Basement Impact Assessment

at

9 The Mount, Hampstead, London NW3 6SZ

for

Mr & Mrs Alex Barnett

Reference: 20353/BIA Rev1.0

October 2022

Control Document

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Th t a valid document for use in the design of the project unless it is titled Final in the document status box.

Current regulations and good practice were used in the preparation of this report. The recommendations given in this report must be reviewed by an appropriately qualified person at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

Commission

Mr & Mrs Alex Barnett commissioned Soils Limited to undertake an intrusive ground investigation and prepare a Basement Impact Assessment (BIA) on land at 9 The Mount, Hampstead, London NW3 6SZ. The scope of the investigation was outlined in the Soils Limited quotation reference Q26020 Rev1, dated 25th July 2022.

This document comprises the BIA and incorporates the results, discussion, and conclusions to the intrusive works and impact assessment.

No Preliminary Investigation Report was produced by Soils Limited, as this did not form part of the Client's brief. A limited number of tests, were undertaken to assist the Client for preliminary information on waste disposal purposes.

Limitations and Disclaimers

This Basement Impact Assessment relates to the site located at 9 The Mount, Hampstead, London NW3 6SZ and was prepared for the sole benefit of Mr & Mrs Alex Barnett (The "Client"). The report was prepared solely for the brief described in Section 1.1 of this report.

The contents, recommendations and advice given in the report are subject to the Terms and Conditions given in Quotation Q26020 Rev1, dated 25th July 2022 accepted by the Client in their acceptance form, dated 25th July 2022.

Soils Limited disclaims any responsibility to the Client and others in respect of any matters outside the scope of the above.

This report has been prepared by Soils Limited, with all reasonable skill, care and diligence within the terms of the Contract with the Client, incorporation of our General Conditions of Contract of Business and taking into account the resources devoted to us by agreement with the Client.

The report is personal and confidential to the Client and Soils Limited accept no responsibility of whatever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report wholly at its own risk.

The Client may not assign the benefit of the report or any part to any third party without the written consent of Soils Limited.

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the Client in accordance with their brief. As such these do not necessarily address all aspects of ground behaviour at the site.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

If the term “competent person” is used in this report or any Soils Limited document, it means an engineering geologist or civil engineer with a minimum of three years post graduate experience in the understanding and application of the appropriate codes of practice.

Unless the site investigation works have been designed and specified in accordance with EC7, this report is a Geotechnical Investigation Report and is not necessarily a Ground Investigation Report as defined by EC7 (Eurocode 7 Part 1, §3.4, Part 2, §6.1) or a Geotechnical Design Report (Eurocode 7 Part 1, §2.8) as defined by Eurocode 7 and as such may not characterise the ground conditions and additional works may be required to comply with the requirements of EC7.

Within the report reference to ground level relates to the site level at the time of the investigation, unless otherwise stated.

Exploratory hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sample borehole implies the specific technique used to produce an exploratory hole.

The depth to roots and/or of desiccation may vary from that found during the investigation. The Client is responsible for establishing the depth to roots and/or of desiccation on a plot by plot basis prior to the construction of foundations. Supplied site surveys may not include substantial shrubs or bushes and is also unlikely to have data or any trees, bushes or shrubs removed prior to or following the site survey.

Where trees are mentioned in the text this means existing trees, substantial bushes or shrubs, recently removed trees (approximately 20 years to full recovery on cohesive soils) and those planned as part of the site landscaping).

The geotechnical laboratory testing was performed by GEO Site & Testing Services Ltd (GSTL) in accordance with the methods given in BS 1377:1990 Parts 1 to 8 and their UKAS accredited test methods.

For the preparation of this report, the relevant BS code of practice were adopted for the geotechnical laboratory testing technical specifications, in the absence of the relevant Eurocode specifications (ref: ISO TS 17892).

The chemical analyses were undertaken by Derwentside Environmental Testing Services (DETS) in accordance with their UKAS and MCERTS accredited test methods or their documented in-house testing procedures. This investigation did not comprise an environmental audit of the site or its environs.

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Non-Technical Summary
The site was located at 9 The Mount, Hampstead, London NW3 6SZ and had an approximate O.S Land Ranger Grid Reference of TQ 26330 85986.

The site comprised a one to two storey semi-detached house with an existing basement, and garden around the house's eastern side. The existing basement was located below the garden area along The Mount, with two garage doors and entrance door accessible from The Mount. A corridor runs from the entrance door off The Mount south below the garden, before turning a right-angle and providing access to basement below the south half of the house.

The proposal comprised an extension to the existing basement, which would be located below the existing garden and deepening of floor level within the existing basement below the house.

This BIA comprised the following elements:

- Desk Study,
- Screening,
- Scoping,
- Site investigation, monitoring and interpretation,
- Ground movement assessment,
- Damage category assessment,
- Impact assessment,
- Conclusions and recommendations.

The Desk Study reviewed desk-based sources, providing information to aid evaluation of the screening questions. This included site history, anticipated geology, topography, hydrogeology, hydrology, drainage, flood risk and other sources of information.

The screening stage reviewed a series of questions regarding issues on groundwater flow, land stability and surface flow and flooding and related flowcharts, to clarify whether a full BIA was required for the development.

The scoping stage addressed each of the issues that arose from the screening process, providing assessment methodology and wider discussion on how the impacts may be mitigated. The issues were used to aid determination of the required site investigation.

The site investigation comprised a sequence of boreholes to establish ground conditions, as well as the installation and monitoring of standpipes to determined groundwater conditions.

The ground conditions were established to be Made Ground overlying bedrock of the Bagshot Formation. The Bagshot was predominantly granular with occasional cohesive beds.

No groundwater was encountered during drilling of the boreholes, which were advanced to a maximum depth of 15.00m below ground level (bgl). Three standpipes were installed to between 6.0m and 7.0m bgl and were recorded as dry when monitoring in September 2022. The groundwater was therefore established to be at a depth greater than 7m. Groundwater could be found migrating through the granular soils of the Bagshot Formation.

The established ground and groundwater conditions were compared against published data and geotechnical parameters determined for the ground movement assessment.

The geometry and proposed loads provide by the Clients consultants were used to calculate the ground movements that may result from the construction of the basement level and to assess how these may affect the conditions of neighbouring buildings.

OASYS Limited PDISP (Pressure induced DISPlacement analysis) analysis software was used to calculate ground movements arisings from basement excavation, and WALLAP by Geosolve to calculate ground movements from retaining wall lateral deflection.

The ground movements were then used to establish the damage category based on the Burland Scale. The critical scenario CS1 present in Figure 12 was modelled, with damage category calculated as very slight. The damage category was considered acceptable.

The proposed basement would not impact the groundwater flow regime, with the groundwater level below the basement. Provided the development follows best practices, with the use of suitable temporary and permanent support, the risk of causing slope instability was negligible.

The cumulative effects of eventual multiple basements, of similar construction to the proposed were considered to have limited effect on the groundwater regime.

The proposed basement was considered to have limited impact on neighbouring properties, groundwater flow, slope stability or surface flow and flooding.

Section 1 Introduction

1.1 Scope

Soils Limited was commissioned by Mr & Mrs Alex Barnett to undertake a BIA for the proposed basement development at 9 The Mount.

The report provides details on the local hydrology, geology and hydrogeology, and potential impact to neighbours and the wider environment.

This BIA follows current planning procedures for basements and lightwells adopted by London Borough (LB) Camden and comprises the following elements:

- Desk Study,
- Screening,
- Scoping,
- Site investigation, monitoring and interpretation,
- Ground movement assessment,
- Impact assessment.

It is recognised that any BIA is a live document and that further detailed assessments will be ongoing, if appropriate, as design and construction progresses.

No Preliminary Investigation Report was produced by Soils Limited, as this did not form part of the Client's brief. A limited number of tests, were undertaken to assist the Client for preliminary information for waste disposal purposes.

1.2 Location

The site was located at 9 The Mount, Hampstead, London NW3 6SZ and had an approximate O.S Land Ranger Grid Reference of TQ 26330 85986.

The site location plan is given in Figure 1.

1.3 Sources of Information

The primary sources of information used within this report are:

1. British Geological Survey Website (accessed October 2022),
2. Ordnance Survey (OS) historic map pack (Appendix B),
3. Topographic Survey (Appendix G)
4. EA Website (accessed October 2022),
5. Defra Magic Map (accessed October 2022),

6. Google Earth™ (accessed October 2022),
7. The Lost Rivers of London, Historical Publications Ltd, 1992, N Barton.
8. National Library of Scotland (accessed September 2022)
9. LB Camden, Strategic Flood Risk Assessment (SFRA) (produced by URS, 2014),
10. LB Camden, Surface Water management Plan (2011),
11. LB Camden, Planning Guidance (CPG) – Basements (March 2018),
12. LB Camden, Camden Geological, Hydrogeological and Hydrological Study (GHHS) – Guidance for Subterranean Development (produced by Arup, 2010),
13. LB Camden, Local Plan Policy A5 Basements (2017).

1.4 Site Description

The site comprised a one to three storey semi-detached house with existing basement, and garden around the house's eastern side. The site was bounded by The Mount to the east, Grove Passage to the north, and shared party walls with No.8 to 14 Hampstead Grove and No.8 The Mount to the south. The ground surface level of the garden and ground floor was approximately 2.6m above the level of The Mount. The existing basement was located below the garden area along The Mount, with two garage doors and entrance door accessible from The Mount. A corridor runs from the entrance door off The Mount south below the garden, before turning a right-angle and providing access to basement below the south half of the house.

The site was typically level, with elevations in the garden of ~124.7 to 124.9m AOD. The garden was terrace out and at a higher elevation to the surrounding land. Grove Passage to the north sloped down in an east direction, by ~8°, from 125.9m to 123.7m AOD, followed by steps down to The Mount, which in turn sloped down in a south direction, by ~3°, from 122.5m to 121.7m AOD along the southern side of the site. Within the garden there were two trees located in the southeast corner. Off-site a mature tree was located opposite the site on the eastern side of The Mount.

An aerial photograph of the site and its close environs has been included in Figure 2.

1.5 Proposed Development

The proposal comprised an extension to the existing basement and deepening of the floor level within the existing basement below the house. The extension was to be located below the existing garden on the western side of the existing below ground corridor, which connects the garage to the main basement below the house. The basement extension was to be constructed using contiguous piles and mass concrete spread foundations. The existing basement floor was to be lowered by approximately 0.2 to 1.0m using mass concrete underpinning.

In compiling this report reliance was placed the development plans and surveys provided by the Client. A list of provided documents are presented in Table 1.1.

The development plans provided by the Client are presented in Appendix G.

Table 1.1 Reference Documents

Document	Reference No.	Rev.	Date	Author
Existing Basement Plan	20057/B/01-01	A	Nov. 2021	EDI Surveys Ltd
Elevations & Sections	20057/ES/01-08 to 20057/ES/08-08	A	Dec. 2021	
Topographic Survey	20057/T/01-01	-	Nov. 2021	
Basement Floor Plan	PL-00-100	-	01/02/2022	Charlton Brown Architecture & Interiors
Ground Floor Plan	PL-00-101	-	04/02/2022	

The recommendations provided within this report are made exclusively in relation to the scheme outlined above and must not be applied to any other scheme without further consultation with Soils Limited. Soils Limited must be notified about any change or deviation from the scheme outlined.

Section 2 Desk Study

2.1 Site History

A review was undertaken of available historic OS mapping and aerial photography, using the following resources, OS Historic Map Pack (Appendix B) and Google Earth™ (GE).

The age of the property was determined to be pre-1871. A summary of pertinent information from the available OS maps and aerial photography are provided in Table 2.1.

Table 2.1 Site History

Map	Description
OS 1871	Site boundary off-set ~6m in an east direction. Building located on the western half of the site into the southwestern corner. Outdoor space appears to surround the building on its eastern and northern side. A rectangular structure is marked in the northeast corner. The building adjoins No.8 The Mount to the south and No.8 to 14 Hampstead Grove to the west. Grove Passage runs along the northern boundary and The Mount along the eastern boundary.
OS 1870-1979	Site boundary off-set ~4m in an east direction. No change to structures onsite, apart from rectangular structure in northeast corner marked as a 'Glazed Roof Building'.
OS 1934-1936	Extension added to the building on it northern side, with the northwest corner of the site. Glazed Roof Building in northeast corner now only partially glazed.
OS 1953-1955	Structure in northeast corner no longer marked with glazed or partial glazed roof.
OS 1969-1970	No change.
OS 1967-1981	Further extension on the northern side of the building within the northwest corner. Building in northeast corner no longer marked. However, road markings indicate access from The Mount to a structure below the now garden area in the northeast corner.
Aerial 1999 (GE)	Main building located in the southwest corner with an extension into the northwest corner. The building extends from the northern side boundary to the southern side boundary, where the building adjoins No.8 The Mount. Remaining area of the site garden which wraps around in the building in an upside down reversed 'L' shape. The northern section of the garden appeared to be hard landscaped with grass covering the remaining garden along the eastern side. Small trees or shrubs were dotted around the garden.
Aerial 2001 to 2022 (GE)	No significant change.

