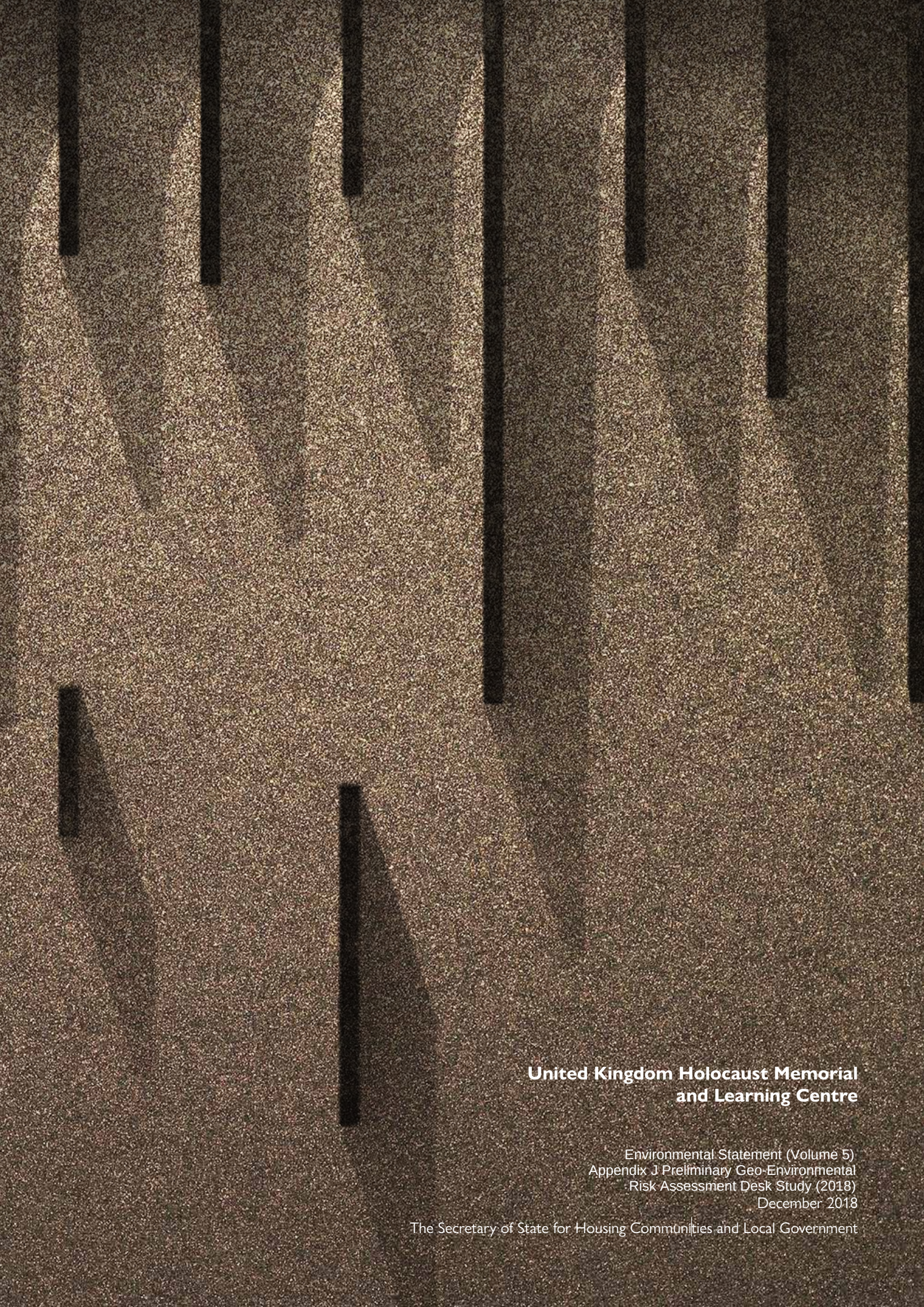

United Kingdom Holocaust Memorial and Learning Centre

Environmental Statement (Volume 5)
Appendix J Preliminary Geo-Environmental Risk Assessment Desk Study (2018)
December 2018

The Secretary of State for Housing Communities and Local Government

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EXECUTIVE SUMMARY

CLIENT	UK Holocaust Memorial Foundation
CURRENT SITE USE	The site lies within Victoria Tower Gardens, immediately to the south of the Palace of Westminster, bounded to the east by the River Thames, to the west by Abingdon Street and Millbank and to the south by Horseferry Road/Lambeth Bridge. The site is an area of level ground and has been a public garden since 1879. It was extended to the south in 1914. Much of the site area lies on land that was reclaimed from the Thames foreshore in the post-medieval period. The gardens currently comprise amenity grassland crossed by several formal tarmac paths that link directly to the Thames riverside. There are no trees in the central part of the gardens, but mature trees almost completely line the perimeter of the site. The Victoria Tower Gardens currently house three different memorials; • The Buxton Memorial (a fountain in the centre of the site). • The Emmeline Pankhurst Memorial (a stature in the north west of the gardens). • The Burghers of Calais (a statue in the north of the gardens).
PROPOSED DEVELOPMENT	The UK Holocaust Memorial will incorporate a new national memorial and a learning centre. It is envisaged that the learning centre will be constructed below ground, comprising a double level basement.
GEOLOGY	The published geology for the area, combined with a review of the available BGS logs in the vicinity of the site indicated that the site is likely to be underlain by Made Ground, Alluvium deposits and River Terrace Gravels (Kempton Park Gravels) over the London Clay. At depth, London Clay is underlain by the Reading Beds, which form part of the Lambeth Group, Thanet Sand and Upper Chalk.
HYDROGEOLOGY	The superficial drift deposits are classified as 'Secondary Undifferentiated' aquifers (Alluvium) and 'Secondary A' aquifers (River Terrace Deposits). The River Terrace Gravels are likely to be in hydraulic continuity with the River Thames. The site is underlain at depth by the London Clay. The London Clay is classified as 'Unproductive Strata'. The Lambeth Group beds and the Thanet Sands are classified as 'Secondary Aquifer – A' (permeable layers capable of supporting water supplies at a local rather than strategic case, and in some cases forming an important source of base flow to rivers). The Chalk present at depth is classified as a Principal Aquifer.
HYDROLOGY	The nearest surface water feature is the Thames River, located adjacent to the eastern boundary of the site. The former River Tyburn runs culverted to the north of the site. The river runs underground from South Hampstead through St James's Park to meet the River Thames near Downing Street and between Millbank Tower and Thames House. Two water abstractions are recorded within 250m of the site. The closest water obstruction is located 118m south of the site and comprises a single point of abstraction for drinking, cooking, sanitary, washing (small garden). The second closest water abstraction is located 139m west of the site and comprises a single point of abstraction for non-evaporative cooling. Several abstractions are located beyond 250m of the site. These include non-evaporative cooling, heat pump, drinking, cooking, sanitary, washing, (small garden). The site is not located within a groundwater Source Protection Zone (SPZ). However, the Envirocheck report indicates that a SPZ is located 509m to the south of the site.
CONTAMINATION	Generic Environmental Risk Assessment (GQRA) will be required. This will inform the

CONSIDERATIONS	requirement for a Remediation Strategy and Detailed Environmental Risk Assessment (DQRA). WSP has identified a LOW to MEDIUM risk of possible source-pathway-receptor pollutant linkages being present; which should be assessed further by undertaking an intrusive site investigation.
ASBESTOS	There are no present buildings on the site other than the memorials. The presence of asbestos within the Made Ground cannot be discounted.
ARCHAEOLOGY	The northern part of the site lies within the Lundenwic and Thorney Island Archaeological Priority Area due to the identified high potential for this area to contain significant archaeological remains relating to the Saxon (early medieval) and medieval settlement of Thorney Island (the area now occupied by Westminster Abbey and the Palace of Westminster).
BOMB DAMAGE	It is recommended that a specialist UXO desk study and threat assessment is prepared for the site.
LUL STRUCTURES	TFL have confirmed there are no LUL assets within 50 metres of the site. However, there are cable ducts in the area and further liaison with TFL should be undertaken if any highway works are undertaken at this location.
UNDERGROUND STRUCTURES	Liaison with BT, Metropolitan Police and the Government has been progressed to confirm the presence of any underground assets. The details of these will be issued once received.
GEOTECHNICAL CONSIDERATIONS	Foundations for the development will need to be established further to the completion of the site investigation and confirmation of the proposed development loads and settlement tolerances. A site investigation is required to confirm the ground, groundwater and ground gas regime beneath the site and to confirm the geotechnical parameters for design. A ground investigation report (GIR) and geotechnical design report (GDR) will be required in accordance with the Eurocodes for the foundations and the likely basement wall design. A piling risk assessment will be required where piled foundations are adopted. Significant obstructions may be present associated with the former buildings across the site. Liaison with TW regarding the location of any asset within or in the vicinity of the site, and any requirements as part of the development works. Investigation of the Thames Embankment Wall along the eastern boundary of the site and of the southern retaining wall to Lambeth Bridge may be required. A risk assessment will need to be completed to confirm any structures / assets at risk from ground movements from the development which will require a Ground Movement Assessment to be completed. The Ground Movement Assessment will determine if the assets will be detrimentally affected by the development. This assessment shall include any ground movement sensitive services/structures present in the vicinity of the site. Buried utilities (TW) will need to be considered. Depending on the conclusion of these assessments the following maybe required: • Ground movement assessment including cat II or III checks; • Structural monitoring of the assets; • Monitoring actions plans (MAP's); • Monitoring data interpretative reports and management of the MAP's. Based on the information contained in this report and with due regard to the geotechnical aspects of the proposed development, it is the opinion of WSP that the site represents a **LOW** to **MEDIUM** risk with respect to development issues.

1 EXECUTIVE SUMMARY

1.1 AUTHORIZATION

WSP was instructed by UK Holocaust Memorial Foundation (the Client) to undertake a Preliminary Geo-Environmental Risk Assessment at Victoria Tower Gardens (the Site). Site location plans are provided in Appendix A.

1.2 OBJECTIVES

The principal purpose of undertaking the assessment is to highlight land contamination and geotechnical considerations, with respect to ground, ground gas and groundwater conditions, which may potentially arise as issues associated with the redevelopment of the site.

1.3 PROPOSED DEVELOPMENT

The UK Holocaust Memorial will incorporate a new national memorial and a learning centre. It is envisaged that the learning centre will be constructed below ground, comprising a double level basement.

1.4 SCOPE OF WORKS

This Preliminary Geo-Environmental Risk Assessment has been designed to provide information relating to:

- Detailed assessment of the current site status;
- Collation of historical maps and assessment of former land uses on and surrounding the site;
- Collation of information on site and surrounding hydrological features, hydrology, neighbouring land use, ecologically sensitive uses, geology, etc.;
- Informal enquiries with relevant regulators including the Local Authority (Contaminated Land Officer) and the Environment Agency;
- Highlight environmental consideration / risks, predominantly with respect to ground, groundwater and ground gas conditions, which may potentially arise as liabilities associated with the redevelopment of the site;
- Analyse the significance of potential environmental risks identified in the context of the proposed site use via the source-pathway-receptor pollutant linkage approach and presentation of the findings in a conceptual site model;
- Provide a preliminary geotechnical assessment of existing ground conditions at the site in relation to the proposed development, to provide an indication of possible foundation solutions, and the assessment of the potential for variable engineering properties and potential construction risks;
- Assessment of the presence or absence of underground assets which may restrict the redevelopment of the site; and,
- Presentation of findings in a non-technical executive summary, with clear conclusions and recommendations.

1.5 BASIS OF ENVIRONMENTAL RISK ASSESSMENT

This assessment has been undertaken with due regard to Contaminated Land Guidance documents issued by the Department for Environment, Food and Rural Affairs (and its predecessors) including CLR 11 Model Procedures for the Management of Land Contamination, the British Standards Institute (the BSI) and the Royal Institution of Chartered Surveyors (RICS). The methods used follow a risk-based approach, with the potential environmental risk assessed qualitatively using the 'source-pathway-receptor pollutant linkage' concept introduced in the Environmental Protection Act 1990.

Specific comment is made regarding the site's status under the Contaminated Land Regime implemented on the 1st April 2000 as Part IIA of the Environmental Protection Act 1990, and the actual or potential designation of the site as 'Contaminated Land' as defined in Section 78A(2). Unless specifically stated as relating to this definition, references to 'contamination' and 'contaminants' relate in general terms to the presence of potentially hazardous substances in, on or under the site.

In addition, consideration has been given to a wide range of related topics including (where appropriate): environmental processes; current and foreseeable environmental legislation; the practices and duties of environmental regulators; the health and safety of occupiers and neighbours as affected by contamination; effects on the structure of buildings; and financial implications. References to risk classifications are made according to the following definitions;

- **LOW Risk** – it is unlikely that the issue will arise as a liability/cost for the owner of the site.
- **MEDIUM Risk** – it is possible that the issue could arise as a liability/cost for the owner of the site. Further work is usually required to clarify the risk.
- **HIGH Risk** – it is likely that the issue will arise as a liability/cost for the site owner.

1.6 REFERENCES

1. British Geological Society (BGS), Geological Map Sheet no. 270, South London, 1:50 000.
2. BGS 'Geology of Britain' online viewer.
3. Bombsight website.
4. Landmark Envirocheck Report ref. 144655595_1.
5. Atkins – UK Holocaust Memorial, Arboricultural Impact Assessment Revision P1 dated December 2016.
6. SUMO Services Ltd, Victoria Tower Gardens, Westminster, London, Geophysical Survey Report 11461 dated September 2017.
7. Atkins – UK Holocaust Memorial, Heritage Appraisal Revision P1 dated January 2017.
8. Atkins – UK Holocaust Memorial, Level 1 Flood Risk Assessment Revision P1 dated April 2017.
9. Burland, J. B. and Hancock, R. J. R., 1977 Underground car park at the House of Commons, London: Geotechnical Aspects

1.7 LIMITATIONS

The general limitations to the assessment are outlined in Appendix J.

2 LAND USE AND EXISTING CONSTRAINS

2.1 CURRENT LAND USE

The site is approximately centres on National Grid Reference TQ302791 and is located at 5 Milbank Westminster, London SW1P 3JA, covering a total area of circa 2.08 hectares.

A site walkover was undertaken on 12th January 2018. Key observations of the site are presented in Table 1. Site location plans are included in Appendix A. A photographic record is enclosed within Appendix B.

Table 1 – Site Reconnaissance

SITE DESCRIPTION	The site is located in Victoria Tower Gardens, which is situated on the north bank of the River Thames immediately to the south of the Palace of Westminster. The Victoria Tower Gardens is a public park managed by The Royal Parks and is a designated Grade II listed garden. The gardens were created as part of Sir Joseph Bazalgette's construction of major sewage works for London in the 1870s. The site is bounded to the north by the Palace of Westminster, to the east by the River Thames (circa 360m frontage), to the south by Horseferry Road/Lambeth Bridge and to the west by Abingdon Street and Milbank. The Palace of Westminster to the north of the Gardens is a Grade I listed building within the Westminster World Heritage Site and within the Westminster Abbey and Parliament Square Conservation Area. The House of Commons and Big Ben are to the north of the palace and Westminster Abbey is on the opposite side of Abingdon Street. The site is an area of level ground, although some undulations are present at some locations, and has been a public garden since 1879. It was extended to the south in 1914. Much of the site area lies on land that was reclaimed from the Thames foreshore in the post-medieval period. The boundaries of the Gardens to the west and north are demarcated by iron railings, to the south by the retaining wall of Lambeth Bridge, and to the east by the granite embankment wall. The Gardens have four entrances through metal gates and via pedestrian pathways from Abingdon Street and Millbank to the west, and a fifth entrance through Lambeth Bridge to the south, being the only one with steps. A cafeteria and a children's play area are presented at the southernmost part of the site, beyond which are the steps leading up to Lambeth Bridge. The gardens currently comprise amenity grassland crossed by several formal tarmac paths that link directly to the Thames riverside. There are no trees in the central part of the gardens, but mature trees almost completely line the perimeter of the site. The Victoria Tower Gardens currently house three different memorials; The Buxton Memorial (a fountain in the centre of the site); The Emmeline Pankhurst Memorial (a stature in the north west of the gardens); The Burghers of Calais (a statue in the north of the gardens). Slight cracking and swelling of the tarmac and other hard surfacing adjacent to the trees was noticed. This appears to be related with root activity. Several unmarked inspection covers and drainage grates were identified across the site.
TREES	A tree survey has been instructed by UK Holocaust Memorial Foundation and undertaken by Atkins (see **Reference 5**). The Arboricultural Impact Assessment report is enclosed in Appendix F and the main findings are summarised below. The tree survey extents included all the trees within the Gardens, and also trees on the west side of the adjoining street (Millbank). A total of 79no individual tress, 1no group and 2no hedgerows were captured within the site. The mature plane trees at the site appeared to be in good conditions and displaying good vitality. The younger trees at the northern end of the site were generally of less high quality, and some had structural or physiological defects. The collection of trees in Victoria Tower Gardens was found to be heavily dependent on London Plane, which makes it vulnerable to attack by a disease that might target this

particular species. The Arboricultural Impact Assessment recommends that any new planting of trees within the garden should avoid London Plane and increase the diversity of species at the site. The Arboricultural Impact Assessment also states that the presence of Massaria (Splanchnonema platani), a fungi pathogen that increases the risk of branches falling from the tree when under drought stress, was not observed in the tree survey. It must be noted that a detailed condition assessment was not undertaken by an arboriculture.

