HAMPSTEAD POLICE STATION, LONDON

COMBINED PHASE 1 AND PHASE 2 GEO-ENVIRONMENTAL INVESTIGATION AND RISK ASSESSMENT

Job Number: LKC 22 5242
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LK Consult

Document Verification

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R1	March 2024	Update to development proposals and Client name.	SJ

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EXECUTIVE SUMMARY

Site Details

Site Location:	- 56 Downshire Hill, London, NW3 1PA. - Centred at approximate National Grid 526870E, 185560N.
Current Land Use:	- The site currently comprises 3 storey plus basement, grade II listed brick building with external tarmacadam car parking to the rear.
Proposed Development:	- Change of use and extension to former police station (*sui generis*) to provide 5no. residential apartments (Use Class C3) and commercial floorspace (Use Class E), space for a private healthcare use (Use Class E(e)), external and internal alterations, landscaping, cycle and refuse storage, rooftop plant and associated ancillary works.
Purpose of Report:	- Preliminary Risk Assessment, with Contamination and Geotechnical Assessment

Phase 1 Assessment

History:	Residential properties present on site 1879-1896, Magistrates Court present on site 1934-present, Police Station present on site 1934-present.
Landfills:	- No recorded landfills noted within 250m of the site.
Geology:	- No superficial recorded on site. - Claygate Member (clay, silt and sand), in south. - London Clay Formation (clay, silt and sand), in north.
Nearest watercourse:	- None within 100m of site.
Coal Mining:	- Not within coal reporting area.
UXO:	- High Risk (Zetica Risk Map). - Preliminary desk study assessment recommends detailed desk study and risk assessment.
Potential Constraints:	<u>Contamination</u> - Risk of contamination associated former buildings on site. - Hazardous gas may be present (associated with infilled features within 250m) and given sensitive end use (residential) gas monitoring is required.
	<u>Geotechnical</u> - Unknown depth of made ground, which may not be a suitable founding strata. - Unknown strength of soils and bedrock for foundation design. - Unknown depth and variability of water table. - Unknown sulphate content of natural ground. - Possible plasticity of soils. - Unknown CBR value for access areas.

Phase 2 Ground Investigation Work

Investigation Date:	- 6th March 2023.
Work Undertaken:	- 1no. window sample boreholes (WS01). - 1no. cable percussive boreholes (BH01) - 7no. mechanically excavated trial pits (TP01-TP07).
Soil Sampling:	- 2no. samples tested for metals, speciated PAHs, cyanide, pH, sulphate, asbestos, phenol, TPHCWG, BTEX and SOM. - 2no samples tested for metals, speciated PAHs, cyanide, pH, sulphate, asbestos, SOM. - 6no. samples tested for BRE Short Suite.
Geotechnical Tests:	- Standard Penetration Tests, Single Triaxial Tests, Atterberg (plasticity).

Ground Conditions and Geo-Environmental Assessments

General Ground Conditions:	- Based on WS1, BH01 and TP01-TP07 the ground conditions are as follows: - Tarmacadam recorded from ground level to 0.03-0.05mbgl (WS01, BH01, TP01, TP05). - Concrete recorded to 0.07-0.15mbgl, also encountered at base of TP06 (1.19-1.20mbgl). - Reinforced concrete recorded at 0.20mbgl and 0.75mbgl in TP07; and 1.00mbgl in TP03. - Lino flooring, fibrous membrane over concrete recorded to 0.20mbgl (TP03, TP04). - Made ground recorded to 1.85-3.50mbgl, comprising flint, brick, clinker, ash, rootlets and cobbles. - BH01: Natural firm sandy silty CLAY to 5.50mbgl, firm to stiff sandy silty CLAY with fine grained selenite crystals to 8.70mbg, stiff grey silt CLAY to 9.90mbgl, medium to coarse GRAVEL and COBBLES to 10.30mbgl, very stiff silty CLAY to 14.40mbgl, and very stiff silty CLAY to >15.10mbgl. - WS1: Natural soft to firm slightly sandy silty CLAY to 2.00mbgl, Firm slightly sandy silty CLAY to 5.00mbgl, Firm sandy silty CLAY with gypsum crystals to > 6.45mbgl. - Brick footing encountered at 0.70mbgl in TP02.
Groundwater:	- Groundwater was recorded in the window samples and cable percussive boreholes at 4.50mbgl and 9.90mbgl (during site investigation). - No groundwater was recorded in the trial pits.
Contamination Assessment:	- No further investigation, assessment or remediation is recommended with respect to the contamination risk to future receptors (assuming a new potable water supply is not required). - Consideration should be given to construction works exposed to the soils during groundworks. Standard health and safety precautions (as per HSE guidance) should be adopted by all workers involved with site enabling and construction works.

Contamination Risk Assessment

The table below shows a summary of the risk assessments undertaken for each pollutant linkage, the revised conceptual model and recommendation for either remediation and / or further investigation.

	Pollutant Linkage	Risk	Recommendations
1	Contaminants posing a risk to site users and offsite receptors via dermal contact, ingestion and inhalation (of soil, dust and fibres).	-	- No pollutant linkage therefore no further assessment required.
2	Volatile contaminants posing a risk to site users via the inhalation of vapours.	**Low**	- No remediation required.
3	Gas posing a risk to buildings and site users via the migration of gas into building causing explosion and asphyxiation.	Moderate / **Low**	- Further monitoring required.
4	Mobile contamination posing a risk to controlled waters via the migration through permeable strata.	**Low**	- No remediation required.
5	Organic contaminants posing a risk to water pipes.	**Low**	- No further assessment required. However if new pipeline is proposed, a water pipeline risk assessment for Severn Trent Water is likely to be required.

Geotechnical Assessment

Allowable Bearing Pressure	- 140kN at 7.00mbgl for a 0.6m pile diameter.
Anticipated Foundation Type	- Pile foundation or ground improvement technique.
Other Considerations	- Concrete design: DS-1 AC-1 for soils of Made Ground. As minimum, DS-2 AC-3 for the natural strata. - Details design should be caried out by structural engineer.

Recommendations and Remedial Strategy

The table below shows the remediation and validation requirements for the site. This information should be documented in a Site Completion Report for submission to the local authority.

PL	Remediation Requirements	Validation Requirements
ALL	<u>Earthworks Inspections / Unexpected Contamination</u> The relevant contractors should be briefed that during development works at the site should any unusual ground conditions and / or visual or olfactory evidence of contamination (including asbestos containing material) be encountered at the site, LKC and the Local Authority should be informed, and further assessment of the material may be required. Should asbestos be identified during groundworks, precautions should be taken to ensure the safety of the construction workers and nearby land users. It would be	Log of work undertaken including photographs. Details of any sampling undertaken and validation of any potential additional remedial work.

	advisable to introduce an asbestos management strategy in line with CIRIA C733[1].	
3	Gas Risk Assessment Additional monitoring visits may be required to satisfy the Local Planning Authority. Six visits over a 3 months period is the typical / idealised monitoring period and frequency is in line with C6652 for a very low gassing potential of a source and high sensitivity of development (residential with gardens).	Liaison with LPA
5	New Potable Water Pipes It is recommended that a Water Pipeline Assessment is undertaken if new in ground potable water pipes are to be laid. It is possible that barrier pipe will be required.	Delivery Notes of Pipe Material. Photographs of the Installed Pipe.
Other Considerations	Health and Safety Considerations In working with, removing or treating any contaminating material it is important that any potential risks associated with the actual site works are mitigated by good environmental management of the site during the remedial phases. Standard health and safety precautions (as per HSE guidance[3]) should be adopted by all workers involved with site enabling and construction works.	
	Asbestos Survey A Pre-Demolition and Major Refurbishment Asbestos Survey should be undertaken, and any ACMs removed and properly disposed of, prior to the refurbishment of the existing buildings, by a suitably qualified professional.	

The remediation recommended in the table above should be validated to ensure it has been carried out appropriately. This should be documented in a Completion/Validation Report and submitted to the local authority for completion.

[1] CIRIA (2014). "Asbestos in Soil and Made Ground: A Guide to Understanding and Managing Risks". C733.
[2] CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665.
[3] HSE (1991). "Protection of Workers and the General Public During Development of Contaminated Land" London HMSO.

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Appendices

1 Introduction

LK Consult Ltd (LKC) has been commissioned to carry out a Combined Phase 1 and Phase 2 Geo-Environmental Investigation and Risk Assessment for Hampstead Police Station, London.

In accordance with current guidance (including LCRM[4] and the National Planning Policy Framework (NPPF)5[)], the PRA will include a site reconnaissance, site history, geology, hydrogeology, hydrology, mineral search and a landfill search. Information gathered from the desk study and site reconnaissance will be used to develop a contamination conceptual model for the site.

This report also includes the Phase 2 investigation work undertaken to confirm ground conditions, provide geotechnical information to assist the structural engineer in their foundation assessment to assess potential contamination constraints

Site details are provided in Table 1-1. Figure 1 shows the site location and boundary. Figure 2 shows the existing site plan.

Site Location	56 Downshire Hill, London, NW3 1PA. Centred at approximate National Grid 526870E, 185560N.
Approximate Area	1,300m^2.
Topography	The rear portion of the site slopes downwards slightly to the north.
Current Site Use	The site currently comprises 3 storey plus basement, grade II listed brick building with external tarmacadam car parking to the rear.
Proposed Development	Change of use and extension to former police station (*sui generis*) to provide 5no. residential apartments (Use Class C3) and commercial floorspace (Use Class E), space for a private healthcare use (Use Class E(e)), external and internal alterations, landscaping, cycle and refuse storage, rooftop plant and associated ancillary works.

Table 1-1: Summary of site details.

[4] Land Contamination Risk Management (LCRM) https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm

-[5] "National Planning Policy Framework." The Ministry of Housing, Communities and Local Government. Published March 2012, Updated July 2021.

2 Historical Review

In compiling the site history, LKC consulted Envirocheck historical mapping (Appendix A), aerial photography, google earth pro and google imagery.

Table 2-1 summarises features on site. Table 2-2 summarises potentially contaminative land uses within approximately 50m and potentially infilled features within approximate 250m.

Site Features	Location on Site	Dates Present		Comments
		From	To	
Residential Properties	SW	1879	1896	Private gardens present to the rear. No longer present by 1915 mapping.
Magistrates Court	W	1934	present	No longer annotated as 'magistrates court' by 2016 mapping. Building still present.
Police Station	S	1934	present	No longer annotated as 'police station' by 2016 mapping. Building still present.

Table 2-1: Summary of site features. Dates based on available historical map editions.

Surrounding Area Features	Distance (m)	Direction	Dates Present		Comments
			From	To	
2no. Ponds	88	NW	1879 only		No longer present by 1961 mapping. Potentially infilled.
	111	NW	1879 only		No longer present by 1954 mapping. Potentially infilled.

Table 2-2 (continued): Summary of potentially contaminative features within 50m and potentially infilled features with 250m. Dates are based on available historical map editions.

3 Environmental Setting

A summary of environmental settings is presented in Table 3-1, based on a review of available environmental data.

Categories(data sources)			Details
Geology[1,2]	Artificial		- No artificial ground recorded.
	Superficial		- No superficial recorded.
	Bedrock		- Claygate Member (clay, silt and sand), in south. - London Clay Formation (clay, silt and sand), in north.
	BGS Logs (<50m)[2]		- None.
Hydro-geology[1]	Aquifer Designation	- Superficial	- Unproductive Stata.
		- Bedrock	- Secondary A Aquifer.
	Source Protection Zone (SPZ)		- Not within SPZ.
	Groundwater Abstractions (100m)		- None.
Hydrology[1]	Surface Water Courses (100m)		- None.
	Flooding risk		- Limited potential for Groundwater Flooding to Occur.
	Surface Water Abstractions (100m)		- None.
	Discharge Consents (onsite)		- None
	Pollution Incidents (onsite)		- None.
Minerals & Mining[1,2]	Coal Mining		- Not within a Coal Reporting Area.
	Surface Mineral Extractions (250m)		- None.
	Cheshire Brine Compensation District		- Not within Compensation District.
	Non-Coal Mining Area		- No Hazard.
Ground Stability[1]	Collapsible Ground		- Very low hazard.
	Compressible Ground		- No Hazard.
	Ground Dissolution		- No hazard.
	Landslide		- Very low hazard.
	Running Sand		- Very low hazard.
	Shrinking / Swelling Clay		- Moderate hazard.
Landfill Sites (250m)[1]	Known / Registered		- None.
	Potentially Infilled Land (non-water and water), based on Envirocheck Report		- None.
	Potentially infilled sites, based on LKC historical review		- 2no. features: See Table 2-1 and Table 2-2.
Radon Potential[1]			- The property is in a Lower probability radon area (less than 1% of homes are estimated to be at or above the Action Level). - No radon protective measures are necessary in the construction of new dwellings or extensions.
Designated Sites (50m)[1]			- None.
Contemporary Trade Directory (50m)[1]			- 96m W, Bang & Olufsen, electrical goods sales manufacturers and wholesalers, inactive.
Fuel Station Entries (50m)[1]			- None.
Unexploded Ordnance Risk (UXO) – Zetica Risk Map[4]	Zetica Risk Map		- Bomb Risk: High. - Strategic Targets: None identified within 100m.
	Pre-Desk Study Assessment		- Detailed UXO desk study recommended.

Table 3-1 (continued): Summary of the environmental setting.
Notes: Distance in brackets is the distance from site that features are included. Where no distance given, features relate to on site only.
Data Sources:
1 Envirocheck Report (Appendix A & B)
2 BGS GeoIndex http://mapapps2.bgs.ac.uk/geoindex/home.html
3 The Coal Authority Web Mapping Services (WMS) / Interactive Map Viewer http://coal.decc.gov.uk/en/coal/cms/publications/data/map/map.aspx
4 Zetica UXO Unexploded Bomb Risk Map and Preliminary Desk Study Assessment (Appendix C)

4 Site Reconnaissance

A site reconnaissance was carried out on 20th February 2023. Relevant features identified on site are summarised below:

- The site consists of a 3 storey, grade II listed brick building with basement (including former cells) formerly used as a Police Station.
- There is an area of tarmacadam car parking to the rear.
- Several borehole covers from a previous phase of ground investigation were noted in the rear of the property and these had not been cemented into position.
- The eastern boundary of the site is delineated by a brickwall to the adjacent property and access along the site boundary in this area is limited due to the presence of large external air conditioning units.
- Portions of the building are occupied as artists studios.
- The site is on a sloped topography with a significant drop in elevation to the rear (north) of the property.
- Vehicular access to site via Downshire Hill to the west whilst pedestrian access is via Rosslyn Hill on the southern elevation.
- Evidence of an incoming gas supply and gasmeter were noted at the basement level on the south of the property, beneath the main pedestrian entrance.
- IT and telecommunications equipment and supply were noted in the basement level on the eastern elevation and an incoming electrical supply was noted on the western elevation at basement level.
- No evidence of ground contamination identified; however, there were several areas storing ceiling tiles which appeared to contain fibrous material suspected to potentially contain asbestos.
- Adjacent land uses include residential to the north and east and commercial premises to the south and west.

Relevant photographs are provided in Plate 4-2.

Photograph 1: View of rear of property

Photograph 2: Stored ceiling tiles

	
Photograph 3: eastern site boundary.	**Photograph 4:** Uncemented borehole cover

Plate 4-2: Site photographs.

5 Preliminary Conceptual Model

5.1 Introduction

The aim of the conceptual model is to provide a preliminary assessment of the likelihood of a pollutant linkage for each potential combination of contaminant, pathway and receptor. A conceptual model can be used to make an informed decision on the contamination risks associated with the site and whether further site investigation work is required.

The Sections below are therefore divided into potential contaminant, potential pathway and potential receptor as described in LCRM[6], on the premise that, if there is no pollutant linkage, then there will be no risk to the receptor. The final Section provides an assessment of the potential pollutant linkages that may still be present on the site if redevelopment were to occur.

5.2 Potential Contaminants

Potential viable contamination sources are detailed in Table 5-1. These are split into onsite sources, offsite sources and underlying geology.

Potential Source	Contaminants
On Site	
Deep Made Ground below some or all of the site (e.g. former buildings)	- Demolition rubble, ash and clinker: Asbestos, heavy metals, sulphates, PAHs[7]. - Other fill material sources: Unknown organic / inorganic compounds. - If organic / putrescible material: Hazardous gas (principally carbon dioxide and methane).
Demolished buildings	- Asbestos Containing Material (ACM).
Commercial / public building	- Assuming a boiler house is / has been present: Petroleum hydrocarbons (fuel / oils) and heavy metals, sulphates, PAHs[3] (waste ash and clinker). - Demolished buildings: ACM.
Surrounding Area	
Surrounding land uses (commercial buildings, residential buildings)	- Not expected to be a significant additional source of contaminations given type of commercial use.
Landfills / offsite potentially infilled features within 250m	- Given size, distance and age of features, there is considered to be a source of hazardous gas (principally carbon dioxide and methane).
Underlying Geology	
Underlying London Clay	- Strata identified a sulphide bearing strata jn England and Wales[8]. This is considered further in the geotechnical assessment.