2.2 Published Geological Data

The 1:50,000 BGS map showed the site to be located directly upon the bedrock Bagshot Formation, which overlies the Claygate Member. There were no overlying superficial deposits. An extract from the BGS geology maps is presented in Figure 4.

2.2.1 Bagshot Formation

The Bagshot Formation overlies the London Clay Formation in the London Basin. The Bagshot Formation was formed after a swallowing of the sea and deposition of the London Clay Formation in a shallow marine or estuarine environment. The formation is variable in thickness, between 7m and 40m, comprising mainly fine grained yellow, pink and brown sand with ferruginous concretions, with frequent beds of grey clay "pipe clay" and beds of black flint gravel. In Hampstead Heath area the Bagshot Formation has a basal bed of coarse grit and sub-rounded flint pebbles.

2.2.2 Claygate Member

The Claygate Member comprises alternating layers of clayey fine-grained sand, silts, and sandy clays. The sands usually overlie the clays. The clays are typically brown to mauve mottled and are overconsolidated. The Claygate Member is the youngest part of the London Clay Formation and forms a transition from the underlying clay and the coarser sand of the overlying Bagshot Formation.

2.3 Web Published Geology

A review of historic boreholes around the site obtained from the BGS suggest the following sequence and approximate thickness of each stratum.

- Made Ground/Superficial Deposits: 1m
- Bagshot Formation: 5m to >51m
- Claygate Member: 15m
- London Clay Formation: 110m
- Lambeth Ground: 15m
- Thanet Sand Formation: 10m
- Chalk: >50m

2.3.1 Groundwater

The closest historic BGS borehole (ref: TW28NE92) was circa 4m north of the site and was recorded as dry with a final depth of 18.89m bgl. The second nearest borehole (ref: TQ28NW93) was located circa 50m south and was drilled to 15.72m bgl. Water strikes were recorded at depths of 8.8m and 14.3m. Both boreholes were drilled circa 1969.

2.4 Topography

The site was typically level, with elevations in the garden of ~124.7 to 124.9m AOD. The garden was at a higher elevation to the surrounding land. Grove Passage to the north sloped down in an east direction, by 7.6^{o}, from 125.9m to 123.7m AOD, followed by steps down to The Mount, which in turn sloped down in a south direction, by 2.6^{o}, from 122.5m to 121.7m AOD along the southern side of the site. The garden was approximately 2.6m higher than The Mount.

The surrounding area was generally sloping down in a south easterly direction, with a maximum slope angle of 9.4° and average angle of 5.8°, based on Google Earth™ elevation data. Traversing west the land rose to ~127m AOD by ~50m from the site before sloping back down. To the north the land rose to ~134m over ~500m before sloping back down, and the northeast the land rose to ~127m over ~150m before sloping back down.

Review of the Slope Angle Map, Figure 16 in the LB Camden GHHS recorded the closest slope angle of >7° to be ~130m southwest. An extract of Slope Angle Map is presented in Figure 5.

2.5 Hydrogeology

The Environment Agency has produced an aquifer designation system consistent with the requirements of the Water Framework Directive. The designations have been set for superficial and bedrock geology and are based on the importance of aquifers for potable water supply and their role in supporting water bodies and wetland ecosystems.

The London groundwater model was generally split into three aquifers, the Upper, Intermediate and Lower Aquifer.

- The Upper Aquifer comprises groundwater within the superficial River Terrace Deposits and granular deposits (including Bagshot Formation, which overly the London Clay Formation. The underlying London Clay Formation acts as an aquiclude to the underlying Intermediate and Lower Aquifers.
- The Intermediate Aquifer was generally associated with granular layers within the Lambeth Group.
- The Lower Aquifer was principally associated with the Chalk but can include the overlying Thanet Formation.

No superficial River Terrace Deposits were anticipated, but the Bagshot Formation was expected to overlay the London Clay Formation, of which the Claygate Member is a part. The Bagshot Formation and granular bed of the underlying Claygate Member are relatively permeable compared to the cohesive beds of the remaining London Clay Formation. The Bagshot Formation was classified as a Secondary A Aquifer.

Shallow groundwater could be present within the Bagshot Formation and granular beds of the Claygate Member. Any water infiltrating the underlying cohesive London Clay Formation will generally tend to flow either with the topography or vertically downwards at a very slow rate towards the Intermediate and subsequently Lower Aquifer. Data for the London Clay Formation indicates horizontal permeability of between 10^{-7} m/s close to the surface increasing to 10^{-10} m/s at depth.

The site was not within a source protection zone, as presented in Figure 6. Groundwater was anticipated to be flowing in a south easterly direction in alignment with the immediate surrounding land.

2.6 Hydrology

The nearest surface water features were Whitestone Pond ~285m north at an elevation of 133m AOD, followed by the Hampstead Ponds ~450m northeast at an elevation of 112m AOD, within Hampstead Heath. The site was outside the Hampstead Heath Chain Catchment (GHHS, Figure 12).

Based on the Environmental Agency (EA) online catchment data explorer the site was within the London surface water management catchment area, but outside any operational catchment areas. The nearest operational catchment was Brent Rivers and Lakes 265m north.

The site lies within 240m of a tributary of the Westbourne, situated northwest, and is one of the lost rivers of London (Lost Rivers of London, N Barton). An extract of the Lost Rivers Of London map is presented in Figure 7.

2.7 Drainage

The site had an existing impermeable area of ~230m^2 formed by the building's footprint (~175m^2) and hard landscaping (~55m^2). The remaining area (~70m^2) of the site was expected to be permeable. The proposed basement would be below ground surface with a covering of soil and topsoil above it and, therefore, would not change the percentage of impermeable to permeable surface area.

The site was anticipated to be underlain by bedrock of the Bagshot Formation, with no overlying superficial deposits.

The drainage of surface water into the ground would depend on the exact ground conditions encountered. The Bagshot Formation is classified as a Secondary A Aquifer, and expected to be predominantly granular, with localised clay beds. Surface water was expected to penetrate any overlying Made Ground/Topsoil, into the Bagshot Formation permeating down to any cohesive beds where it will then flow in alignment with the topography.

2.8 Flood Risk

The risk of flooding was assessed taking account of the information available from the EA flood maps, LB Camden SFRA, SWMP and Local Plan.

The site was situated in Flood Zone 1, an area with a low probability of flooding from rivers and seas. The EA and SFRA showed the site to have a very low risk from surface water flooding.

The site was within critical drainage area Group3_010, but not within a local flood risk zone, near a historic watercourse or along a street historically recorded as having flooded.

Extracts of surface water risk and Historical flooding and Local Flood Risk Zones map are presented in Figure 8 and Figure 9, respectively.

In summary, the site of interest lies within Flood Zone 1, has an area of less than 1 hectare and did not fall into an area at risk from river and sea flooding or surface water flooding. The site was in a CDA, but not within a local flood risk zone or along a street recorded to have historically flooded. Therefore, the undertaking of a detailed site-specific flood risk assessment was not technically required as specified in the Camden Local Plan.

2.9 Neighbouring Properties

No.9 The Mount shared party walls with No.8 The Mount to the south, a 3-storey semidetached house similar in design and age, and on the western side adjoined No.6 to No.14 Hampstead Grove, with No.4 located 2m away from the site boundary to the southwest.

Historic estate agency plans indicate that No.8 has a basement. A review of planning applications No.4 and No.6 Hampstead Grove had applications for basement granted in 1966 and 2000 respectively. There were no applications which indicated basements at No.8 to No.14 Hampstead Grove, although this does not preclude there being basements at these properties.

2.10 Statutory and Locally Listed Buildings & Structures

No.9 and adjoining No.8 The Mount are both Grade II listed buildings. The next nearest listed buildings are No.11 and No.10 Caroline House, both Grade II, located 19m north, and No.6 Cloth Hill, Grade II*, located 28m south. The nearest structures were the garden wall of No.26 Old Grove House to the north-west and garden wall of Cloth Hill, 30m to the south.

There were no locally listed buildings, natural features, or structures nearby the site.

2.11 Underground Infrastructure

The Transport for London asset map showed the nearest asset to be Northern underground line. The zone of influence was 21m west of the site. An extract of the asset map is presented in Figure 10.

Information on the presence of public utilities, such as sewers or water mains, was not available at this stage.

2.12 Unexploded Ordinance (UXO)

Review of Zetica UXO risk maps indicated the site to be within a moderate risk area from bomb strikes. An assessment by a UXO specialist is recommended for moderate and high-risk sites. A copy of the Zetica UXO risk map is presented in Figure 11.

Section 3 Screening

3.1 Introduction

The Ove Arup 2008 Scoping Study prepared for the London Borough of Camden and the 2021 Camden Planning Guidance: Basements require that any development proposal that includes a subterranean basement should be screened to determine whether a full BIA is required.

A number of screening tools are included in the Arup document (Ref: Camden geological, hydrogeological and hydrological study, Issue01/November 2010) and the CPG, comprising a series of questions within a screening flowchart for three categories: Groundwater Flow, Land Stability and Surface Flow and Flooding. Responses to the questions are tabulated below.

3.2 Groundwater Flow

The response to the Groundwater Flow screening assessment is given in Table 3.1.

Table 3.1 – Subterranean (Ground Water) Flow Screening

Question	Response
1a. Is the site located directly above an aquifer?	**Yes** – The Bagshot Formation was classified as a Secondary A Aquifer.
1b. Will the proposed basement extend beneath the water table surface?	**Unknown** – The basement could extend beneath the water table if groundwater is present.
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	No – The nearest surface water was Whitestone Pond 285m N, and the nearest watercourse the Westbourne 240m NW (Figure 7).
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No – The site was outside the Hampstead Heath Chain Catchment (GHHS).
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No – The proportion impermeable to permeable surface area will remain the same.
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No – There will be no additional areas of impermeable surface, and permeable areas will be retained.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	No – Nearest pond (285m N) was at an elevation ~8.5m above the site.

3.3 Slope Stability

The response to the Slope Stability screening assessment is given in Table 3.2.

Table 3.2 – Slope Stability Screening

Question	Response
1. Does the existing site include slopes, natural or manmade, greater than 7° (approximately 1 in 8)?	No – There are no slopes on-site that exceed 7°.
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7° (approximately 1 in 8)?	No – No reprofiling was part of the proposed development.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7° (approximately 1 in 8)?	**Yes** – Grove Passage to the north sloped down by ~8°.
4. Is the site within a wider hillside setting in which the general slope is greater than 7° (approximately 1 in 8)?	No – The average slope of the surrounding area was below 7°.
5. Is the London Clay the shallowest strata at the site?	No – The BGS and GHHS show Bagshot Formation to be the shallowest strata.
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	No – The proposed plans did not show any trees being removed.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	**Unknown** – Although unlikely given Bagshot Formation was typically granular.
8. Is the site within 100 m of a watercourse or potential spring line?	No – The nearest surface water was Whitestone Pond 285m N, and the nearest watercourse the Westbourne 240m NW (Figure 7).
9. Is the site within an area of previously worked ground?	No - The relevant geological map did not show any Made Ground or Worked Ground within or near by the site.
10. Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	**Yes/Unknown** – The site was within a Secondary A Aquifer, but the groundwater level as unknown.
11. Is the site within 50m of the Hampstead Heath ponds?	No – The site was outside the Hampstead Heath Chain Catchment (GHHS, Figure 12).
12. Is the site within 5 m of a highway or pedestrian right of way?	**Yes** – Groove Passage directly to the north and The Mount directly to the east.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	**Unknown** – It was unknown whether all the neighbouring properties had existing basements.
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No – Exclusion zone for underground line was 21m west (Figure 10)

3.4 Surface Flow and Flooding

The response to the Surface Flow and Flooding screening assessment is given in Table 3.3.

Table 3.3 – Surface Flow and Flooding Screening

Question	Response
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No – The site was outside the Hampstead Heath Chain Catchment (GHHS,)
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	No – Existing permeable and impermeable areas will be maintained.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	No – There will be no additional areas of impermeable surface, and permeable areas will be retained.
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	No – No changes were anticipated to site drainage.
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No – The quality of surface water would not be affected.
6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature?	No – The site was not at risk from surface water flooding or in a local flood risk zone.

