to advise on the method statement for the safe handling of asbestos materials onsite where encountered and air monitoring if required.

Where it is necessary to sample and test soils for waste classification purposes, verification, or for dealing with unexpected contamination, this should be undertaken in an appropriate manner by appropriately experienced and qualified staff. Soil testing should be to MCERTS and UKAS standards (where available). All such activities should be recorded and reported on.

These measures and any others deemed necessary by the contractor should be included in the relevant method statements. The contractor will prepare a method detailing how unexpected contamination will be dealt with should it be encountered during the works to comply with planning condition 12. This condition requires unexpected contamination to be dealt with to the satisfaction of the local authority. This would normally include;

- suspending excavation in the area and undertaking in situ soil sampling, or segregating and stockpiling the excavated material separately in an appropriate manner and then collecting soil samples;
- undertaking laboratory testing of potentially contaminated materials; and
- carrying out measures to restrict dust, odour and surface water run-off.

Any additional significant contamination will need to be reported to LBC and any necessary modifications to the remediation scheme should be submitted to and approved by LBC prior to implementation.

7.7 Materials management

7.7.1 Excavated soils

During the earthworks, the contractor will ensure that stockpiles and arisings will be appropriately managed to prevent the spread of material and potential cross contamination. The contractor will implement a robust material and waste management procedure to ensure that all necessary licences/ permits and waste documentation are compliant with the relevant regulations and guidance.

7.7.2 Imported materials

Material will be imported onto site, which is likely to consist of:

- topsoil and subsoil, to be placed in tree pits and soft landscaping; and,
- 'product' material, such as concrete and 'virgin' quarry materials which may include drainage shingle, bedding sands and road/pavement aggregate.

The contractor will document their import of material in their works method statement, but as a minimum will implement the following:

- prior to any import: review the suppliers' certificates, including chemical testing results (where/if available);
- upon arrival to site: visual inspection to ensure that the material is free of any obvious visual or olfactory evidence of contamination and is consistent with the expected material. If suspect material is identified, any lorry loads should either be rejected or chemically tested prior to placement;
- in situ validation chemical testing (or stockpile testing onsite): topsoil and sub-soil verification sampling on a frequency of one sample every $50m^3$ for a suite of chemical determinands consisting of metals, TPH, PAH and asbestos;
- the frequency may be subject to review, for example, based on Local Authority requirements or volume/consistency of source(s);
- if it proposed to import recycled material or use site won material, then testing for asbestos will be undertaken; and,
- 'product' materials will not be chemically tested on site.

7.8 Decommissioning standpipes

The three groundwater monitoring wells will require decommissioning. Where required, these wells should be decommissioned in line with the EA guidance [10]. This is required to ensure that no preferential flow pathways are created during the development works from the surface/Made Ground to the underlying natural soils/aquifer. This shall be undertaken before any significant ground works takes place.

7.9 Verification report

A brief verification report should be prepared following completion of the works in order to demonstrate that the requirements of the remediation strategy have been achieved. Typical information which is included in a verification report and which will need to be collected is set out in Table 10 below.

Table 10 Requirements relating to verification

Requirement	Method
Details of works	• details of the parties involved and a summary of the works undertaken, including method of works, health and safety and environmental control measures implemented, as-built records and photographs of key stages of the ground works.