The tree survey drawing is presented in Appendix A.15.

All of the nature trees within the garden (50no in total) and one of the planes trees on Millbank were recorded as 'Category A' trees in accordance with the British Standard 5837-2012 categorisation system – 'high quality' trees with an estimated remaining life expectancy of at least 40 years. The roots of many trees have caused cracking and swelling of the tarmac and other hard surfacing adjacent to the trees.

A number of trees were recorded as 'Category B' trees in accordance with the British Standard 5837-2012 categorisation system – 'moderate quality' trees with an estimated remaining life expectancy of at least 20 years.

Several trees were classified as 'Category C' trees in accordance with the British Standard 5837-2012 categorisation system – 'low quality' trees with an estimated remaining life expectancy of at least 10 years. Many of these were young or small ornamental trees. The young holly hedge along the western fence line was also placed in 'Category C'. While many trees were placed in this category on account of their young age, others had minor structural defects such as co-dominant stems, rubbing and crossing branches, or unbalanced crowns due to suppression by larger neighbouring trees. The smaller trees on Millbank were typically placed in this category due to their modest age and/or size. All of the trees on Millbank were growing in structural soil with a high stone/sand content, in small rectangles amid the pavement slabs and kerbstones.

The root protection area for each tree was assessed in the Arboricultural Impact Assessment and is illustrated on the tree survey drawing. This is the minimum recommended area for each tree to avoid potentially harmful disturbance.

The Arboricultural Impact Assessment make the following recommendations;

- The designers should seek to retain trees where possible within the site extents using sympathetic layouts and observing the root protection areas illustrated in the tree survey drawing.
- In general terms the BS Category C tress should not hinder the development as they are low-quality specimens, either due to their young age or to structural or physiological health issues that may limit their useful remaining life expectancy below 10 years.
- The designers should seek to retain the moderate and high quality trees, the BS Categories B and A specimens respectively.
- Trees will tolerate a degree of root zone infringement depending on the works proposed and if they require any excavations, similarly, other factors to consider are species tolerance and the remaining un-surfaced root protection area that can be retained. The BS5837 makes reference to 20% as a general rule in determining the amount of root protection area infringement that could be achievable. The designers or contractors should use this information to inform the extent of the proposals including works areas and consider reducing or re-aligning these areas where possible to retain trees.
- The designers or contractors should use the produced tree survey drawing to place any construction-related activities outside of the soft surfaces within the root protection areas of the trees on site. This is to preserve the soil structure within these areas from compaction and the detrimental effects this will have on the underlying root systems of these trees.

A geophysical survey report was commissioned by Atkins and undertaken by SUMO Services Ltd in September 2017 to investigate the below ground environment at Victoria Tower Gardens (see **Reference 6**). The geophysical survey report is enclosed in Appendix G. The geophysical survey report states that no conclusive evidences were

	gathered to show the presence and location of roots associated with the trees lining the edges of the garden or the sporadic trees within the gardens. This may be explained by the narrow diameter of the roots that could not be resolved by the survey.
TOPOGRAPHY	The site falls from north to south with a relatively flat gradient. The elevations vary between +4.4 and +5.2mOD across the site. At the southernmost boundary of the site, a change in level of circa 1.5 to 2.0m is present between the site and Lambeth Bridge. This change in level is formed by the bridge retaining wall. A staircase is present to provide access to the site from Lambeth Bridge side.
River Wall	The site is bounded to the east by the Thames Embankment Wall. This was constructed between February 1864 and July 1870 by Sir Joseph Bazalgette, comprising typically brick walls faced with granite to a depth of circa 10m below the high water mark. Available records drawings available provided by the Environment Agency (see **Reference 8**) and enclosed in Appendix A.18 suggest the section of the river wall along the site to comprise a gravity unreinforced concrete retaining wall faced with granite. The back of the wall is shown to step back in depth circa 3.6m from the foreshore into land. The wall parapet was originally 1.2m above ground level. The parapet was then raised and strengthened by 1900 to its current condition. Details regarding the foundation of the retaining wall are missing. However, giving the typical geology of central London and the geometry of the retaining wall, it is expected the wall to be founded within the London Clay. A limited area of sand and gravel is present at the base of the embankment wall to the exterior of the site. The extent of this limited land strip is likely to be measured by tidal activity.
BULK STORAGE MATERIALS	The site lies within Victoria Tower Gardens and comprises a public garden. No bulk material storages are present within the site boundary.
POLYCHLORINATED BIPHENYLS (PCBS)	The site lies within Victoria Tower Gardens and comprises a public garden. No sub-stations are present within the site boundary.
OZONE DEPLETING SUBSTANCES (ODS)	The site lies within Victoria Tower Gardens and comprises a public garden. No air conditioning units are present within the site boundary.
WASTE MANAGEMENT (NON HAZARDOUS)	The site lies within Victoria Tower Gardens and comprises a public garden managed by The Royal Parks.
WASTE MANAGEMENT (HAZARDOUS)	The site lies within Victoria Tower Gardens and comprises a public garden managed by The Royal Parks.
DRAINAGE	It is anticipated that the site is currently served by a private surface water drainage system comprising gullies and that some surface water flows may also run-off to the soft landscape areas. Notwithstanding this, the rate of infiltration will be controlled by the permeability of the Made Ground. The geophysical survey has detected and mapped numerous cables and pipes crossing the site. A drawing showing the surveyed utilities is enclosed within Appendix A.17. The utilities identified on site generally include drainage, British Telecom, Electric and Water. Additional unknown utilities were also identified. The geophysical survey report states that none of the utilities shown on the statutory records were detected on site. This is anticipated to be due to the inherent inaccuracies of the statutory drawings, or due to the depth/narrow size of the utilities.
ASBESTOS CONTAINING MATERIALS (ACMS)	There are no present buildings on the site other than the memorials. The presence of asbestos within the Made Ground cannot be discounted.

2.2 FORMER LAND USES AND SURROUNDING AREA

An assessment of the potential impacts of construction a UK national Holocaust Memorial within Victoria Tower Gardens was commissioned by the Department for Communities and Local Government (DCLG) and undertaken by Atkins (see Reference 7). The Heritage Appraisal report is enclosed in Appendix H and the main conclusions summarised below.

- There is no specific site potential for remains or deposits dating to the prehistoric, Roman and early medieval periods to be present within the site.
- There is specific site potential for remains or deposits dating to both the medieval and post-medieval periods.
- There is extensive evidence that the site was developed throughout the post-medieval period and remains relating to a wide range of riverside and industrial activities are likely to be present. The historical maps indicate the potential for buried archaeological remains ranging from foundations of former buildings to in-filled formed docks.
- The impact of bombing during the Second World War has not been determined although it is probable that this will have a severe, localised impact on below ground remains within the Site.

A study of available historical maps from 1875-1879 have been undertaken to identify any potential contaminative former land uses. Table 2 provides a summary of this information and selected historical maps are provided in Appendix C.

Table 2 – Overview of the Historical Land Uses

DATE	LAND USE
OS 1:2,500 Map, 1875-1879	The earliest plans dated c. 1875-1879. The whole of the western edge of the site, facing onto Millbank, is shown as being covered by buildings. The map is sufficiently detailed to indicate the extent to which the river bank lay to the west of the site. The northernmost part of the site is shown as open ground separating the Houses of Parliament from the wharf buildings to the south. Two docks are shown in the northern part of the site. These were associated with Abingdon Wharf, St Perter's Wharf and Norway Wharf. The buildings to the south of these include an Oil Factory, a Cement Works and Flour Mills as well as further wharf buildings. A public house, facing onto Milbank is also present. The surrounding area to the site is shown as being fully developed. The Houses of Parliament and associated buildings are shown to the north. Residential buildings, the Great College Street, Wood Street and Church Street are shown to the west. A small area of wharfs and Lambeth Bridge are shown to the south.
OS 1:2,500 Map, 1896	This is the first map to show Victoria Tower Gardens. At this date, the Gardens only covered the northernmost part of the site. The map indicates that a section of the River Thames foreshore has been reclaimed as part of the realignment of the embankment that was undertaken by Bazalgette in 1879. This also added land to the Gardens. The buildings of Abingdon Wharf, St Peter's Wharf and Norway Wharf have all been demolished to make way for the Gardens by this date. The map indicates the presence of a pumping station by this date to the south of the gardens. The presence of a wide range of post-medieval industrial activities within the area of the site raises the potential for significant levels of ground contamination to be identified. No significant changes to the surrounding area to the site are noticed. Gasometers are shown within 500m of the site.
OS 1:2,500 Map, 1916	The map indicates the same gardens extent as the present day. The surrounding area to the site is shown as being similar to the present day. The residential buildings to the west of the site are shown replaced by generally larger buildings. The buildings appear to be residential and commercial buildings.

OS 1:2,500 Map, 1950-1952	The Second World Wall bomb strike location map enclosed within Appendix A.7 indicates that four bomb impacts were recorded within Victoria Tower Gardens. The map indicates some alterations to the layout of the gardens. This may have been associated with the reconstruction works after the bomb strikes during the Second World War. The gasometers were demolished.
OS 1:2,500 Map, 1991	Generally as c. 1950-1952

In the area near the Houses of Parliament, the sewer system designed by Joseph Bazalgette in the nineteenth century comprises a large diameter sewer running parallel to the Thames River and two small storm water sewers perpendicular to the truck sewer. The northernmost storm sewer runs beneath Great Peter Street, crosses Victoria Tower Gardens and discharges into the river. The southernmost storm sewer runs beneath Horseferry Road and discharges into the Thames.

The surrounding area is shown as being fully developed by 1875-1879, comprising residential and commercial land uses. Significant redevelopments to the surrounding area to the west have taken place by 1916. Large commercial offices were noted to the west of Millbank by 1952. No significant changes were identified on subsequent maps.

The historical maps indicate that the embankment was extended with the construction of a river wall for the northern part of the gardens prior to their opening in 1879. The gardens were subsequently expanded southwards by 1916. The construction of the new river wall was supported by the reclamation of extensive areas of the Thames River foreshore. The line of the former wharfs was located approximately 15 to 20m inland from the current position of the river wall. The form of the original foreshore is not known from the historical maps. It may have comprised a timber of a masonry wall. It is also unknown if the remains of the former river wall are still present buried beneath the gardens.

The results of the geophysical survey identified a circular ‘roundabout’ feature towards the northern part of the site. This feature was identified to be relatively shallow (circa 0.20m depth) and is likely to be caused by the remains of the central pathway identified on the OS 1:2,500 Map, 1916. Some linear stubs were also identified, which are likely to be the pathways leading to and the central circular path.

Towards the southern part of the site, a linear anomaly was identified, which is similar to the pathways highlighted in the northern part of the site. Notwithstanding this, the OS historical maps do not show evidence of such pathways to have existed at this part of the site. This anomaly occupies a similar location and orientation as the former shoreline and could relate to a former river wall or wharf. Several other anomalies in the vicinity appear to form a rectilinear pattern and could also relate to former buildings or the line of the former wharf.

Several sporadic anomalies that do not form a recognisable regular pattern were identified across the site, but predominantly in the central area. These anomalies may relate to the remains of former post medieval buildings present at the western part of the site identified on the OS historical maps until 1896. These sporadic anomalies are less present towards the eastern part of the site, which is known to be reclaimed land.

The geophysical survey report infers a boundary line demarcating a previous foreshore or wharf based on the concentration of sporadic anomalies. This boundary line is supported by the several anomalies identified at its location. These anomalies suggest that a distinct change is occurring at this point. Additionally, the OS historical maps indicate that the former shoreline was located further to the west than its present location.

The geophysical survey interpretation drawing is enclosed within Appendix A.15.

2.3 REGULATORY INFORMATION

A review of the archive records detailing licensing. Pollution incidences, the location of landfills and other available relevant information within 500m of the site is summarised below based on the Envirocheck report. The Environmental Health Officer at the local authority and the Environment Agency were not contacted as part of the desk study. The Envirocheck datasheet is included in Appendix D.

Table 3 – Summary from Environmental Database

Environmental Data	On Site	Within 250m	Within 500m	Details
Discharge Consents	0	4	2	Sewage discharges – pumping station (not water company) – saline estuary, 163m north of the site. • Public sewage – storm sewage overflow – saline estuary, 198m south of the site. • Public sewage – storm sewage overflow – saline estuary, 198m south of the site. • Sewage discharges – storm overflow/storm tank (Water Company) – saline estuary, 198m south of site. • Sewage discharges – storm overflow/storm tank (Water Company) – saline estuary, 257m south of site. • Sewage discharges – storm overflow/storm tank (Water Company) – saline estuary, 447m south of site.
Prosecutions Relating to Controlled Waters				Not applicable
Enforcement and Prohibition Notices	0	0	1	**Location**: Lambeth Palace Road, Lambeth, London, SE1 7EH (306m east of the site). **Permit Reference**: AC1121 **Enforcement Date**: 26th July 1995 **Details**: Press release HM258, breach of disposal limit for on-site incineration of radioactive waste under RSA93.
Local Authority Pollution Prevention Controls (LAPPC)	0	0	3	Three local authority pollution prevention controls are recorded within 500m of the site.
Pollution Incidents to Controlled Water	0	1	3	Four pollution incidents to controlled water are recorded within 500m of the site. • Lambeth, 208m to the east of the site. Pollutant – Oils. Category 3 – minor accident. • Lambeth, 311m to the south of the site. Pollutant – Oils. Category 3 – minor accident. • Vauxhall, 330m to the northeast of the site. Pollutant – Oils. Category 3 – minor accident. • Westminster Peer, 476m north of the site. Pollutant – miscellaneous. Category 2 – significant incident.
Registered Radioactive Substances	0	3	28	Three registered radioactive substances are recorded within 250m of the site. • Government Central Purchasing Department, 118m south of the site. Dated 1st October 1997. Authorisation superseded by a substantial or non-substantial variation. • Government Central Purchasing Department, 127m south of the site. Dated 1st December 2003. Application has been authorised and any conditions apply to the operator. • Westminster Hospital and Medical School NHS Trust, 154m southwest of the site. Dated 31st March 1991. Authorisation either revoked or cancelled.

Substantiated Pollution Incident Register	0	1	0	Environment Agency – Thames Region, North East Area, 43m south of the site. Dated 29th June 2017. Incident reference 1535561. Water Impact Category 2 – significant incident. Air Impact Category 4 – no impact. Land Impact Category 4 – no impact. Pollutant – oils.
Water Abstractions	0	2	25	Two water abstractions are recorded within 250m of the site; • Building Services Group, 118m south of the site. Single point of abstraction for drinking, cooking, sanitary, washing (small garden). • Lord and Lady Sainsbury of Turville, 139m west of the site. Single point of abstraction for public administration (non-evaporative cooling). Several abstractions are located beyond 250m of the site. These include non-evaporative cooling, heat pump, drinking, cooking, sanitary, washing, (small garden).
Source Protection Zones	0	0	0	There is a Zone II (outer protection zone) located 509m south of the site.
OS Water Network Lines	0	1	0	River Thames (tidal river)
Historical Landfill Sites	0	0	0	No historical landfill sites are recorded within 500m of the site.
Integrated Pollution Control Registered Wastes Sites				No integrated pollution control registered wastes sites are recorded within 500m of the site.
Licensed Waste Management Facilities	0	0	0	No licensed waste management facilities are recorded within 500m of the site.
Local Authority Landfill Coverage	1	0	0	Westminster City Council
Local Authority Recorded Landfill Sites	0	0	0	No local authority recorded landfill sites are recorded within 500m of the site.
Potentially Infilled Land (Non-Water)				No potentially infilled land (non-water) is recorded within 500m of the site.
Potentially Infilled Land (Water)	0	0	1	Unknown filled ground (pond, marsh, river, stream, dock, etc.) dated 1896 and located 439m northeast of the site.
Registered Landfill Sites	0	0	0	No registered landfill sites are recorded within 500m of the site.
Registered Waste Transfer Sites	0	0	0	No registered waste transfer sites are recorded within 500m of the site.