Table 5-1: Potential contamination sources.

[6] Land Contamination Risk Management (LCRM) https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm
[7] Defra (2002). "Potential Contaminants for the Assessment of Land". R&D Publication CLR 8.
[8] BRE (2005). "Concrete in Aggressive Ground". SD1.

5.3 Potential Receptors

Potential receptors are detailed in Table 5-2.

Receptors	
Human Health	- Future site users (including residents, visitors and site workers). - Offsite land users.
Controlled Waters	- Secondary A Aquifer (bedrock). - No surface water receptors within influencing distance.
Buildings.	
Potable water pipes.	

Table 5-2: Potential receptors.

5.4 Potential Pathways

Potential pathways are detailed in Table 5-3.

Pathways		
Soil	Human Health[9] (residential land use: apartments with no soft landscaping)	- Inhalation of vapours outside. - Inhalation of vapours inside. - Omitted as no private gardens or soft landscaping: ingestion of soil, ingestion of soil-derived indoor dust, dermal contact with soil, dermal contact with soil-derived indoor dust, inhalation of soil-derived outdoor dust, inhalation of soil-derived indoor dust, ingestion of contaminated home-grown produce and ingestion of soil attached to home-grown produce.
	- Windblown dust and fibres to adjacent receptors.	
	- Direct contact with receptors (services).	
Water	- Majority of site is covered by hardstanding or buildings, therefore surface run-off over impermeable surface.	
	- Site is predominantly hardstood; therefore, infiltration is likely to be limited.	
Water and Gas	- Migration through potentially permeable strata and preferential pathways. - No superficial deposits recorded. Direct pathway to bedrock. - Bedrock (clay, silt, sand) likely to variably permeable. - Preferential pathways: services.	
Gas	- Migration into buildings (e.g. via services) and accumulation of gases in confined spaces (potentially causing explosion if methane is present).	

Table 5-3: Potential pathways.

[9] EA (2008). "Updated Technical Background to the CLEA Model". Science Report – SC050021/SR3.

5.5 Preliminary Contamination Conceptual Model

The Preliminary Contamination Conceptual Model is illustrated in Table 5-4 and has identified four generic potential pollutant linkages.

Each linkage is described along with an assessment of the risk based upon guidance on probabilities and consequences outlined in CIRIA C552[10].

In order to assess the potential risk for each pollutant linkage, an assessment of the magnitude of the potential consequence (severity) of the risk occurring and the magnitude of the probability (likelihood) of the risk occurring has been considered and classified. This is based on the guidance provided in CIRIA C552 and further details including a risk matrix is provided in Appendix D.

Where LKC identified a low to very low risk, targeted or low density intrusive investigation work, a watching brief (during construction work) or no investigation work will be recommended. This will be dependent on the nature of the site and the proposed development.

Where the risk falls into the moderate/low risk, LKC will undertake an assessment to establish what category the pollutant linkage will fall into (i.e. moderate or low risk will be chosen).

Where LKC identifies a moderate or higher risk, intrusive investigation work or precautionary remedial measures will be recommended.

Due to the minor consequence associated with the phytotoxic effect to flora (i.e. loss of plants in a landscaping scheme), the overall risk for the majority of sites will be very low to low. Where soils contain significant concentrations of heavy metals, in general there will other pollutant linkages (i.e. the risk to human health) that will trigger the requirement for remediation (e.g. a clean environmental cover system). As such the risk to flora associated with phytotoxic contaminants will not be considered further.

The risk to buildings associated with elevated sulphate will be considered as part of the geotechnical assessment and will not be included in the contamination risk assessment.

It should be noted that there may be risk from short term exposure from contaminated soil to site workers. The Preliminary Contamination Conceptual Model deals with long term exposure to key receptors. Acute risks can be easily mitigated by good environmental management of the site during site works. Standard health and safety precautions (as per HSE guidance[11]) should be adopted by all workers involved with site enabling and construction works. Therefore, this receptor is not considered in the contamination conceptual model.

[10] CIRIA (2001). "Contaminated Land Risk Assessment: A Guide to Good Practice". C552.
[11] HSE (1991). "Protection of Workers and the General Public During Development of Contaminated Land". London HMSO.

PL	Pathway	Receptor	Contaminants of Concern (CoC)	Probability	Consequence	Risk	Recommendations
1	- No viable pathways (dermal inhalation, ingestion).	- Future site users. - Offsite receptors.	- ACM - Heavy metals - PAHs - Petroleum hydrocarbons	-	-	-	No viable human health pathways as no soft landscaping. No pollutant linkage therefore no further assessment required.
2	- Inhalation of vapours. - Migration via permeable strata and preferential pathways.	- Future site users.	- Volatile contaminants (TPHCWG, SVOC, VOCs).	Low likelihood (given site history)	Medium	**Moderate** / Low (moderate assumed until ground conditions confirmed)	Intrusive investigation required, to include PID testing. Soil analysis of CoC, subject to ground conditions encountered and PID testing.
3	- Inhalation of gas. - Migration via permeable strata and preferential pathways. - Explosion in confined spaces. - Exposure to radon.	- Future site users. - Buildings. - Offsite land users.	- Ground / hazardous gas (carbon dioxide, methane).	Likely (given sensitive end use, viable source of gas identified with direct pathway given no recorded superficial)	Severe	**High**	Gas monitoring required.
4	- Surface run-off. - Migration via permeable strata and preferential pathways. - Perched waters migration.	- Groundwater (Secondary A Aquifer)	- Mobile contaminants such as metals, PAHs, hydrocarbons, volatile compounds.	Low likelihood (minimal mobile contamination anticipated with direct pathway to bedrock)	Medium	**Moderate** / Low (moderate assumed until ground conditions confirmed)	Intrusive investigation required. Groundwater sampling, subject to ground conditions encountered. Analysis of CoC.
5	- Ingestion of tainted water supply.	- Future site users. - Water pipes.	- Organic contaminants such as petroleum hydrocarbons, naphthalene, volatile compounds.	Low Likelihood (although some contamination may be present, significant contamination not expected at pipeline depth)	Medium	Moderate / **Low** (low risk assumed given minimal contamination anticipated)	No further assessment required. If new pipelines are proposed a water pipeline risk assessment

Table 5-4: Preliminary Contamination Conceptual Model.
Notes: PL = Pollutant Linkage. Contaminant of Concern (CoC) - See Table 5-1 for contamination sources. Site conditions based on observations during site reconnaissance.

6 Preliminary Geotechnical Risk Assessment

Table 6-1 summarises the possible geotechnical constraints of the site, based on the site history, environmental settings and site reconnaissance.

Slope Stability	Site is relatively flat. No significant slope stability risk anticipated. No further assessment required.
Envirocheck Ground Stability Hazards	Moderate Risk identified for Shrinking / Swelling Clay. Further action required.
Made Ground	Unknown depth and constituent of made ground across the site. Initial information indicates relatively shallow made ground below existing building to be refurbished.
Superficial	None recorded.
Bedrock	Unknown depth to bedrock.
Groundwater	Unknown depth and variability of groundwater. Shallow / fluctuating groundwater can affect the strength of the soil, particularly in granular ground. Shallow groundwater can also affect construction works.
Plasticity	Plasticity of clay deposits should be confirmed to identify the shrink / swell risk.
Sulphate	Unknown sulphate content of the made ground and natural strata. London Clay Formation recorded beneath site - sulphate bearing strata.

Table 6-1: Summary of geotechnical constraints.

7 Ground Investigation

7.1 Site Investigation Design and Methodology

In order to assess the ground conditions at the site and to investigate the potential pollutant linkages identified in the preliminary contamination conceptual model an intrusive investigation was undertaken.

The investigation was carried out on 6th March 2023 and comprised the following:

- 1no. window sample boreholes drilled to 6.45 metres below ground level (mbgl) (ref. WS1).
- 1no. cable percussive boreholes drilled to 15.10mbgl (Ref. BH01)
- 7no. trial pits excavated to 0.70-1.20mbgl (ref. TP101 to TP107).

All site investigation locations were determined by the project design team prior to attendance and are shown in Figure 3.

All profile logs are provided in Appendix E and are in line with BS14688-1[12] and BS5930[13].

[12] British Standards (2002) Geotechnical investigation and testing – Identification and Classification of Soil. Part 1: Identification and description. BS EN ISO 14688-1:2002.
[13] British Standard (2015). "Code of Practice for Ground Investigations". BS5930:2015.

7.2 Sampling Protocol

7.2.1 Soil Sampling (Contamination)

Standard sampling protocol and preservation of samples was undertaken as described in the EA guidance on site investigation[14].

Soil samples of approximately 500g were recovered in amber jars, amber vials for volatile analysis and plastic tubs. All the samples were labelled and stored in cool boxes prior to being collected by courier at the end of the day for delivery to the Chemtest laboratory in Newmarket for chemical testing. If collection was not possible the same day then samples were stored in the sample storage fridge at the LK Group offices below 4˚C. Samples were tracked using appropriate Chain of Custody forms provided by Chemtest.

Many of the contamination tests are UKAS or MCERTS accredited and further details are given in the Certificate of Analysis presented in Appendix F. Table 7-1 shows the soil testing undertaken.

Suites and Contaminants	No. Samples	Location & Depth	Justification
Metals / metalloids, pH, water soluble sulphate, speciated PAHs, SOM and asbestos	2	BH1 0.80-1.00 TP6 0.60-0.80	A basic suite with a broad selection of contaminants tested on samples across the site where no significant evidence of contamination was identified (with the exception of occasional ash).
Metals / metalloids, pH, water soluble sulphate, cyanide suite, phenol, TPHCWG, BTEX, MTBE, speciated PAHs, SOM and asbestos screen.	2	WS1 1.00-1.20 TP7 0.45-0.65	Although no visual/olfactory evidence of contamination was identified (with the exception of some ash), due to location of of the site a detailed suite undertaken to confirm the contamination risk.

Table 7-1. Summary of soil sample testing undertaken.

Notes:
If asbestos present during screen identification and quantification will be undertaken.
Metal/metalloids=arsenic, cadmium, chromium, (total and hexavalent), copper, lead, mercury, nickel, selenium, vanadium, zinc and boron; TPHCWG=carbon banded and aromatic/aliphatic split petroleum hydrocarbons; PAH=polycyclic aromatic hydrocarbons, BTEX=benzene, toluene, ethylbenzene and xylenes; MTBE=Methyl tert-butyl ether, SOM=Soil Organic Matter.

7.2.2 Water Sampling / Leaching Testing

To establish the condition of shallow groundwater LKC undertook 2no. groundwater samples.

The groundwater samples were collected a minimum of 1 week after drilling had finished and following well development. Sample collection was undertaken using a low flow sampling pump using thin walled tubing to encourage laminar flow and minimise the potential loss of volatiles during. The borehole was purged of all standing water and the sample collected from the recharged water. The sample was collected in glass and plastic bottles and a glass vial. A water meter was used to test the pH, temperature and conductivity before sampling until equilibrium conditions were met, as per BS10175[15] guidelines.

[14] EA (2000). "Technical Aspects of Site Investigation. Volumes 1 & 2 Text Supplements Research and Development Technical Report." P5-065/Tr.
[15] British Standard (2017). "Investigation of Potentially Contaminated Sites – Code of Practice." BS10175:2017.

WS101 had limited groundwater present at the time of sampling. Therefore, only limited purging was possible and only one vial and a partially filled glass bottle of groundwater was collected.

All water samples were placed in glass bottles, plastic bottles and septum topped vials and stored in ice packed cool boxes. The samples were sent to Chemtest on the same day for analysis. The sampling suite is presented in Table 7-2.

Sampling was carried out in accordance with BS5930[16] and BS5667-11[17].

Many of the tests are UKAS or MCERTS accredited and further details are given in the Certificate of Analysis presented in Appendix F. Table 7-2 shows the groundwater / leachate testing undertaken.

Suites and Contaminants	No. Samples	Location	Justification
Metals / metalloids, pH, sulphate, cyanide suite, TPHCWG, BTEX, MTBE, speciated PAHs, phenol and hardness.	2	BH01 (G) WS1 (G)	Detailed suite undertaken across the site to confirm the absence of contamination, due to the direct pathway to bedrock.

Table 7-2. Summary of groundwater sampling tests undertaken.
Notes:
G=Groundwater Sample
Metal/metalloids=arsenic, cadmium, chromium, (total and hexavalent), copper, lead, mercury, nickel, selenium, vanadium, zinc and boron; TPHCWG=carbon banded and aromatic/aliphatic split petroleum hydrocarbons; PAH=polycyclic aromatic hydrocarbons, BTEX=benzene, toluene, ethylbenzene and xylenes; MTBE=Methyl tert-butyl ether, VOC=Volatile organic Compounds, SVOC= Semi Volatile Organic Compounds, PCB=polychlorinated biphenyls.

7.3 Gas Monitoring

All the installed boreholes have been monitored for gas. To date, four gas monitoring visits have been undertaken and no further visits are proposed.

Monitoring is being undertaken using an Infra Red Gas Analyser GFM430 in accordance with the monitoring protocol outlined in CIRIA C665[18] (flow rate measured first). The monitoring will aim to be undertaken over a range of weather conditions (including low and falling barometric pressure and heavy rain) to demonstrate worst-case conditions.

Six visits over a 3 months period is the typical / idealised monitoring period and frequency is in line with C665[19] for a very low gassing potential of a source and high sensitivity of development (residential with gardens).

Given the above, further monitoring visits are required for a complete risk assessment to be carried out.

The gas monitoring results to date, are reproduced in full in Appendix H.

[16] British Standard (2015). "Code of Practice for Ground Investigations". BS5930:2015.
[17] British Standard (2009). "Water Quality – Sampling. Part 11: Guidance on Sampling of Groundwaters". BS ISO 5667-11:2009.
[18] CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665.
[19] CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665.

7.4 Geotechnical Testing

7.4.1 In-situ Onsite Geotechnical Testing

In-situ geotechnical tests were performed in the boreholes to further characterise the sub-soil conditions. The following tests were undertaken:

- Standard Penetration Tests (SPTs) were performed in the window sample borehole at approximately 1m intervals, and in the cable percussive boreholes, generally within the natural strata.

The SPT readings are provided within the profile logs (Appendix E).

7.4.2 Laboratory Geotechnical Testing

Soil samples taken during the investigation were collected in tubs and bulk bags and sent to Murray Rix Laboratories and Dets for geotechnical testing.

Many of the tests are UKAS accredited and further details are given in the laboratory report presented in Appendix G. Table 7-2 shows the geotechnical testing undertaken.

Suites and Contaminants	No. Samples	Location	Justification
BRE Short Suite	6	WS01 1.90-2.00m WS01 3.90-4.00m WS01 5.90-6.00m BH01 4.95m BH01 8.70m BH01 14.60m	Additional samples of made ground were analysed to determine concrete classification. pH and water-soluble sulphate are also included in the test suires detailed in Section 7.2.1 above.
Atterberg Limits (plasticity testing)	4	BH01 1.00m BH01 1.20m BH01 3.00m BH01 11.00m	A selection of clay samples were tested for Atterberg Limits to assess their shrinkability.
Single Stage Triaxial	3	BH01 4.50m BH01 10.50m BH01 14.60m	Undertaken to assess the in-situ undrained strength of the clay strata.

Table 7-2. Summary of geotechnical testing undertaken.

8 Ground Conditions

8.1 Geology – Generalised Sequence

The ground conditions beneath the site comprised made ground underlain by gravelly sandy silty clay, gravelly sandy silt and gravelly silty sand. A summary section of the logs is provided in Plate 8-1, with additional comments below.