3.5 Non-technical Summary of Screening Process

Based on the screening exercise, further stages of the basement impact assessment are required. A summary of the basement impact assessment requirements has been provided in Table 3.4 and Table 3.5.

Table 3.4 – Groundwater Flow

Item	Description
Q1a	**Yes** – The Bagshot Formation was classified as a Secondary A Aquifer.
Q1b	**Unknown** – The basement could extend beneath the water table if groundwater is present.

Table 3.5 – Land Stability

Item	Description
Q3	**Yes** – Grove Passage to the north sloped down by 7.6°.
Q7	**Unknown** – Although unlikely given Bagshot Formation was typically granular.
Q10	**Yes/Unknown** – The site was within a Secondary A Aquifer, the groundwater level is unknown.
Q12	**Yes** – Groove Passage directly to the north and The Mount directly to the east.
Q13	**Unknown** – It was unknown whether all the neighbouring properties had existing basements.

Section 4 Scoping

4.1 Introduction

The purpose of scoping is to assess in more detail the issues of concern identified in the screening process (i.e. where the answer is “yes” or “unknown” to any of the questions posed) to be investigated in the impact assessment. Potential hazards are assessed for each of the identified potential impact factors.

The scoping stage is furthermore to assist in defining the nature of the investigation required to assess the impact of the issues of concern identified in the screening process. The scope of the investigation must comply with the guidance issued by the London Borough of Camden Council and be a suitable basis on which to assess the potential impacts.

4.2 Potential Impacts

The following potential impacts were identified in Table 4.1.

Table 4.1 – Potential Impacts

Screening Flowchart Question	Potential Impacts	Discussion
Is the site located directly above an aquifer? Will the proposed basement extend beneath the water table surface?	Basement could extend into an underlying aquifer and thus affect the groundwater flow regime. Alterations of an existing groundwater flow regime could cause local increase or decrease of groundwater levels.	The BGS data showed the presence Bagshot Formation, which was expected to comprise sands was classified as a Secondary “A” Aquifer and thus expected to be permeable allowing groundwater flow. Site investigation and groundwater monitoring to establish soil and groundwater conditions. **Effects mitigated at design stage.**
Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7° (approximately 1 in 8)?	Basement development could cause slope instability within neighbouring sites.	Permanent and/or temporary works must be designed to ensure the induced ground movements are within tolerable limits and temporary works to prevent causing instability to neighbouring sites. **Effects mitigated at design stage**.

Screening Flowchart Question	Potential Impacts	Discussion
Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	Changes to moisture content in soils with a shrink-swell potential can cause damage to structures.	The anticipated ground conditions are indicated to be the Bagshot Formation, which was considered unlikely to have any significant cohesive contained, which would pose a risk from shrinkage and swelling. Site investigation establish soil conditions. **Effects mitigated at design stage.**
Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	The proposed construction could require dewatering, which can cause ground subsidence.	Site investigation and groundwater monitoring to establish soil and groundwater conditions. **Effects mitigated at design stage.**
Is the site within 5 m of a highway or pedestrian right of way? Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Basement construction can result in undermining of foundations of neighbouring properties and cause excessive ground movements resulting in structural instability.	Several of the neighbouring properties were expected to have basements based on historic planning applications, although there were no details on whether the remaining properties had basements. The site had a complex of existing basement structures with the proposed extension within the existing basement structure. It is therefore considered unlikely that the proposed basement extension would have any material effect to the existing foundation structure relative to neighbouring properties. However, undertaking of a Ground Movement Assessment was recommended. For the highway structures, permanent and/or temporary works must be designed to ensure the induced ground movements are within tolerable limits and temporary works to prevent damage during construction. **Effects mitigated at design stage**.

Section 5 Intrusive Investigation

5.1 Proposed Project Works

The proposed intrusive investigation was designed to provide information on the ground conditions and to aid the design of foundations for the proposed basement development. The intended investigation, as outlined within the Soils Limited quotation (Q26020 Rev1, dated 25th July 2022), was to comprise the following items:

- 1No. 15m CP borehole,
- 2No. up to 6m WS boreholes,
- 2No. up to 6m SPT N profiles via dynamic probes,
- 3No up to 6m deep groundwater monitoring wells,
- 1No. post site works groundwater level monitoring,
- Geotechnical laboratory testing,
- Contamination analysis to aid waste classification.

5.1.1 Actual Project Works

The actual project works were undertaken between the 25th and 30th August 2022, with subsequent sample logging, laboratory testing, monitoring, and reporting. The actual works comprised:

- 1No. 15m CP borehole (BH1),
- 2No. 6m WS boreholes (WS1 and WS2),
- 2No. 6m SPT N profiles via dynamic probes (DP1 and DP2),
- 3No up to 7m deep groundwater monitoring wells,
- 1No. post site works groundwater level monitoring,
- Geotechnical laboratory testing,
- Contamination analysis to aid waste classification.

The CP borehole was backfilled with arisings to 7.0m below ground level (bgl), followed by the installation of a 7m monitoring well. Monitoring wells were installed into WS1 and WS2 to the base of each borehole at 6.0m bgl.

All exploratory hole locations have been presented in Figure 3.

Following completion of site works, soil cores were logged, and sub sampled so that samples could be sent to the laboratory for both contamination and geotechnical testing.

5.2 Ground Conditions

The intrusive investigation was conducted between the 25th and 30th August 2022 and comprised:

- One 15m deep cable percussive borehole (BH1) drilled using a demountable rig, at a location provided by the Client's engineers. Standard Penetration Tests (SPT) were undertaken at 1.0m centres for the first 5.0m metres, and then at 1.5m centre to 15.0m bgl. A 7m monitoring well was installed into the borehole for post site works groundwater observations.
- Two 6.0m deep windowless sampler boreholes (WS1 and WS2) were drilled using an Archway Mast-Off drilling rig at locations provided by the Client's engineers (WS1) and Soils Limited (WS2).
- Two 6.0m deep super heavy dynamic probes (DP1 and DP2) undertaken prior and adjacent to their respective windowless sampler boreholes.
- Installation of three 6 to 7m deep groundwater monitoring wells. Once located in each borehole and comprised 1m of plain pipe with a bentonite surround followed by 5m of slotted pipe with a gravel surround.

The maximum depths of exploratory holes have been included in Table 5.1.

All exploratory holes were scanned with a Cable Avoidance Tool (C.A.T.) and GENNY prior to excavation to ensure the health and safety of the operatives.

Table 5.1 Final Depth of Exploratory Holes

Exploratory Hole	Depth (m bgl)
BH1^{W}	15.00
WS1^{W} [DP1]	6.00 [6.00]
WS2^{W} [DP2]	6.00 [6.00]

Note(s): ^{W} - well installation. The depths given in this table are taken from the ground level on-site at the time of investigation.

The approximate exploratory hole locations are shown on Figure 3.

The soil conditions encountered were recorded and soil sampling commensurate with the purposes of the investigation was carried out. The depths given on the exploratory hole logs and quoted in this report were measured from ground level.

The soils encountered from immediately below ground surface have been described in the following manner. Where the soil incorporated an organic content such as either decomposing leaf litter or roots or has been identified as part of the in-situ weathering profile, it has been described as Topsoil both on the logs and within this report. Where man has clearly either placed the soil, or the composition altered, with say greater than an estimated 5% of a non-natural constituent, it has been referred to as Made Ground both on the log and within this report.

For more complete information about the soils encountered within the general area of the site reference must be made to the detailed records given within Appendix B, but for the purposes of discussion, the succession of conditions encountered in the exploratory holes in descending order can be summarised as:

Made Ground (MG)
Bagshot Formation (BGS)

The ground conditions encountered in the exploratory holes are summarised in Table 5.2.

Table 5.2 Ground Conditions

Strata	Epoch	Depth Encountered (m bgl)		Typical Thickness (m)	Typical Description
		Top	Bottom		
MG	Anthropo-cene	G.L.	1.00 to 2.50	2.00	Orangish brown slightly gravelly/ gravelly clayey fine to medium SAND, with ash, and brick.
BGS	Eocene	1.00 to 2.50	>15.00[1]	Not proven[2]	Brownish yellow very silty/clay fine to medium SAND, with occasional beds of orangish brown sandy CLAY.

Note(s): [1] Final depth of exploratory hole. [2] Base of strata not encountered. The depths given in this table are taken from the ground level on-site at the time of investigation.

5.3 Ground Conditions Encountered in Exploratory Holes

The ground conditions encountered in exploratory holes have been described below in descending order. The engineering logs are presented in Appendix C.1.

5.3.1 Made Ground

Soils described as Made Ground were encountered in all three boreholes from ground level to depths between 1.00 and 2.50m bgl.

The Made Ground was dominant strata was orangish brown slightly gravelly/ gravelly clayey fine to medium SAND. The gravel as fine to medium, angular to sub-rounded flint, ash, and brick.

The Made Ground also included occasional beds of soft brown slightly gravelly sandy CLAY. The gravel was fine to medium sub-rounded to angular flint, brick and ash.

The established depth of Made Ground found at each exploratory hole location have been included in Table 5.3.

Table 5.3 Established Depth of Made Ground

Exploratory Hole	Depth (m bgl)
BH1	2.50
WS1	1.00
WS2	2.50

5.3.2 Bagshot Formation

Soil described as Bagshot Formation was encountered underlying the Made Ground and persisted to the base of all three boreholes at 6.00m and 15.00m bgl.

The Bagshot Formation was generally a SAND with occasional beds/ pockets of CLAY. The soil encountered typically comprised brownish yellow very silty/clay fine to medium SAND, with occasional beds of orangish brown sandy CLAY.

The established depth of Bagshot Formation found at each exploratory hole location have been included in Table 5.4.

Table 5.4 Established Depth of Bagshot Formation

Exploratory Hole	Depth (m bgl)
BH1	15.00[1]
WS1	6.00[1]
WS2	6.00[1]

Note(s): [1] Final depth of exploratory hole.

5.4 Roots

No roots were encountered within the boreholes. However, it must be emphasised that the probability of determining the maximum depth of roots from a narrow diameter borehole is low. A direct observation such as from within a trial pit is necessary to gain a better indication of the presence/ maximum root depth.

Roots may be found at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs.

Within the garden there were two trees located in the southeast corner. Off-site a mature tree was located opposite the site on the eastern side of The Mount

5.5 Groundwater

Groundwater was not encountered during the drilling process. It was possible, the speed of drilling, use of casing and or water to aid the drilling process, masked any groundwater strikes.

A 6m monitoring well was installed WS1 and WS2, and a 7m monitoring well in BH1, comprising 5 to 6m of slotted pipe with a gravel filter pack, followed by 1m of plain with bentonite seal to ground level. Following installation, the wells were monitored on a single occasion on the 16th September 2022. All three wells were recorded as dry.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted between August and September (2022), when groundwater levels are typically at their annual minimum (lowest) elevation. Then raising to their annual maximum (highest) which typically occurs around March.

Groundwater equilibrium conditions may only be conclusively established, if a series of observations are made via groundwater monitoring wells.

Section 6 Discussion of Geotechnical In-Situ and Laboratory Testing

6.1 Standard Penetration Tests

Standard Penetration Tests (SPTs) were undertaken in BH1. The results were interpreted based on the classifications outlined in Appendix D.1, Table D.1.1 to Table D.1.2.

The SPT “N60” values presented have been corrected in accordance with BS EN 22476 Part 3, to account for the rig’s trip hammer efficiency, borehole depth, overburden factors etc. Further correction of the ‘N’ values should therefore not be necessary. The energy ratio of the drilling rig was 66%. The energy ratio for each location is presented on the individual logs within Appendix C.1.

The Bagshot Formation recorded SPT “N60” values between 15 and 34 in granular soils and 22 in cohesive soil. Classifying the relative density of the granular soils as medium dense to dense and classifying the cohesive soils as high strength. The cohesive soil has an inferred undrained cohesive strength of 110kPa. The relative density of the granular soils was increasing with depth.

A full interpretation of the SPT results, are outlined in Appendix D.2, Table D.2.1.

6.2 Dynamic Probe Tests

Dynamic probing (DPSH) was undertaken at two locations (DP1 to DP2) adjacent and prior to the drilling of WS1 and WS2 both to a depth of 6.00m bgl. The results were converted to equivalent SPT “N60” values based on dynamic energy using commercial computer software (Geostru). The results were then interpreted based on the classifications outlined in Appendix D.1,Table D.1.1 to Table D.1.2.