Requirement	Method
Health and Safety	• method statement and risk assessment from earthworks contractor and specialist sub-contractors and/or consultants relating to contamination/waste/asbestos; • contamination and asbestos discovery strategies and records of communication to operatives via site induction and tool box talks; and • minutes of site progress meetings including a section on safety and environment.
Asbestos	• evidence of compliance with CAR 2012 and other legislation; • CAR assessment and asbestos management plan; • evidence of induction and toolbox talks to operatives; • evidence of control measures; • records of results above relevant exposure limits and actions undertaken as a result to mitigate associated risks; and • waste disposal records.
Tank removal (if undertaken)	• details of any tank removal undertaken and evidence that this was completed in accordance with good practice; • photographic record; and • verification soil sampling and testing of underlying soils.
Marker layer	• details of any marker layer and clean fill above which should be shown on drawings to inform future maintenance works.
Watching brief	• details of any ground contamination encountered and how it was dealt with; • any other observations made by general operatives during works; and • photographic records to be included.
Previously unidentified contamination	• record of actions taken and mitigation measures put in place; • records of chemical sampling to assess nature and extent of potential contamination; and • records of excavation, stockpiling and waste disposal.
Dust control	• mitigation measures to be detailed in contractor's method statements; and • evidence that proactive dust control was implemented.
Imported material	• results of testing of imported material at source (prior to import) and in situ testing following placement. This should include details of volumes, material sources and chemical testing, where appropriate, with assessment against GAC; and • record of the extent and thickness of any imported soil/soft landscaping layers.
Waste management	• results of waste classification testing (chemical laboratory results); • summary of waste disposal records, including conveyance tickets and evidence of compliance with the relevant waste regulations; • volumes or tonnage of each waste stream removed from site; • permits of all hauliers, treatment centres, landfills and other receiving facilities used to remove waste from site; and • haulage/disposal tickets.
Photographs	• photographic record of activities undertaken onsite, with particular attention to key tasks; and • if fixed points can be set out at the site which will remain constant for periodic photographs to be taken to document the progress of the site, this would be beneficial.

Requirement	Method
Regulatory correspondence	• evidence of communication with the regulators, such as the Local Authority Environmental Health Officer (EHO) and Environment Agency and compliance with any permit, consent and licence and relevant planning condition requirements.
Outstanding actions	• details of any outstanding actions and site constraints and how these will be addressed, including maintenance plan; and • description of final site conditions

The verification report should form part of the Health and Safety file in accordance with the Construction Design and Management (CDM) Regulations 2015 and the development operations & maintenance (O&M) manual or maintenance plan. This is to allow the owner/occupant to address any residual ground contamination risks associated with future operations and maintenance.

References

[1] Arup (2017), 1 Triton Square Contamination Desk Study and Risk Assessment Report, November 2017.

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[3] Concept (2018), Site Investigation report, Longford Place, 1 Triton Square.

[4] CIRIA (2001), Contaminated Land Risk Assessment – A Guide to Good Practice (C552).

[5] CLR 11 (2004), Model Procedures for the Management of Land Contamination, Department for Environment, Food and Rural Affairs.

[6] Defra, 2012. Environmental Protection Act 1990: Part 2A. Contaminated Land Statutory Guidance.