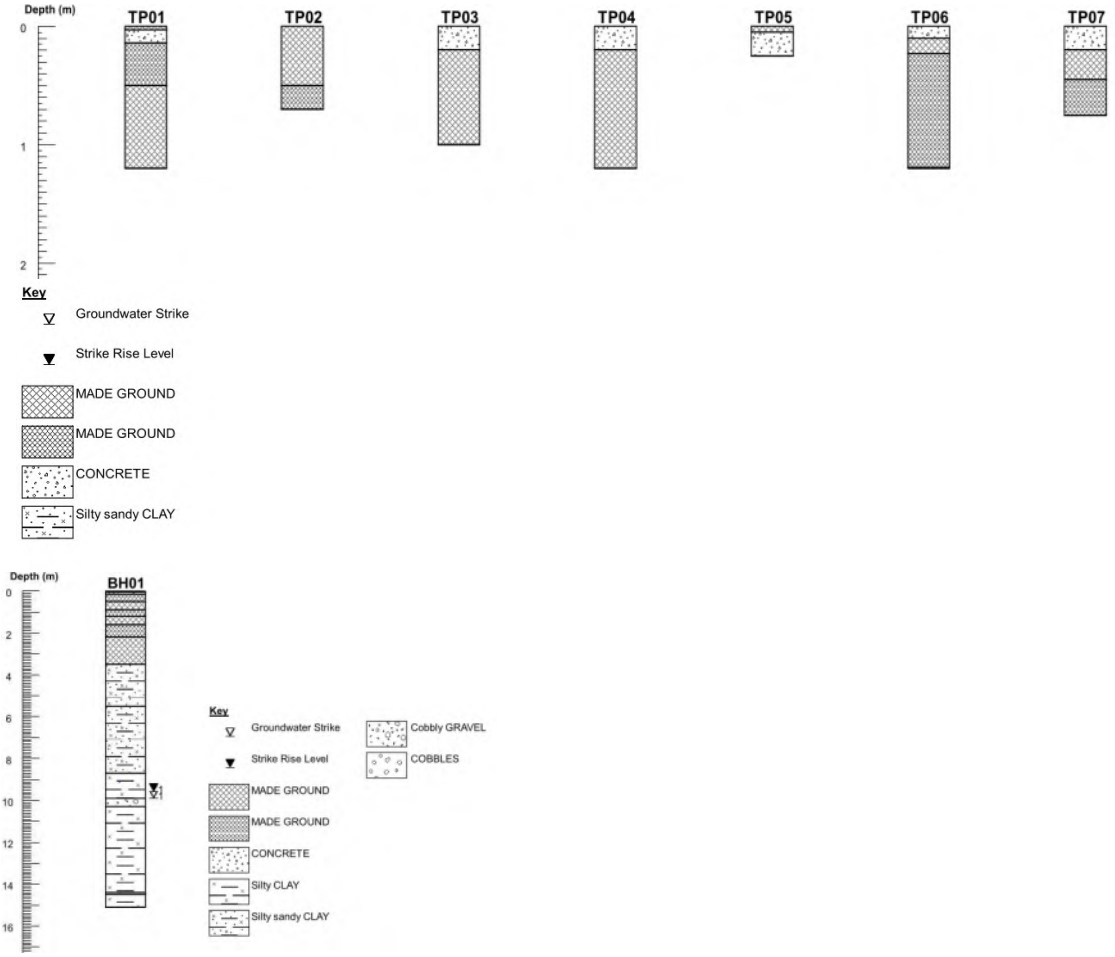


Plate 8-1: Summary of ground conditions.

Additional information on ground conditions:

Made Ground

Based on WS1, BH01 and TP01-TP07 the ground conditions are as follows:

Tarmacadam recorded from ground level to 0.03-0.05mbgl (WS1, BH01, TP01, TP05). Concrete recorded to 0.07-0.15mbgl, also encountered at base of TP06 (1.19-1.20mbgl).

Reinforced concrete recorded at 0.20mbgl and 0.75mbgl in TP07; and 1.00mbgl in TP03.

Lino flooring, fibrous membrane over concrete recorded to 0.20mbgl (TP03, TP04). Made ground recorded to 1.85-3.50mbgl, comprising flint, brick, clinker, ash, rootlets and cobbles.

There was no visual / olfactory evidence of hydrocarbons or volatile contaminants in any locations.

Natural

BH01: Natural firm sandy silty CLAY to 5.50mbgl, firm to stiff sandy silty CLAY with fine grained selenite crystals to 8.70mbg, stiff grey silt CLAY to 9.90mbgl, medium to coarse GRAVEL and COBBLES to 10.30mbgl, very stiff silty CLAY to 14.40mbgl, and very stiff silty CLAY to >15.10mbgl.

WS1: Natural soft to firm slightly sandy silty CLAY to 2.00mbgl, Firm slightly sandy silty CLAY to 5.00mbgl, Firm sandy silty CLAY with gypsum crystals to > 6.45mbgl.

In ground structures

Brick footing encountered at 0.70mbgl in TP02.

8.2 Groundwater

8.2.1 Groundwater Levels

Groundwater strikes were recorded during the investigation in trial pits and boreholes. In addition, groundwater monitoring within the borehole wells has been undertaken on four occasions.

.

Results are summarised in Table 8-1.

BH/TP	Water Strike Depths (mbgl)	No. of Monitoring Visits	Monitoring Depths (mbgl)			Sample Taken?	Evidence of Contam?
			Min	Max	Base		
WS101	4.50	4	1.60	1.72	5.42-5.43	Y (G)	N
BH1	9.90	4	2.73	2.77	9.77-9.79	Y (G)	N
TP01	N/A	-	-	-	-	N	N
TP02	N/A	-	-	-	-	N	N
TP03	N/A	-	-	-	-	N	N
TP04	N/A	-	-	-	-	N	N
TP05	N/A	-	-	-	-	N	N
TP06	N/A	-	-	-	-	N	N
TP07	N/A	-	-	-	-	N	N

Table 8-1: Summary of water strike depths within boreholes and trial pits.

Notes:

G=Groundwater Sample

8.3 In-Situ Geotechnical Testing

8.3.1 Standard Penetration Tests

In-situ standard penetration tests (SPTs) were undertaken, predominantly in the natural ground. The results are summarised in Table 8-1 and provided within the profile logs in Appendix E.

Approximate Depth (mbgl)	SPT 'N' Values	
	WS01	BH01
1-2	5 (MG)	9 (MG)
2-3	9 (C)	8 (MG)
3-4	12 (C)	19 (C)
4-5	11 (C)	-
5-6	11 (C)	-
6-7	11 (C)	18 (C)
7-8	-	22 (C)
9-10	-	20 (C)
12-11	-	48 (C)
13-14	-	55 (C)
GW Level	1.60-4.50	2.73-9.90

Table 8-1: Summary of SPT (N) values.
Notes:
MG=Made Ground C=Clay
Groundwater level based on strikes during investigation and monitoring data.

8.4 Geotechnical Laboratory Testing

8.4.1 Single Stage Triaxial Test

Single stage triaxial testing has been undertaken on four samples of the natural clay strata. The results are presented in Appendix G and summarised in Table 8-2.

Location	Depth (mbgl)	Lab Material Description	Undrained Shear strength (kPa)
BH01	4.50	Stiff grey brown mottled silty slightly sandy CLAY	81
BH01	10.50	Stiff dark brown grey clayey slightly sandy SILT	98
BH01	14.60	Stiff dark brown grey clayey slightly sandy SILT	132

Table 8-2: Summary of single stage triaxial results.

8.4.2 Atterberg Limits

Representative samples of natural clay were subjected to Atterberg Limits (plasticity) and Moisture Content testing. Results are presented in Appendix G and summarised in Table 8-3.

Table 8-3 also includes the modified plasticity index as detailed in Chapter 4.2-D5 of the NHBC standards (modified plasticity index = plasticity index x % less than 425µm sieve / 100%).

Location	Depth (mbgl)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Class	Passing 425 micron (%)	Modified Plasticity Index (%)
BH1	1.0	22.1	33.0	18	15	CIL	77	11.5
BH1	1.2	19.6	36	17	19	CIM	67	12.7
BH1	3.0	24.4	49	21	28	CIM	100	28.0

BH1	11.0	28.6	63	24	39	CIH	100	39.0

Table 8-3: Summary of plasticity index testing.

The modified plasticity index is between 11.5% and 12.7% within the cohesive soils of the Made Ground and between 28% and 39% for the natural strata. This characterises the clay as having a low and high volume change potential for the Made Ground and the natural strata, respectively.

8.4.3 Sulphate and pH

Water soluble sulphate and pH tests were carried out on soil samples. Full results are presented in Appendix G and summarised in Table 8-4.

Strata	pH	Sulphate (g/l)
Made Ground	6.5-8.9	0.03-0.18
Natural Strata	7.6-8.3	0.20-2.40

Table 8-4: Summary of pH and sulphate results.

9 Generic Risk Assessment

9.1 Introduction

Current good practice requires that the findings from a site investigation should be evaluated on a site-specific basis, using a risk-based approach. Risk assessment involves identification and evaluation of the hazards presented by the concentrations of contaminants measured followed by an evaluation of the risks which are associated with these hazards (LCRM[20]). Information gathered from the risk assessment has been collated in the revised contamination conceptual model in Section 9.1.

9.2 Soil Risk Assessment

9.2.1 Methodology

With regards to the soil risk assessment LKC will use the following hierarchy:

- Category 4 Screening Levels (C4SLs).
- LQM Suitable 4 Use Levels (S4ULs).
- ATRISK Soil Screening Values (SSVs) and CL:AIRE Generic Assessment Criteria (GACs).

C4SLs were published in 2013[21,22]. The recent change to the contaminated land guidance has changed the evaluation of risk from 'minimal' (referred to as Health Criteria values (HCVs))[23] used to generate Soil Guideline Values (SGVs) to 'low' (referred to as Lowest Level of Toxicological Concern (LLTCs)). The policy companion document and supporting letter by Defra, dated 3rd September 2014, states that C4SLs *'could be used under the planning regime, as well as within Part 2A'.* Based on these comments LKC considers the justifications and assumptions used to generate 'low' risk are suitable for the planning regime.

Where no C4SLs have been generated LKC will use the LQM S4ULs[24]. Similar assumptions and land uses to C4SLs have been used. However, toxicological information has been based on 'minimal risk' as per previous guidelines and assumptions[25,26,27,28].

If contaminants are not present as C4SLs and S4ULs then LKC will use ATRISK SSVs or CL:AIRE GACs[29]. These follow the 'minimal' risk principle and more stringent exposure parameters and will be conservative.

LKC consider the main risk drivers for PAHs are benzo(a)pyrene (B(a)P) and naphthalene. This is due to B(a)P possibly being a carcinogen and most toxic of the

[20] Land Contamination Risk Management (LCRM) https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm
[21] Defra (2014). "SP1010: Development of Category 4 Screening Levels and Assessment of Land Affected by Contamination – Policy Companion Document."
[22] CL:AIRE (2013). "SP1010: Development of Category 4 Screening Levels and Assessment of Land Affected by Contamination – Final project Report."
[23] EA (2008). "Human Health Toxicological Assessment of Contaminants in Soils." Science Report – SC050021/SR2.
[24] LQM (2014). "The LQM/CIEH S4ULs for Human Health Risk Assessment."
[25] EA (2008). "Updated Technical Background to the CLEA Model." Science Report – SC050021/SR3.
[26] EA (2008). "Human Health Toxicological Assessment of Contaminants in Soils." Science Report – SC050021/SR2.
[27] EA (2008). "A Review of Body Weight and Height Data used within the Contaminated Land Exposure Assessment Model (CLEA)." Project SC050021/Technical Review 1.
[28] EA (2009). "Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values." Science report SC050021/SR7.
[29] CL:AIRE (2009). "The Soil Generic Assessment Criteria for Human Health Risk Assessment."

PAHs[30,31] and naphthalene the most volatile and soluble[32]. The new C4SLs indicate B(a)P as a surrogate marker for carcinogenic PAHs, if it falls within appropriate limits, since the risk from other non-carcinogenic PAHs are considered negligible[33]. For B(a)P to be used as a surrogate marker it should follow the profile described by the HPA (2008)[34] and CL:AIRE (2013). Naphthalene will be treated separately using the LQM S4ULs.

The proposed refurbishment is for a mix of commercial and residential use without gardens, therefore the more sensitive assessment criteria for residential without plant uptake has been used.

All criteria have been generated using the CLEA V1.06 model[35] based either on 1%, 2.5% and 6% Soil Organic matter (SOM). Results will be compared to the nearest appropriate SOM.

A summary of the generic assessment criteria is provided in Appendix I. ATRISK SSVs and CL:AIRE GACs were not required for this dataset and have not been included.

B(a)P as Surrogate Marker

An assessment of the data should be undertaken to confirm B(a)P is a suitable surrogate marker by assessing the ratios of carcinogenic PAHs to B(a)P. However, as the majority of the PAHs were recorded as less than detection limits, the assessment could not be undertaken.

9.2.2 Soil Results Comparison against Assessment Criteria

All analysis sheets are presented in Appendix F.

Results have been compared to the relevant assessment criteria and no elevated contaminants were identified.

No asbestos was identified in any soil samples analysed, including those taken from the stored ceiling tiles.

9.2.3 Direct Contact Risk – Pollutant Linkage 1

No elevated contaminants identified within the soil samples analysed.

The existing site plan does not comprise any soft landscaping, therefore no viable human health pathway exists. No pollutant linkage therefore no further assessment required.

9.2.4 *Risk from Inhalation of Vapours – Pollutant Linkage 2*

No visual / olfactory evidence of volatile contaminants was identified during the investigation. No significant source of volatile contaminants identified during PRA, therefore no detailed testing undertaken.

[30] EA (2002). "Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans. Benzo[a]pyrene." R&D Publication TOX2.
[31] USEPA (1984). "Health Effects Assessment of Polycyclic Aromatic Hydrocarbons (PAHs). EPA 540/1-86-013."
[32] EA (2003). "Review of the Fate and Transport of Selected Contaminants in the Soil Environment." Draft technical report P5- 079/TR1.
[33] CL:AIRE (2013). "SP1010: Development of Category 4 Screening Levels and Assessment of Land Affected by Contamination – Final project Report."
[34] HPA (2010). "HPA Contaminated Land Information Sheet: Risk Assessment Approaches for Polycyclic Aromatic Hydrocarbons (PAHs)." Version 3.
[35] EA (2008). "CLEA Software (Version 1.05) Handbook." Science Report – SC050021/SR4.

LKC therefore consider the probability of volatile contaminants affecting site users as unlikely. The consequence is expected to be medium, giving a low risk and no remediation is required with respect to pollutant linkage 2.

9.3 Gas Risk Assessment

4no. gas monitoring visits have been undertaken on the study site. Gas monitoring results in full are presented in Appendix H. Following guidance set out in CIRIA C665[36] and BS8485[37] peak methane and carbon dioxide concentrations have been used in the gas risk assessment. In addition, and as per guidance, flow rates were measured first.

All gas concentrations, flow, pressure and groundwater levels are shown on Table 9-1.

Boreholes	Visit	CH_4 (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	H_2S (ppm)	CO (ppm)	Flow (l/h)	Groundwater (mbgl)	Pressure (mb)
WS1	1	<0.1	0.2 (0.1)	20.3	<10	<10	<1.0	2.75	1002
	2	<0.1	0.4 (0.1)	20.2	<10	<10	<1.0	2.73	1007
	3	<0.1	0.8 (0.1)	20.4 (19.7)	<10	<10	<1.0	2.77	1018
	4	<0.1	<0.1	20.5	<10	<10	<1.0	2.76	1010
BH01	1	<0.1	1.9 (1.2)	19.4 (19.0)	<10	<10	<1.0	1.60	1002
	2	<0.1	2.3 (1.9)	19.2 (18.9)	<10	<10	<1.0	1.66	1007
	3	<0.1	2.1 (1.9)	19.5 (19.2)	<10	<10	<1.0	1.72	1018
	4	<0.1	3.1 (2.5)	19.0 (18.8)	<10	<10	<1.0	1.65	1011

Table 9-1: Summary of gas monitoring.

Notes:
If concentrations / flow is zero, then equipment detection limits are assumed.
Table shows peak concentrations of CH_4, CO_2, O_2, H_2S and CO.
Where peak CO_2 differs significantly to the steady, steady is shown in brackets.
Bold where CO_2 exceeds 5%v/v and CH_4 exceeds 1%v/v.
Atmospheric pressure (over past 24hrs): r=rising, f=falling, s=steady

No elevations of carbon dioxide or methane were recorded, with maximum flow of <1.0l/hr.

Groundwater was noted between 2.73-2.77mbgl in WS1 and 1.60-1.72mbgl in BH01, with very minimal fluctuation.

Gas Screening Value

In accordance with CIRIA C665[38], a Gas Screening Value (GSV) may be calculated. Assuming worst-case scenario maximum gas concentrations and flow for each

[36] CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665.
[37] BSI (2015). "Code of Practice for the Characterisation and Remediation from Ground Gas in Affected Developments." BS8485:2015.
[38] CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665.

borehole have been used to calculate the GSV. The GSV can be used to determine the characteristic situation (CS).

Table 9-2 shows the maximum GSV for each borehole and the appropriate characteristic situation (based on GSV only). An overall site assessment (WS1 and BH01) has also been included (worst case values across the site).

Boreholes	Max GSV (l/hr)	CS / TL
WS1	0.008	CS1 / Green
BH01	0.031	CS1 / Green

Table 9-2: Summary of worst-case Gas Screening Values (GSV).
Notes:
CS – Characteristic Situation; TL= Traffic Light.

In addition, in accordance with CIRIA C665[39], if carbon dioxide and methane are recorded above 5%v/v and 1%v/v respectively, you should consider upgrading the characteristic situation from CS1 to CS2.

Given the minimal gas concentrations recorded with low flow (max <1.0l/hr), the site is currently CS1 classification. Additional monitoring visits will be required in order to complete a full assessment.