Registered Waste Treatment or Disposal Sites	0	0	0	No registered waste treatment or disposal sites are recorded within 500m of the site.
Control of Major Accident Hazards Sites (COMAH)	0	0	0	No control of major accident hazards sites are recorded within 500m of the site.
Explosive Sites	0	0	0	No explosive sites are recorded within 500m of the site.
BGS Measured Urban Soil Chemistry	1	0	4	British Geological Survey, National Geoscience Information Service On Site – Sample of Topsoil. Arsenic Measure 20.50mg/kg. Cadmium Measured 0.60mg/kg. Chromium Measured: 54.60mg/kg. Lead Measured: 505.10mg/kg. Nickel Measured: 29.00mg/kg. 324m north of the site – Sample of Topsoil. Arsenic Measure 11.00mg/kg. Cadmium Measured 0.50mg/kg. Chromium Measured: 59.80mg/kg. Lead Measured: 44.10mg/kg. Nickel Measured: 17.50mg/kg. 346m south of the site – Sample of Topsoil. Arsenic Measure 21.00mg/kg. Cadmium Measured 0.60mg/kg. Chromium Measured: 64.40mg/kg. Lead Measured: 132.90mg/kg. Nickel Measured: 22.00mg/kg. 454m east of the site – Sample of Topsoil. Arsenic Measure 22.70mg/kg. Cadmium Measured 0.50mg/kg. Chromium Measured: 50.10mg/kg. Lead Measured: 380.40mg/kg. Nickel Measured: 27.00mg/kg. 466m southeast of the site – Sample of Topsoil. Arsenic Measure 19.90mg/kg. Cadmium Measured 0.60mg/kg. Chromium Measured: 64.60mg/kg. Lead Measured: 355.80mg/kg. Nickel Measured: 33.10mg/kg.
BGS Urban Soil Chemistry Averages	1	0	0	British Geological Survey, National Geoscience Information Service Arsenic – minimum 1.00mg/kg; average 17.00mg/kg; maximum 161.00mg/kg. Cadmium – minimum 0.10mg/kg; average 0.90mg/kg; maximum 165.20mg/kg. Chromium – minimum 13.00mg/kg; average 79.00mg/kg; maximum 2,094.00 mg/kg. Lead – minimum 11.00 mg/kg; average 280.00 mg/kg; maximum 10,000 mg/kg. Nickel – minimum 2.00 mg/kg; average 28.00 mg/kg; maximum 506.00 mg/kg.
Man-Made Mining Cavities	0	0	0	No man-made mining cavities are recorded within 500m of the site.
Natural Cavities	0	0	1	A scour hollow is located 351m northwest of the site. The solid geology comprises Chalk, Thanet Sands, Lambeth Group and London Clay formation. The superficial geology comprises alluvium and Kempton Park Gravel.
Radon Potential – Radon Affected Areas	1	0	0	British Geological Survey, National Geoscience Information Service. The site is in a lower probability radon area (less than 1% of homes are estimated to be above the Action Level)

Radon Potential – Radon Protection Measures	1	0	0	British Geological Survey, National Geoscience Information Service. No radon protective measures are necessary in the construction of new dwellings or extensions.
Ground Subsidence Hazards	1	0	0	Risk levels for various subsidence hazards for the site are as follows: Collapsible ground stability – Very Low Risk Compressive ground stability – Moderate Risk Ground dissolution stability – No Hazard Landslide Ground Stability – Low Risk Running Sand Stability – Very Low Risk Shrinking or Swelling Clay Ground Stability – Low Risk
Contemporary Trade Directory Entries	0	13	53	Several active contemporary trade directory entries are recorded within 500m of the site comprising small factories, services and distribution companies (see Envirocheck report).
Fuel Station Entries	0	0	0	No fuel station entries are recorded within 500m of the site. It should be noted that the fuel stations will have underground fuel storage tanks that have the potential to be a significant source of off-site contamination.
Marine Nature Reserves	1	0	0	Thames Estuary in accordance with Natural England.
World Heritage Sites	1	0	0	Palace of Westminster, Westminster Abbey and St. Margaret's Church in accordance with Historic England (designation date 1st January 1987).

2.4 PLANNING HISTORY

WSP has reviewed the current planning history held on the City of Westminster Council website.

Planning permission was granted on 10th June 2014 for the 'erection of new education centre for the Palace of Westminster for a temporary period of 10 years with associated alterations to the Victoria Tower Gardens landscaping' (ref. 13/07747/Full). Several other planning permissions were granted for maintenance works and minor changes of the layout of the gardens.

Multiple planning applications are present surrounding site area (see website: http://idoxpa.westminster.gov.uk/online-applications/).

2.5 ARCHAEOLOGY

In accordance with **Reference 7**, the northern part of the site lies within the Lundenwic and Thorney Island Archaeological Priority Area due to the identified high potential for this area to contain significant archaeological remains relating to the Saxon (early medieval) and medieval settlement of Thorney Island (the area now occupied by Westminster Abbey and the Palace of Westminster).

An assessment of the potential impacts of construction a UK National Holocaust Memorial within Victoria Tower Gardens was commissioned by the Department for Communities and Local Government (DCLG) and undertaken by Atkins (see **Reference 7**).

The following recommendations were provided in the Heritage Appraisal report;

- It was recommended the new memorial to be erected in the southern part of Victoria Tower Gardens, to the south of the Buxton Memorial Fountain, to minimize the potential impacts upon the setting of a number of surrounding designated heritage assets and important views.

- It was stated that a programme of archaeological investigation and mitigation will be required to identify the presence and survival of any below ground archaeological remains within the site. The scope and nature of this programme must be agreed in consultation with the advisors at the Greater London Archaeological Advisory Service.

It was envisaged that further mitigation is likely to comprise a combination of geophysical survey (see **Reference 6**), archaeological watching brief, excavation and environmental sampling. Detailed setting analysis will be undertaken once a finalized location and design have been selected.

2.6 LISTED BUILDINGS

The site is located to the south of the Palace of Westminster, which is a Grade I listed building within the Westminster World Heritage Site and within the Westminster Abbey and Parliament Square Conservation Area.

The area surrounding the site contains a very large number of heritage assets, both designated and non-designated. A summary of statutory listed buildings around the site is presented below (source: City of Westminster Portal);

- Victoria Tower Lodge and Gates to Black Rod Garden (Grade I Listed)
- House of Parliament the Palace of Westminster (Grade I Listed)
- The Church Commissioners (Grade II* Listed)
- St John's Smith Square Concert Hall (Grade I Listed)
- Norwest House (Grade II Listed)
- Lambeth Bridge and Attached Parapets, Light Standards, Associated Walls to Approaches and Obelisks (Grade II Listed)

A plan showing the location of the aforementioned buildings in relation to site is enclosed in Appendix A.14.

The following are likely to be required (this will be confirmed once the development proposals are finalised and once the ground and groundwater conditions at the site are confirmed);

- A risk assessment will need to be completed to confirm the structures at risk from ground movements and which structures will require a ground movement and damage assessment to be completed. The following may be required depending on the conclusions of the ground movement assessment;
    - Condition surveys of the structures prior to the works commencing and at the end of the construction.
    - Ground movement assessment.
    - Structural monitoring of the assets.
    - Monitoring Action Plans (MAPs).
    - Monitoring data interpretations and management of the MAPs.

2.7 LONDON UNDERGROUND LIMITED (LUL)

Liaison with LUL has been progressed to confirm the presence of any underground assets.

TFL have confirmed there are no LUL assets within 50 metres of the site. However, there are cable ducts in the area and further liaison with TFL should be undertaken if any highway works are undertaken at this location. Contact details are below.

NRSWA Enquiries
Power Delivery
London Underground
Tel: 0203 054 8354
LULHVpowerassets@tfl.gov.uk

The correspondence is enclosed in Appendix D.

The location of the site relative to the LUL stations is shown in Figure 1.

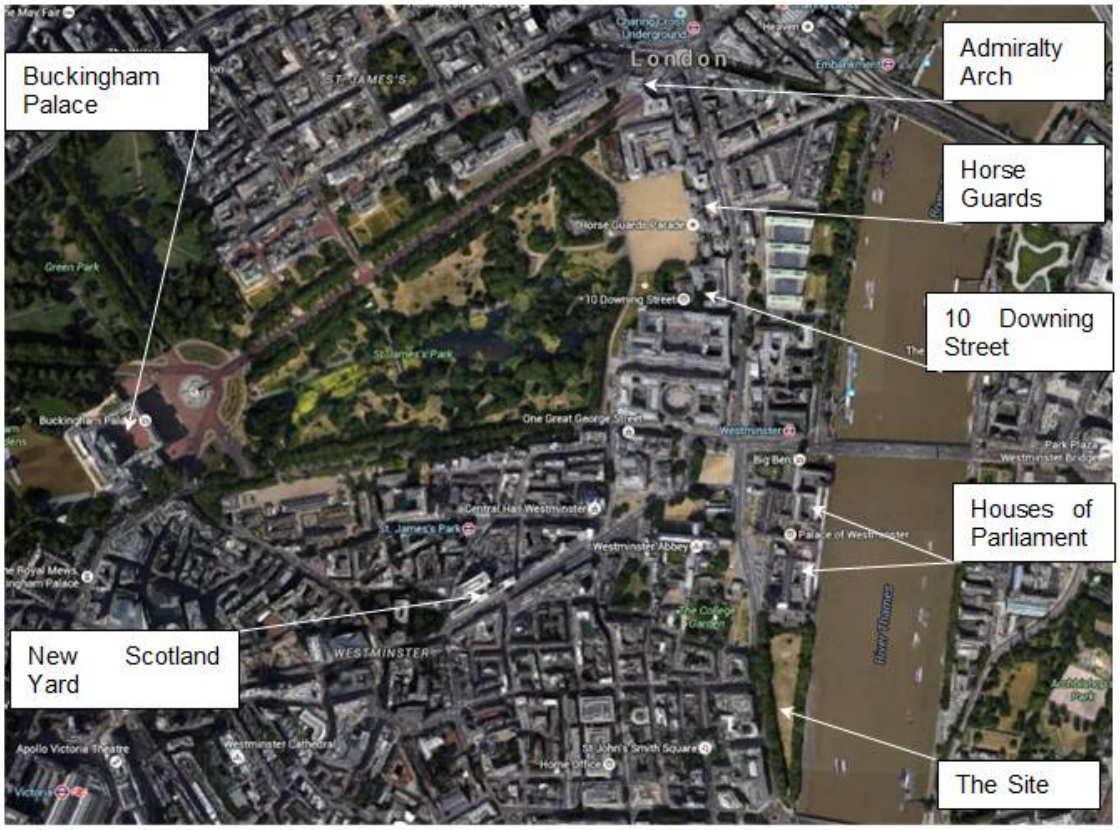


Figure 1 – Indicative location of LUL assets

2.8 BT ASSETS

Liaison with BT has been progressed to confirm the location of any BT underground infrastructure. The correspondence is enclosed in Appendix D. The response from BT will be provided once received.

2.9 GOVERNMENT TUNNELS

The Metropolitan Police and the London Government Land department were contacted to confirm the location of any 'confidential' government underground infrastructure. The correspondence is enclosed in Appendix D. The response from Metropolitan Police / London Government Land department will be provided once received.

2.10 POST OFFICE TUNNEL ASSETS

The post office tunnels run between Paddington Railway Station, broadly beneath Oxford Street and trend eastwards towards Liverpool Street Station and beyond. Therefore, the main post office tunnel assets are not present beneath the development site. WSP are not aware of any other post office tunnels present beneath London. It is recommended that a formal request is completed.

2.11 EDF / UTILITY TUNNEL

The presence of EDF / Utility tunnels is not known and liaison with the utility provider will be required to confirm their presence.

2.12 BURIED UTILITIES

The impact the proposed development will have on any buried utilities will need to be considered. A risk assessment will need to be completed to confirm which utilities are at risk (i.e. depth, diameter, relative distance from the development and critical material construction). Liaison with the utilities asset protection engineer maybe required to agree the risk assessment conclusions. The most critical assets are typically high pressure cast iron water mains or gas mains, strategic water mains and brick sewers.

It is assumed that the Mechanical/Electrical/Drainage engineer will liaise with UK Power Networks (UKPN), Thames Water (TW) and any other relevant asset holder in order to identify any relevant critical assets in the vicinity of the site. The available information regarding existing utilities in and around the site is presented in Appendix A.16.

The Thames Water location plan suggests that a 2,363mmm diameter combined water sewer rungs parallel to the west of the site, beneath Millbank. Additionally, a 1,576mm x 914mm diameter storm relief sewer is shown running beneath Great Peter Street, across the site, and discharging to the Thames River.

2.13 OBSTRUCTIONS AND SERVICES

The current and historical developments are likely to have resulted in significant buried obstructions being present in the ground. The geophysical survey drawing showing the location of potential underground obstructions is enclosed in Appendix A.17. A detailed strategy for obstruction removal should be considered to ensure that abnormal costs are appropriately managed.

It should be noted that services are likely to be present within the site boundary that may impose obstructions for the piling and excavation works.

2.14 HIGHWAYS

Abingdon Street and Millbank are present to the west of the site. Horseferry Road and Lambeth Bridge are present to the south of the site at a higher elevation and are supported by a retaining wall along the southernmost boundary of the site. Liaison with the Highways Agency / Local Authority is recommended to ascertain the ownership of the retaining wall and any requirements to enable redevelopment of the site.

2.15 RIVER WALL

The Thames Embankment Wall along the easternmost boundary of the site. Liaison with the relevant statutory authorities is likely to be required.

2.16 UNEXPLODED ORDNANCE

The internet website 'Bomb Site' (http://bombsight.org/#17/51.52116/-0.17322) summarises the London World War II bomb census information between 07/10/1940 and 06/06/1941. The information presented in the website suggests that were three number recorded strikes on site and the surrounding area shows significant bomb strike records. A map showing the aforementioned bombs is included in Appendix A.7.

Given the location of the site and the absence of any development since the nineteenth century, a UXO desk-study is recommended previously to any intrusive works being undertaken on site.

3 ENVIRONMENTAL SETTING

3.1 GEOLOGY

The British Geological Survey (BGS) Map No. 270 (South London, 1:50 000 series) indicate the geology within the study area to comprise superficial deposits of Alluvium. In accordance with the BGS Lexicon of Named Rock Units, the Alluvium deposits generally comprises soft to firm normally consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. It is also stated that a stronger, desiccated surface zone may be present.

The northwest corner of the site is indicated to be underlain by Kempton Park Gravel (River Terrace Deposits). Notwithstanding this, it is likely that these deposits extend beneath the Alluvium deposits across the site. These deposits are generally described as sand and gravel, locally with lenses of silt, clay or peat.

Given the site location and development history, man-made soils are expected near the surface across the site. These soils are likely to exhibit a certain degree of heterogeneity. The nature of the material can be expected to vary substantially in both composition and thickness over short distances. Imported soils used as fill as the land was reclaimed to Thames River and the river wall migrated to the east are also anticipated. Buried remains of former buildings are also anticipated.

The superficial deposits are underlain by the London Clay (bioturbated or poorly laminated, blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay), Harwich Formation (in the south of the London Basin typically comprises glauconitic silty or sandy clays, silts and fine to coarse grained glauconitic sands, some gravelly, varying to flint gravel beds), Lambeth Group (vertically and laterally variable sequences mainly of clay, some silty and sandy, with some sands and gravels, minor limestones and lignite and occasional sandstone and conglomerate), Thanet Sand (glauconite-coated, nodular flint at base, overlain by pale yellow-brown, fine grained sand that can be clayey and glauconitic; rare calcareous or siliceous sandstones) and Upper Chalk Formations (chalk, with or without flint and discrete limestone, marl, sponge, calcarenite, phosphatic, hardground and fossil rich beds). An extract of the BGS map is presented in Appendix A.4.