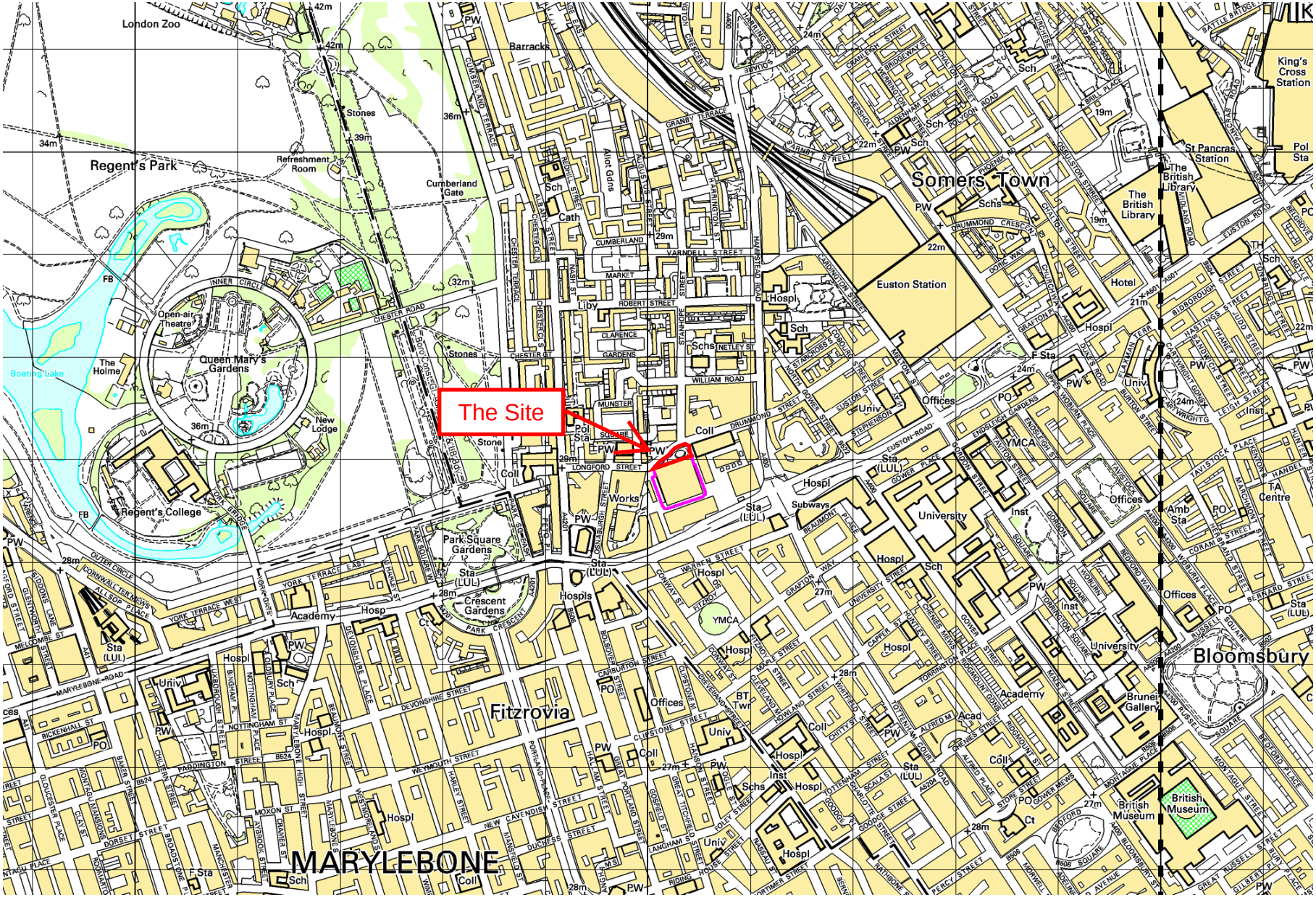
[7] BSI (2015), Specification for topsoil, BS3882:2015.

[8] HSE (2012) The Control of Asbestos Regulations (CAR).

[9] CAR-SOIL™ (CLAIRE & JIWG) (2016) Control of Asbestos Regulations 2012, Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials, Industry Guidance.

[10] Environment Agency (March 2012), Good practice for decommissioning redundant boreholes and wells.