9.4 Controlled Water Assessment

LKC considers the Secondary A Aquifer as the primary receptor.

LKC have compared results above Limits of Detection (LOD). Where relevant the review of priority substances takes precedence considering threshold values for groundwater cannot be used '*as part of site-specific investigations*'. The hierarchy is as follows:

- River Basin District Standards[40] and updated Water Framework Directive[41] for Annual Average / Maximum Allowable Concentration Environmental Quality Standards (AA-MAC-EQS) for priority substances (surface water risk).
- 2016 private water supply standards (UKDWS potable)[42].
- 2001 Environment Agency Values for Environmental Quality Standards (EQS) and UK Drinking Water Standard (UKDWS)[43].
- Resource Protection Values (RPVs)[44].
- Minimal Reporting Values (MRVs).

No elevated contaminants above detection limits were identified in any water sample.

Based on the above, LKC considers the probability of contaminants on site affecting the Secondary A Aquifer as unlikely. Given the medium consequence, a low risk is anticipated (Pollutant Linkage 4) and no remediation is required.

[39] CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665.
[40] Defra (2010). "The River Basin Districts Typology, Standards and Groundwater Threshold Values". Water Framework Directive (England and Wales) Directions 2010.
[41] Defra (2015). " Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015".
[42] Statutory Instruments (2016). "The Private Water Supplies Regulation 2016." No. 614
[43] EA (2002). "Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part IIA of the Environment Protection Act 1990."
[44] SEPA (2010). "Assigning Groundwater Assessment Criteria for Pollutant Inputs." WAT-PS-10-01.

9.5 Additional Risk Assessments

9.5.1 Potable Water Supply (Pollutant Linkage 5)

Severn Trent Water (STW) guidelines for new connections[45], make reference to the past history of the site and proximity of past pollution incidents and fuel filling stations.

No significantly elevated concentrations of organic contaminants have been identified on the site and the PRA report has not identified any pollution incidents within 250m of the site. The closest fuel filling station was identified as 441m southeast of the site, therefore not within influencing distance.

On the basis of a qualitative review of STW guidance LKC consider the risk to potable water supplies as low. A potable water risk assessment form will be required if new pipelines are proposed, referring to the UKWIR[46] guidance document. However, this should be confirmed, as appropriate, with STW.

9.6 Revised Contamination Conceptual Model

The preliminary contamination conceptual model (Table 9-1) has been revised following the risk assessments undertaken in Sections 9.1-9.5. The revised contamination conceptual model follows the same methodology and guidance used in the preliminary contamination conceptual model. The risk matrix is provided in Appendix D.

The revised contamination conceptual model is presented in Table 9-1.

Where a very low risk is identified, no specific remediation is required.

Where a low risk is identified, some form of remediation may be required depending on the pollutant linkage, the type and concentration of contaminants present and the proposed development.

Where a moderate/low risk is identified, an assessment will be undertaken to establish what category the pollutant linkage will fall into.

Where a moderate or higher risk is identified, remediation or further investigation work is recommended.

Further details of the remedial proposals and a remedial option appraisal are given in Section 12.

[45] http://www.stwater.co.uk/content/ConMediaFile/2625
[46] UKWIR (2010). Guidance for the Selection of Water Supply Pipes to be used in Brownfield Suites." Report ref: 10/WM/03/21.

PL	Pathway	Receptor	Contaminant	Probability	Consequence	Risk	Assessment
1	– No viable pathways (dermal inhalation, ingestion).	- Future site users. – Offsite receptors.	- ACM - Heavy metals - PAHs - Petroleum hydrocarbons	-	-	-	– No elevated contaminants identified within soils analysed. – No viable human health pathways as no soft landscaping. – No pollutant linkage therefore no further assessment required.
2	– Inhalation of vapours. – Migration through permeable strata and preferential pathways.	– Future site users.	Volatile Contaminants: - None identified.	Unlikely	Medium	**Low**	– No elevated naphthalene in any soil samples analysed. – No significant source of volatiles identified during SI, therefore no detailed testing undertaken. – **Recommendation:** No remediation required.
3	– Inhalation of gas. – Migration through permeable strata and preferential pathways. – Explosion in confined spaces (methane only).	– Future site users. – Buildings. – Offsite land users.	- Carbon dioxide - Methane	Unlikely (minimal gas concentrations recorded on site, max CH4 <0.1%v/v, max CO2 2.3%v/v)	Severe	Moderate / **Low** (low risk given minimal gas concentrations and low flow of <0.1l/hr)	– GSV values classified site as CS1, given data so far. – **Recommendation:** Further monitoring required.

Table 9-1: Revised Contamination Conceptual Model.

Notes

*[1] Although no ACM identified, contractors should be vigilant during earthworks of any potential ACM. This is discussed further in Section 12.2.

*[2] The conceptual model only takes into consideration the future use of the site and long-term exposure. Consideration should also be given to the short-term exposure of construction workers and nearby land users to ACM containing soils during groundworks. This is discussed further in Section 12.2

*[3] Although no phytotoxic contaminants identified in soils, the characteristics of the made ground should also be taken into account if it is to be used as a topsoil / growing medium for flora. The material should be assessed against the parameters outlined in Table 1 of BS3882 (not included within this assessment)

PL	Pathway	Receptor	Contaminant	Probability	Consequence	Risk	Assessment
4	– Surface Run-off. – Migration through permeable strata and preferential pathways – Perched waters migration.	– Groundwater (Secondary A Aquifer).	Mobile contaminants: - None identified.	Unlikely	Medium	**Low**	– No elevated concentrations recorded in soils analysed and no visual / olfactory evidence of mobile contaminants identified during the site investigation. – No elevated concentrations recorded in confirmatory groundwater samples analysed. – **Recommendation**: No remediation required.
5	– Ingestion of tainted water supply.	- Future site users. - Water pipes.	Organic Contaminants	Unlikely	Medium	**Low**	– No proposed pipelines as works include change of use and refurbishment of existing building. – **Recommendation:** No further assessment required. However if new pipeline is proposed, a water pipeline risk assessment for Severn Trent Water is likely to be required.

Table 9-1 (continued): Revised Contamination Conceptual Model.

Notes

*1 Although no ACM identified, contractors should be vigilant during earthworks of any potential ACM. This is discussed further in Section 12.2.

*2 The conceptual model only takes into consideration the future use of the site and long-term exposure. Consideration should also be given to the short-term exposure of construction workers and nearby land users to ACM containing soils during groundworks. This is discussed further in Section 12.2

*3 Although no phytotoxic contaminants identified in soils, the characteristics of the made ground should also be taken into account if it is to be used as a topsoil / growing medium for flora. The material should be assessed against the parameters outlined in Table 1 of BS3882 (not included within this assessment)

10 Geotechnical Assessment

10.1 Proposed Development

It is understood that the proposed development will comprise a change of use and possible extension to a mixed commercial and residential development with associated landscaping and infrastructure. Details of the proposed loadings are not known at this stage and therefore the preliminary geotechnical assessment will be undertaken in terms of undrained shear strength for the cohesive soils.

The finished ground levels have not been provided and it is therefore anticipated that they will not vary significantly from current levels. However, should the development proposals or finished levels be altered then the comments/recommendations in this section may require revising.

The depths of any underground engineering works (sewers etc.) are unknown and therefore have not been taken into account in the following assessment. It is considered that any such works will be designed so as not to have an effect on, or compromise, proposed or existing foundations or ground stability.

Given the nature of the proposed development it is considered that the structure meets the criteria of Geotechnical Category 1 of Euro Code 7[47].

Given the nature of the development it is considered that acceptable risk from settlement is a total settlement value of 25mm for a masonry structure.

10.2 Summary of Ground Conditions

Ground conditions identified at the site are detailed in Section 8.1 and typically comprises Made Ground to depths of between 1.85m and 3.50mbgl in WS01 and BH01 respectively. The extent of the Made Ground was not proven in any of the trial pit locations.

Natural strata was encountered beneath Made Ground in WS01 and BH01 to the maximum depth investigated and typically comprised firm to stiff becoming very stiff with depth, CLAY (London Clay).

Groundwater was encountered during the site investigation at depth of 9.90mbgl and 4.50mbgl in BH01 and WS01 respectively. During the subsequent monitoring, the water levels were recorded at 2.73m to 2.77mbgl (BH01) and between 1.60m and 1.72mbgl (WS01).

10.3 Site Preparation

An areas of the site proposed for an extension or new build structure should be cleared and any vegetation below areas of proposed development stripped in accordance with Series 200 of the Specification for Highway Works[48]. This should include:

[47] British Standard. Eurocode 7: Geotechnical design – Part 1: Generals rules. BS EN 1997-1:2004+A1:2013
[48] Specification for Highway Works, Volume 1. Series 200 – Site clearance. February 2016.

- Roots present below the footprint of proposed structures and infrastructure should be grubbed out and the resulting void infilled with suitable compacted engineered fill;
- Redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill; and,
- Buried structures and old foundations are expected to be present on site. These should be excavated from below the proposed development foot print with the resulting void backfilled.

The near surface soils may potentially be disturbed by weathering and site traffic. Precautions should be taken to avoid this, as excessive disturbance may result in more onerous floor slab design, road cap thickness and increased amount of site disposal etc. Based on site observations it is not anticipated that the near surface soils require any treatment or reinforcing to allow safe movement of construction plant and labour.

10.4 Foundation Conditions and Bearing Capacity

10.4.1 General

It is considered that the Made Ground is not suitable for a founding material due to the inherent variability of the material. The load of the proposed building should be transferred to the natural strata of the firm to very stiff high strength CLAY.

Foundation options are therefore:

- Piled foundations.

An assessment of the undrained shear strength (s_u) has been undertaken using the data obtained from in-situ geotechnical testing. This data is shown in Graph 10-1 below.

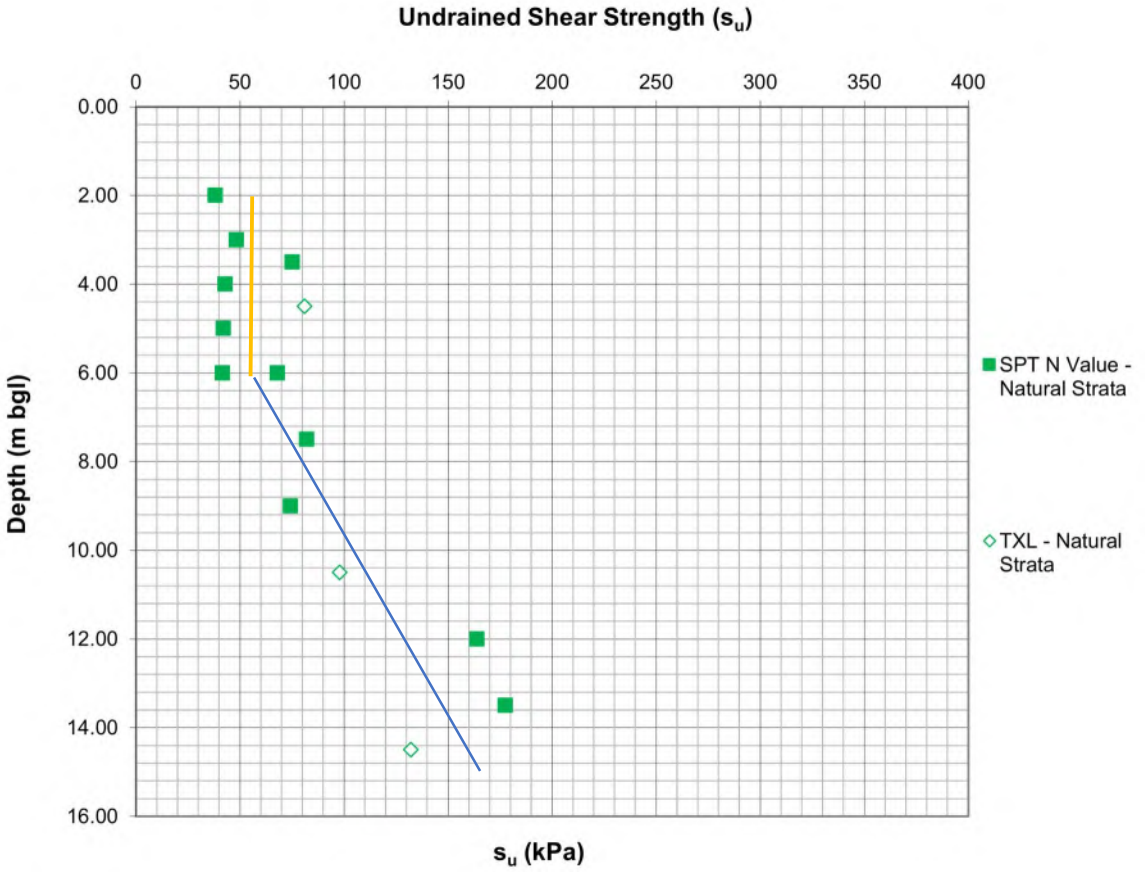
From Graph 10-1 it can be seen that the strength of the cohesive deposits typically is constant to a depth of 6.00mbl and increases with depth. The triaxial test results of the CLAY are in agreement with the SPT-derived s_u values.

The SPT N values for the cohesive soils are N9 to N19 within the firm to stiff CLAY to a depth of 6.00mbgl, returning a s_u of 38kPa to 75kPa. Below the depth of 6.00mbgl, SPT N values ranged between N20 and N55, returning a s_u of 74kPa to 178kPa.

The triaxial testing results of su ranged between 81kPa and 132kPa, at the cable percussive location.

A conservative s_u of 55kPa is assigned to the cohesive soils from a depth of approximately 2.00mbgl (at WS101 borehole location) to 6.00mbgl (design line in yellow in Graph 5-1) increasing to 80kPa at depth of 8.00mbgl and 130kPa at 12.00mbgl (design line in blue in Graph 5-1).

These options are discussed in the following Sections.



Graph 10-1: Summary of s_u vs depth from in-situ geotechnical testing.
Note:
Design line in yellow and blue. See text for explanation.

10.4.2 Ground Improvement

The use of ground improvement techniques, such as vibro stone columns or controlled modulus columns, will allow shallow foundations to be utilised within the Made Ground and natural strata and will depend on the proposed loads. The ground improvement techniques should provide a bearing capacity of around 150kN/m² but will also remove variability within the ground. Specialist advice should be sought from a suitably experienced contractor with regard to allowable bearing capacity and settlements and advising on the suitability of the technique.

As a general rule the NHBC[49] recommend that these columns should not be used in cohesive soils with plasticity index above 40%, or undrained shear strength lower than 30kPa. It is recommended that this is discussed with a specialist contractor should this option be considered.

10.4.3 Piled Foundations

Pile foundations are considered a suitable solution due to the presence of thick Made Ground.

For preliminary purposes the following initial pile capacities have been calculated.

For this analysis, the Made Ground was considered up to 2.00m thick. It has been assumed that the pile is driven within the firm to stiff high strength CLAY to a depth of 6.00mbgl and very stiff high strength to 15.10mbgl.

[49] National Housing Board Council (2022). Foundations. Part 4.

When undertaking these preliminary calculations the following parameters have been used:

- Unit weight value of 21kN/m^3 for the CLAY, assumed from Table 1 of BS8004[50];
- Undrained shear strength of 55kPa to a depth of 6.00mbgl for the firm to stiff high strength CLAY, increasing to 80kPa at 8.00mbgl and 130kPa at 12.00mbgl for the very stiff high strength;
- Groundwater table at 5.00mbgl;
- Factors of safety of 1.5 on side resistance and 3 on base resistance; and,
- Global Factor of safety of 2.5.

Depth (mbgl)	Pile Carrying Capacity (kN)	
	300mm dia	600mm dia
3.0	20	67
5.0	33	93
7.0	53	140
9.0	94	234
11.0	146	351
13.0	210	491

Table 5-2: Preliminary Pile Capacity.

The preliminary pile capacity assessment, undertaken to the depth of the investigated ground at approximately 13.00mbgl, shows that a load of 140kN can supported on a pile of 0.60m diameter driven to 7.00mbgl, increasing to a load of 351kN at 11.00mbgl.

At BH01 borehole location, the Made Ground was recorded to 3.50mbgl and to 1.85mbgl at WS01. Consideration must be given to the potential for negative skin friction to have an adverse effect upon the piles.

Pile design should be undertaken by a specialist contractor to allow them to reduce the factor of safety based on their extensive pile testing data.

10.5 Ground Floor Slabs

The Made Ground has a thickness up to 3.50m across the site.

A piled structure will generally have a suspended or piled floor due to potential differential settlement between the floor and the shell. Suspended floor slab could be a viable solution also if ground improvement techniques are used for the foundations.

Where suspended floor slabs are employed ventilation of the under-floor void will be required to address condensation issues.

10.6 Drainage

The presence of Made Ground of a thickness to 3.50m across the site may result in settlement. It is therefore recommended that drain runs are designed using steeper gradients and flexible joints to allow for some differential settlement.