The SPT “N60” values presented have been corrected in accordance with BS EN 22476 Part 3, to account for the rig’s trip hammer efficiency, borehole depth, overburden factors etc. Further correction of the ‘N’ values should therefore not be necessary. The energy ratio of the drilling rig was 73.70%. The energy ratio for each location is presented on the individual logs within Appendix C.1.

The Bagshot Formation recorded equivalent SPT “N60” values between 7 and 13 within cohesive beds and 11 and 34 in granular beds. The cohesive beds were classified as low to medium strength, with an inferred undrained cohesive strength of 35 to 65kPa. The relative density of the granular beds was classified as medium dense to dense. The cohesive soils increased in strength with depth apart from between 4.30m and 4.60m bgl which corresponded to a low strength bed of CLAY. The relative density of the granular soils increased with depth.

A full interpretation of the DPSH tests, are outlined in Appendix D.2, Table D.2.2.

6.3 Atterberg Limit Tests

Atterberg Limit tests were performed on two samples obtained from the Bagshot Formation, one cohesive and one granular. The results were classified in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

The cohesive sample was classified as low volume change potential in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

The granular sample was confirmed as non-plastic and has not volume change potential in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

A full interpretation of the Atterberg Limit tests, are outlined in Table D.2.3, Appendix D.2 and the laboratory report in Appendix D.3.

6.4 Particle Size Distribution Tests

Particle Size Distribution (PSD) tests were performed on six samples from the Bagshot Formation. Two out of the six samples were classified as cohesive SILT/CLAY and the remaining four samples as granular SAND.

The two cohesive samples recorded percentage passing the 63um sieve of 57% and 81%, taken from depths of 9.00m and 12.00m bgl. These cohesive soils have a volume change potential in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

The four granular samples recorded percentage passing the 63um sieve between 21% and 28%. In accordance with NHBC Standards Chapter 4.2 these samples had no volume change potential. All four samples had a potential volume change potential in accordance with BRE Digest 240.

Note that a cohesive soil is only classified as having a volume change potential if it is also plastic and an Atterberg Limit test can be conducted on the strata.

A full interpretation of the PSD tests, are outlined in Table D.2.4, Appendix D.2 and the laboratory report in Appendix D.3.

6.5 Sulphate and pH Tests

Five samples, one from the Made Ground and four from the Bagshot Formation where submitted for water soluble sulphate (2:1) and pH testing in accordance with Building Research Establishment Special Digest 1, 2005, ‘Concrete in Aggressive Ground’.

The tests recorded water soluble sulphate between <10mg/l and 28mg/l with pH values of 5.7 to 7.8.

The significance of the sulphate and pH Test results are discussed in Section 8.2 and the laboratory report in Appendix D.3.

Section 7 Engineering Appraisal

7.1 Established Ground Conditions

An engineering appraisal of the soil types encountered during the site investigation and likely to be encountered during the redevelopment of this site is presented. Soil descriptions are based on analysis of disturbed samples taken from the exploratory holes.

7.1.1 Made Ground

Foundations must not be placed on non-engineered fill unless such use can be justified on the basis of a thorough ground investigation and detailed design. Foundations must be taken through any Topsoil and/or Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

Soils described as Made Ground were encountered in all three boreholes from ground level to depths between 1.00 and 2.50m bgl.

7.1.2 Bagshot Formation

Soil described as Bagshot Formation was encountered underlying the Made Ground and persisted to the base of all three boreholes at 6.00m and 15.00m bgl. The Bagshot Formation was generally a SAND with occasional beds/ pockets of CLAY.

The SPTs and inferred SPTs classified the relative density of the granular soils as medium to dense, with the density increasing with depth. The cohesive soils were low to high strength within inferred undrained cohesive strength of 35 to 110kPa. The cohesive soils increased in strength with depth apart from between 4.30m and 4.60m bgl which corresponded to a low strength bed of CLAY.

Atterberg Limit and PSD testing classified the granular soils as having no volume change potential in accordance with NHBC Standards Chapter 4.2. All four samples of granular soils were classified as having a volume change potential in accordance with BRE Digest 240. An Atterberg Limit test carried out on a granular sample was recorded as none-plastic and would have no volume change potential. The cohesive soils were classified as low volume change potential in accordance with both NHBC Standards Chapter 4.2 and BRE Digest 240.

Soils of the Bagshot Formation are predominantly granular soils with beds of overconsolidated cohesive soil. These soils are expected to display moderate bearing capacities with low to moderate settlement characteristics. The soils of the Bagshot Formation are considered suitable for the proposed basement, with foundations taken through any localised cohesive beds into granular soils to prevent increased localised settlements.

7.1.3 Guidance on Shrinkable Soils

The ground conditions were established as Made Ground with a typical thickness off 2.00m, overlying the bedrock of Bagshot Formation.

Atterberg Limit and PSD testing were classified in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2 to determine the volume change potential.

The volume change potential for each stratum was established and presented in Table 7.1.

Table 7.1 Established Volume Change Potential by Strata

Strata	Volume Change Potential		Established Lower Boundary (m bgl)
	BRE	NHBC	
BGS – Cohesive	Low	Low	Variable
BGS - Granular	Yes	No	Not proven[1]

Note(s): [1]Base of strata not encountered.

The Bagshot Formation was variable with cohesive and granular beds, with the dominant soil classification being granular.

7.1.4 Groundwater

Groundwater has not been encountered as part of this investigation, which included monitoring on a single occasion of installed wells. The maximum depth of the installed wells was 7.00m bgl and was recorded as dry.

Due to the granular nature of the Bagshot Formation groundwater could be found migrating through these soils, with localised perched groundwater where cohesive beds are encountered.

Section 8 Foundation Scheme

8.1 Foundation Recommendations

Foundations **must not** be constructed within any Made Ground/Topsoil due to the likely variability and potential for large load induced settlements both total and differential.

It was understood that the basement extension was to be constructed using contiguous piles and mass concrete spread foundations. The deepening works within the existing basement was to be undertaken using mass concrete underpinning.

8.1.1 Shallow Foundations within new Basement Excavations

Foundations constructed within the basement excavation could be considered and the bearing capacity of such foundations is given below. If the foundation is to include lateral load from retained soil, then the distribution of loads on the foundation will be trapezoidal and the maximum pressure will be at the toe of the foundation. In such cases additional analyses must be requested by the Client such that the appropriate analyse is undertaken.

If the wall is to have backfill placed on both sides, the backfill must be placed in shallow rises on both sides to maintain similar lateral forces on both sides of the wall.

The proposed basement development would require excavations of between 0.20m and 3.40m. The corresponding unloading of the soils at formation level was evaluated as circa 4kPa to 60kPa, adopting for the removed soil with an average unit weight of circa 18kN/m^3.

An "**net**" allowable bearing capacity of **155kPa** was calculated, founding at a minimum depth of 3.40m bgl within granular Bagshot Formation, based on a 5m by 0.50m spread foundation.

Taking account of the removed overburden pressure the "**gross**" bearing value could be taken as **215kPa** for the 3.40m deep basement extension. For the deepening works below the existing basement, where limited overburn will be removed an allowable bearing capacity of 155kPa was recommended.

For the allowable bearing value given above, settlements **should not** exceed **25mm**, provided that excavation bases are carefully bottomed out and blinded, or concreted as soon after excavation as is possible and kept dry. Settlements may be taken as proportional to the applied foundation pressure for the given size of the foundations.

The use of reinforced trench fill foundations reduces the potential for differential settlement affecting the foundations.

Anticipated settlements may be taken as proportional to the bearing capacity adopted (for the same configuration of foundation), therefore if the bearing value is halved the anticipated settlement will halve.

All foundation formations must be examined, recorded, and signed off by a competent person.

Foundations must not be cast over foundations of former structures and other hard spots.

8.1.2 Piled Foundations

For the contiguous piled wall section of the basement, preliminary pile vertical load capacities are provided founding in the Bagshot Formation.

The construction of a piled foundation is a specialist job with the actual pile working load depending on the pile type and installation method. Prior to finalising the foundation design the advice from a reputable contractor who is familiar with the ground and groundwater conditions present at the site must be sought.

The vertical load capacities are provided for varying diameters and lengths of bored piles taken into the Bagshot Formation, based on geotechnical laboratory testing and in-situ tests, and must only be used for preliminary design purposes.

A factor of safety of 3 was applied to the characteristic line derived from testing undertaken, for both the shaft and base load capacities.

The bearing values are given in Appendix E.1. and are applicable to single vertically loaded piles. Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of about 0.8 and a calculation made to check the factor of safety against block failure.

From ground level the upper 4m of the pile shaft has been ignored in the preliminary pile design given.

To prevent necking of the green concrete, temporary casing may be required where the pile passes through the Made Ground or Bagshot Formation and below the groundwater table (if encountered). To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

No allowance has been made for any negative skin friction that could be generated if the piles passed through very soft cohesive soils. The negative skin friction must be applied to the pile working load and must not be factored.

8.1.3 Stability Issues

The excavation of the basement must not affect the integrity of any adjacent structures or land beyond the site boundaries. Where there is a sufficient distance between the site boundary and the basement excavation, support may be permitted using a wide strip foundation to form an earth retaining structure. In other cases, the most suitable form of construction could be within a coffer dam structure using a sheet piles, secant or contiguous concrete piled wall around the periphery of the structure.

Generally cantilevered piled walls have an open face to embedded ratio of about one to two ie. a supported face 3.40m in height would require a penetration into the ground, below the base of the excavation, of about 7.00m. Should the piled wall be purely an unsupported cantilever then it is likely that quite deep section sheet piles or large diameter bored piles would be required. Installing a braced waling to the wall could reduce the sheet section, or diameter of the piles.

The excavation of the proposed basement was estimated at 3.4m bgl. Groundwater was not encountered at this depth during the investigation but could be through migration through the Bagshot Formation. The groundwater level could be encountered at a higher elevation following periods of heavy rainfall or during winter months.

Groundwater levels could rise, particularly after prolonged periods of wet weather.

If the construction works take place during the winter months or during/after prolonged periods of wet weather perched water could accumulate or groundwater could be found migrating through the granular deposits of the Bagshot Formation. If any water ingress is not prevented by dewatering, the basement slab could become “buoyant” whilst empty. This must be taken into account in the design. Support of excavation and dewatering with pumps from sumps introduced into the floor of the excavation must be considered.

8.2 Subsurface Concrete

The sulphate and pH tests carried out in accordance with BRE Special Digest 1, 2005, ‘Concrete in Aggressive Ground’, established the site concrete classifications for each stratum as presented in Table 8.1.

Table 8.1 Concrete Classification

Stratum	Design Sulphate Class	ACEC Class
MG/BGS	DS-1	AC-2z

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1 2005, *‘Concrete in Aggressive Ground’* taking into account any possible exposure of potentially pyrite bearing natural ground and the pH of the soils.

8.3 Excavations

Shallow excavations in the Made Ground and Bagshot Formation are likely to be marginally stable in the short term at best.

Deeper excavations taken into the Bagshot Formation are unlikely to be stable and required support in the temporary and permeant case. Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions must therefore be taken to ensure that such earth faces are adequately supported or battered back to a safe angle of repose.

Excavations beneath the groundwater table (if encountered) are likely to be unstable and dewatering of foundation trenches may be necessary.

Section 9 Chemical Analysis

9.1 General

Soils Limited have undertaken chemical analysis on a single soil sample from WS2 between 1.20m and 1.70m bgl. The analysis including asbestos screening, metals, semi-metals, speciated polyaromatic hydrocarbons (PAH), extractable petroleum hydrocarbons (EPH) and waste acceptance criteria (WAC).

Sampling was undertaken to assist the client with off-site disposal of soils arising from the construction of the basement.

The results of the chemical analyses are presented in Appendix F.

Section 10 Ground Movement Assessment

10.1 Introduction

A ground movement assessment was carried out to provide an estimate of the expected damage on the neighbouring properties due to the excavation and construction of the proposed basement at No.9 The Mount. The ground movement assessment was developed on the basis of information from the Client and their Consultants.

This section provides calculations to determine ground movements that may result from the construction of the proposed basement development and to assess how these may affect the stability of neighbouring buildings. Movements are likely to occur through the following mechanisms:

10.1.1 Heave Movements

The construction of the proposed development will require the lowering of the existing basement floor level to match the formation levels presented on the drawings prepared by Constructure. Soil removal was variable and ranged between circa 0.20m and 1.00m, increasing to circa 3.40m bgl in correspondence of the new storage vaults. The excavation will cause the unloading of the soils of the Bagshot Formation, and this may cause a degree of heave in both the short and the long-term within cohesive layers.