BGS historical exploratory boreholes in the vicinity of the site were reviewed. The basic sequence of the geological strata beneath the site is set out in Table 3. BGS logs for the summary below are provided in Appendix E.

Table 4 – Average Ground Profile with Material Description

STRATUM	THICKNESS (m)	TYPICAL STRATA DESCRIPTION
Made Ground *	0.91 – 5.64	Manmade soils.
Alluvium	0.91 – 5.03	Dark sandy clay.
River Terrace Deposits	1.22 – 7.32	Fine to course sandy gravel.
London Clay **	27.10 – 31.70	Firm to stiff, becoming very stiff dark grey brown laminated silty clay.
Lambeth Group	14.35 – 15.54	Mottled clay with sand and pebble beds.
Thanet Sand	13.11	Fine grained sand.
Upper Chalk	Unproven	-

* The results of the geophysical survey suggest a relative thickening of the upper layer of material towards the eastern part of the site, which reflects the use of made ground to build up the foreshore to the present ground level.

** The available BGS logs suggest the top of the London Clay to fall towards the Thames River. In the specific site investigation works for the underground carpark at the House of Commons (refer to Burland & Hancock, 1977), a layer of London Clay was found to contain partings of fine sand and silt up to 10mm thick and at 50mm spacing. This layer was identified near the top of the formation and the frequency of the partings found to reduce with depth. The presence of sand layers may impose difficulties in the construction of piles and induce pore water pressures beneath the excavation leading to hydraulic uplift or base failure.

Within the central area of London, groundwater is expected as a perched water table in the Made Ground/Alluvium and within the River Terrace Deposits. Pore pressures are present in the London Clay. Environment Agency records indicate that within the Thanet Sands/Chalk, groundwater levels are at circa -30.0mOD (see Appendix A.6).

In the specific site investigation works for the underground carpark at the House of Commons (refer to Burland & Hancock, 1977), Casagrande standpipes were installed in exploratory holes across the site in order to study the ground water conditions in details. Additionally, three rapid response pneumatic piezometers were installed beneath the centre of the excavation. The groundwater level was found at circa -2.0mOD and the porewater pressure to be hydrostatic from the water table to a depth of circa 34m below ground level with a tendency to reduce below this level. It is likely that the groundwater level may be subject to tidal activity and in hydraulic connectivity with the river.

3.2 HYDROLOGY

The nearest surface water feature is the Thames River, located adjacent to the eastern boundary of the site. The former River Tyburn runs culverted to the north of the site (see Appendix A.5). The river runs underground from South Hampstead through St James's Park to meet the River Thames near Downing Street and between Millbank Tower and Thames House.

Two water abstractions are recorded within 250m of the site. The closest water obstruction is located 118m south of the site and comprises a single point of abstraction for drinking, cooking, sanitary, washing (small garden). The second closest water abstraction is located 139m west of the site and comprises a single point of abstraction for non-evaporative cooling.

Several abstractions are located beyond 250m of the site. These include non-evaporative cooling, heat pump, drinking, cooking, sanitary, washing, (small garden).

The site is not located within a groundwater Source Protection Zone (SPZ). These zones show the risk of contamination from any activities that might cause pollution in the area around a well or borehole that supplies groundwater of potable quality. However, the Envirocheck report indicates that a SPZ is located 509m to the south of the site.

3.3 HYDROGEOLOGY

The superficial drift deposits are classified as 'Secondary Undifferentiated' aquifers (Alluvium) and 'Secondary A' aquifers (River Terrace Deposits). The River Terrace Gravels are likely to be in hydraulic continuity with the River Thames.

The site is underlain at depth by the London Clay. The London Clay is classified as 'Unproductive Strata'.

The Lambeth Group beds and the Thanet Sands are classified as 'Secondary Aquifer – A' (permeable layers capable of supporting water supplies at a local rather than strategic case, and in some cases forming an important source of base flow to rivers). The Chalk present at depth is classified as a Principal Aquifer.

3.4 FLOODING

The site lies within a flood risk zone 3, in accordance with the Environmental Agency. Notwithstanding this, the site is identified to benefit from flood defences.

A Level 1 flood risk assessment to support design development at the UK Holocaust site in Victoria Tower Gardens was undertaken by Atkins (see Reference 8). The purpose of this report was to outline the existing risk of all forms of flooding at the site and to determine whether there will be the potential for a change in flood risk as a result of the proposed development works. The report is enclosed in Appendix I and the main conclusions are summarised below;

- Fluvial flooding, groundwater flooding and other sources of flooding (reservoirs, canals and water mains) have been scoped out of further assessment because the development will not affect the existing very low risk of flooding from these sources.

3.5 SENSITIVITY ANALYSIS

Overall, the site location is considered to be of **LOW** to **MEDIUM** environmental sensitivity, based on the following reasons;

- Presence of Made Ground across the site. These soils are likely to exhibit a certain degree of heterogeneity. The nature of the material can be expected to vary substantially in both composition and thickness over short distances, with geotechnical properties that are often difficult to assess. Imported soils used as fill as the land was reclaimed to Thames River and the river wall migrated to the east are also anticipated. Buried remains of former buildings are also anticipated. The Made Ground should not be considered as being a suitable foundation stratum.
- Buried remains of formed post medieval buildings may present obstructions to piling and excavation works for the construction of the new proposed basement. These buried remains may also induce potential groundwater flow paths that can undermine the foundations or impose increased porewater pressures on the back of the embedded retaining structures.
- The near surface natural soils below the Made Ground may also be expected to vary substantially in both composition and thickness over short distances, with geotechnical properties that are often difficult to assess. The Alluvium deposits should not be considered as being a suitable foundation stratum.
- The River Terrace Deposits are classified as a 'Secondary A' aquifers by the Environmental Agency. It is likely that hydraulic continuity is present within these deposits and the Thames River.
- The site is underlying by the London Clay, which acts as an aquitard and prevent the hydraulic connectivity between the shallow groundwater body and the deep groundwater body.
- Previous land uses included an oil factory, cement works, a pumping station, wharfs, and docks.
- Presence of trees along the edges of the site. The substructure and pavements constructed in the vicinity of the trees may experience damage due to root penetration. Additionally, soils with shrinkage potential (as the London Clay), may experience volume changes with small variations of moisture content within the zone of influence of the roots.
- There is a potential for unexploded ordnance being present within the site boundary and this risk must be addressed during the specific site investigation works and groundworks for the proposed development.
- Low risk of fluvial flooding, groundwater flooding and other sources of flooding (reservoirs, canals and water mains).

4 PRELIMINARY CONCEPTUAL SITE MODEL

4.1 INTRODUCTION

The objectives of the pollutant linkage assessment process are to;

- Determine the sources of contamination (if present);
- Identify specific chemicals of potential concern (if present);
- Identify possible contaminant migration pathways;
- Identify possible receptors (e.g. soil, groundwater, humans and third parties) which could be affected, including their relative potential sensitivity to contaminants given their nature of exposure; and,
- Construct a conceptual model for the site which clarifies the mechanisms by which the site may present a risk, highlighting those sources of risk which will require further assessment and those which can be eliminated.

The conceptual model provides a description of three elements i.e.;

- The actual and probable nature, extent and location of contaminants, i.e. the SOURCE term;
- The potential existing and reasonably foreseeable future on-site and off-site RECEPTORS to contamination; and,
- The likely migration PATHWAYS by which contaminants may reach such receptors.

Such information enables the development of plausible POLLUTANT LINKAGES between sources of contamination and receptors, and thus an estimation of the risks that may be present. The typical chemicals associated with the identified land uses have been referenced within DEFRA R&D Publication CLR8: Potential Contaminants for the Assessment of Land and this information has been used to inform our conceptual site model.

4.2 PLAUSIBLE POLLUTANT LINKAGE

Table 5 and Table 6 provide overviews of the potential pollutant linkages identified from on-site sources and off-site sources, respectively.

Table 5 – Plausible Pollutant Linkage (On-site)

POTENTIAL CONTAMINANT RESOURCES	ASSOCIATED CONTAMINANTS	POTENTIAL MIGRATION PATHS	SENSITIVE RECEPTORS
Former site uses included an oil factory, cement works, wharfs and a pumping station. • Made Ground • Reclaimed land to the Thames River (historical landfill) • Buried remains of post medieval buildings • Existing buried services	Metals and inorganics, Polycyclic Aromatic Hydrocarbons (PAH), Ground gases (methane and carbon) and Asbestos.	Human Health: Inhalation of volatile vapours/ ground gases; Direct contact with soil and groundwater; Soil and dust ingestion; Ingestion of contaminated water. Controlled Waters: Ingress into potable water supply pipes; Leaching into groundwater by lateral and vertical migration. Built Environment: Permeation into plastic pipes; Direct Contact with aggressive ground and/or groundwater.	Future Site Users; Construction & Maintenance Staff; On site residents, workers and visitors; Thames River. Underlying Secondary A Aquifer within the Thanet Sands; Principal Aquifer within the Chalk Formation; Below Ground Service: Potable supply pipes & building service entry points; Building Fabric: Potential degradation of concrete foundations & below ground structures.

Table 6 – Plausible Pollutant Linkage (Off-site)

POTENTIAL CONTAMINANT RESOURCES	ASSOCIATED CONTAMINANTS	POTENTIAL MIGRATION PATHS	SENSITIVE RECEPTORS
Made Ground	Metals and inorganics, Polycyclic Aromatic Hydrocarbons (PAH), Ground gases (methane and carbon) and Asbestos.	Human Health: Inhalation of volatile vapours/ ground gases; Direct contact with soil and groundwater; Soil and dust ingestion; Ingestion of contaminated water. Controlled Waters: Ingress into potable water supply pipes; Leaching into groundwater by lateral and vertical migration. Built Environment: Permeation into plastic pipes; Direct Contact with aggressive ground and/or groundwater.	Future Site Users; Construction & Maintenance Staff; On site residents, workers and visitors; Thames River. Underlying Secondary A Aquifer within the Thanet Sands; Principal Aquifer within the Chalk Formation; Below Ground Service: Potable supply pipes & building service entry points; Building Fabric: Potential degradation of concrete foundations & below ground structures.
Engineering Works	Full range of contaminants including asbestos, mineral oils and Total Petroleum Hydrocarbon (TPH).		

5 GEOTECHNICAL CONSIDERATIONS

5.1 GENERAL

The UK Holocaust Memorial will incorporate a new national memorial and a learning centre. It is envisaged that the learning centre will be construction below ground, comprising a double level basement. Excavation to depths of circa 8m-10m is anticipated.

5.2 BASEMENT AND FOUNDATION DESIGN

Specific site investigation has not been completed at the time of writing this report. Published data suggests that the general geology across the site comprises Made Ground, Alluvium and Kempton Park Gravels overlying the London Clay. A shallow groundwater level is present within the Terrace Gravels. A site investigation will be required to confirm the ground and groundwater regime beneath the site.

Trees are present along the edges of the site, which have the potential to change the moisture content in the soil. The potential for desiccation within the site is deemed to be minor, given the depth of the London Clay. Additionally, it is anticipated that basement formation level will be above the London Clay. The impact of the trees on the elevation of the groundwater level across the site must be account in the wall design and allowance should be given for the potential removal of the trees during the life time of the structure.

The configuration of the site suggests that Made Ground is likely to be present beneath the site, which, because of the site history, may potentially be contaminated. A Generic Quantitative Risk Assessment (GQRA) will be produced further to the competition of the specific site investigation. The findings of this report will dictate further requirements for a Detailed Quantitative Risk Assessment (DQRA) and Remediation Strategy.

Should any gross contamination be encountered during the excavation, a generic mitigation strategy shall be adopted: work to cease in the area; geo-environmental engineer to be notified, sample material and supervise the excavation of contaminated material; the contaminated material shall be placed in a bounded area and covered to prevent rainwater infiltration; samples shall be obtained to demonstrate that the full area of contamination has been removed.

The proposed basement will be excavated and constructed inside an embedded retaining. The best approach for the walling works will depend on the underlying geology, the groundwater elevation and the depth of the required excavation. It is however likely that a secant pile wall will be required around the perimeter of the new basement. This will ensure the water tightness and the stability of the basement during both the temporary and the permanent conditions. A minimum embedment of 1m into the London Clay of both male and female piles shall be required to provide an effective groundwater seal during construction.

The appropriate piling technique will need to be selected based on the groundwater regime, ground conditions, loads, differential and total settlement tolerances and vibration restrictions due to nearby sensitive assets. It is however likely that the secant piled wall will be installed using contiguous flight-auger techniques to avoid the need for casings and bentonite support fluids within the drift deposits. Additionally, this will mitigate the impact of water strikes within the London Clay. Casing CFA techniques may be required to increase the vertical tolerances of the wall, ensure the adequate interlock between piles and mitigate any potential areas of leakage.

The degree of water tightness of the wall will allow dewatering within the excavation during the construction.

Trees are present along the edges of the site. The root protection area defines the minimum area around a tree deemed to contain sufficient roots and rooting volume to maintain the tree's viability and where the protection of the roots and soil structure is treated as a priority. The basement layout must allow for the root protection areas for the trees to retain along the edges of the site.

All obstructions along the wall line, such as buried remains associated with the former post medieval buildings present on the site, shall be removed as part of an enabling works contract. Probing shall be required prior to the commencement of the piling works.

The best approach for the excavation staging will depend on the underlying geology, the groundwater elevation and the depth of the required excavation. Notwithstanding this, given the likely depth of the

excavation and the anticipated poor ground conditions, a propping arrangement may be required across the basement in the temporary condition. In the permanent condition, it is envisaged the perimeter piled wall will be propped by the floor slabs.

It is anticipated that the majority of the footprint of the basement will be lightly loaded. The foundation slab may be required to resist a certain amount of soil heave pressure induced by the un-loading due to the excavation works and porewater pressure in the long-term condition. Tension piles will be required, pending for the specific site investigation and finalised scheme for the sub and superstructure.

The feasibility of using a ground bearing slab as foundation solution for the scheme is pending for confirmation of the loads and specific site investigation data. The proposed basement is likely to be found within the River Terrace Gravels, which may be in hydraulic connectivity with the river. It is likely that groundwater level is susceptible to tidal action. Additionally, the fine content of the gravel deposits may be significant due to the depositional environment close to the river. An increased fine content may induce a more plastic behaviour and make the material susceptible to volumetric changes due to changes in moisture content.

The walling, excavation and construction works are actions that result in unloading and re-loading of the underlying soil. These changes in the soil stress state induce ground movements in and around the vicinity of the site. The roots of the existing trees along the edges of the site are anticipated to have a positive impact in controlling the ground movements arising from the proposed works.

The following further works will be required:

- A condition survey of the existing Thames Embankment Wall and existing buried services (Thames Water sewers) may be required to confirm the position and the current condition of these assets.
- A pre-piling enabling works package should be allowed to remove all obstructions at pile and pile wall locations;
- A site investigation will be required to confirm the ground and groundwater regime beneath the site;
- A Ground Investigation Report (GIR) will be required in accordance with the Eurocodes;
- A piling risk assessment will be required where piled foundations into the lower aquifer are proposed;
- Geotechnical Design Report (GDR) will be required in accordance with the Eurocodes for the foundations and the basement retaining wall design;
- Slope stability assessment along the southern boundary.
- A risk assessment will need to be completed to confirm the structures / assets at risk from ground movements and which assets will require a ground movement assessment to be completed. Liaison with the adjacent asset holders will be required to discuss the ground movements, monitoring strategy and any remedial measures required or monitoring response actions plans (MRAPs) which will be required to be implemented during the works. These are discussed in more detail below.