10.7 Concrete Durability

Based upon the results of the chemical analyses summarised in Table 8-4 it is considered that concrete can be designed in accordance with Design Sulphate Class

[50] British Standard (2015). Code of practice for foundations. BS8004:2015.

DS-2, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-2z in accordance with the recommendations provided in BRE Special Digest 1 (2005) within the soils of the Made Ground.

The cohesive soils of the natural strata are part of the London Clay Formation, which is well-known as naturally rich in sulphate. From the laboratory testing up to a depth of 5.90mbgl, the CLAY was found to have low content in sulphate, retuning a concrete class of DS-1 and AC-1. Below this depth, the sulphate content within the CLAY was higher and the CLAY was described as containing visible crystals of selenite. From depth of 5.90mbgl it is recommended to use as minimum DS-3 and AC-3 for the concrete design.

10.8 Excavations

Site observations indicated that excavations should be feasible in the near surface with normal plant; however, obstructions may be present in the near surface including former foundations and former floor slabs. It is anticipated that any obstructions will be grubbed out during the reduced level dig for the sub structure works.

10.9 Construction Activity and Inspection

The following activities and inspections should be incorporated into the site works:

- Due to the variability of the soils at the site it is recommended that sufficient allowance is made for the inspection of formation and sub formations to foundations and pavement construction;
- Excavations where access is required should be subject to a risk assessment from a competent person and where appropriate mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA R97[51] utilised;
- Where access to confined spaces is required appropriate mitigation measures should be addressed within the Construction Stage Health and Safety Plan. Particular account should be taken of the gas results;
- The presence of potential contamination and mitigation measures should be addressed as part of the Construction Stage Health and Safety Plan and should include measures to design out the risks, reduce their impact and finally the use of Personnel Protective Equipment (PPE).

[51] CIRIA Report 97 – Trenching Practice – Second Edition (2001 revision)

11 Waste Disposal Assessment

The soil contamination results as presented in Appendix F have been used to help determine the waste classification of material for off-site disposal.

As an initial screen the soil results were inputted into Hazwaste Online™. This is a web-based facility that allows an assessment waste as either hazardous or non-hazardous waste based on relevant guidance and legislation[52, 53 ,54,55 ,56 ,57, 58, 59, 60].

Hazwaste Online™. has been designed to cover, amongst other waste types, the European Waste List of Waste (LoW) code number 17 "Construction and Demolition Waste (Including Excavated Soil from Contaminated Sites)".

Where less than limits of detection (LOD) were recorded, the value of the LOD was inputted.

Where applicable, appropriate metal species based on hazard statements/ molecular weight, site history, ground conditions and likely species present in soils were used (e.g. metal oxides relating to an ash based source).

The results show that all the samples tested are classified as NON-HAZARDOUS WASTE and LoW code "17-05-04 - soil and stones other than those mentioned in 17 05 03" is suitable. The Hazwaste Online™ output sheets are provided in Appendix J.

[52] EA (2018). "Guidance on the Classification and Assessment of Waste (1st Edition v1.1)". Technical Guidance WM3.
[53] CLP Regulation - Regulation 1272/2008/EC of 16 December 2008.
[54] 1st ATP - Regulation 790/2009/EC of 10 August 2009
[55] Correction to 1st ATP - Regulation 758/2013/EU of 7 August 2013
[56] WFD Annex III replacement - Regulation 1357/2014/EU of 18 December 2014
[57] Revised List of Wastes 2014 - Decision 2014/955/EU of 18 December 2014
[58] 13th ATP - Regulation (EU) 2018/1480 of 4 October 2018
[59] POPs Regulation 2004 - Regulation 850/2004/EC of 29 April 2004
[60] 2nd ATP to POPs Regulation - Regulation 757/2010/EU of 24 August 2010

12 Conclusions

12.1 Contamination Assessment

A revised contamination conceptual model has been produced by LKC which is summarised in Table 12-1 below (more detailed model provided in Section 9).

Pollutant Linkage		Risk	Recommendations
1	Contaminants posing a risk to site users and offsite receptors via dermal contact, ingestion and inhalation (of soil, dust and fibres).	-	No pollutant linkage therefore no further assessment required.
2	Volatile contaminants posing a risk to site users via the inhalation of vapours.	**Low**	No remediation required.
3	Gas posing a risk to buildings and site users via the migration of gas into building causing explosion and asphyxiation.	Moderate / **Low**	Further monitoring required.
4	Mobile contamination posing a risk to controlled waters via the migration through permeable strata.	**Low**	No remediation required.
5	Organic contaminants posing a risk to water pipes.	**Low**	No further assessment required. However if new pipeline is proposed, a water pipeline risk assessment for Severn Trent Water is likely to be required.

Table 12-1: Summary Risk Table.

Samples of the subbase from trial pits have high pH (probably from breaking out of concrete) which would classify the soils as hazardous waste. However, similar made ground collected from the boreholes (cored slab) have a lower pH and are classified as non-hazardous. Therefore the subbase is likely not hazardous waste.

No further investigation, assessment or remediation is recommended with respect to the contamination risk to future receptors (assuming a new potable water supply is not required).

Consideration should be given to construction works exposed to the soils during groundworks. Standard health and safety precautions (as per HSE guidance) should be adopted by all workers involved with site enabling and construction works.

Recommendations are presented in Section 12.

13 Recommendations

The recommendations provided below are considered appropriate for the site based on the site investigation work undertaken.

13.1 Remediation and Validation Recommendations

Table 13-1 details the further works and remedial recommendations.

PL	Remediation Requirements	Validation Requirements
ALL	Earthworks Inspections / Unexpected Contamination The relevant contractors should be briefed that during development works at the site should any unusual ground conditions and / or visual or olfactory evidence of contamination (including asbestos containing material) be encountered at the site, LKC and the Local Authority should be informed, and further assessment of the material may be required. Should asbestos be identified during groundworks, precautions should be taken to ensure the safety of the construction workers and nearby land users. It would be advisable to introduce an asbestos management strategy in line with CIRIA C733[61].	Log of work undertaken including photographs. Details of any sampling undertaken and validation of any potential additional remedial work.
3	Gas Risk Assessment Additional monitoring visits may be required to satisfy the Local Planning Authority. Six visits over a 3 months period is the typical / idealised monitoring period and frequency in line with C665 for a very low gassing potential of a source and high sensitivity of development (residential).	Liaison with LPA
5	New Potable Water Pipes It is recommended that a Water Pipeline Assessment is undertaken if new in ground potable water pipes are to be laid. It is possible that barrier pipe will be required.	Delivery Notes of Pipe Material. Photographs of the Installed Pipe.
Other Considerations	Health and Safety Considerations In working with, removing or treating any contaminating material it is important that any potential risks associated with the actual site works are mitigated by good environmental management of the site during the remedial phases. Standard health and safety precautions (as per HSE guidance[62]) should be adopted by all workers involved with site enabling and construction works.	
	Asbestos Survey A Pre-Demolition and Major Refurbishment Asbestos Survey should be undertaken, and any ACMs removed and properly disposed of, prior to the refurbishment of the existing buildings, by a suitably qualified professional.	

Table 13-1: Remediation Recommendations.
Notes: See Table 9-1 for pollutant linkage (PL) details.

[61] CIRIA (2014). "Asbestos in Soil and Made Ground: A Guide to Understanding and Managing Risks". C733.
[62] HSE (1991). "Protection of Workers and the General Public During Development of Contaminated Land" London HMSO.

13.2 Geotechnical Recommendations

Table 13-1 summarises the key geotechnical recommendations.

Allowable Bearing Pressure	- 140kN at 7.00mbgl for a 0.6m pile diameter.
Anticipated Foundation Type	- Pile foundation or ground improvement technique.
Other Considerations	- Concrete design: DS-1 AC-1 for soils of Made Ground. As minimum, DS-2 AC-3 for the natural strata. - Details design should be caried out by structural engineer.

Table 13-2: Geotechnical Recommendations.

13.3 Site Completion Report

It is recommended that any remediation carried out on the site is validated by a third party and suitable documentary evidence provided in a Site Completion Report, such as photographs, consignment documents and analytical results. This should include as a minimum:

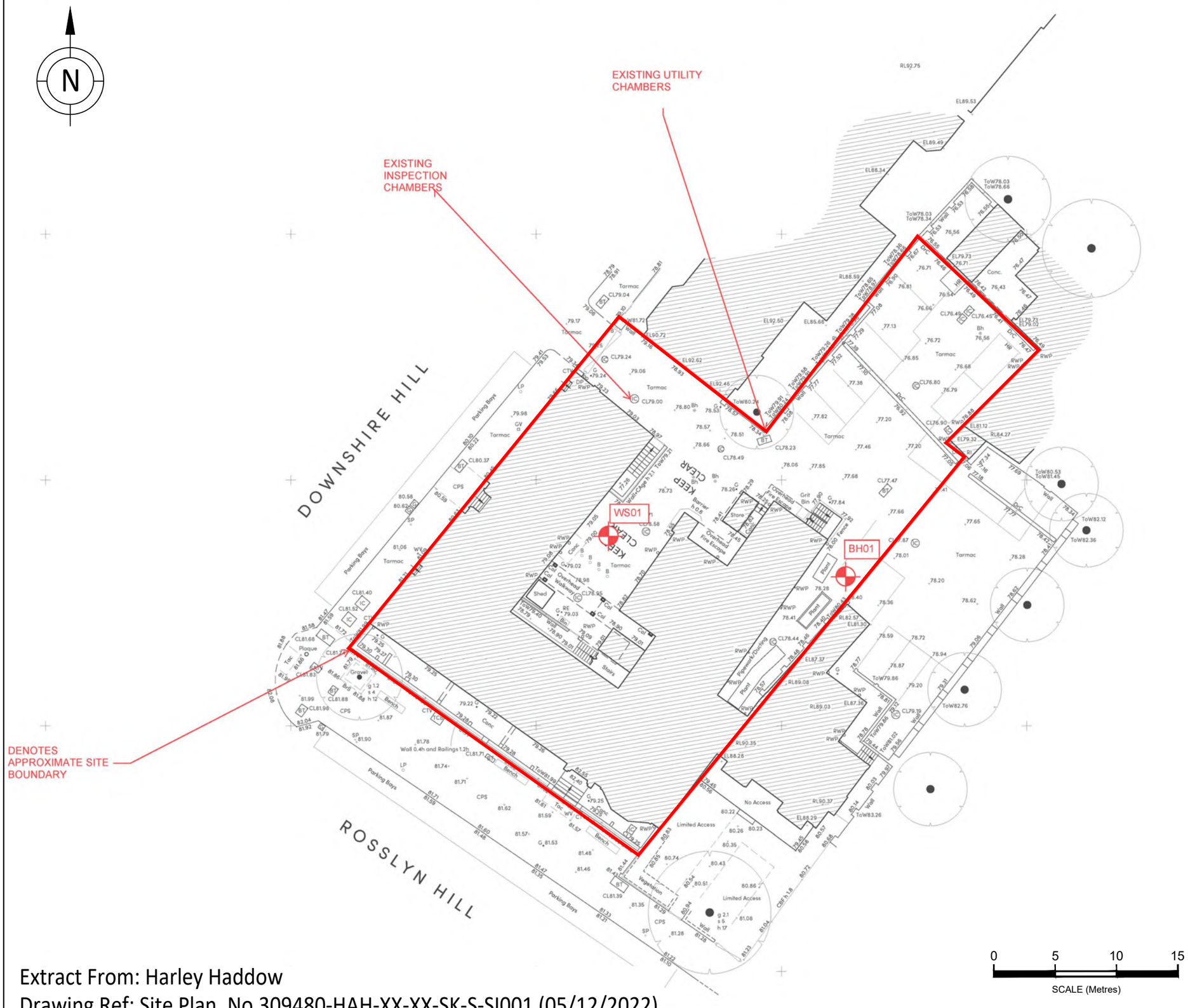
- Provision of waste transfer documents.
- Details of any unexpected contamination identified onsite, suitably risk assessed and / or validated.
- Information on the installation of protective pipes.
- Details of all borehole monitoring visits with complete risk assessment.

The Site Completion Report will assist the Local Authority in the discharge of any future relevant planning condition and will also be of use to solicitors acting on behalf of any prospective conveyancer who may have concerns over the former use of the site.

Figures

Client: Rostrack Limited				Title: Site Location & Boundary Plan	
Site: Hampstead Police Station				Scale (see scale bar): 1:15,000 & 1:500 @ A4	Figure: 1 / Revision: A
Job No.: LKC 22 5242	Drawn By: AE	Checked By: SJ	Drawn: March 2024		

LK CONSULT



Extract From: Harley Haddow

Drawing Ref: Site Plan, No.309480-HAH-XX-XX-SK-S-SI001 (05/12/2022)

KEY

Site Boundary

WS01 WINDOW SAMPLE

BH01 BOREHOLE

Sampling Locations and features annotated by LK Consult Ltd are approximate and are based upon observed measurements unless otherwise stated. Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor. Where this drawing includes information provided to LK Consult Ltd by others, LK Consult Ltd gives no warranty, representation or assurance as to the accuracy of such information.

LK CONSULT LIMITED

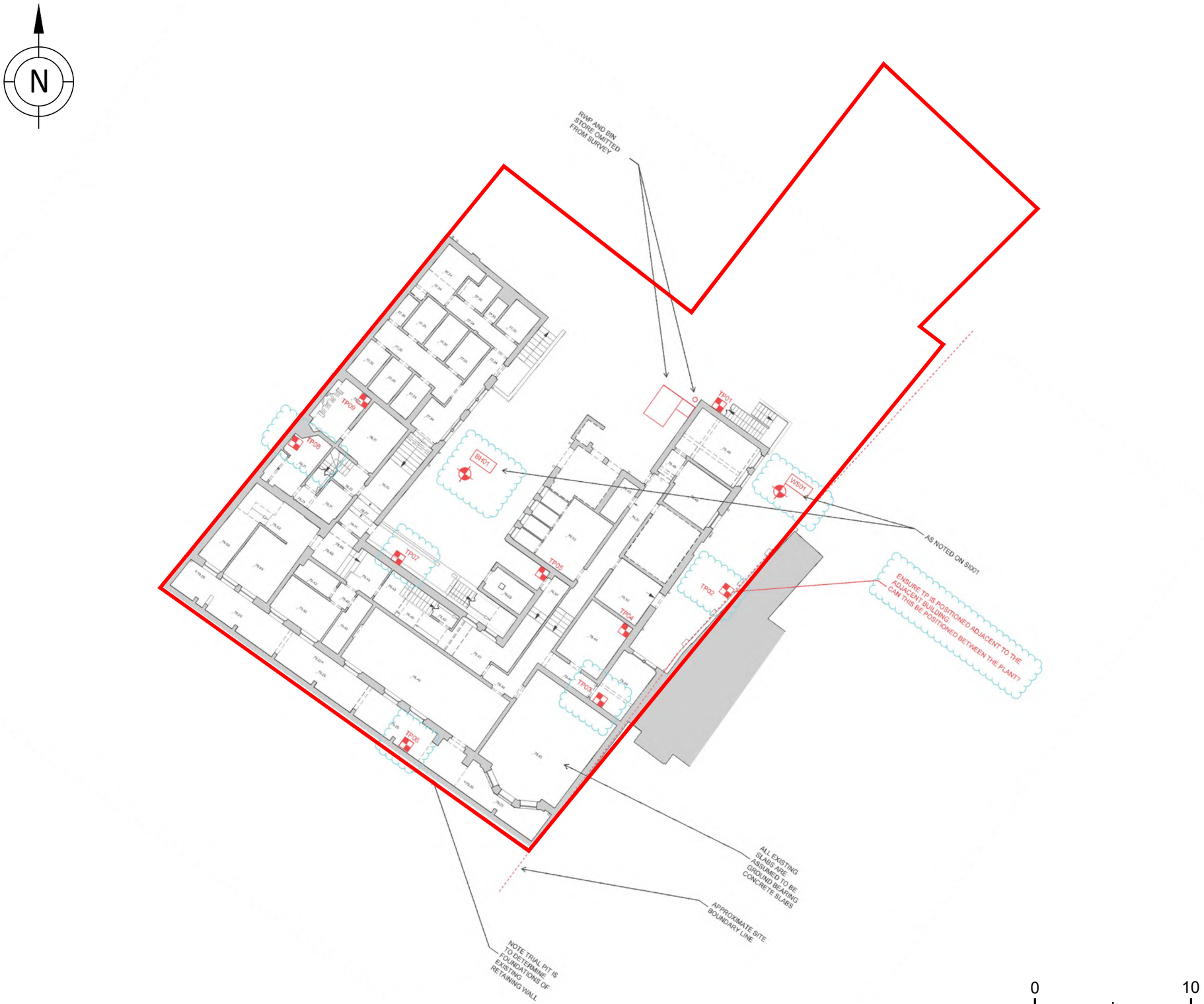
Client: Rostrack Limited

Site: Hampstead Police Station

Title: Existing Site Plan

Job No.:	Scale (See Scale Bar):	Figure:	Revision:
LKC 22 5242	See Scale Bar	2	A

Drawn By:	Checked By:	Drawn:
AC	SJ	Mar 2024



0 10

SCALE (Metres)

Extract From: Harley Haddow

Drawing Ref: Site Investigations Basement, No.309480-HAH-XX-XX-SK-S-SI002, Rev:A (23/02/2023)

KEY

Site Boundary

WS01 WINDOW SAMPLE

BH01 BOREHOLE

TP01 TRIALPIT (MIN 1m X 1m)

Sampling Locations and features annotated by LK Consult Ltd are approximate and are based upon observed measurements unless otherwise stated. Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor. Where this drawing includes information provided to LK Consult Ltd by others, LK Consult Ltd gives no warranty, representation or assurance as to the accuracy of such information.