10.1.2 Foundation Construction

Construction of foundations can lead to movements due to basement wall construction and any net increase in loading.

The nature of final movements depends on the level of loading achieved. Downwards movements (settlements) must be expected when the applied load is greater than the weight of soil removed. A certain degree of heave will remain in the long term when the applied load is lower than the weight removed. Settlement may potentially also occur where foundation loads are transferred to deeper, previously unloaded soil.

Workmanship will affect the adjoining structures because of the application of the dry pack between the existing foundations and the underpinning and will be considered within the ground movement analysis.

10.1.3 Lateral Wall Deflection

The bending of the basement walls would directly cause lateral movements within the retained ground. The relaxation in the soils induced by the transition to the active state then causes the settlement of the soils within the failure wedge.

10.2 Site Model and Mechanical Properties

For this BIA, a thickness of 2.50m of Made Ground was considered at the site. The Made Ground was conservatively considered as predominantly cohesive.

The proposed basement will be set within the soil of the Bagshot Formation, which included an upper granular horizon directly underlying the Made Ground, a cohesive layer and a further granular layer to the final investigated depth.

The stratigraphy and the mechanical parameters of the soils involved in the analyses under undrained and drained conditions were respectively presented in Table 10.1 and Table 10.2.

Table 10.1 – Soil Parameters – Undrained Conditions

Stratum	Top of Stratum (m bgl)	Undrained Cohesion (kPa)	Young's Modulus (MPa)	Poisson's Ratio
MG	0.00	40	15	0.50
BGS – G	2.50	-[1]	16.5	0.30
BGS – C	8.00	90	20	0.50
BGS – G	12.00	-[1]	30	0.29

Note: [1] Undrained conditions not compatible with granular soils. G = granular, C = cohesive

Table 10.2 – Soil Parameters – Drained Conditions

Stratum	Top of Stratum (m bgl)	Friction Angle (ϕ°)	Effective Cohesion (kPa)	Young's Modulus (MPa)	Poisson's Ratio
MG	0.00	23	0	10.5	0.33
BGS – G	2.50	31	0	16.5	0.30
BGS – C	8.00	25	0	15	0.31
BGS – G	12.00	33	0	30	0.29

Note: G = granular, C = cohesive

Groundwater was not encountered at the time of drilling and during the agreed monitoring visit, but was considered at ground level for the development of the ground movement assessment. This therefore represents a very conservative approach. Should groundwater be encountered during further monitoring visits or at the time of the excavation, this would not negatively impact the ground movements presented in this report.

10.3 Ground Movement Arising from Basement Excavation

The ground movement assessment was carried out considering the underpinning of the existing basement walls and the installation of a contiguous pile wall upslope of the proposed storage vaults.

Ground movements will be caused by the excavation for reaching the desired basement depths, the construction of the underpinning/contiguous pile wall and the workmanship errors derived from the application of the dry pack between the existing foundations and the underpinning.

The proposed development considered the excavation of 0.20m to 3.40m of soil within the Made Ground and the Bagshot Formation. The corresponding unloading of the soils at formation level was evaluated as circa 4kPa to 60kPa, adopting for the removed soils an average unit weight of circa $18kN/m^3$.

The underpinning will be built in individual narrow bays remote from the next bay in a prescribed sequence specified by the Structural Engineer, according to a scheme developed, to avoid excessive deformation of the soils surrounding the excavation. Steel reinforcement and dowel bars must be incorporated to provide structural integrity between the bays. Once the concrete has attained the strength specified by the Structural Engineer and the dry pack has been installed between the pier and the existing foundation, an adjacent bay may be excavated.

A ground movement assessment has been undertaken using OASYS Limited PDISP (Pressure induced DISPlacement analysis) analysis software. PDISP assumes that the ground behaves as an elastic material under loading, with movements calculated based on the applied loads and the soil stiffness (Eu and E') for each stratum input by the user. PDISP assumes perfectly flexible loaded areas and as such tends to overestimate movements in the centre of loaded areas and underestimate movements around the perimeters. If a different foundation/underpinning solution is adopted within the final design the ground movement assessment must be reviewed.

The ground movement assessment was undertaken on the assumption of high quality workmanship. However, the installation of the dry pack between the underpinning and the overlying foundations would cause a certain amount of settlements, which, with high quality work, is considered as not exceeding 5mm per underpinning lift. No workmanship error was considered applied to the contiguous pile wall. The mechanical properties of the soils involved in the analyses were defined in Table 10.1 and Table 10.2 of this report.

The most sensitive adjacent building was the adjoining property at No.8 Hampstead Grove, located to the west, which was assumed not to have a basement. No.8 The Mount to the south was determined to have a basement and therefore the differential depth would not be increased. The detail of the critical scenario considered for the development of the Ground Movement Assessment (GMA) and the undertaking of the Damage Category Assessment (DCA) using the approach on CIRIA C760 and the Burland scale are provided below.

10.3.1 Critical Scenario CS1

Critical scenario CS1 considered the effects of excavation and construction on the adjoining building at 8 Hampstead Grove. The critical distance adopted for the development of the GMA and the DCA was considered equal to 6.60m, equal to the width of the building.

The critical section considered in scenario CS1 is presented in Figure 12.

The calculation of lateral movements in correspondence of the basement did not take into account the presence of liner walls. The underpins in correspondence of scenario CS1 were of a minimum of 0.40m thick and the second moment of inertia of the basement walls was evaluated as 533,333cm^4.

The excavations to the proposed basement formation level must be carried out by retaining the passive resistance of the soils in place, as prescribed In CIRIA C760.

The construction sequence considered in the ground movement assessment included the installation of three levels of temporary props for the excavation of the basement, respectively at the top, the middle and the base of the underpinning to prevent the development of excessive lateral ground movements. The temporary props applied during the excavation cannot be removed from the walls before being replaced by suitable permanent ones, before the concrete has reached a prescribed strength and before new permanent restraints are applied or when the Structural Engineers specify. The final permanent propping was represented by the ground and basement floor slabs, providing a “high stiffness” scheme, in agreement with the definition in CIRIA C760.

It is the Client’s responsibility to provide information on any changes to the layout and/or structural characteristics of the basement. Soils Limited must be immediately informed of any changes, as this could potentially invalidate the results of this Basement Impact Assessment.

Horizontal deflections at CS1 were due to just the lowering of the basement formation level. In this GMA, however, they were conservatively calculated considering the full height of the basement walls of circa 3.40m, with the deflection caused by the excavation of 3.40m of soil.

An accurate monitoring of ground and structural movements is required before, during and for a certain period after the completion of the construction process to check that movements do not exceed those calculated and presented in this report and allow the design of remedial measures, should the calculated movement be exceeded. If a different construction process is adopted, Soils Limited must be immediately informed and a reassessment of ground movements and expected damage on neighbouring structures must be carried out.

Horizontal movements rapidly dissipate with the distance from the excavation face. However, in this report the expected damage was conservatively calculated using the horizontal deflection in correspondence of the excavation, without applying any dissipation.

10.3.2 Short Term Heave

Calculated short term heave, due to the removal of soils above the formation level, was evaluated by adopting the parameters in Table 10.1 and intended as deriving from the unloading of the soils of the Bagshot Formation.

The largest short-term heave across the footprint of the proposed development was predicted to be of a maximum of -16mm (negative values indicate an upwards movement throughout this text) near the centre of the excavation. The movement decreased towards the boundaries of the excavation, along the boundary lengths of the basement. Heave was noted to occur within these areas ranging between -9mm and -1mm due to the net increase of surcharge load. A contour plot showing the variation of short-term movements across the entire basement footprint is presented in Figure 13, which showed that ground movements reduce to zero within <12m from the excavation.

10.3.3 Long Term Ground Movement

Long term movements generally depend on the development of the increase of heave (negative settlements) in the long-term due to the reduction in stiffness of the soils, with the dissipation of negative pore-water pressures, and the development of (positive) settlements due to the construction of the basement and the application of the loads from the upper structure to greater depths. Those movements develop contemporarily and generally cannot be distinguished, but an evaluation of the long-term heave, as independent values, was also reported for completeness on the contour plot in Figure 14. The maximum expected heave was calculated as circa -18mm and was caused by the stress relief caused by up to 3.40m deep excavations in the area of the new storage vaults. The expected heave due to excavations in the remaining area of the basement was less intense and did not exceed -9mm. Ground movements dissipated to zero within <15m from the excavation.

The maximum overall long-term ground movements under the proposed building footprint were calculated as between 17mm under the underpinning and -5mm (residual upwards movement due to applied load lower than the weight removed in the area of the new storage vaults). Movements along the excavation boundaries ranged between 17mm and 3mm. A contour plot with the variation of long-term movements across the basement footprint is presented in Figure 15, which showed the ground movements reducing to zero within <15m from the excavation.

The above ground movements were cumulative and, therefore, included long-term heave and settlements caused by the structural loads.

10.3.4 Settlements Due To Workmanship

The heave/settlement assessment undertaken within PDisp assumes perfect workmanship in the underpin construction and does not allow for settlement of the dry pack between existing footings and the new concrete. With good construction practice, these would be expected to not exceed 5mm (assuming 5mm per underpin lift). This value will be applied to the overall ground movement and corresponding impact assessment to give a worst-case damage category for the adjacent party wall properties.

10.4 Ground Movement Due to Retaining Wall Lateral Deflection

The excavation of the proposed basement will comprise the construction of retaining structures to preserve the stability of soils and of neighbouring structures. The excavations would be taken down to circa 3.40m below ground level, with the lateral wall deflection at CS1 due to the removal of circa 0.20m to 1.00m of soil to the passive side of the wall. For the purpose of this GMA, however, full excavations to 3.40m bgl were conservatively considered in the calculations.

The underpinning was considered surcharged by loads representing the normal activities that could develop on neighbouring residential sites, considered equal to 2kPa. The lateral wall deflection was calculated using the dedicated software Wallap by Geosolve. The horizontal movement at the excavation were therefore evaluated as <1.0mm and was presented in Figure 17.

Horizontal movements then rapidly dissipate with the distance from the excavation, as presented in CIRIA C760, Figure 6.15. However, in this report the expected damage was conservatively calculated using the horizontal deflection in correspondence of the excavation, without applying any dissipation.

It is the Client's responsibility to provide information on changes to the layout and structural characteristics of the basement. Soils Limited must be immediately informed of any changes, as this could potentially invalidate the results of this Basement Impact Assessment.

The analyses were developed considering information provided by the Client's Consultants with regards to building layout, construction sequence and loads. The results are therefore site specific and provide ground movements to be considered as limit values for a satisfactory development and must not be exceeded.

Different solutions could be adopted by the structural consultants or the contractor, but it is recommended to undertake the monitoring of ground and structure movements before, during and after the construction in order to avoid the limit values to be exceeded. Soils Limited must be immediately notified in the case of unexpected large movements, or movements in excess of those presented within this report.

The calculated movements for the evaluation of the expected damage on the neighbouring structures were summarised within Table 10.3 and the related ground movements identified on Figure 16 to Figure 17.

Table 10.3 – Summary of Estimated Movements

Scenario	Distance from the Excavation (m)	Critical Distance (m)	Horizontal Deflection (mm)	Vertical Deflection (mm)
CS1	0.00	6.60	1.0	5.4

Note: Vertical and horizontal movements are reported as absolute values.

Section 11 Damage Category Assessment

11.1 Introduction

The ground movements reported in Section 10, from both the detailed and the simplified approaches, were considered for assessing the expected potential damage category that the construction of a new basement was supposed to induce onto the adjoining properties. The assessment was carried out considering the method described in CIRIA Special Publication 200 (Burland et al., 2001) and CIRIA C760 (Gaba et al., 2017), based upon the method proposed by Burland et al. (2001) and taking into account the works by Burland and Wroth (1974) and Boscardin and Cording (1989).

The general categories of damage entity were summarised in Table 11.1.

Table 11.1 – Classification of Visible Damage To Walls

Category	Description
0 (Negligible)	Negligible – hairline cracks
1 (Very slight)	Fine cracks that can easily be treated during normal decoration (crack width <1mm)
2 (Slight)	Cracks easily filled, redecoration probably required. Some repointing may be required externally (crack width <5mm)
3 (Moderate)	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced (crack width 5 to 15mm or a number of cracks > 3mm).
4 (Severe)	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows (crack width 15mm to 25mm but also depends on number of cracks).
5 (Very severe)	This requires a major repair involving partial or complete re-building (crack width usually >25mm but depends on number of cracks).

11.2 Summary of Ground Movements and Evaluation of Relative Deflection

The analysis of the ground movements reported in Section 10 allowed to estimate the relative vertical and horizontal deflections on the properties adjoining the building for the proposed development at 9 The Mount.