6 GEO-ENVIRONMENTAL RISK ASSESSMENT

Having evaluated the information gathered during this desk study and described in the previous sections, WSP has produced the following assessment (Table 6) of risk primarily focused on contaminated land issues:

Table 7 – Risk Assessment Matrix

ISSUE		RISK CATEGORY	REASON
CONTAMINATION POTENTIAL	Potential for Significant On-site Contamination	MEDIUM	Given the general history associated with the site and area, it is likely that Made Ground will be present beneath some areas of the site and the presence of contamination cannot be discounted.
	Potential for Contaminants Migrating off the Site	MEDIUM	Potential sources of contamination have been identified on site. The likelihood of the presence of Kempton Park Gravel deposits will allow lateral migration of any leachable or soluble materials offsite.
	Potential for Contaminants Migrating onto the Site	LOW TO MEDIUM	The likelihood of the presence of Kempton Park Gravel deposits beneath the site will allow lateral migration of any leachable or soluble materials onto the site. No significant sources of contamination were observed in close proximity to the site.
	Asbestos	LOW	There are no present buildings on the site other than the memorials. The presence of asbestos within the Made Ground cannot be discounted.
ANY OTHER LIABILITY ISSUES	Unexploded Ordnance	LOW TO MEDIUM	The 'Bomb Sight' website indicates that there were three number recorded strikes on site and there were significant recorded strikes in the surrounding area. It is recommended that a specialist UXO desk study threat assessment is prepared for the site by a specialist contractor.
	Buried Services	High	Existing buried services are present in and around the site. Some of these services may have to be diverted before the piling and excavation works and may impose obstructions to these works. The integrity of the remaining services has to me ensured during the works.
	Archaeology	High	In accordance with Reference 7, the northern part of the site lies within the Lundenwic and Thorney Island Archaeological Priority Area due to the identified high potential for this area to contain significant archaeological remains relating to the Saxon (early medieval) and medieval settlement of Thorney Island (the area now occupied by Westminster Abbey and the Palace of Westminster).
	Listed Buildings	High	The surrounding area to the site contains a significant number of heritage assets, both designated and non-designated. In accordance with Reference 7, a 500m study area surrounding the site has identified one World Heritage Site, two scheduled monuments, 23 grade I listed buildings, 50 grade II* listed buildings, one registered park and garden grade I, three registered parks and gardens grade II, one archaeological priority area and two conservation areas. Victoria Tower Gardens lies to the south of the Palace of Westminster, Westminster Abbey and St. Margaret's Church World Heritage Site.
	Conservation Areas	High	Victoria Tower Gardens lies within the Westminster Abbey and Parliament conservation area and immediately adjacent to the Smith Square conservation area which lies to the west.
	Geotechnical Risk	MEDIUM	The development involves the construction of a double level basement. A site investigation will be required to confirm the ground and groundwater regime across the site. Based on the likely loading, it is anticipated that tension piles may be required. Once the loads are confirm, the feasibility of adopting a ground

	ISSUE	RISK CATEGORY	REASON
			bearing foundation slab shall be reviewed. The best approach for the walling and excavation works will depend on the underlying geology, the groundwater elevation and the depth of the required excavation. Consideration will need to be given to the temporary propping requirements during the excavation works to restrict lateral deflection and induced ground movements during these works. Existing trees are present along the edges of the site. The trees must be account for in the embedded retaining wall design. Sensitive structures and utilities are present in the surrounding area to the site and along its boundaries. These structures must be account for in the embedded retaining wall design and temporary works design.
ENVIRONMENTAL CONSEQUENCES	Risk of Pollution of Controlled Waters	LOW TO MEDIUM	The site is likely to be underlain by a shallow 'Secondary Undifferentiated Aquifer'. A Generic Quantitative Environmental Risk Assessment (GQRA) is required to determine the appropriate mitigation measures, if required. Once implemented, the risk will reduce to LOW.
	Risk of Damage to Property	LOW TO MEDIUM	A site investigation and site specific ground gas assessment is required so the appropriate measures can be adopted in the new structure. Once implemented the risk will reduce to LOW.
	Risk of Harm to Human Health	LOW TO MEDIUM	Given that the site is currently occupied by a public garden, the current risks to human health are considered to be limited. Risks to construction workers will be triggered by redevelopment of the site. Prior to the development proceeding an environmental assessment of the ground and groundwater will be required to mitigate any identified contaminates within this material. Once these mitigation measures are implemented the risk will reduce to LOW.
	Likelihood of Designation as Contaminated Land (EPA 1990)	LOW	Based on the historical and current land use, it is considered unlikely that the site have been designated contaminated land.
BUSINESS CONSEQUENCES	Likelihood of Site Investigation Works Required for Redevelopment	HIGH	Details of ground, groundwater and ground gas conditions and services beneath the site are currently unknown. A ground investigation would be required to characterize the type of ground, ground contamination, ground gas regime and the geotechnical conditions prior to any redevelopment works.
	CURRENT ENVIRONMENTAL RISK RATING – LOW TO MEDIUM **CURRENT GEOTECHNICAL RISK RATING – MEDIUM**		

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

The review of the information available indicates that the site is likely to be underlain by Made Ground, Alluvium deposits, River Terrace deposits (Kempton Park Gravel), London Clay, Lambeth Group, Thanet Sand and Chalk. There is also likely to be deposits of Made Ground present at the site.

The surrounding area to the site comprises a significant number of heritage buildings.

The drift deposits are classified by the Environment Agency as a Secondary Undifferentiated Aquifer. The Thanet Sand is also classified by the EA as a Secondary A Aquifer and the Chalk as a Principal Aquifer.

The nearest surface water feature is the Thames River located adjacent to the east boundary of the site.

The site has been historically used for industrial purposes. The historical maps suggest that the eastern part of the site lies on land reclaimed to the Thames River. It is likely that remains of the former foreshore at present buried beneath the site.

There is a high likelihood that Made Ground is present on site, which may be contaminated. It is likely that the thickness of Made Ground increases towards the eastern part of the site due to the historical reclaiming of land on the Thames River and construction of the existing river wall.

Trees are present along the edges of the site.

Existing buried services are present in and around the site.

The site setting is considered to be of a **LOW** to **MEDIUM** environmental sensitivity.

WSP have identified a **LOW to MEDIUM** risk of possible source-pathway-receptor pollutant linkages being present; which should be assessed further by undertaking an intrusive site investigation.

7.2 GEOTECHNICAL CONSIDERATIONS

It is understood that the proposed development comprises the construction of a double level basement and a new UK national holocaust memorial.

The requirements for the embedded retaining wall and foundations for the development will need to be established further to the completion of the site investigation and confirmation of the proposed development loads and settlement tolerances. An assessment of the impact of the development on ground movement sensitive structures will be required (e.g. existing heritage buildings, highways and utilities).

A site investigation is required to confirm the ground, groundwater and ground gas regime beneath the site and to confirm the geotechnical parameters for design. A ground investigation report (GIR) and geotechnical design report (GDR) will be required in accordance with the Eurocodes for the foundations and the likely basement wall design.

Significant obstructions may be present associated with the former post medieval buildings and shoreline across the site.

Investigation of the retaining wall along the south of the site is required. Liaison with the Highways Agency is recommended to ascertain the ownership of the retaining wall and any requirements to enable redevelopment of the site.

Liaison with LUL has been progressed to confirm the presence of any underground assets. TFL have confirmed there are no LUL assets within 50 metres of the site. However, there are cable ducts in the area and further liaison with TFL should be undertaken if any highway works are undertaken at this location.

Liaison with BT, Metropolitan Police and the Government has been progressed to confirm the presence of any underground assets. The details of these will be issued once received.

Based on the information contained in this report and with due regard to the geotechnical aspects of the proposed development, it is the opinion of WSP that the site represents a **MEDIUM** risk with respect to development issues.

7.3 RECOMMENDATIONS

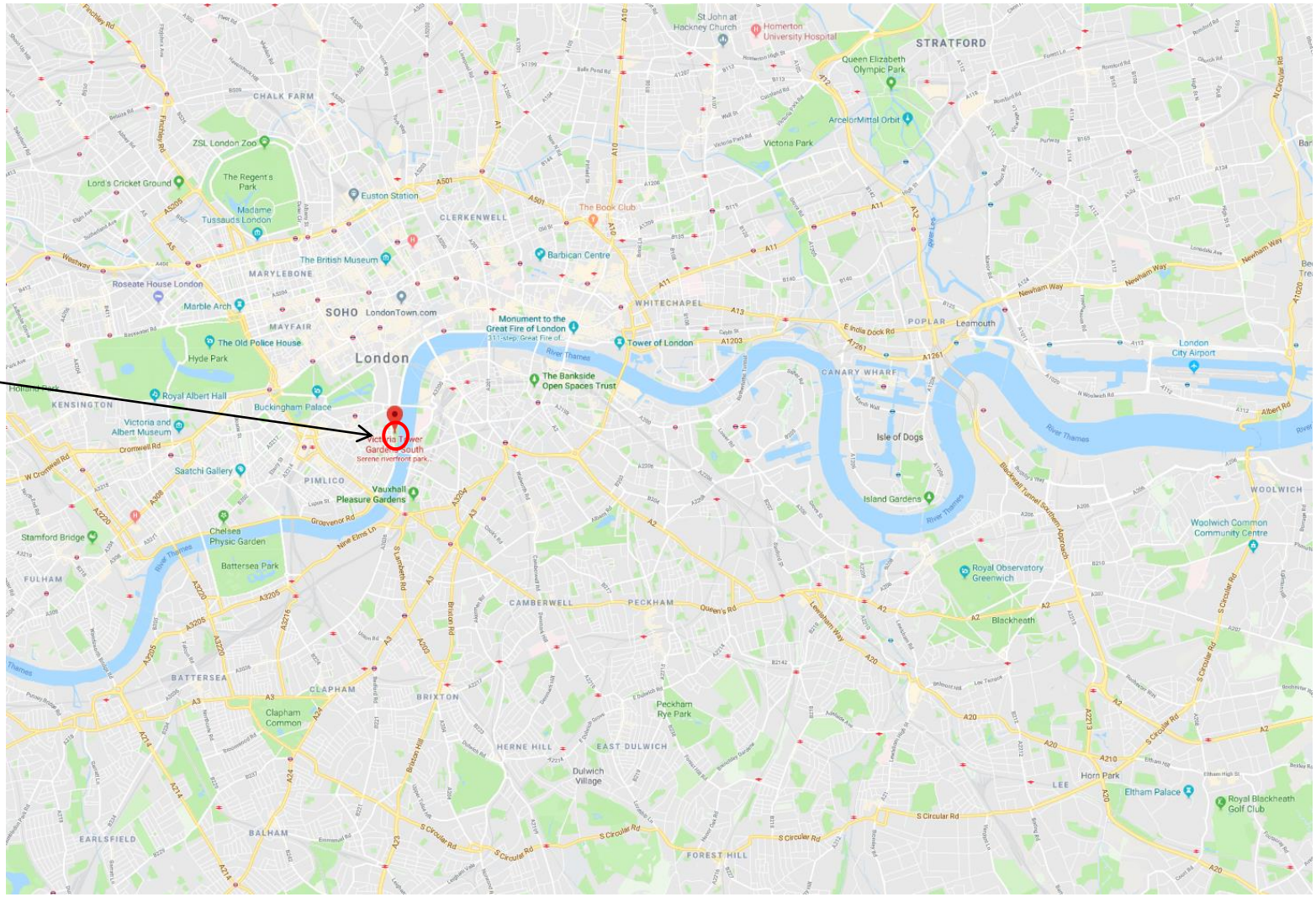
Based on the above conclusions the following recommendations are proposed:

- A condition survey of the existing Thames Embankment Wall and existing buried services (Thames Water sewers) may be required to confirm the position and the current condition of these assets.
- A site specific ground investigation is required. This site investigation will define ground conditions, assess ground gas, ground and groundwater contamination risks (both in terms of onsite risks and risks posed to offsite sources from onsite conditions) and to provide parameters for geotechnical design;
- A UXO Desk Study and Threat Assessment should be obtained;
- A Ground Investigation Report (GIR) will be required to confirm the ground and groundwater conditions beneath the site and the geotechnical design parameters in accordance with the Eurocodes;
- A Geotechnical Design Report (GDR) should be produced in accordance with the Eurocodes for the site once the development proposals, column loads and the serviceability limit state requirements of the structure are known;
- A Generic Environmental Risk Assessment (GQRA) will be required. This will inform the requirement for a Remediation Strategy and Detailed Environmental Risk Assessment (DQRA);
- A piling risk assessment will be required where piled foundations into the lower aquifer are proposed;
- A risk assessment will need to be completed to confirm any structures / assets at risk from ground movements from the development which will require a Ground Movement Assessment to be completed. The Ground Movement Assessment will determine if the assets will be detrimentally affected by the development. This assessment shall include any ground movement sensitive services present in the vicinity of the site. Heritage buildings, buried utilities (TW) and existing river wall will need to be considered. Depending on the conclusion of these assessments the following maybe required:
    - Ground movement assessment including cat II or III checks;
    - Structural monitoring of the assets;
    - Monitoring actions plans (MAP's);
    - Monitoring data interpretative reports and management of the MAPs.

APPENDIX A – SITE LOCATION PLANS

N

Site



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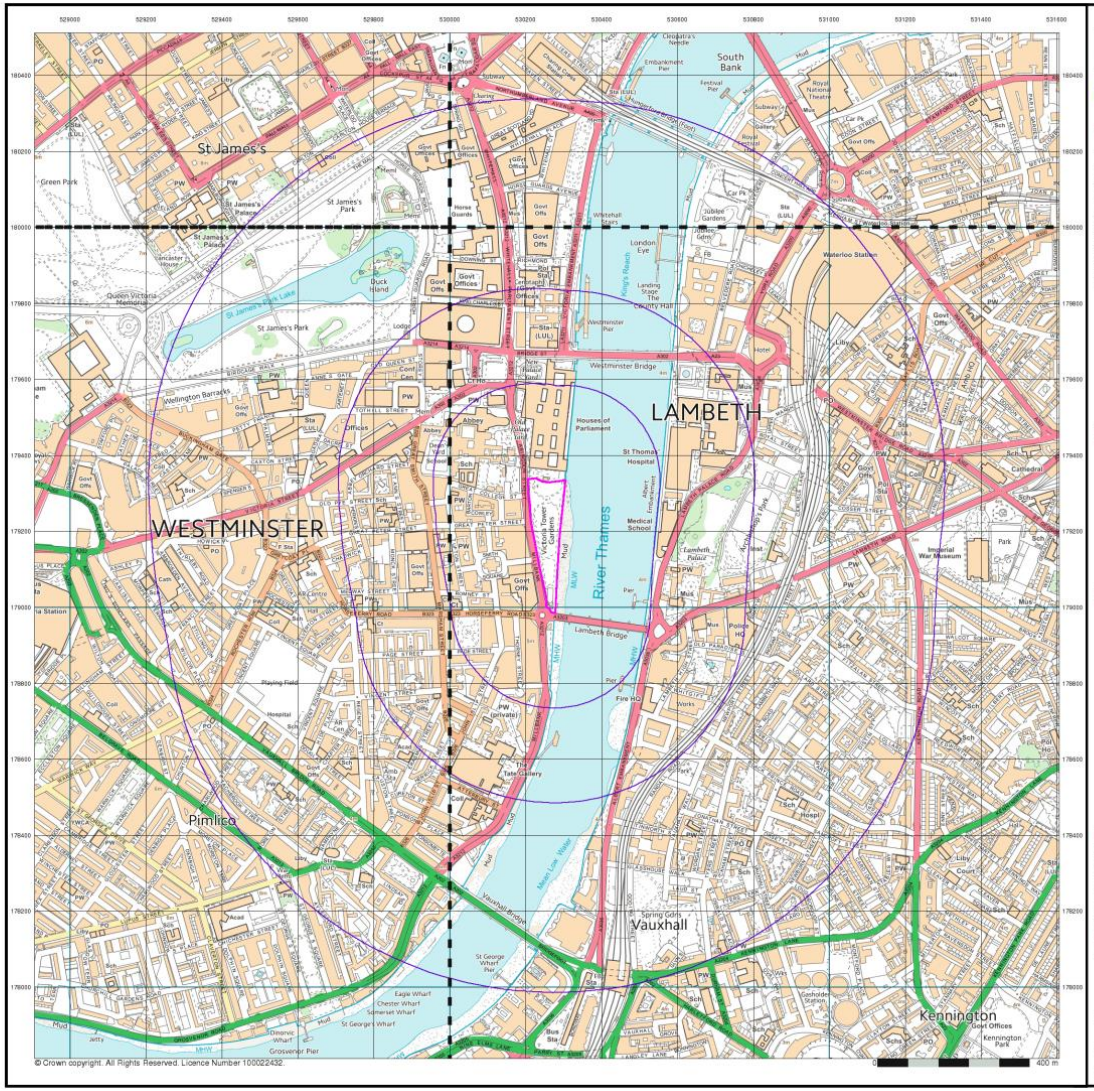
Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.1
Project	UK Holocaust Memorial	Drawn by	JA
Title	Site Location Plan	Checked by	JR



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VectorMap Local

Published 2017

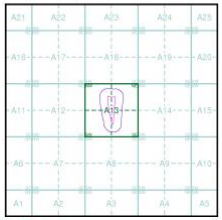
Source map scale - 1:10,000

VectorMap Local (Raster) is Ordnance Survey's highest detailed 'backdrop' mapping product. These maps are produced from OS's VectorMap Local, a simple vector dataset at a nominal scale of 1:10,000, covering the whole of Great Britain, that has been designed for creating graphical mapping. OS VectorMap Local is derived from large-scale information surveyed at 1:1250 scale (covering major towns and cities),1:2500 scale (smaller towns, villages and developed rural areas), and 1:10 000 scale (mountain, moorland and river estuary areas).