LK CONSULT LIMITED

Client: Rostrack Limited

Site: Hampstead Police Station

Title: Site Investigation Plan

Job No.:	Scale (See Scale Bar):	Figure:	Revision:
LKC 22 5242	See Scale Bar	3	A

Drawn By:	Checked By:	Drawn:
AC	SJ	Mar 2024

Appendix A

Historical Maps

Historical Mapping Legends

Ordnance Survey County Series 1:10,560

Gravel Pit
Sand Pit
Other Pits
Quarry
Shingle
Orchard
Osiers
Reeds
Marsh
Mixed Wood
Deciduous
Brushwood
Fir
Furze
Rough Pasture
Arrow denotes flow of water
Trigonometrical Station
Site of Antiquities
Bench Mark
Pump, Guide Post, Signal Post
Well, Spring, Boundary Post
285 Surface Level
Sketched Contour
Instrumental Contour
Main Roads
Fenced
Un-Fenced
Minor Roads
Fenced
Un-Fenced
Sunken Road
Raised Road
Road over Railway
Railway over River
Railway over Road
Level Crossing
Road over River or Canal
Road over Stream
Road over Stream
County Boundary (Geographical)
County & Civil Parish Boundary
Administrative County & Civil Parish Boundary
Co. Boro. Bdy.
County Borough Boundary (England)
Co. Burgh Bdy.
County Burgh Boundary (Scotland)
R.D. Bdy.
Rural District Boundary
Civil Parish Boundary

Ordnance Survey Plan 1:10,000

Chalk Pit, Clay Pit or Quarry
Gravel Pit
Sand Pit
Disused Pit or Quarry
Refuse or Slag Heap
Lake, Loch or Pond
Dunes
Boulders
Coniferous Trees
Non-Coniferous Trees
Orchard
Scrub
Coppice
Bracken
Heath
Rough Grassland
Marsh
Reeds
Saltings
Building
Direction of Flow of Water
Shingle
Sand
Glasshouse
Pylon
Pylon
Electricity Transmission Line
Sloping Masonry
Cutting
Embankment
Standard Gauge Multiple Track
Road Under
Road Over
Level Crossing
Foot Bridge
Standard Gauge Single Track
Siding, Tramway or Mineral Line
Narrow Gauge
Geographical County
Administrative County, County Borough or County of City
Municipal Borough, Urban or Rural District, Burgh or District Council
Borough, Burgh or County Constituency
Shown only when not coincident with other boundaries
Civil Parish
Shown alternately when coincidence of boundaries occurs

BP, BS	Boundary Post or Stone	Pol Sta	Police Station
Ch	Church	PO	Post Office
CH	Club House	PC	Public Convenience
F E Sta	Fire Engine Station	PH	Public House
FB	Foot Bridge	SB	Signal Box
Fn	Fountain	Spr	Spring
GP	Guide Post	TCB	Telephone Call Box
MP	Mile Post	TCP	Telephone Call Post
MS	Mile Stone	W	Well

1:10,000 Raster Mapping

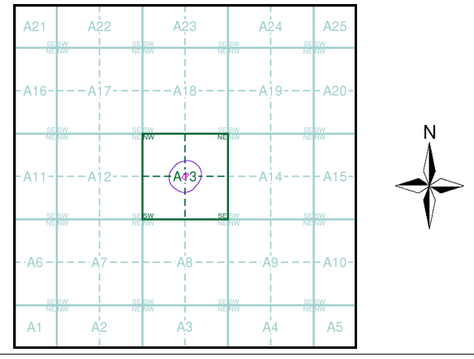
Gravel Pit
Refuse tip or slag heap
Rock
Rock (scattered)
Boulders
Boulders (scattered)
Shingle
Mud
Mud
Sand
Sand
Sand Pit
Slopes
Top of cliff
General detail
Underground detail
Overhead detail
Narrow gauge railway
Multi-track railway
Single track railway
County boundary (England only)
Civil, parish or community boundary
District, Unitary, Metropolitan, London Borough boundary
Constituency boundary
Area of wooded vegetation
Non-coniferous trees
Non-coniferous trees (scattered)
Coniferous trees
Coniferous trees (scattered)
Positioned tree
Orchard
Coppice or Osiers
Rough Grassland
Heath
Scrub
Marsh, Salt Marsh or Reeds
Water feature
Flow arrows
MHW(S) Mean high water (springs)
MLW(S) Mean low water (springs)
Telephone line (where shown)
Electricity transmission line (with poles)
BM 123.45 m Bench mark (where shown)
Triangulation station
Point feature (e.g. Guide Post or Mile Stone)
Pylon, flare stack or lighting tower
Site of (antiquity)
Glasshouse
General Building
Important Building

LK GROUP

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Middlesex	1:10,560	1873 - 1882	3
Middlesex	1:10,560	1879	4
London	1:10,560	1896	5
Essex	1:10,560	1920	6
London	1:10,560	1920	7
Essex	1:10,560	1938	8
London	1:10,560	1938	9
Historical Aerial Photography	1:10,560	1950	10
Ordnance Survey Plan	1:10,000	1951	11
Ordnance Survey Plan	1:10,000	1957 - 1958	12
Ordnance Survey Plan	1:10,000	1968	13
Ordnance Survey Plan	1:10,000	1974 - 1976	14
London	1:25,000	1985	15
Ordnance Survey Plan	1:10,000	1991 - 1996	16
10K Raster Mapping	1:10,000	1999	17
10K Raster Mapping	1:10,000	2006	18
VectorMap Local	1:10,000	2023	19

Historical Map - Slice A



Order Details

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Customer Ref: LKC 22 5242
National Grid Reference: 526870, 185560
Slice: A
Site Area (Ha): 0.13
Search Buffer (m): 1000

Site Details

Hampstead Police Station, Downshire Hill, London, NW3 1PA

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

Russian Military Mapping Legends

1:5,000 and 1:10,000 mapping

a. Not drawn to scale b. Drawn to scale

- Government and Administrative Buildings
- Military and Industrial Buildings
- Military and Communication Areas
- Subway Entrance
- Fireproof Building
- Prominent Fireproof Building
- Non-fireproof Building
- Non-fireproof Building (non-dwelling)
- Factory, mill, and flour mill, with chimneys
- Factory, mill, and flour mill, without chimneys
- Power Station, drawn to scale
- Hydroelectric Power Station
- Radio Station, drawn to scale
- Telephone Station, drawn to scale
- Abandoned Open-pit Mine or Quarry
- Open-pit Salt Mine
- Pit
- Oil Deposit or Well
- Oil Seepage
- Tailings Pile
- Fuel Storage Tanks
- Natural Gas Tank
- Bench Mark
- Drill Hole
- Burial Mound
- Triangulation Point on Burial Mound
- Single-track Railroad
- Double-track Railroad and Station Building
- Coniferous Forest
- Deciduous Forest
- Mixed Forest
- Lawns
- Citrus Orchard
- Wet Ground
- Scattered Vegetation

243,8 Values for prominent elevations

186.0 Numbers for spot elevations, depth soundings, contour lines, etc.

0,2 Velocity of the current, width of river bed, depth of river

Fractional terms: length and capacity of bridges; depth of fords and condition of the river bottom; height of forest and the diameter of trees

Russian Alphabet (For reference and phonetic interpretation of map text)

А а (A)	З з (Z)	П п (P)	Ч ч (CH)
Б б (B)	И и (I)	Р р (R)	Ш ш (SH)
В в (V)	Й й (Y)	С с (S)	Щ щ (SHCH)
Г г (G)	К к (K)	Т т (T)	ъ (–)
Д д (D)	Л л (L)	У у (U)	ы (Y)
Е е (E)	М м (M)	Ф ф (F)	ь (')
Ё ё (YO)	Н н (N)	Х х (KH)	Э э (E)
Ж ж (ZH)	О о (O)	Ц ц (TS)	Ю ю (YU or IU)
			Я я (YA or IA)

1:25,000 mapping

a. Not drawn to scale b. Drawn to scale

- Government and Administrative Buildings
- Military and Industrial Buildings
- Military and Communication Areas
- Subway Entrance
- Partly Demolished Buildings
- Demolished Buildings
- Built-Up Area with Fireproof Buildings Predominant
- Built-Up Area with Non-Fireproof Buildings Predominant
- Individual Fireproof Building
- Prominent Industrial Building
- Individual Dwelling, Fireproof
- Ruins of an Individual Dwelling
- Factory or Mill Chimney
- Factory or Mill with Chimney
- Factory or Mill without Chimney
- Mine or Open Pit Mine
- Operating Shaft or Mine
- Non-Operating Shaft or Mine
- Salt Mine
- Tailings Pile
- Pit
- Stone Quarry
- Gas Pump or Service Station
- Fuel Storage or Natural Gas Tank
- Oil or Natural Gas Derrick
- Small Hydroelectric Power Station
- Power Station
- Transformer Station
- Cemetery
- Burial Mound (height in metres)
- Triangulation Point on Burial Mound
- Triangulation Point
- Bench Mark
- Bench Mark (monumented)
- Telegraph Office
- Telephone Station
- Radio Station
- Radio Tower
- Airfield or Seaplane Base
- Landing Strip
- Main Highway
- Highway under Construction
- Improved Dirt Road (former truck road)
- Double-track Railroad with First Class Station
- Dismantled Railroad
- Railroad Under Construction
- Shore Embankment
- River or Ditch with Embankment
- Direction and velocity of current
- Well
- Water Reservoir or Rain Water Pit
- Spring
- Isobath with value
- Heavy (Index) Contour Line
- Contour Line and Value
- Half Contour Line
- Spot Elevation Value
- Coniferous
- Deciduous
- Mixed
- Scrub

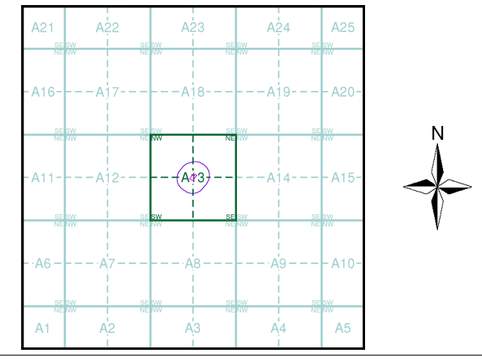
Key to Numbers on Mapping

LKC GROUP

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Middlesex	1:10,560	1873 - 1882	3
Middlesex	1:10,560	1879	4
London	1:10,560	1896	5
Essex	1:10,560	1920	6
London	1:10,560	1920	7
Essex	1:10,560	1938	8
London	1:10,560	1938	9
Historical Aerial Photography	1:10,560	1950	10
Ordnance Survey Plan	1:10,000	1951	11
Ordnance Survey Plan	1:10,000	1957 - 1958	12
Ordnance Survey Plan	1:10,000	1968	13
Ordnance Survey Plan	1:10,000	1974 - 1976	14
London	1:25,000	1985	15
Ordnance Survey Plan	1:10,000	1991 - 1996	16
10K Raster Mapping	1:10,000	1999	17
10K Raster Mapping	1:10,000	2006	18
VectorMap Local	1:10,000	2023	19

Russian Map - Slice A



Order Details

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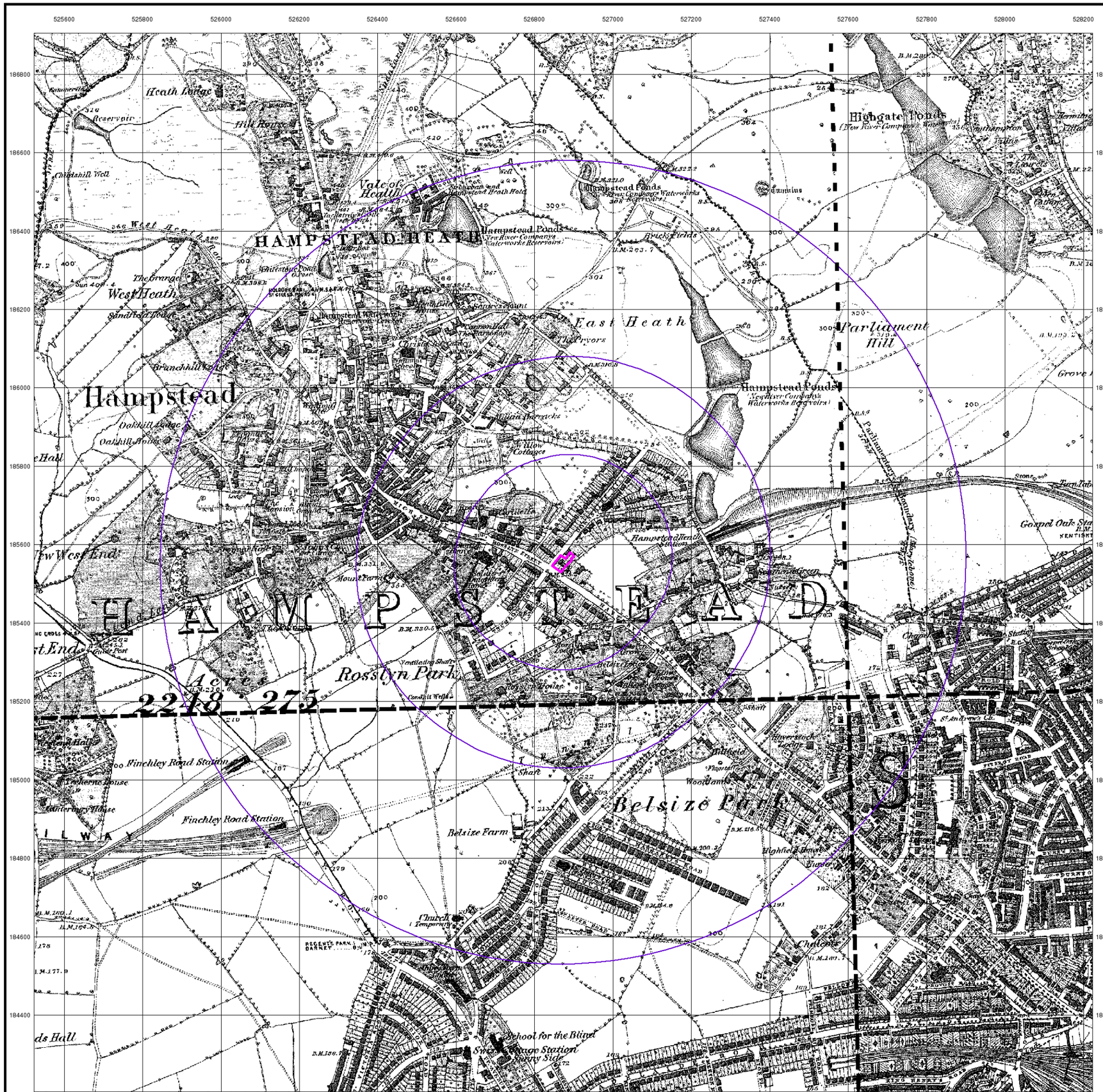
Customer Ref: LKC 22 5242
National Grid Reference: 526870, 185560
Slice: A
Site Area (Ha): 0.13
Search Buffer (m): 1000

Site Details

Hampstead Police Station, Downshire Hill, London, NW3 1PA

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



LK GROUP

Middlesex

Published 1873 - 1882

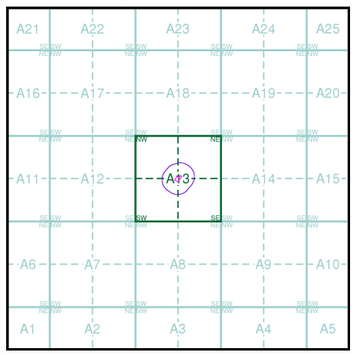
Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