The evaluation of the vertical and horizontal deflections for the cases and the scenario considered was reported on Figure 16 to Figure 17.

The results of the assessment were presented in Table 11.2, while in Figure 18 was defined the expected damage category on the adjoining structure according to the classification by Burland (2001) reported within CIRIA SP200 and CIRIA C760, which was developed for buildings having L/H ratios between width (L) and height (H) of up to 1.0.

Table 11.2 – Expected Damage Category

Section	Distance from Excavation (m)	Critical Distance (m)	Horizontal Deflection (mm)	Vertical Deflection (mm)	Horizontal Strain ε_h (%)	Deflection Ratio Δ/L (%)	Damage Category
CS1	0.00	6.60	1.0	5.4	0.015	0.082	1 (Very slight)

Note: Vertical and horizontal movements are reported as absolute values. The distance from the excavation did not contribute to the evaluation of horizontal strain and deflection ratio.

The Camden Planning Guidance (CPG): Basements, January 2021 revised the general approach with regards to the acceptability of proposed basement developments, with the expected damage considered acceptable if not worse than Category 1 (very slight damage) of the Burland Scale. It can be observed that the critical section considered in this analysis presented the expected damage not exceeding Category 1. The values reported within Table 11.2 are indicative of the stiffness adopted in the calculations and refer to the ground movements calculated within the report.

The calculated ground movements must be considered as limit values for a satisfactory development considering the information provided to Soils Limited at the time of writing this report and must not be exceeded.

It is recommended to undertake the monitoring of ground and structure movements before, during and after the construction in order to avoid the limit values to be exceeded. A pre-construction survey of the properties potentially affected by the proposed development is also recommended. Soils Limited must be immediately notified in the case of unexpected large movements, or movements in excess of those presented.

The above reported was specifically determined for the case considered and can be invalidated if changes are applied to building layout and structures.

11.3 Monitoring of Ground and Structures

Anticipated ground movements are expected to be minimal and reduced by the stiffness of the above structure and those adjoining. It is recommended to appoint a specialist Surveyor for monitoring ground and structural movements at regular intervals to confirm limits presented in this report are not exceeded.

Movement monitoring of the property itself and nearby structures within a radius of 20m must be undertaken before construction starts, continued through the construction phase and for an appropriate period thereafter. The Surveyor will be required to monitor ground movements to check the validity of the ground movement analysis, the performance of the temporary works and working methods adopted by the chosen Contractor.

The proposed monitoring must also include:

- Visual inspection of relevant walls with a condition survey produced of each wall prior to work commencing,
- Vertical movement of each wall must be monitored using as a minimum standard optical equipment,
- Lateral movement must be measured using laser systems.

A traffic light system based on green, amber and red trigger levels must be set in order to confirm the total ground movements and deflections presented throughout this BIA will not be exceeded, with specific actions to be taken if exceeding the amber and red trigger values.

Soils Limited must be immediately notified in the case of unexpected large movements, or movements in excess of those presented. A reassessment of ground movements and expected damage to neighbouring structures should be then carried out to take into account evidence from the construction stage.

Section 12 Basement Impact Assessment

12.1 Mitigation of Adverse Effects

This section of the report addresses the potential impacts identified by the scoping study and the relevant findings of the ground investigation and mitigation measures, where required.

12.1.1 Groundwater Flow

The following potential impacts were identified during the screening and scoping study.

- Basement could extend into an underlying aquifer and thus affect the groundwater flow regime.
- Alterations of an existing groundwater flow regime could cause local increase or decrease of groundwater levels.

The ground conditions were established to be granular Made Ground with a typical thickness of 2.00m, overlying the Bagshot Formation. The Bagshot Formation was predominantly a granular sand with beds of cohesive clay. The proposed basement development extended to a depth of 3.4m bgl and would be within granular sand based on the three boreholes undertaken. No groundwater strikes were recorded during drilling and post site monitoring, with wells installed to depths been 6.00m and 7.00m bgl.

The Bagshot Formation was classified by the EA as a Secondary A Aquifer and therefore groundwater could be found migration through or at a greater depth within the stratum.

Mitigation: The proposed basement would not extend below the groundwater level, with the groundwater level noted as being beyond 7.00m bgl during the course of investigation. The Bagshot Formation is classified as a Secondary A Aquifer and was found to be predominantly a granular sand with beds of cohesive clay. Water could potentially migrate through these soils, but the basement would have limited effect on the overall wider flow of groundwater. Local dewatering may be required if groundwater is found migrating through any of these soils.

12.1.2 Land Stability

The following potential impacts were identified during the screening and scoping study.

- Basement development could cause slope instability within neighbouring sites.
- Changes to moisture content in soils with a shrink-swell potential can cause damage to structures.

- The proposed construction could require dewatering, which can cause ground subsidence.
- Basement construction can result in undermining of foundations of neighbouring properties and cause excessive ground movements resulting in structural instability.

The intrusive investigation established the Bagshot Formation to be predominantly a granular sand with beds of cohesive clay. The sands posing not significant risk from shrinkage and swelling characteristics. Overall, the risk from shrink-swell characteristics was negligible to very low.

The ground movement and damage category assessment established the proposed construction to have a damage category of very slight on the Burland Scale. A damage category of up to very slight is considered acceptable and would not pose excessive risk to neighbouring properties and infrastructure.

Mitigation: Foundations must be designed for a low volume change potential where they pass through cohesive soils.

Structural design and method statements must draw on established successful practices, with the use of suitable temporary and permanent support to prevent damage to neighbouring properties or causing slope instability. Pre-start and completion surveys made of the adjoining properties. Monitoring of ground and structures to be undertaken before, during and for a sufficiently long period after the completion of the basement for the properties falling within the area of influence of the proposed development.

12.2 Surrounding Buildings

This section considers the potential effects of basement construction on nearby properties. The ground movement assessment (Section 10) determined the damage category (Section 11) to be between negligible and very slight on the Burland Scale for the critical sections evaluated.

Detrimental effects would be manifested as cracking and more serious structural damage. Many old buildings do exhibit signs of historic movement and repair. In practice, it is often difficult to attribute cracks visible in a structure to specific site construction activities unless a detailed survey of the affected structure and its founding strata had been undertaken before the construction works.

Any observed changes in the state of the building can then be causally linked to the works with more confidence and less debate than if no pre-works condition survey had been undertaken. Surveys require the cooperation of the property owners, as entry by surveyors into the property will be necessary. This would normally be undertaken in collaboration with the neighbour's party wall surveyors.

Close supervision will be made during the construction phase. Movement monitoring of ground, neighbouring and nearby structures will be undertaken before construction starts and continued through the construction phase and for an appropriate period thereafter.

The data from the site investigation has established soil and groundwater conditions. The client's engineer can prepare working drawings and construction method statements that will mitigate adverse effects of nearby properties.

12.3 Cumulative Effects

The proposed development comprised a single storey basement extension below the existing garden and deepening of the existing basement below the main building.

The proposed basement development was to extend to circa 3.40m bgl, with the western perimeter of the new extension being piled, running in a north to south direction. The basement extension was located between the existing basement and below ground garage. At the deepest point the proposed basement was circa 1.00m below the level of the public footpath along The Mount, with most of the basement below the raised garden area.

Groundwater was anticipated to be flowing in a southeast direction, at a depth of greater than 7.00m bgl. The proposed basement would be located above the groundwater level. Although the piled section would likely extend below the groundwater level at depth, groundwater would be able to flow around this section with limited effect on groundwater levels.

It is probable the neighbouring houses, which are of a similar age and construction have basements. Review of the Council's planning portal and historic estate agency plans indicated basements below No.8 The Mount, No.4 and No.6 Hampstead Grove.

Groundwater was determined during the investigation to be below 7.00m bgl, which suggests that a single storey basement would not significantly impact the overall groundwater flow regime. The site was not within a continuous set of terrace housing, if eventual multiple basements surrounding the site and groundwater levels rose, flow paths would remain around the complex of basements. Any impact would be minor at worst with a local rise in groundwater surrounding the basement sides acting as a barrier to the overall flow path.

Section 13 Conclusions and Recommendations of BIA

13.1 General

The findings of this report are informed by site investigation data and information regarding construction methods, sequences and loading provided by the Client. The analysis was undertaken on the assumption of high-quality workmanship.

The site was not within a wider area with slopes of >7°. However, Grove Passage which bordered the site to the north was locally sloping down in an eastly direction by ~8°. Provided the development follows best practices, with the use of suitable temporary and permanent support, the risk of causing slope instability was negligible. The installation of the proposed contiguous pile wall prior to any excavation works would aid to reduce risk of slope instability to neighbouring land.

The development would not change the percentage of permeable to impermeable surface areas cross the site. The basement extension was to be covered by subsoil and topsoil maintaining surface water infiltration. Although the development of a surface water management plan is recommended.

The site did not fall into an area at risk from river and sea flooding or surface water flooding. The site was in a CDA, but not within a local flood risk zone or along a street recorded to have historically flooded. Therefore, the undertaking of a detailed site-specific flood risk assessment was not technically required.

The existing property and neighbouring No.8 The Mount where Grade II listed buildings and appropriate consideration will be required for development of the proposed basement.

The ground conditions were found to be Made Ground (~2.0m) overlying the Bagshot Formation encountered to the full investigatory depth of 15.00m bgl. The Bagshot Formation was predominantly a granular sand with occasional beds of cohesive clay.

The granular Bagshot Formation had no volume change potential with localised clay beds with a low volume change potential. The risk of shrink and swelling was considered very low to low. Foundations must be designed for a low volume change potential where they pass through cohesive soils.

Groundwater standpipes installed to a maximum depth of 7.00m bgl were recorded as dry. The basement was therefore located above the groundwater level and would not significantly affect the groundwater flow regime. Local dewatering may be required if groundwater is found migrating through these soils.

The ground movement and damage category assessment established the proposed construction to have a damage category of very slight on the Burland Scale. A damage category of up to very slight is considered acceptable and would not pose excessive risk to neighbouring properties and infrastructure.

The cumulative effects of eventual multiple basements, of similar construction to the proposed were considered to have limited effect on the groundwater regime.

The permanent works must be designed to ensure induced ground movements surrounding the site are within tolerable limits and temporary works sufficiently design to prevent damage during construction. It was recommended monitoring of surrounding structure was undertaken before, during and for a certain period after the completion of the construction works.

Overall, it was considered the proposed development would have a limited impact on neighbouring properties provided a suitable basement construction was selected. This BIA was developed with reference to the information provided by the Client's consultant, presented in Appendix G. Soils Limited must be promptly informed in the case of different solutions be designed by the chosen contractor, as this could require the BIA to be reviewed.