Map Name(s) and Date(s)

TQ26SE 2017 Variable	TQ36SW 2017 Variable
TQ27NE 2017 Variable	TQ37NW 2017 Variable

Historical Map - Slice A



Order Details

Order Number:	144655595_1_1
Customer Ref:	50214-1-VictoriaTGrds-JR
National Grid Reference:	530260, 179170
Slice:	A
Site Area (Ha):	2.08
Search Buffer (m):	1000

Site Details

1, Abbey Gardens, LONDON, SW1P 3SE

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Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.2
Project	UK Holocaust Memorial	Drawn by	JA
Title	Site Location Plan	Checked by	JR

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Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.3
Project	UK Holocaust Memorial	Drawn by	JA
Title	Site Location Plan	Checked by	JR

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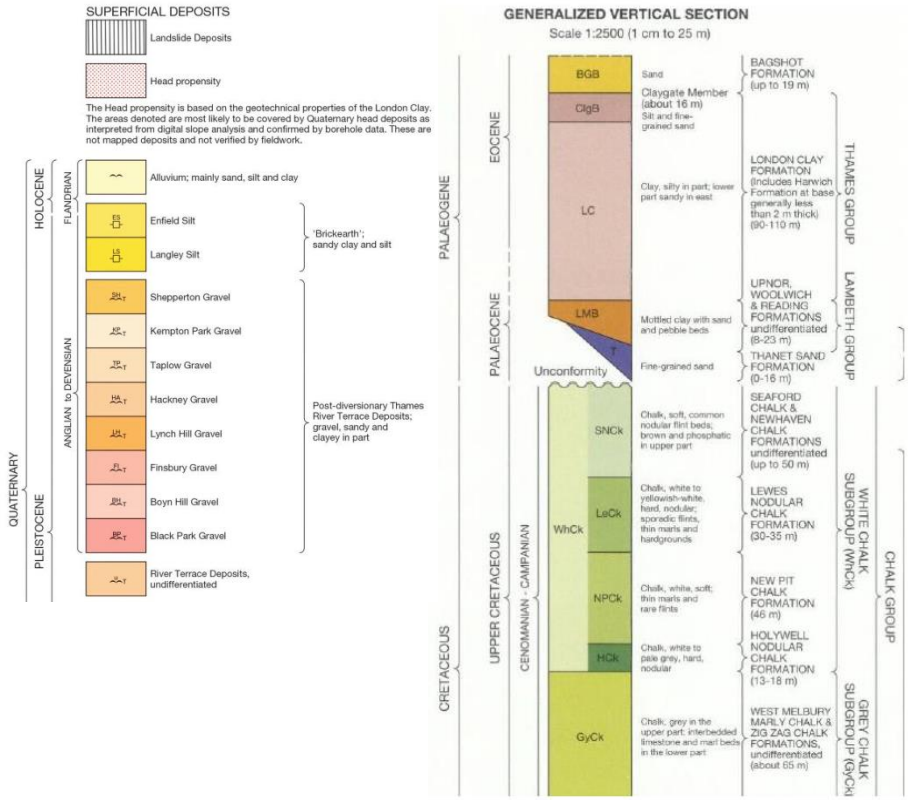
Extract from Geological Survey (BGS) Map No. 270 (South London, 1:50 000 Series)

Site



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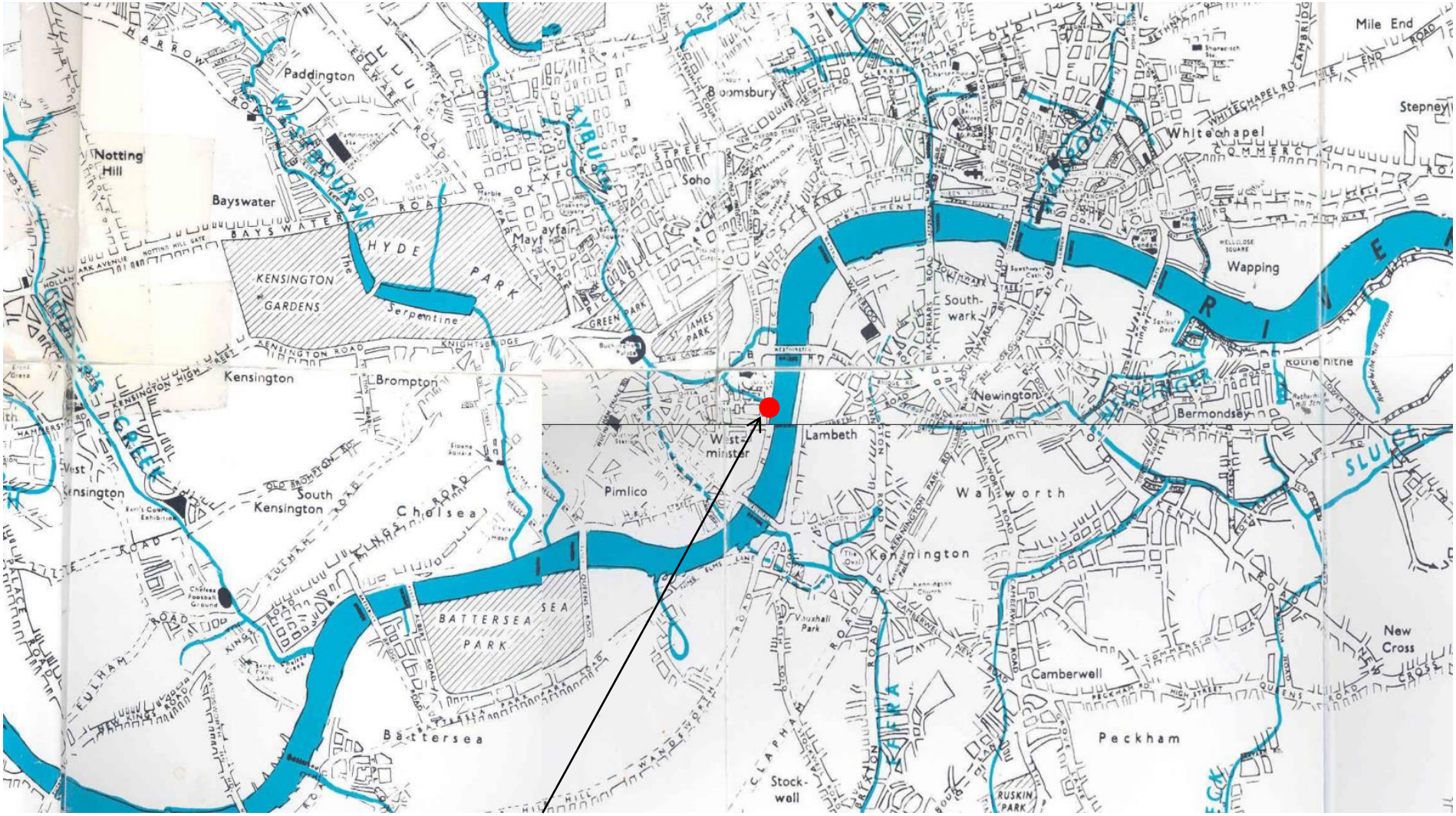
Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.4
Project	UK Holocaust Memorial	Drawn by	JA
Title	Site Location (British Geological Survey – South London Map)	Checked by	JR

Extract from Lost Rivers of London (Barton, 1992)



Site

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Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.5
Project	UK Holocaust Memorial	Drawn by	JA
Title	Site Location (Lost River Maps)	Checked by	JR

Extract from Environment Agency – Management of the London Basin Chalk Aquifer, August 2017

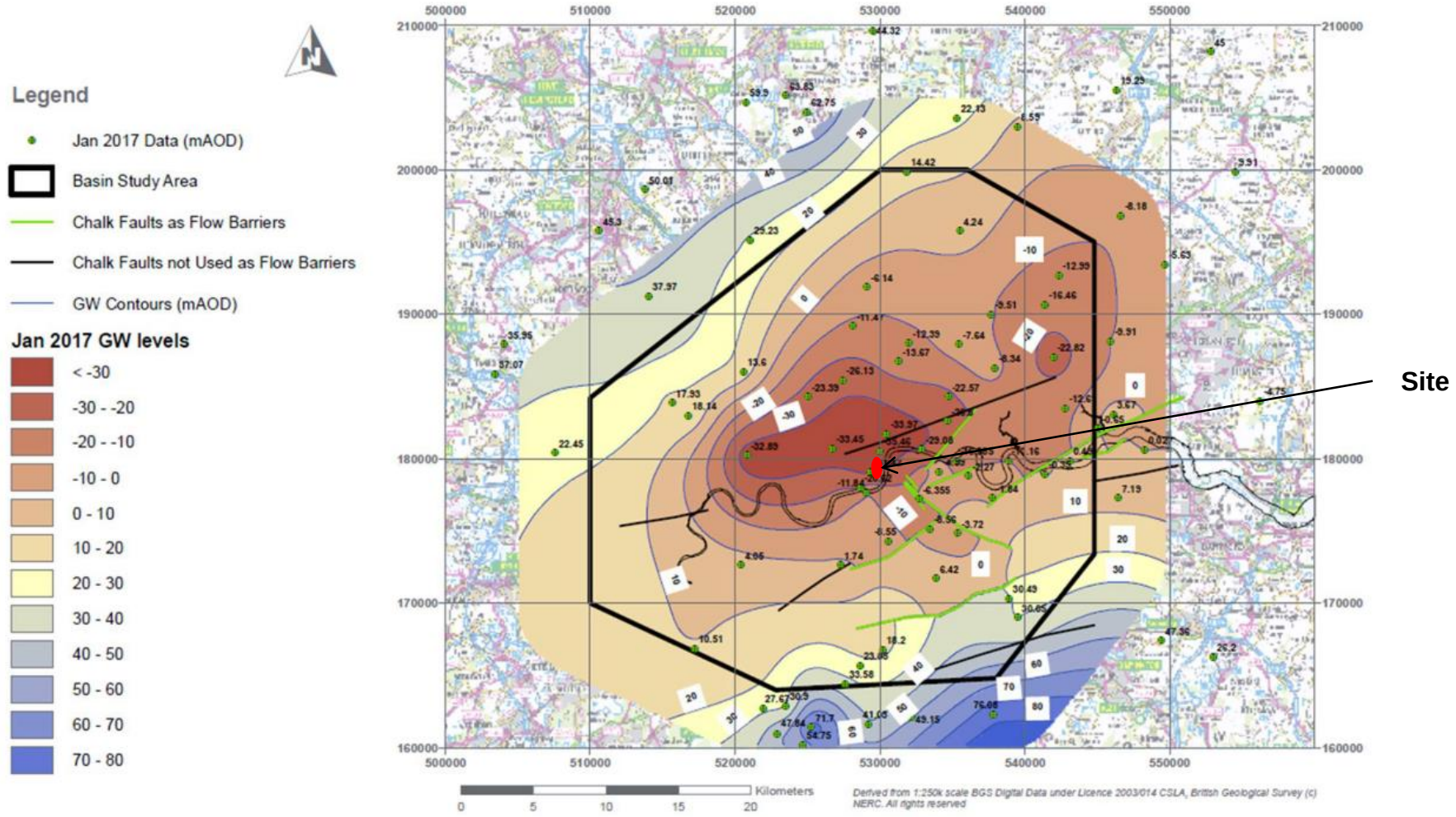

Figure 12 Groundwater Level Contours for January 2017

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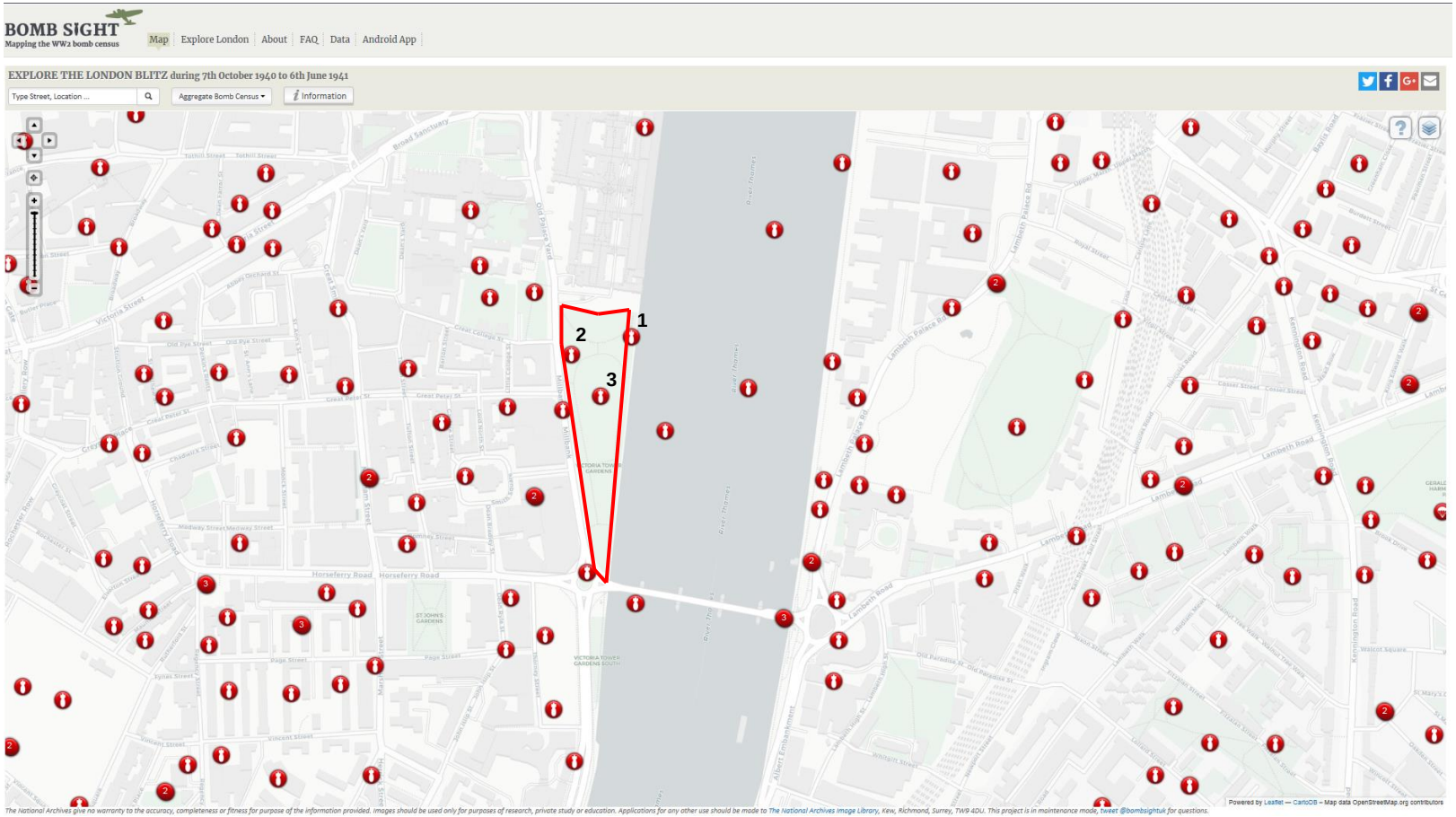
Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.6
Project	UK Holocaust Memorial	Drawn by	JA
Title	Site Location (Ground Water Level Contours – Chalk Aquifer)	Checked by	JR

http://www.bombsight.org/#17/51.49609/-0.12146 (consulted 3rd January 2018)



N

1 – High Explosive Bomb
Source: Aggregate Night Time Bomb Census 7th October 1940 to 6 June 1941
Fell between Oct. 7, 1940 and June 6, 1941

2 – High Explosive Bomb
Source: Aggregate Night Time Bomb Census 7th October 1940 to 6 June 1941
Fell between Oct. 7, 1940 and June 6, 1941