Figures



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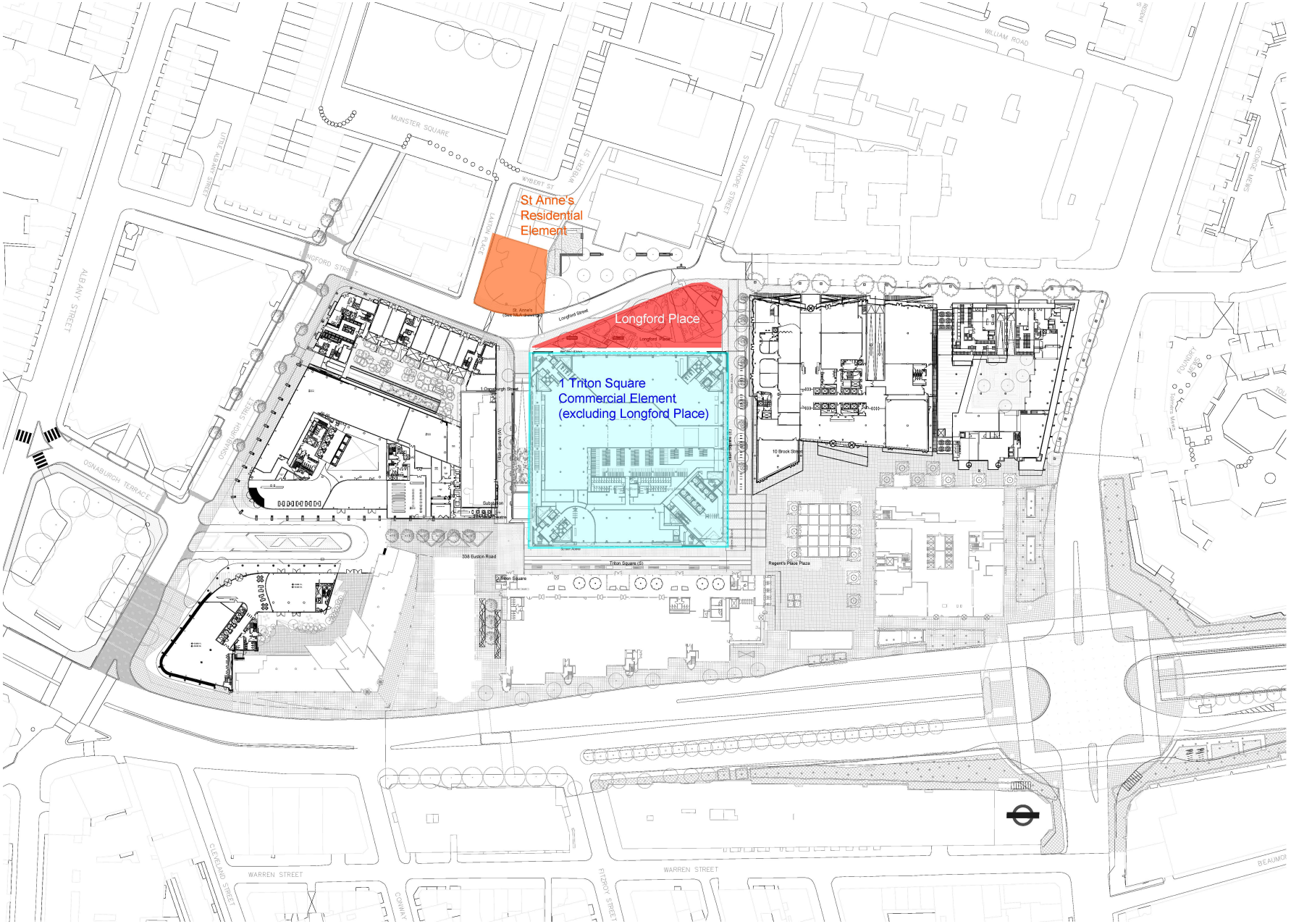
Extract from OS 1:10,000 raster mapping