List of Figures

List of Appendices

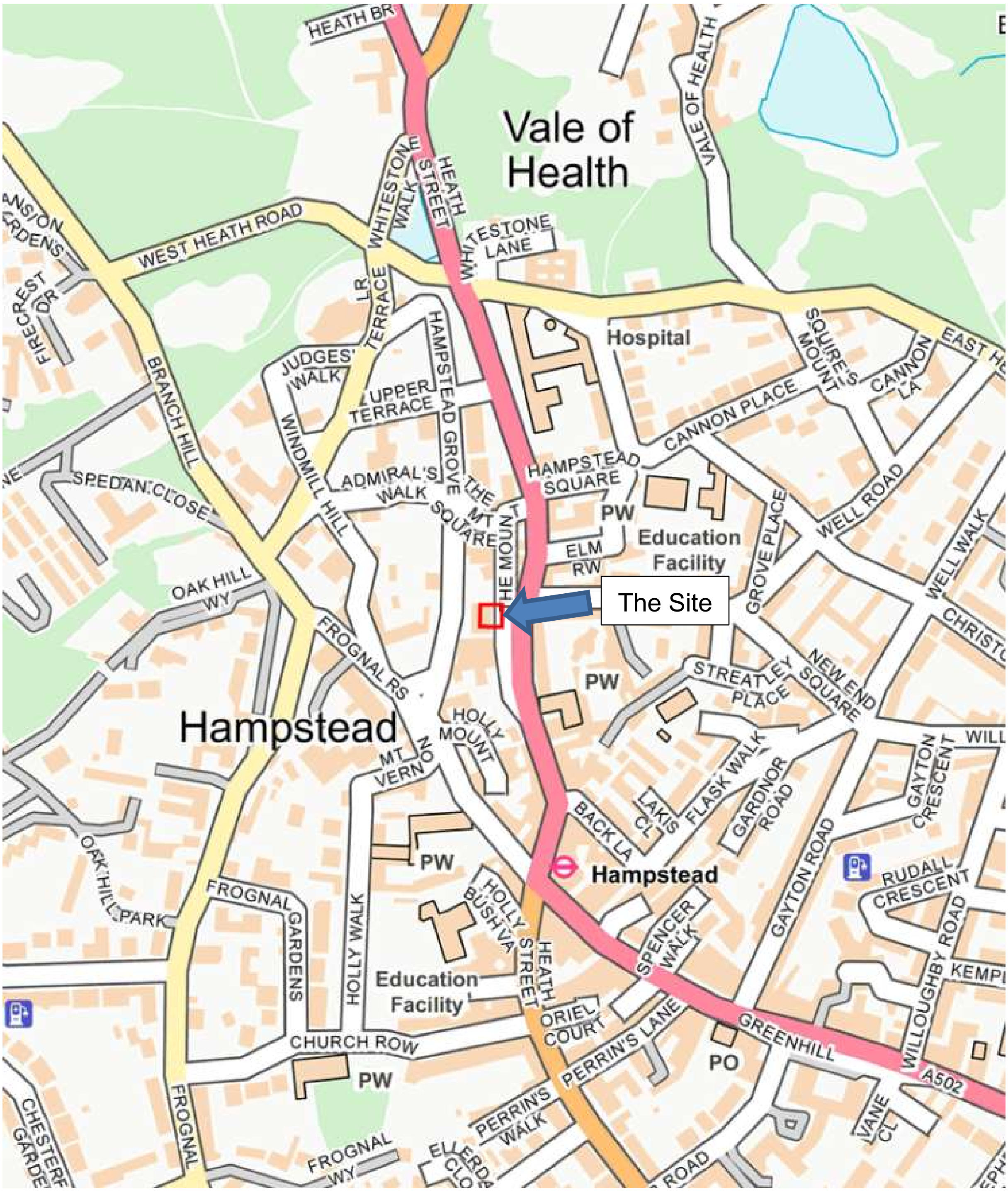

Figure 1 – Site Location Map

Job Number 20353	**Project** 9 The Mount, Hampstead, London NW3 6SZ
Client Mr & Mrs Alex Barnett	**Date** October 2022

Figure 2 – Aerial Photograph

Project
9 The Mount, Hampstead, London
NW3 6SZ

Client
Mr & Mrs Alex Barnett

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October 2022

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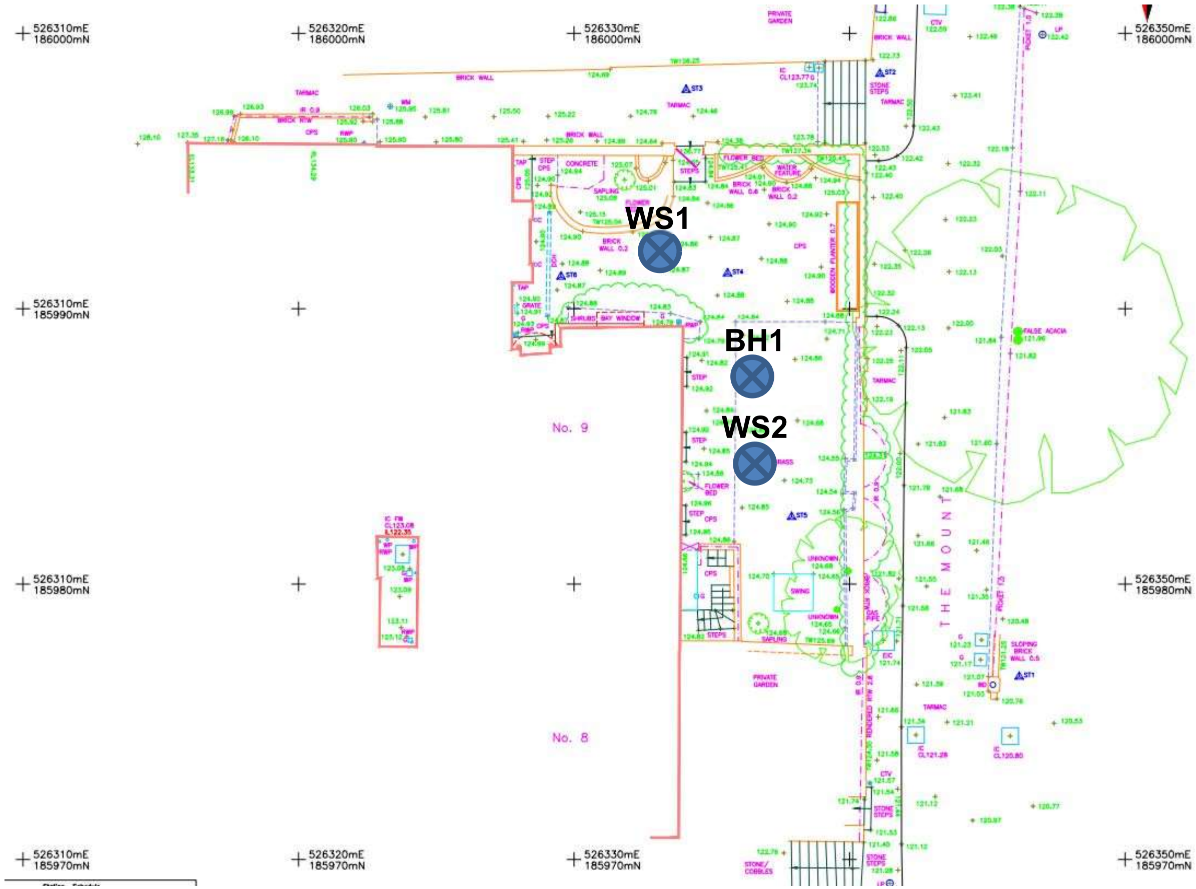
Figure 3 – Exploratory Hole Plan



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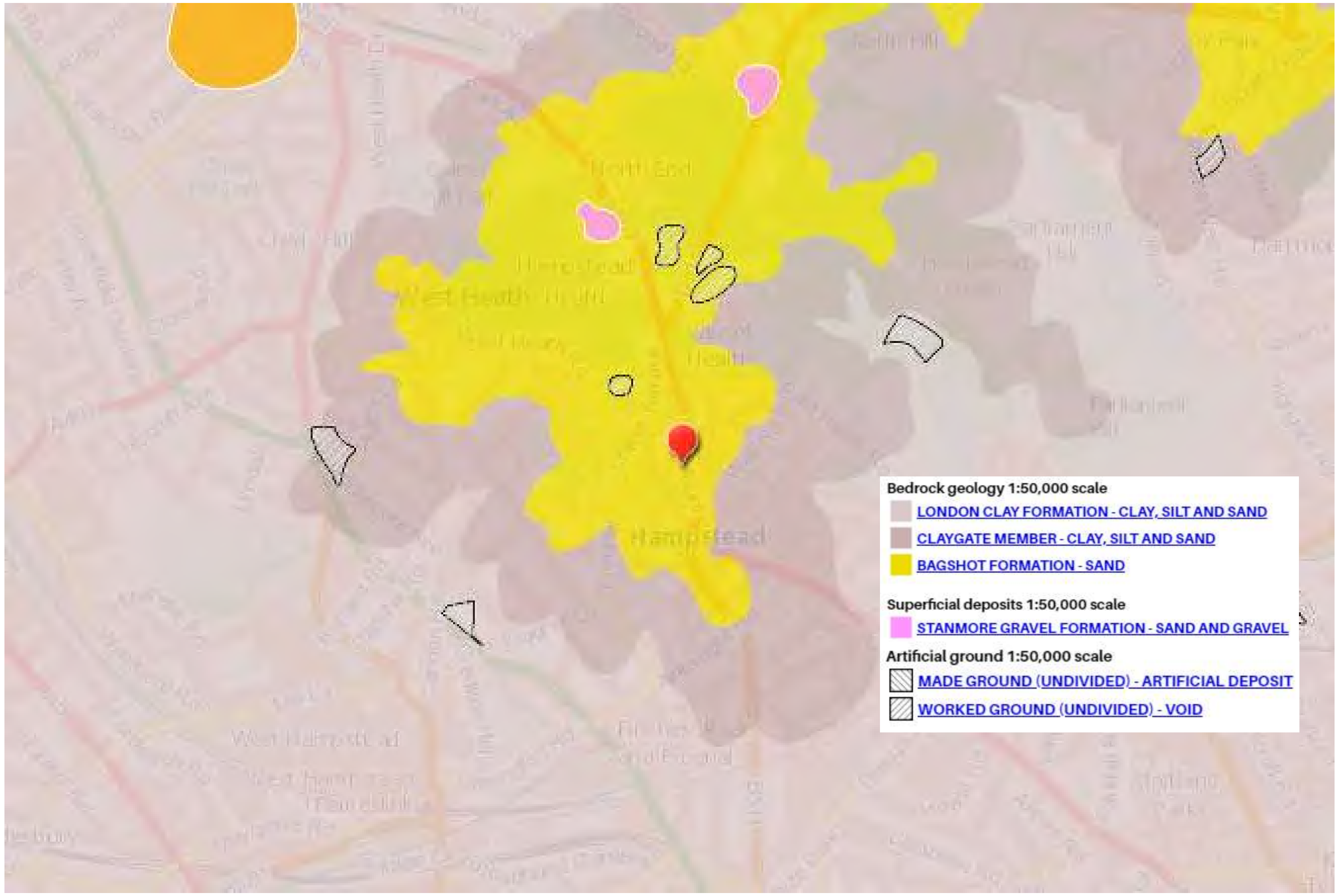

Source: BGS – Geoindex Onshore

Figure 4 – Geological Map

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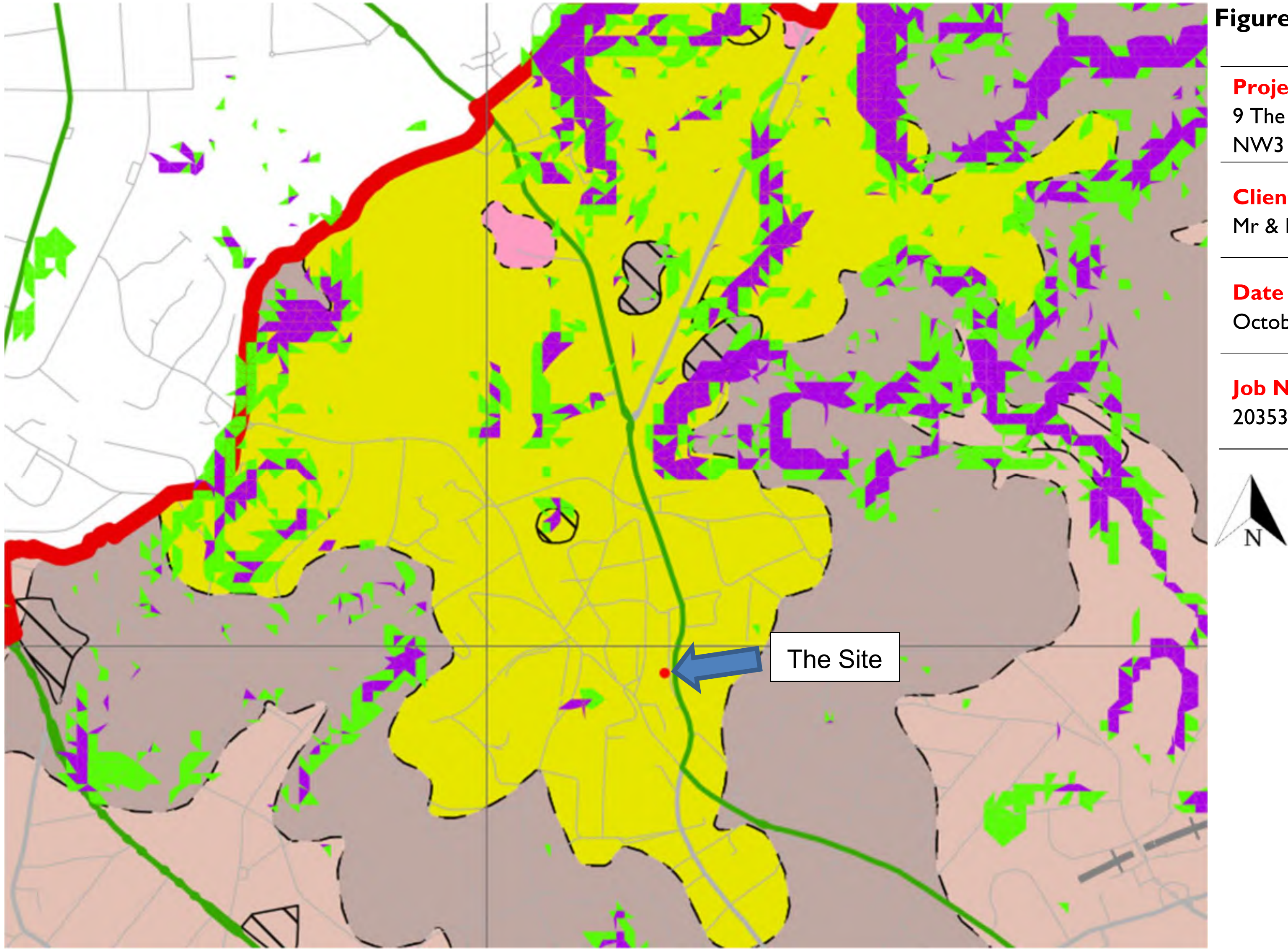