3 – High Explosive Bomb
Source: Aggregate Night Time Bomb Census 7th October 1940 to 6 June 1941
Fell between Oct. 7, 1940 and June 6, 1941

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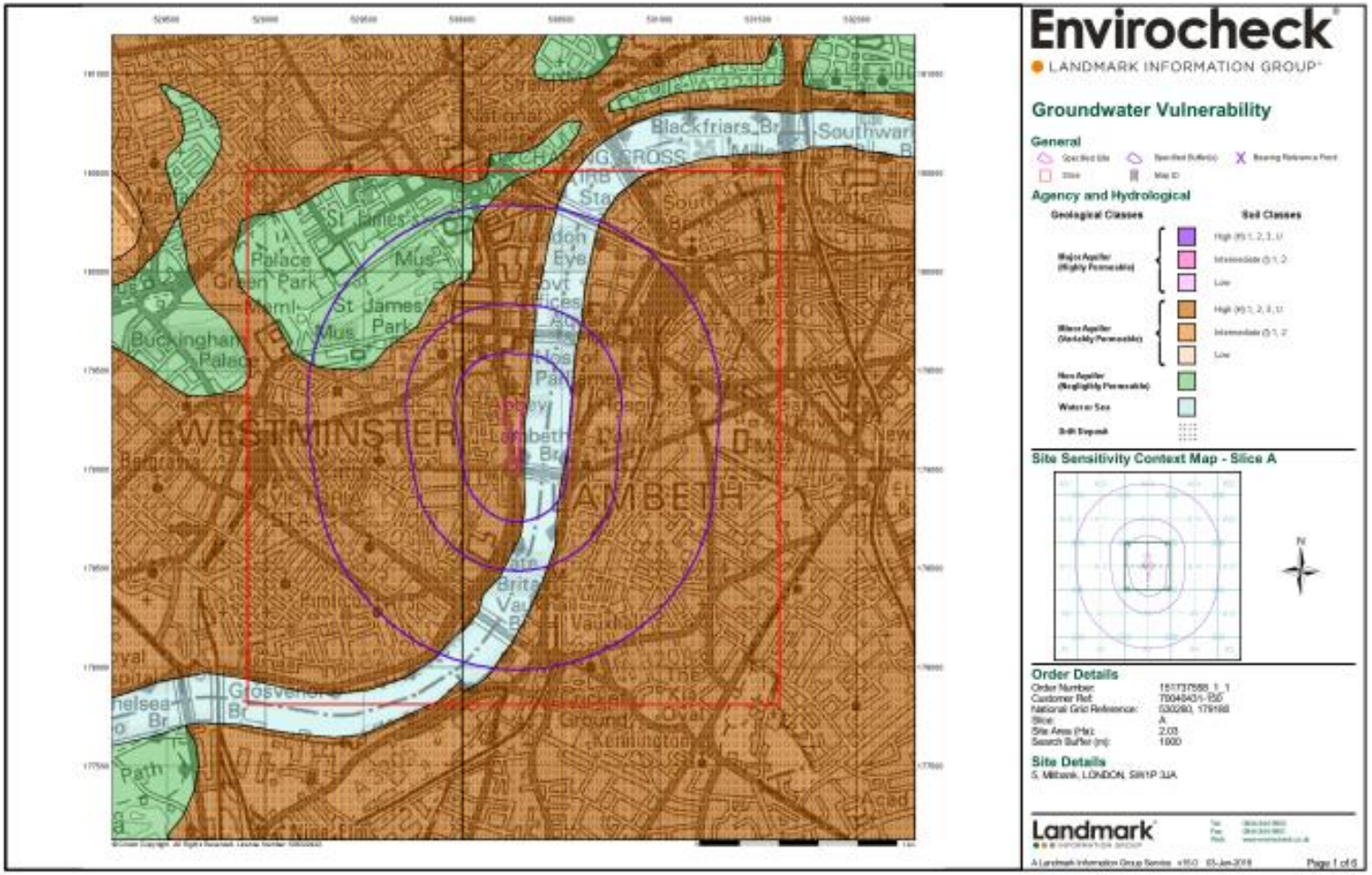
Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.7
Project	UK Holocaust Memorial	Drawn by	JA
Title	Site Location (WWI Bomb Strike Locations)	Checked by	JR



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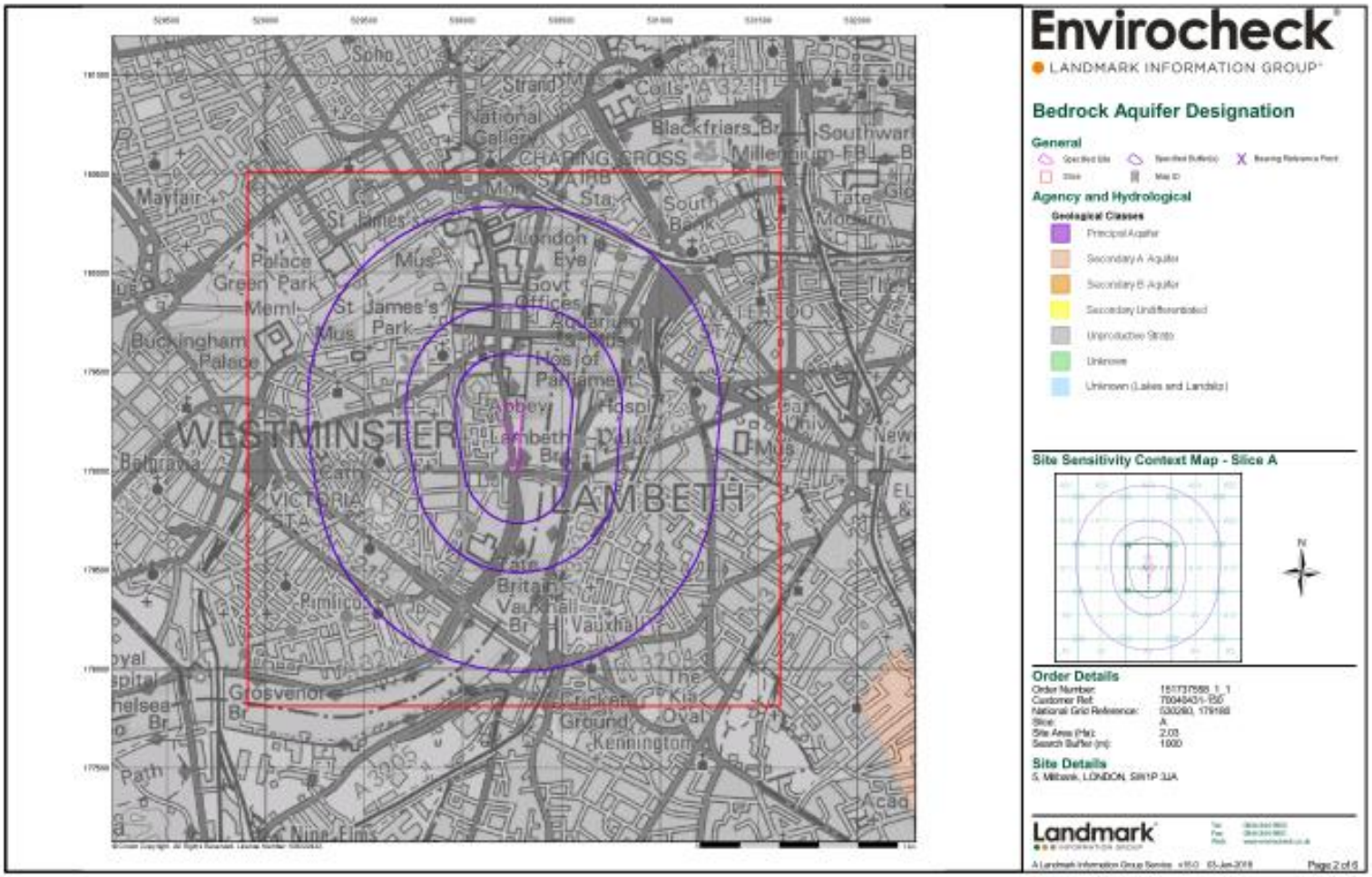
Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.8
Project	UK Holocaust Memorial	Drawn by	JA
Title	Groundwater Vulnerability	Checked by	JR



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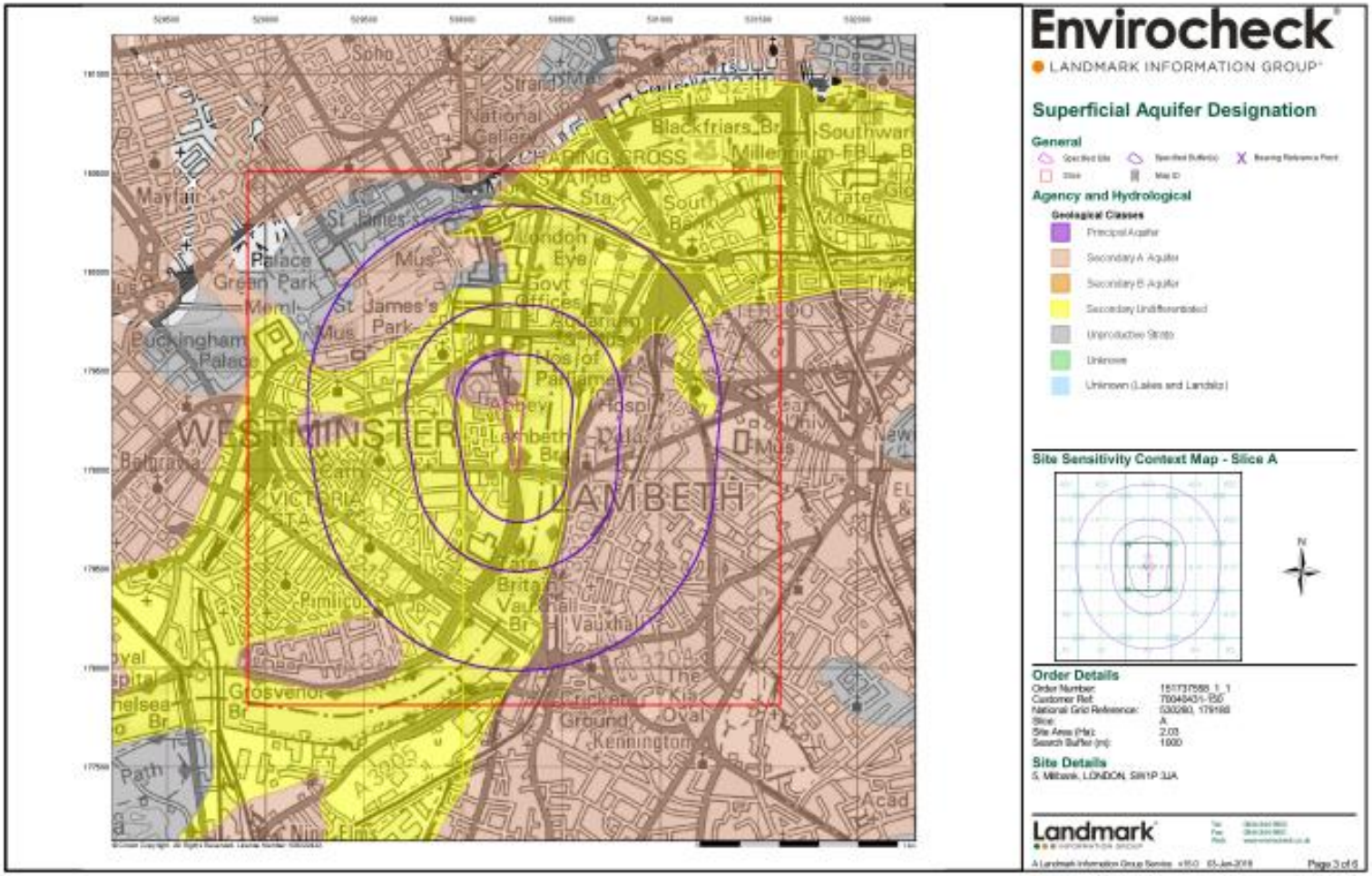
Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.9
Project	UK Holocaust Memorial	Drawn by	JA
Title	Bedrock Aquifer Designation	Checked by	JR



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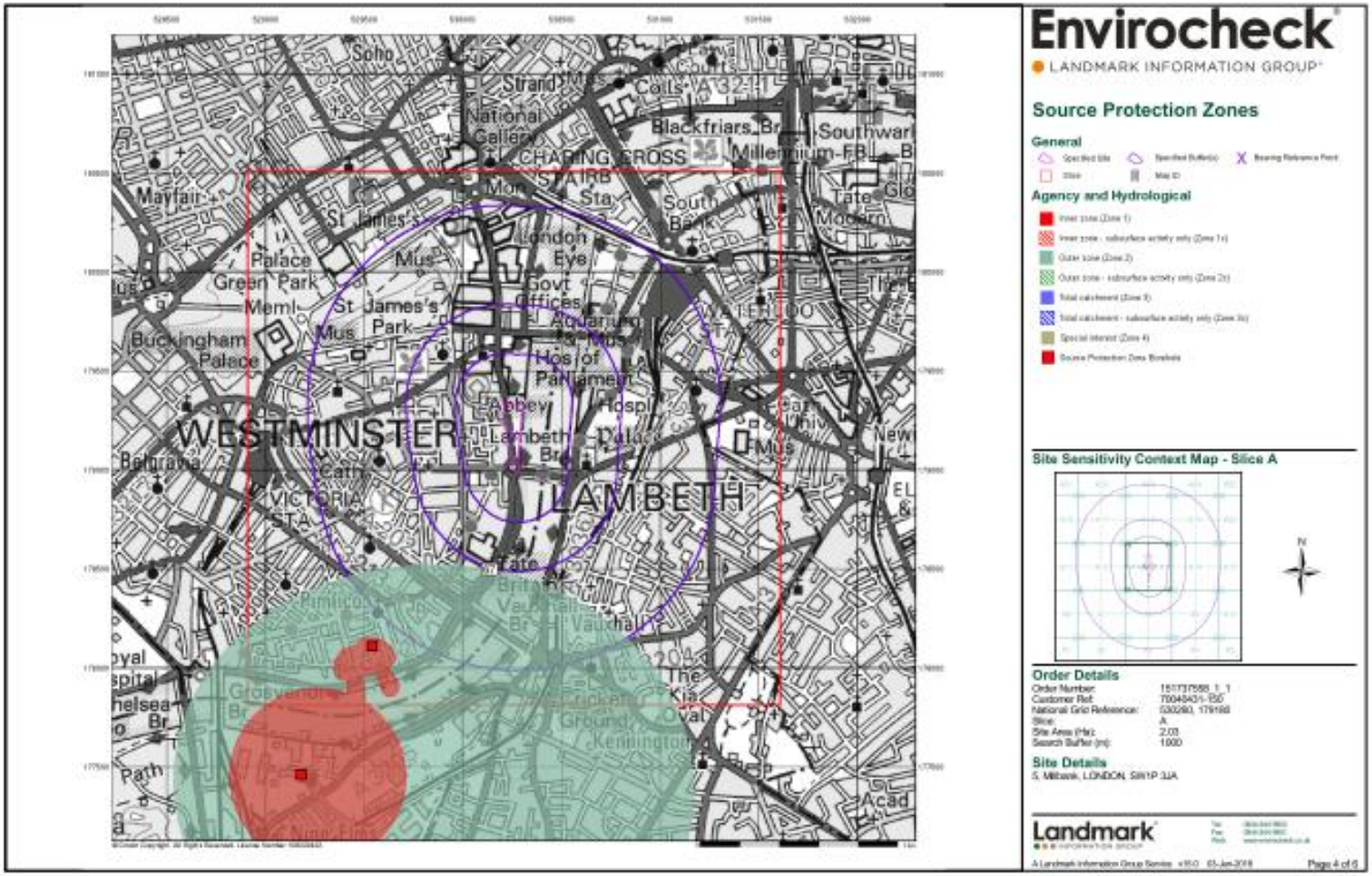
Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.10
Project	UK Holocaust Memorial	Drawn by	JA
Title	Superficial Aquifer Designation	Checked by	JR