LONGFORD PLACE
SITE LOCATION PLAN

246868 **FIGURE 1**

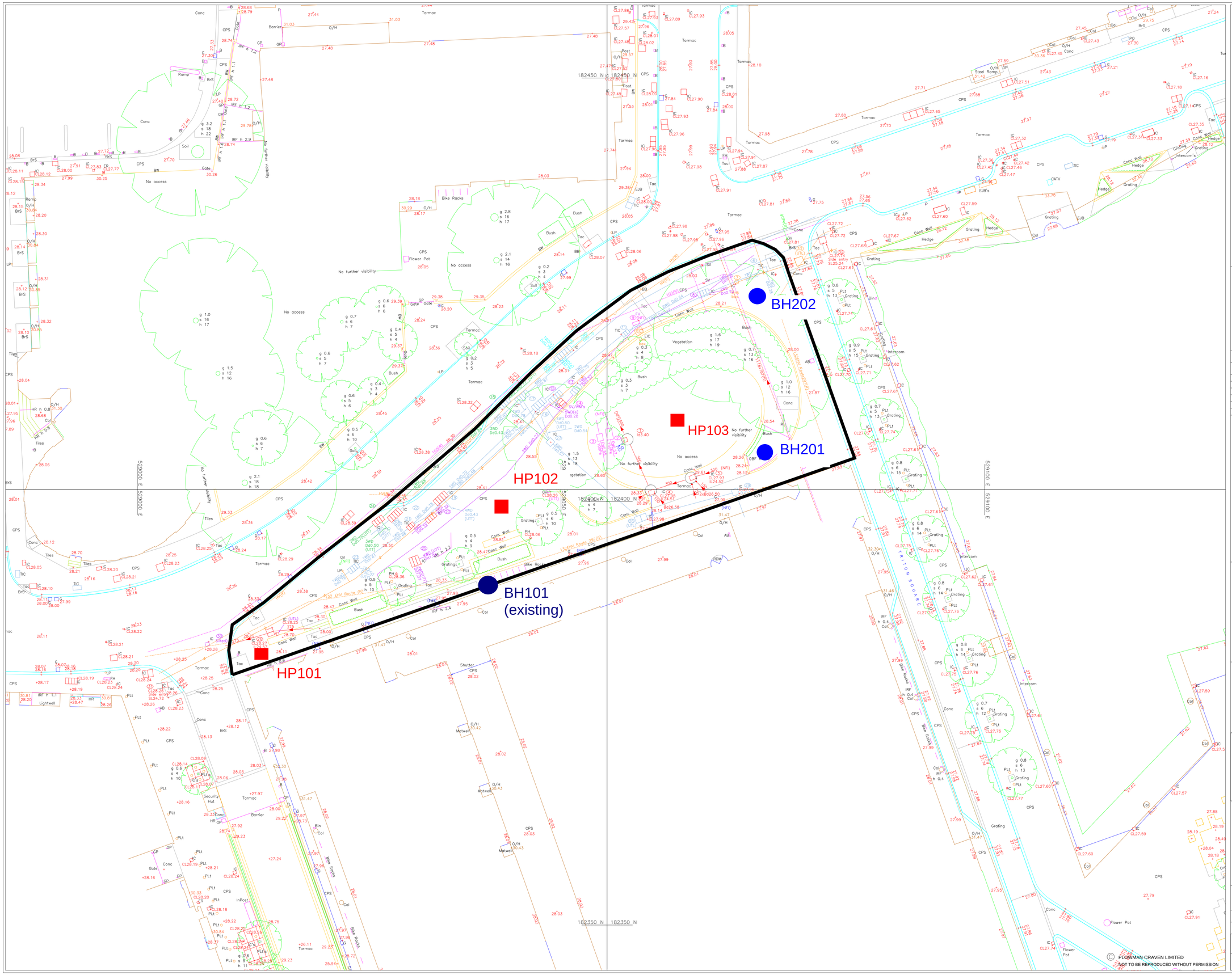


LONGFORD PLACE

Site Layout Plan

246868

FIGURE 2



SERVICE ABBREVIATIONS:

Dd	Depth to top of duct	Pd	Depth to top of pipe
(e)	Empty Duct	Pe	Polyethylene
FH	Fire Hydrant	SL	Sump Level
Id	Invert Depth	(UTL)	Unable to Lift without damage
IL	Invert Level	(UIT)	Unable to Trace
(NFI)	No Further Information	WD	Way Duct

SERVICE LEGEND

- FOUL DRAINAGE
- SURFACE WATER DRAINAGE
- WATER
- GAS
- ELECTRICITY
- TELEPHONE
- COLT
- METROMEDIA
- VERIZON
- VODAPHONE
- UNKNOWN SERVICE
- UNDERGROUND CHAMBER

PROJECT TITLE

Longford Place

Figure 3

Borehole Location Plan

PRESENTATION SCALE	1:200 @ A1
DATE OF ORIGINAL SURVEY	March 2016
DRAWING No.	
ISSUE	

Appendix A

Concept factual report

SITE INVESTIGATION REPORT

Longford Place, 1 Triton Square

ISSUE 02

SITE INVESTIGATION REPORT

Longford Place, 1 Triton Square

Prepared for: Lendlease/British Land Property Management Ltd

Concept: 18/3086 - FR 02 05/06/2018

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DOCUMENT ISSUE REGISTER			
Project Name:	Longford Place, 1 Triton Square		
Project Number:	18/3086		
Document Reference:	18/3086 - FR 02	**Current Issue**	Issue 02
Document Type:	Site Investigation Report		