01100 1873 1:10,560	01200 1873 1:10,560
01600 1874 1:10,560	01700 1882 1:10,560

Historical Map - Slice A

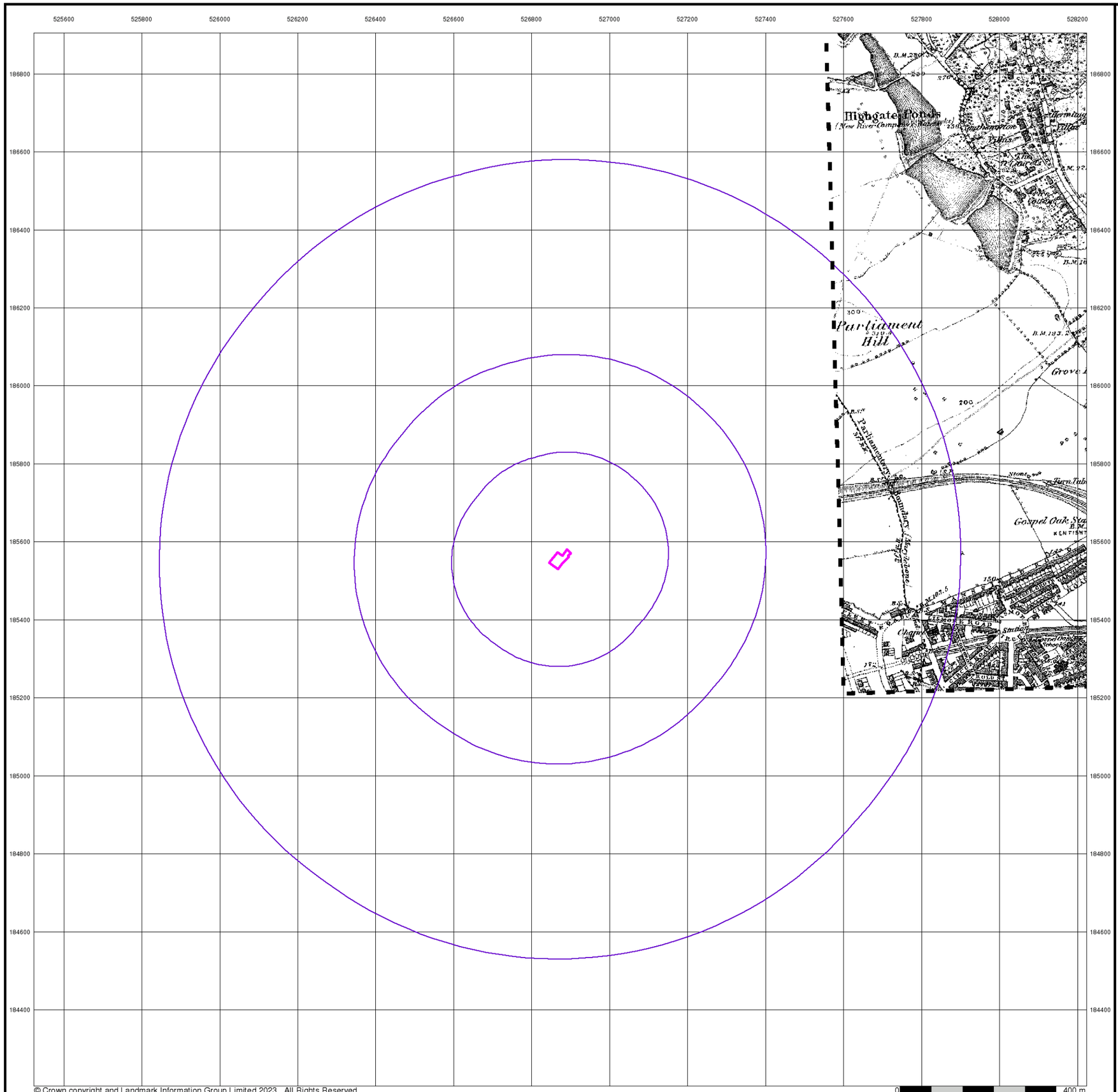


Order Details

Order Number:	312264512_1_1
Customer Ref:	LKC 22 5242
National Grid Reference:	526870, 185560
Slice:	A
Site Area (Ha):	0.13
Search Buffer (m):	1000

Site Details

Hampstead Police Station, Downshire Hill, London, NW3 1PA



LKC GROUP

Middlesex

Published 1879

Source map scale - 1:10,560

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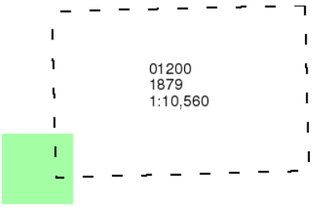
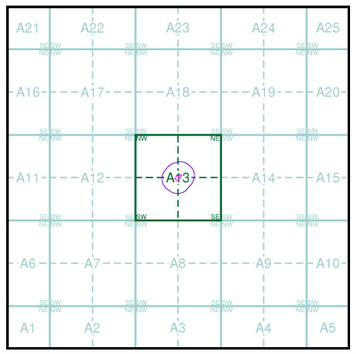
Map Name(s) and Date(s)



Historical Map - Slice A



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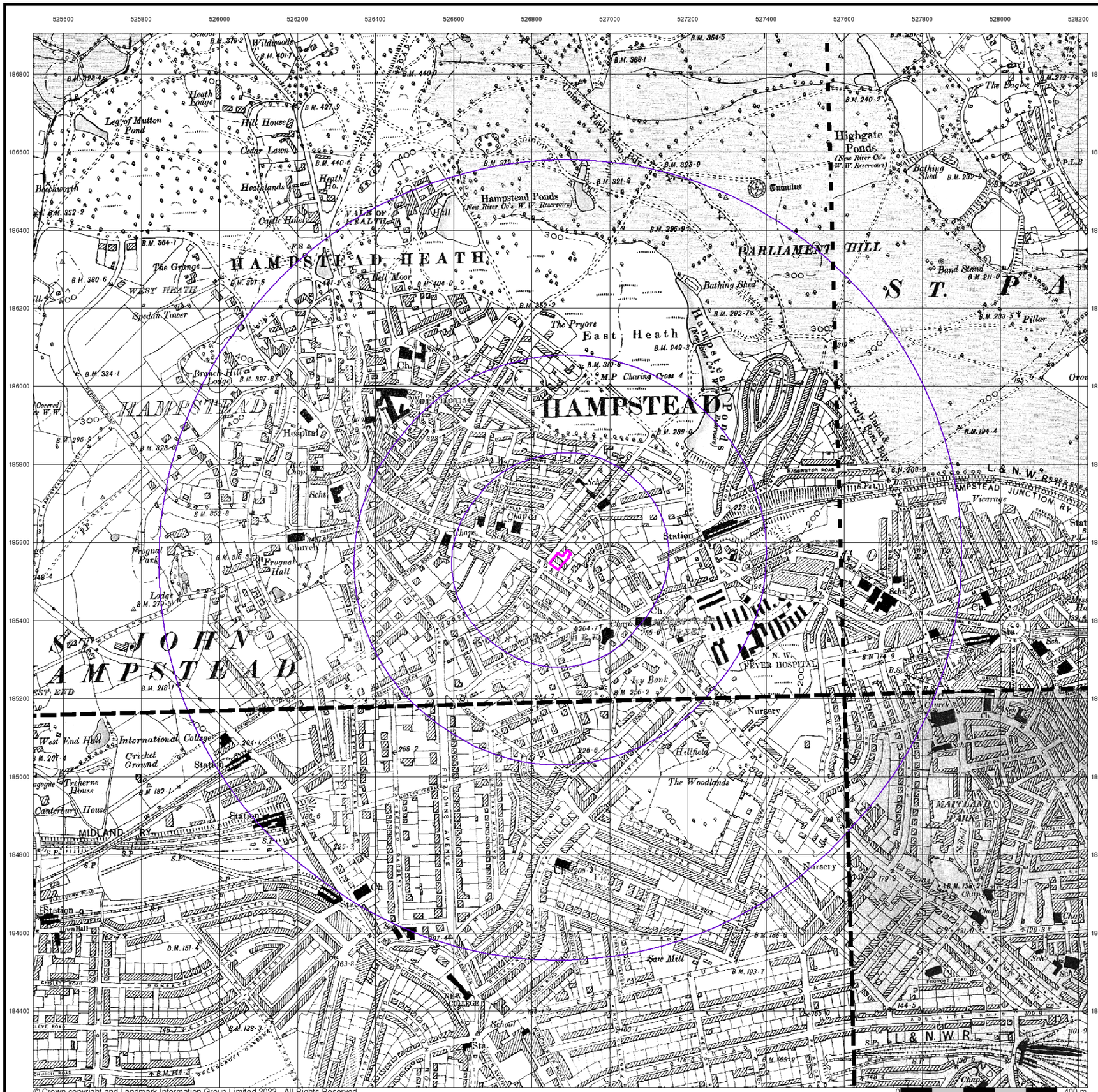

0 400 m

LK GROUP

London

Published 1896

Source map scale - 1:10,560

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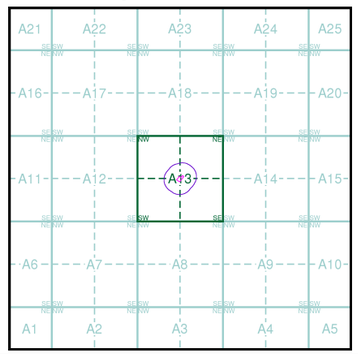
Map Name(s) and Date(s)

002SE 1896 1:10,560
003SW 1896 1:10,560
006NE 1896 1:10,560
007NW 1896 1:10,560

Historical Map - Slice A



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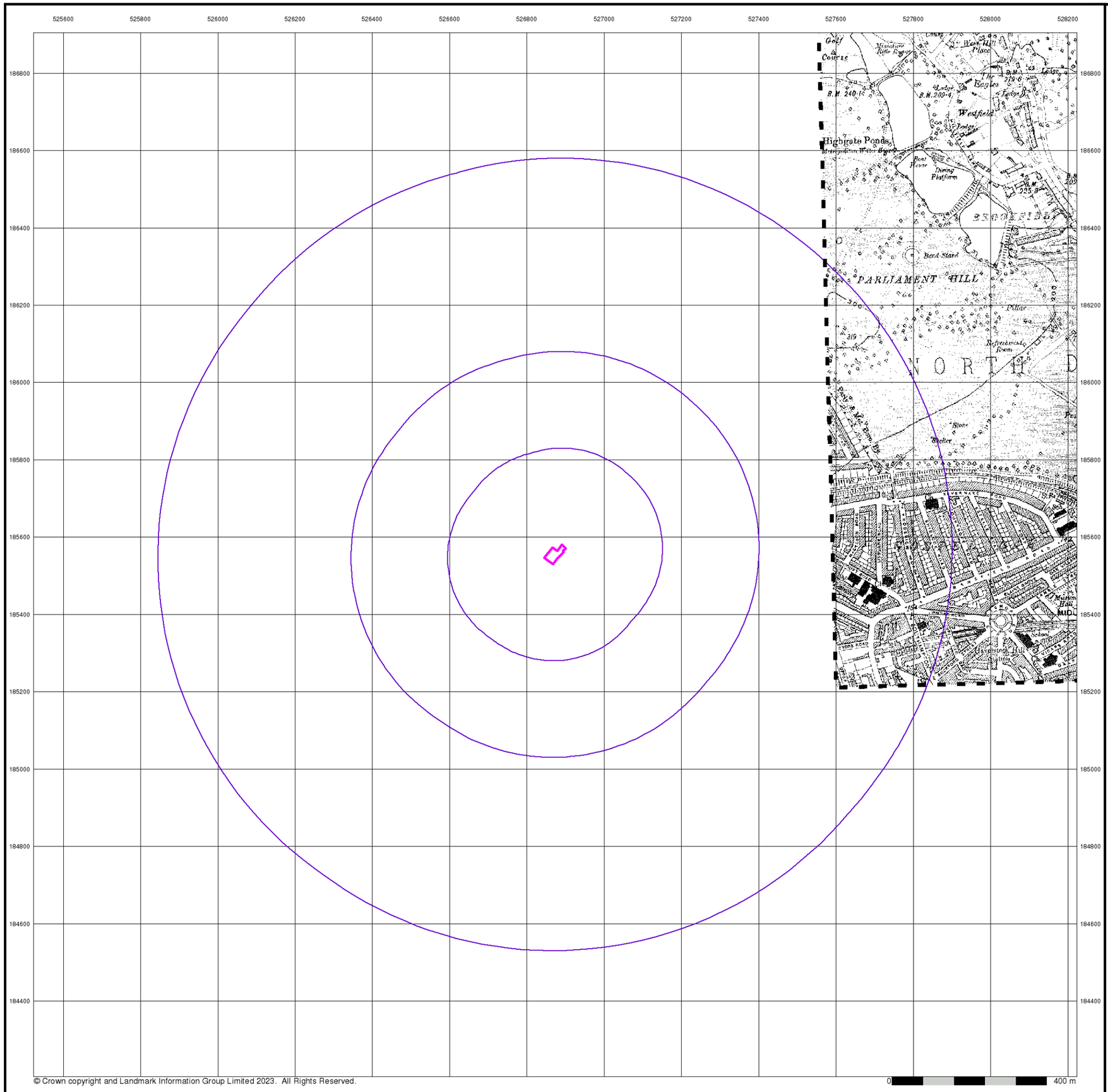

LKC GROUP

Essex

Published 1920

Source map scale - 1:10,560

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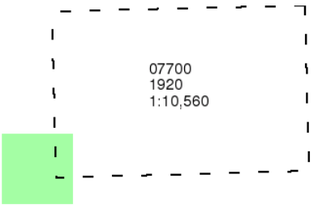
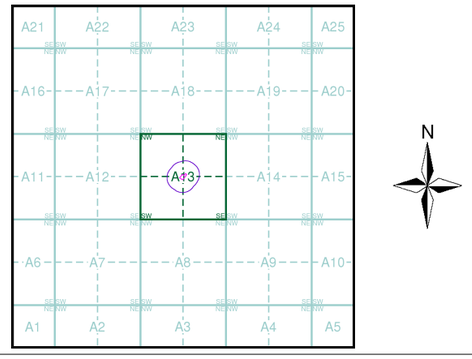
Map Name(s) and Date(s)



Historical Map - Slice A



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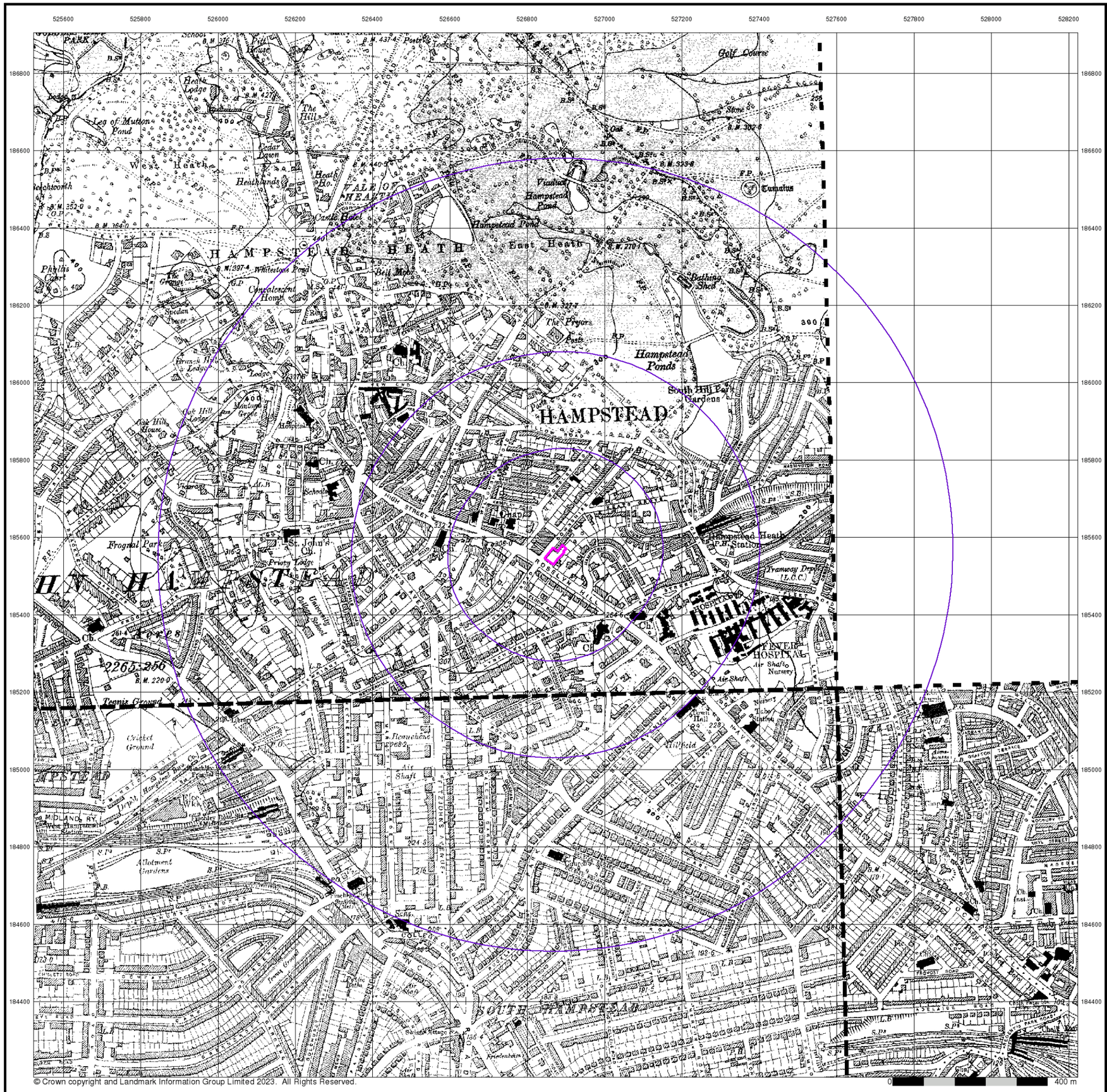