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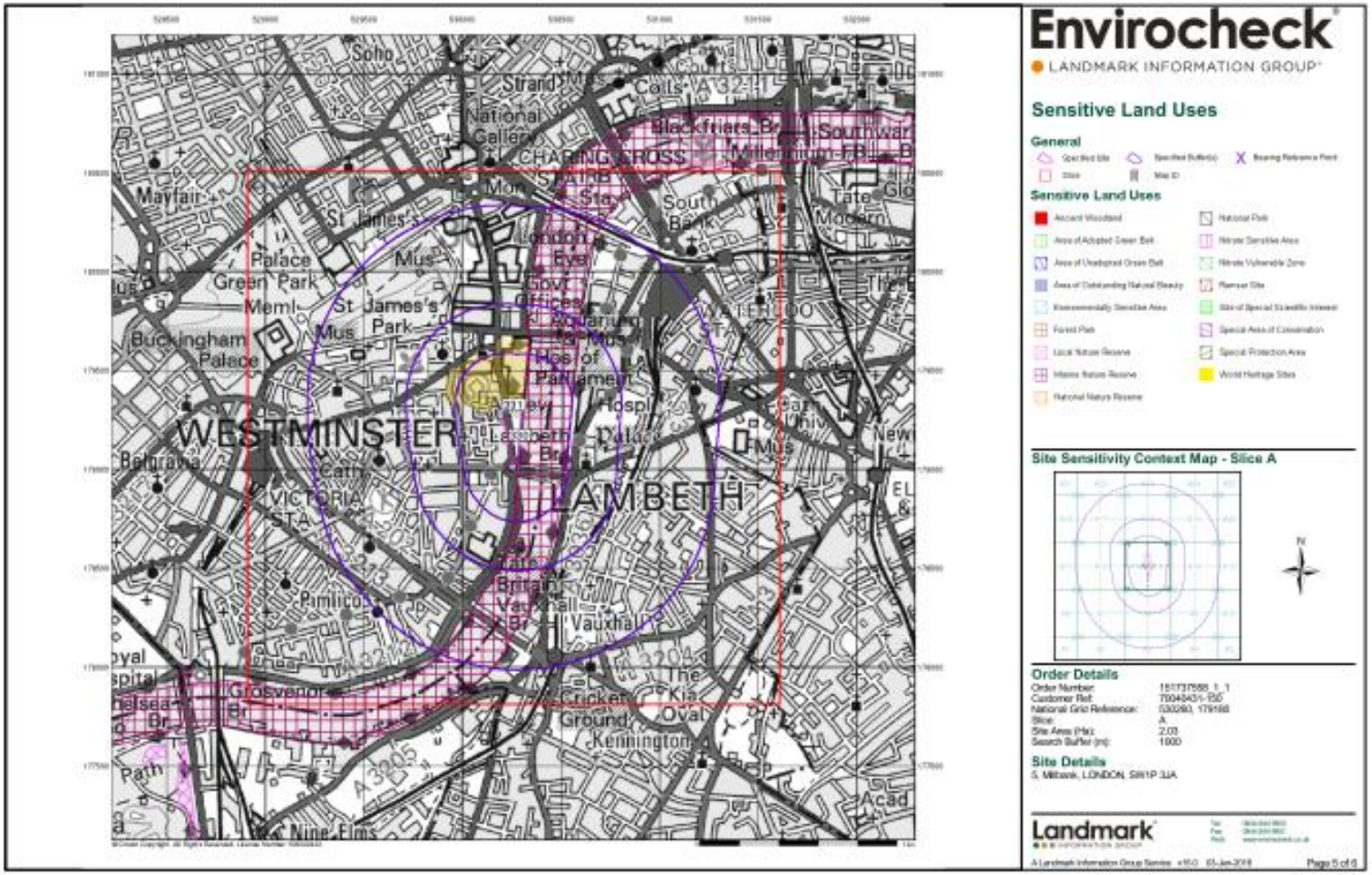
Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.11
Project	UK Holocaust Memorial	Drawn by	JA
Title	Source Protection Zones	Checked by	JR



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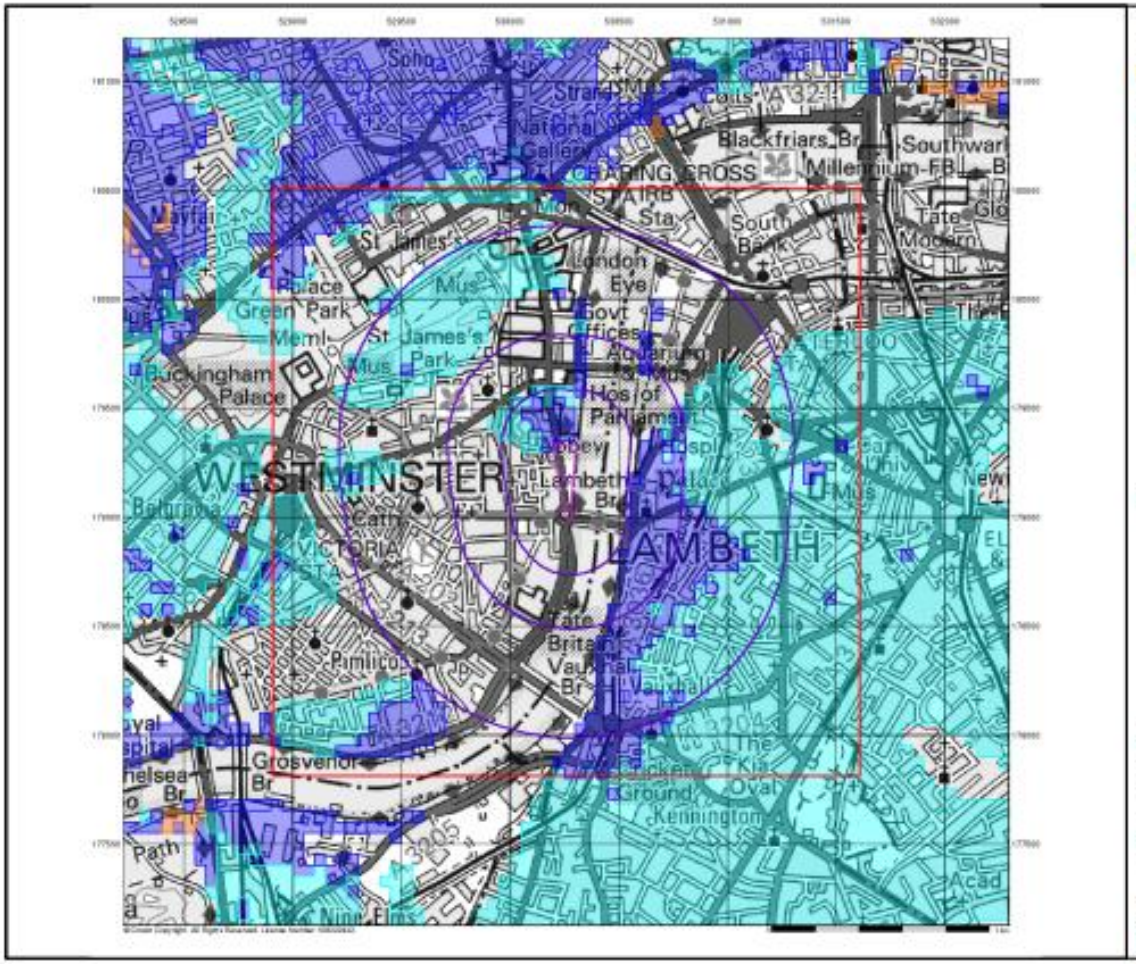
Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.12
Project	UK Holocaust Memorial	Drawn by	JA
Title	Sensitive Land Uses	Checked by	JR



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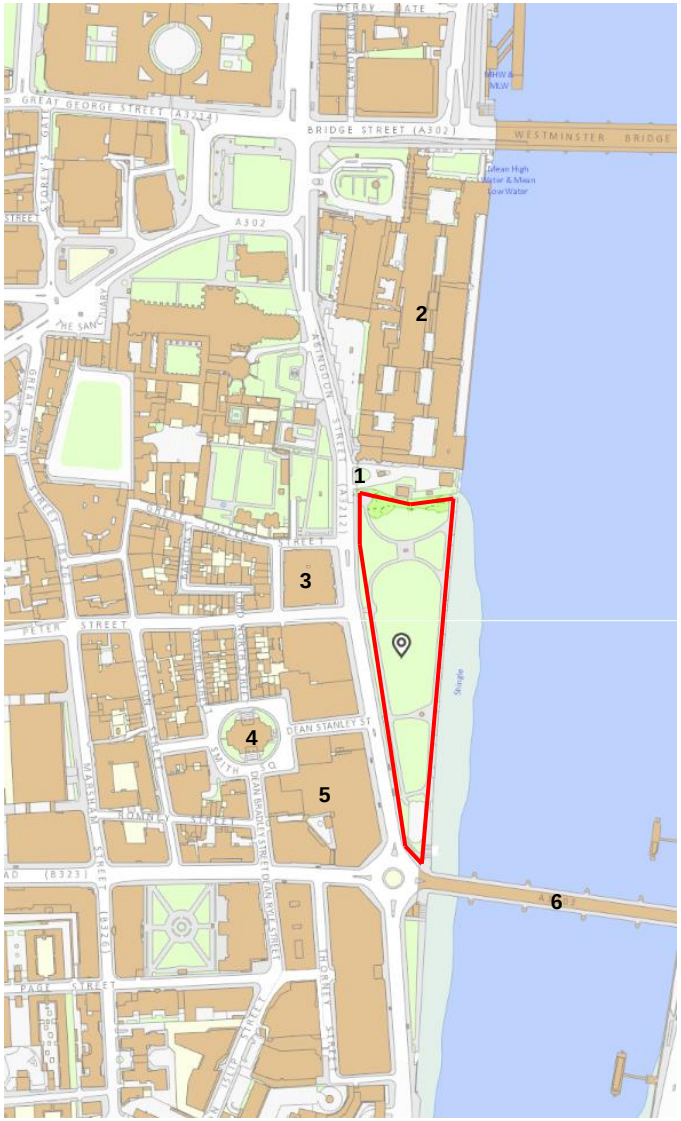
Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.13
Project	UK Holocaust Memorial	Drawn by	JA
Title	BGS Flood GFS Data	Checked by	JR



N

1 – Victoria Tower Lodge and Gates to Black Rod Garden (Grade I Listed)

2 – House of Parliament the Palace of Westminster (Grade I Listed)

3 – The Church Commissioners (Grade II* Listed)

4 – St John's Smith Square Concert Hall (Grade I Listed)

5 – Norwest House (Grade II Listed)

6 – Lambeth Bridge and Attached Parapets, Light Standards, Associated Walls to Approaches and Obelisks (Grade II Listed)

City of Westminster Portal https://lbhf.maps.arcgis.com/apps/LocalPerspective/index.html?appid=d7ce08a3c0a8413e867e4d30b01e6d06 consulted on 4th January 2018

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Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.14
Project	UK Holocaust Memorial	Drawn by	JA
Title	Statutory Listed Buildings	Checked by	JR

Extracted from Atkins – UK Holocaust Memorial, Arboricultural Impact Assessment Revision P1 dated December 2016.

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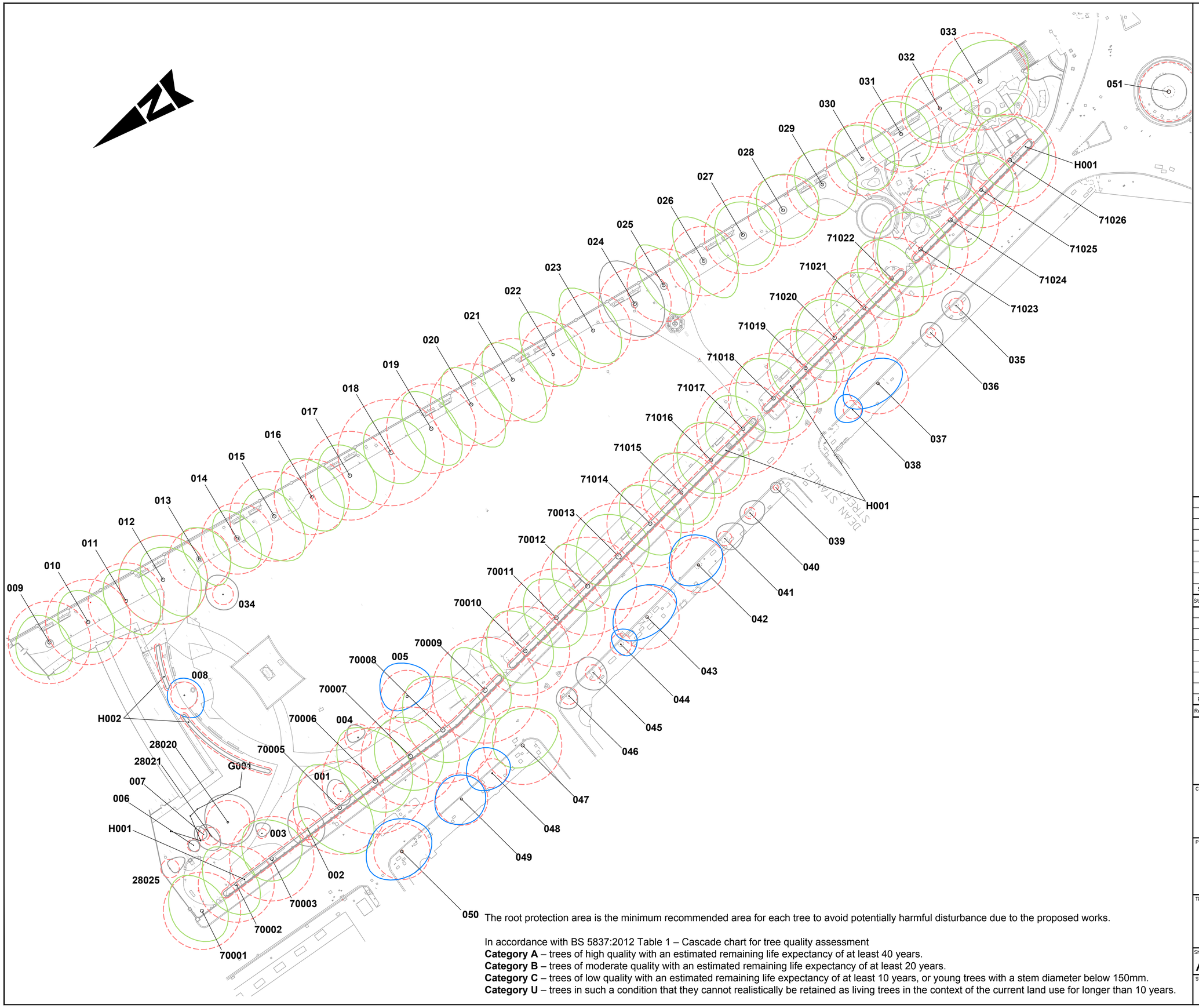
Project No.	70040431	Scale	NTS
Date	January 2017	Figure No.	Appendix A.15
Project	UK Holocaust Memorial	Drawn by	JA
Title	Tree Protection Zone	Checked by	JR



The root protection area is the minimum recommended area for each tree to avoid potentially harmful disturbance due to the proposed works.

In accordance with BS 5837:2012 Table 1 – Cascade chart for tree quality assessment
Category A – trees of high quality with an estimated remaining life expectancy of at least 40 years.
Category B – trees of moderate quality with an estimated remaining life expectancy of at least 20 years.
Category C – trees of low quality with an estimated remaining life expectancy of at least 10 years, or young trees with a stem diameter below 150mm.
Category U – trees in such a condition that they cannot realistically be retained as living trees in the context of the current land use for longer than 10 years.

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KEY

- Category A tree
- Category B tree
- Category C tree
- Category U tree
- Tree group or hedge - colour according to category as above
- Root Protection Area (RPA)
- **001** Tree reference number
- **G001** Tree group reference number
- **H001** Hedge reference number
- **W001** Woodland group reference number

Stat	Purpose of Issue	Date	Auth
S2	FOR INFORMATION	21/12/16	PR

Rev	Description	By	Date	Chk'd	Auth
P01	ORIGINAL	AA	21/12/16	TD	PR

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www.atkinsglobal.com

Client
UK HOLOCAUST MEMORIAL FOUNDATION

Project
VICTORIA TOWER GARDENS

Title
TREE CONSTRAINTS PLAN

Sheet Size	Original Scale	Designed/Drawn	Checked	Authorised
A1	1:500	AA Date 21/12/16	TD Date 21/12/16	PR Date 21/12/16

Status	Drawing Number	Rev
S2	5152854-ATK-BHM-ARB001	-