Development	**Name**	**Signature**	**Date**
Prepared by:	B Milne		05/06/2018
Checked by:	O Savvidou		05/06/2018
Approved by:	I Penchev		05/06/2018

Issued to:	Arup

Date	**Issue**	**Amendment Details/ Reason for issue**	**Issued to**
15/03/18	Issue 00		Arup
20/03/18	Issue 01	Updated with comments	Arup
05/06/18	Issue 02	Updated with comments	Arup

Notes:

CONTENTS

1. PROJECT PARTICULARS

Site Location:	Longford Place, London, NW1 3HG
Client:	Lendlease / British Land Property Management Limited
Investigation Supervisor:	Ove Arup & Partners
Fieldwork:	12/02/2018 – 14/02/2018
Laboratory Work:	15/02/2018 – 14/03/2018

2. PURPOSE AND SCOPE OF WORKS

The purpose of the investigation was to understand the ground and groundwater conditions at the site and to determine the nature and extent of any ground and groundwater contamination from the previous use as a filling station. To confirm levels and thicknesses of the stratigraphy present at site.

The area is occupied by hard landscaping and a crèche which is to be demolished, immediately to the north of 1 Triton Square building.

The development will involve addition of three floors and an 8-storey infill in the buildings central atrium.

The scope of the works comprised the following:

- 2 No. Cable Percussion Boreholes to a maximum depth of 8.15m;
- 3 No. Hand Excavated Pits to a maximum depth of 1.20m;
- Logging and Photographing;
- Instrumentation Monitoring and Sampling;
- Geotechnical & Chemical Testing.

Table 1 – Exploratory Hole List

Hole ID	Hole Type	Depth (m)
BH201	CP	8.15
BH202	CP	8.15
HP101	HP	1.20
HP102	HP	1.20
HP103	HP	0.70

Key

CP – Cable Percussion Borehole
HP – Hand Excavated Trial Pits

3. DESCRIPTION OF WORKS

The works were carried out in accordance with the Arup "1 Triton Square" Technical Note with the reference 246868-24, dated 16 January 2018 and Concept's Method Statement with reference no: 18/3086, dated 31/01/2018.

The site is bounded by Longford Street to the north, and Triton Square to the west, east and south. The approximate centre of the site is located at National Grid Reference: TQ 29038 82366.

The locations of all exploratory holes are shown in the Exploratory Hole Location Plan presented in Section 7 of this report.

4. INVESTIGATION METHODS

4.1 Inspection Pits

Inspection pits were hand excavated to a maximum depth of 1.20m at all borehole locations.

4.2 Cable Percussion Drilling

2 No. Cable Percussion Boreholes (BH201 & BH202) were drilled to a maximum depth of 8.15m depth using a standard cable percussion rig (Dando 4000) with 150mm diameter casing as appropriate.

4.2.1 Sampling and Testing during Cable Percussion Drilling

Bulk samples were taken at regular intervals in the Made Ground.

Standard Penetration Tests (SPT) were carried out at specified intervals or as otherwise instructed by the Investigation Supervisor. The resulting SPT "N" blowcount values are presented in the relevant borehole records. Where an SPT using a split spoon sampler was not possible, due to the granular nature of the material, a solid cone was used.

Small, disturbed samples were retrieved from the SPT split spoon sampler and at intervals specified by the Investigation Supervisor.

Environmental samples (tubs, jars and vials) were taken for chemical analysis in the Made Ground or at each change of strata and where visual or olfactory evidence of contamination was noted or as instructed by the Investigation Supervisor. Headspace readings for volatile organic compound (VOC) content were taken in all the samples using a Phocheck Tiger photoionization detector.

The borehole logs are presented in Section 8 of this report.