LKC GROUP

London

Published 1920

Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

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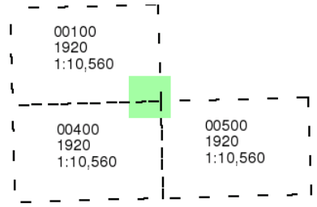
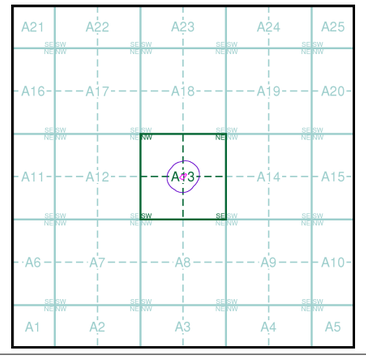


Historical Map - Slice A



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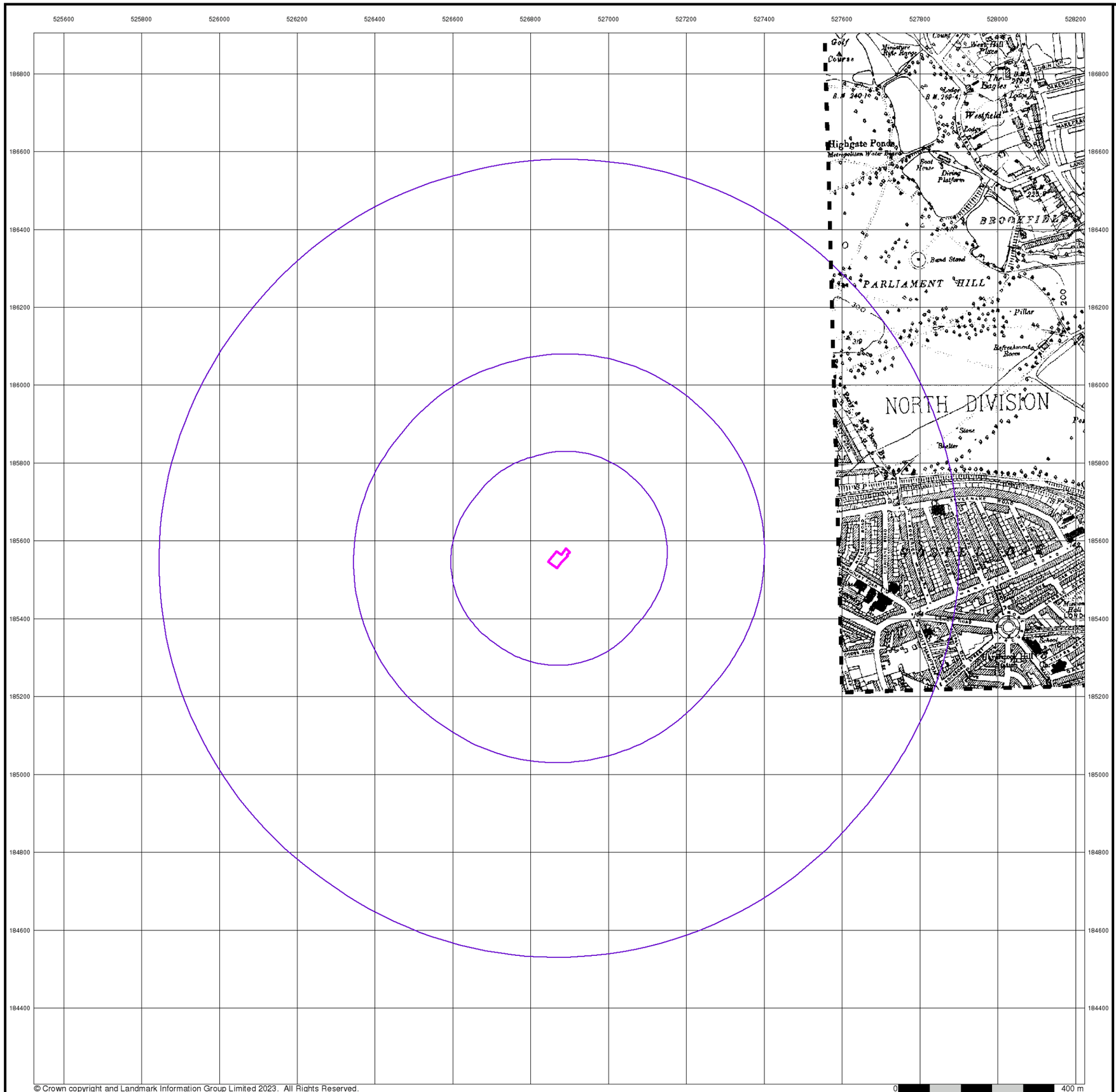

LKC GROUP

Essex

Published 1938

Source map scale - 1:10,560

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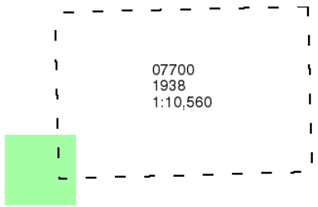
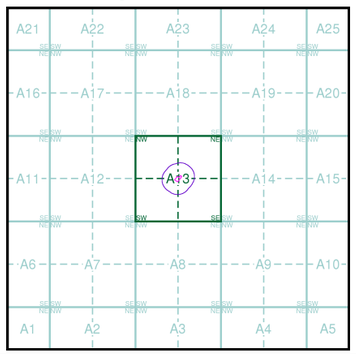
Map Name(s) and Date(s)



Historical Map - Slice A



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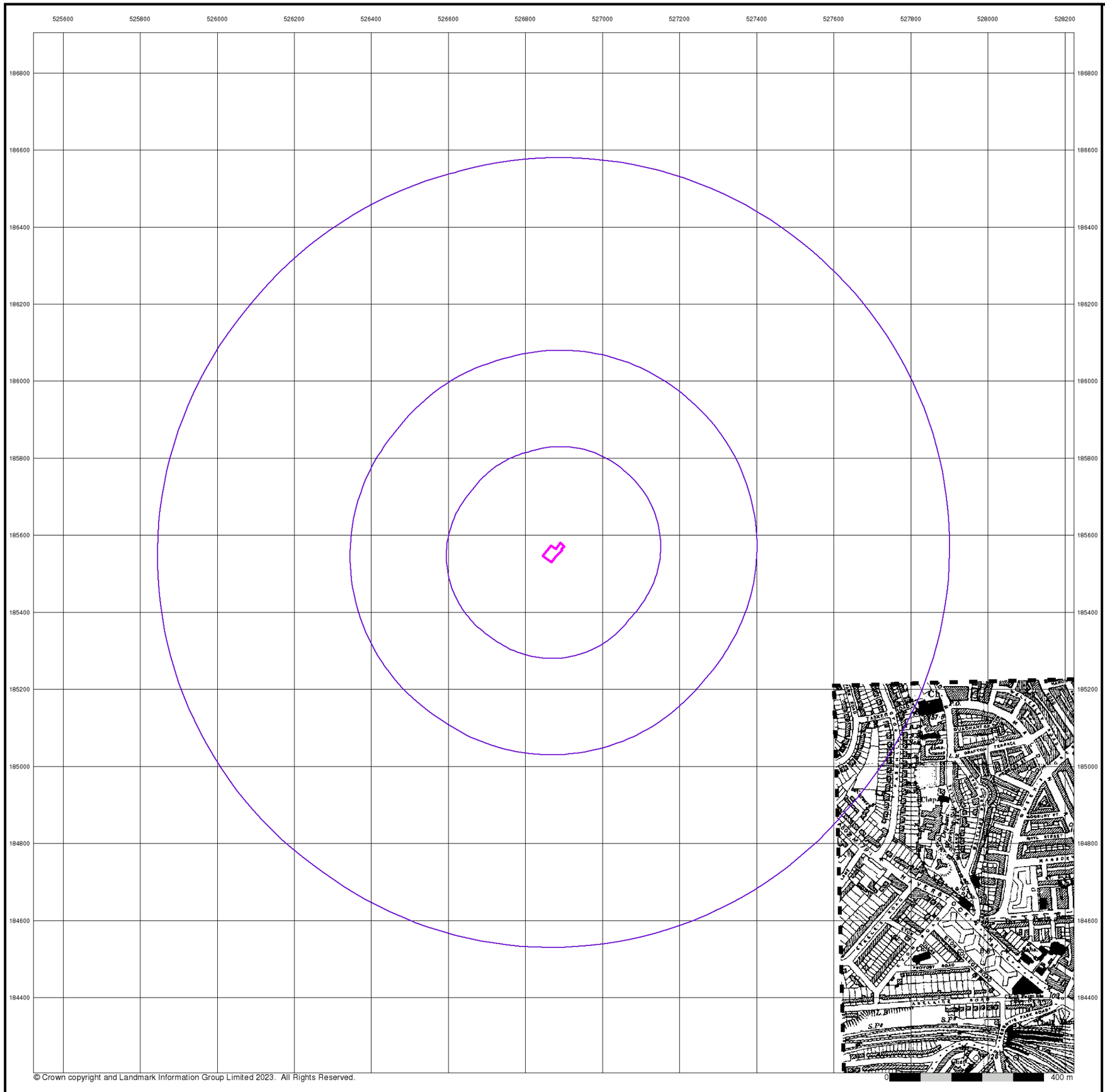

LKC GROUP

London

Published 1938

Source map scale - 1:10,560

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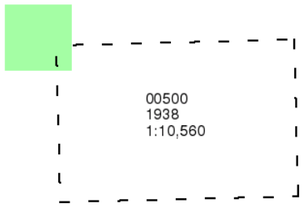
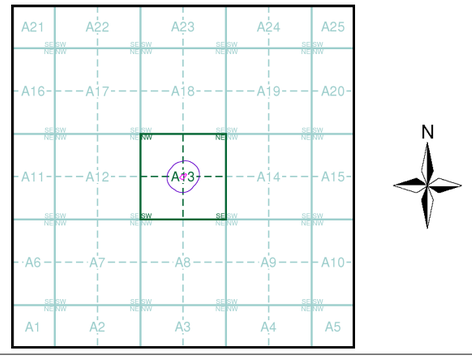


Historical Map - Slice A



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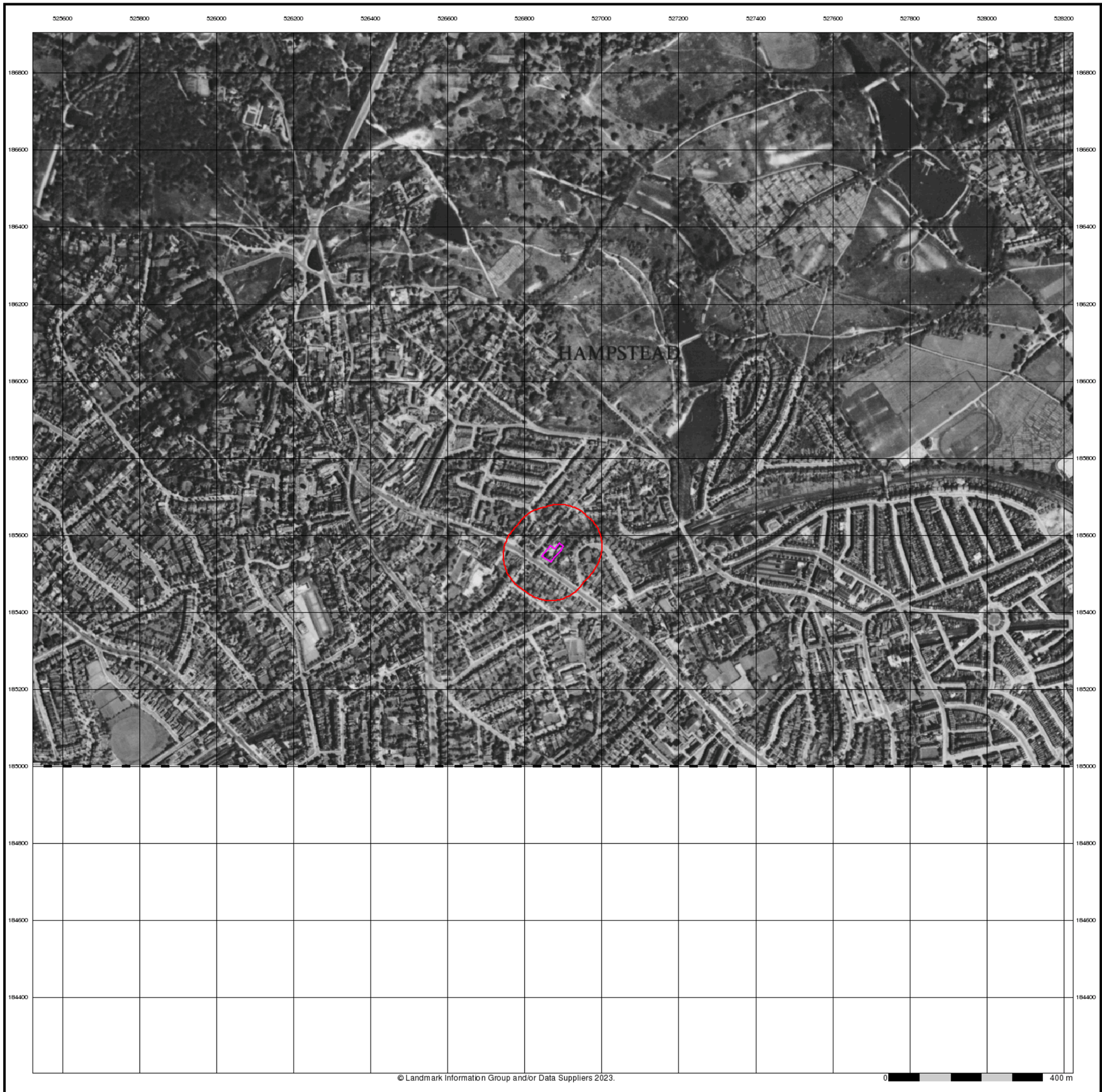


LK GROUP

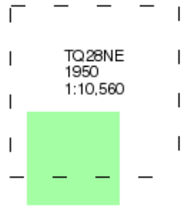
Historical Aerial Photography

Published 1950

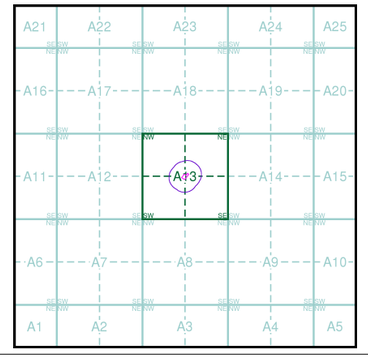
Source map scale - 1:10,560

The Historical Aerial Photos were produced by the Ordnance Survey at a scale of 1:1,250 and 1:10,560 from Air Force photography. They were produced between 1944 and 1951 as an interim measure, pending preparation of conventional mapping, due to post war resource shortages. New security measures in the 1950's meant that every photograph was re-checked for potentially unsafe information with security sites replaced by fake fields or clouds. The original editions were withdrawn and only later made available after a period of fifty years although due to the accuracy of the editing, without viewing both revisions it is not easy to spot the edits. Where available Landmark have included both revisions.

Map Name(s) and Date(s)



Historical Aerial Photography - Slice A



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0 400 m

LK GROUP

Ordnance Survey Plan

Published 1951

Source map scale - 1:10,000

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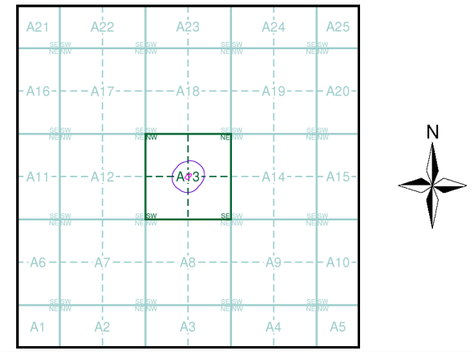
Map Name(s) and Date(s)

TQ28NE
1951
1:10,560

TQ28SE
1951
1:10,560

Historical Map - Slice A



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