4.3 Hand Excavated Pits

3 No. Hand Excavated Pits (HP101, HP102 & HP103) were carried out to a maximum depth of 1.20m.

Environmental samples (tubs, jars and vials) were taken for chemical analysis in the Made Ground or at each change of strata and where visual or olfactory evidence of contamination was noted or as instructed by the Investigation Supervisor. Headspace readings for volatile organic compound (VOC) content were taken in all the samples

using a Phocheck Tiger photoionization detector. Bulk samples were also taken for soils analysis.

The pits were logged and photographed. The logs are presented in Section 9 of this report and the photographs are presented in Section 13 of this report.

4.4 Standpipe Installations

Monitoring wells were installed in the boreholes as follows:

Table 2 – Monitoring Installation Details

Hole ID	Base of Borehole (m bgl)	Diameter of Installation (mm)	Type of Installation	Base (m bgl)	Top RZ (m bgl)	Bottom RZ (m bgl)
BH201	8.15	50	SPGW	7.20	4.20	7.20
BH202	8.15	50	SPGW	7.00	4.00	7.00

KEY
SPGW – Groundwater Standpipe
RZ – Response Zone

The boreholes were backfilled with bentonite pellets with groundwater response zones backfilled with a 10mm pea shingle filter. All installations were finished with bentonite pellets to the surface with concrete and a lockable stopcock cover flush with the ground.

4.5 Instrumentation Monitoring

Groundwater monitoring and sampling was carried out by Concept subsequent to completion of the boreholes. Monitoring of the historic borehole (BH101) from the previous phase of the investigation was also monitored.

Groundwater in the standpipes was monitored using an In-Situ Rugged interface dipmeter. The results are presented in Section 10 of this report.

4.6 Logging / Laboratory Testing

Logging of all soil samples was carried out in accordance with BS 5930:2015.

Geotechnical testing is performed at Concept Site Investigations laboratory in accordance with BS1377:1990 unless otherwise stated in the report. Concept is accredited by UKAS for tests where the UKAS logo is appended to the individual test report or summary. Approved signatories for laboratory testing are as follows:

- LG – Lynn Griffin (Quality Manager)
- KM – Kasia Mazerant (Laboratory Manager)

Where subcontracted analysis has been carried out, the details of the laboratory (and accreditation where applicable) are shown in the individual test report or summary.

The results are presented in tabular format in Section 11 of this report.

All chemical testing was specified and scheduled by Arup and carried out by i2 Analytical Ltd in accordance with the requirements of UKAS ISO17025 and MCERTS. The results are presented in tabular format in Section 12 of this report.

4.7 Setting Out

The locations of all exploratory holes were agreed with the Investigation Supervisor and set out prior to commencement of the site works.

Following completion of the ground works the locations and elevations of the boreholes and pits were established by Concept using total survey and GPS equipment.

The co-ordinates and levels of the as-built locations of the boreholes and trial pits are shown in the Exploratory Hole Location Plan presented in Section 7 of this report.

5. GEOLOGICAL GROUND PROFILE

The geological strata encountered during the investigation are summarised in the table below. The Top and Bottom of the strata noted in the table indicates the highest and lowest boundaries encountered in all exploratory holes.

Table 3 - Geological Ground Profile

STRATUM	TOP (mOD)	BASE (mOD)	DESCRIPTION
MADE GROUND	28.32	25.52	Yellowish brown silty clayey sandy GRAVEL. Gravel comprises subangular to subrounded fine to coarse flint, brick and concrete fragments. Greyish brown slightly gravelly silty fine to coarse SAND with occasional rootlets.
RIVER TERRACE DEPOSITS	26.12	21.22	Very dense, yellowish brown slightly sandy GRAVEL. Gravel is subangular to subrounded fine to coarse flint. Sand is fine to coarse.
LONDON CLAY	21.42	Extent not proven	Stiff, brownish grey slightly micaceous CLAY.

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6. SITE LOCATION PLAN

Not to Scale © Crown Copyright reserved

7. EXPLORATORY HOLE LOCATION PLAN