Figure 5 – Slope Angle Map

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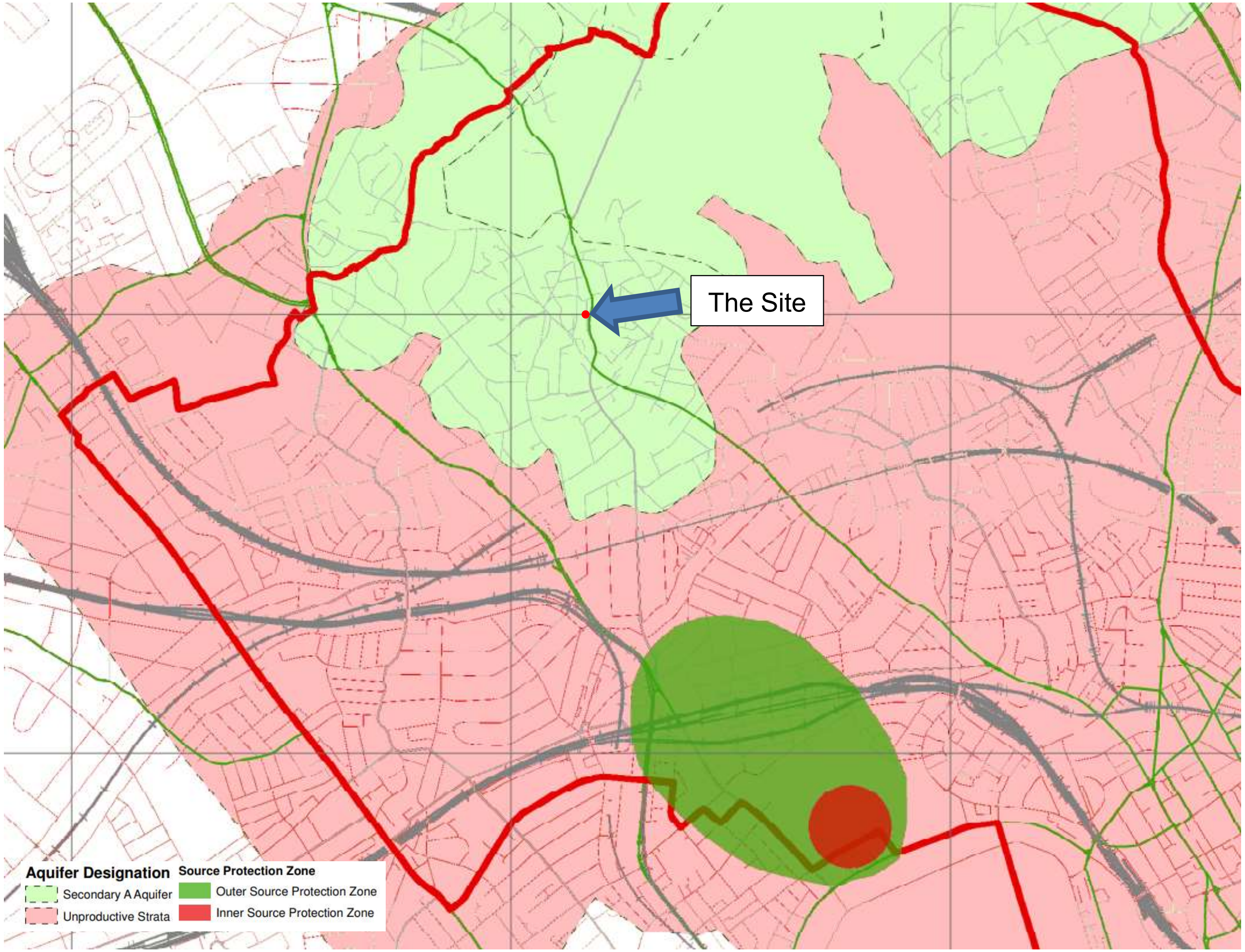
Source: LB Camden GHHS, Figure 16. Green = 7° – 10° slopes, Purple = >10° slopes.



Source: LB Camden GHHS, Figure 8.

Figure 6 – Groundwater Protection Zone Map

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Figure 7 – Historical Water Courses Map

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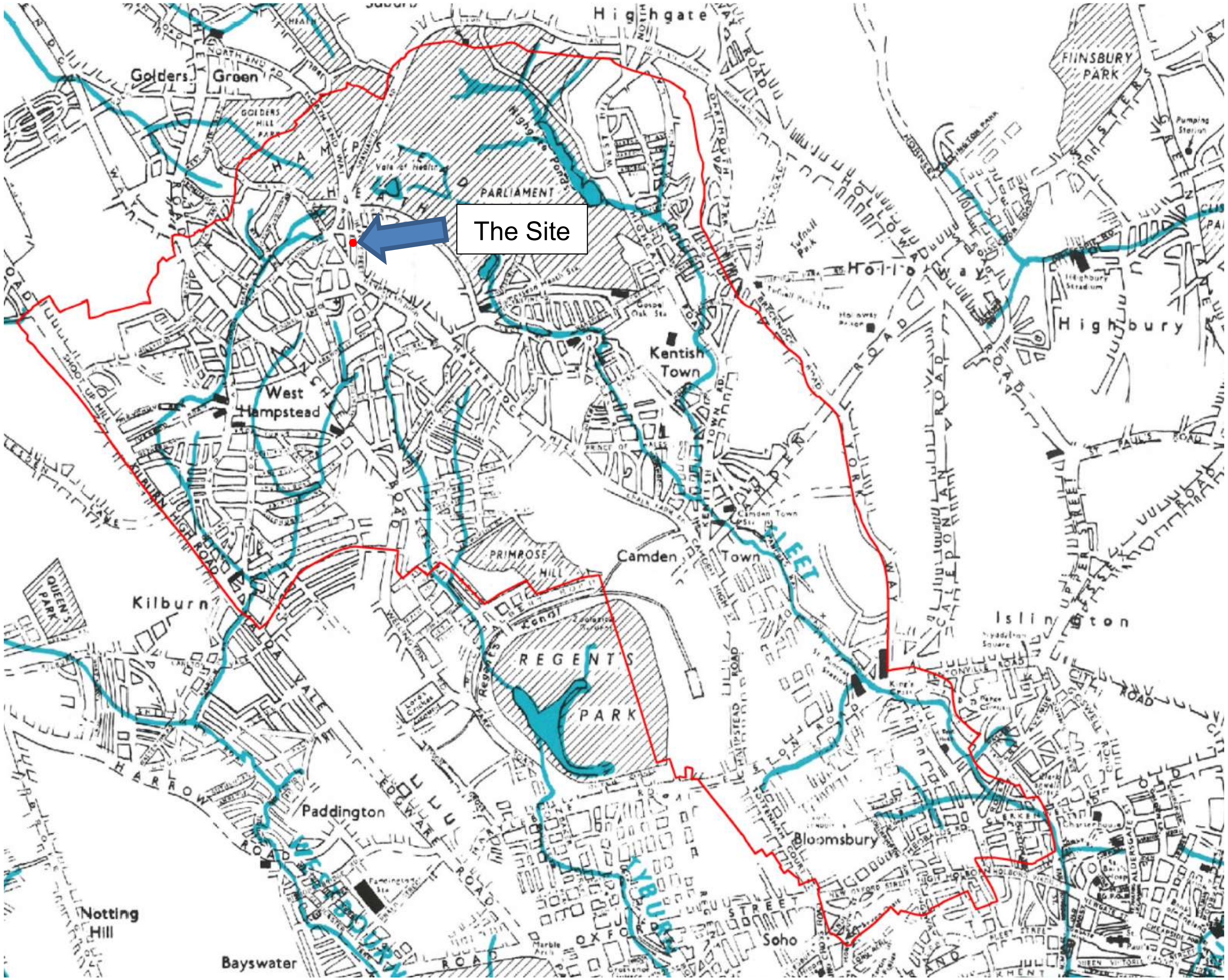

Source: Lost Rivers of London, N Barton

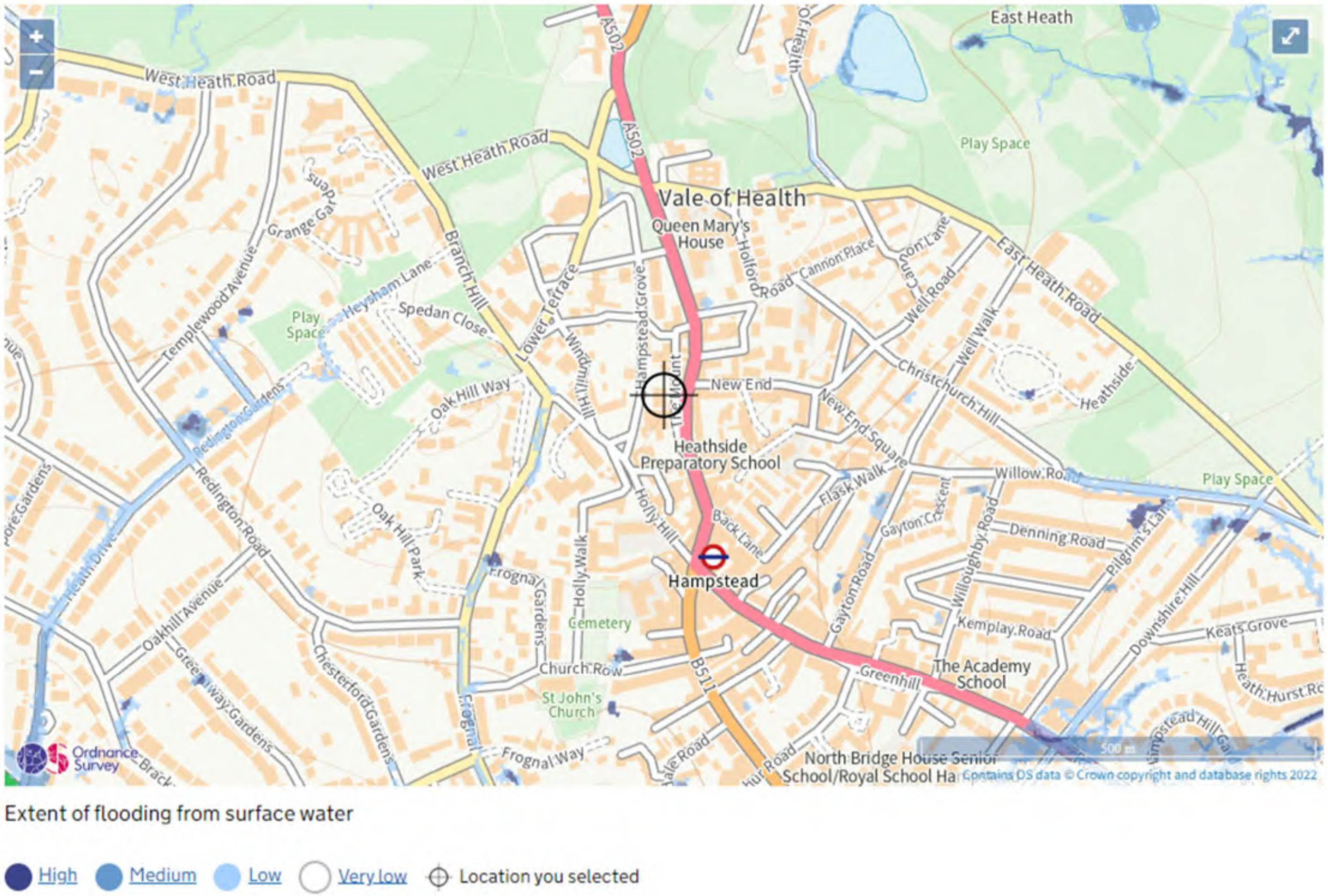

Figure 8 – Surface Water Risk Map

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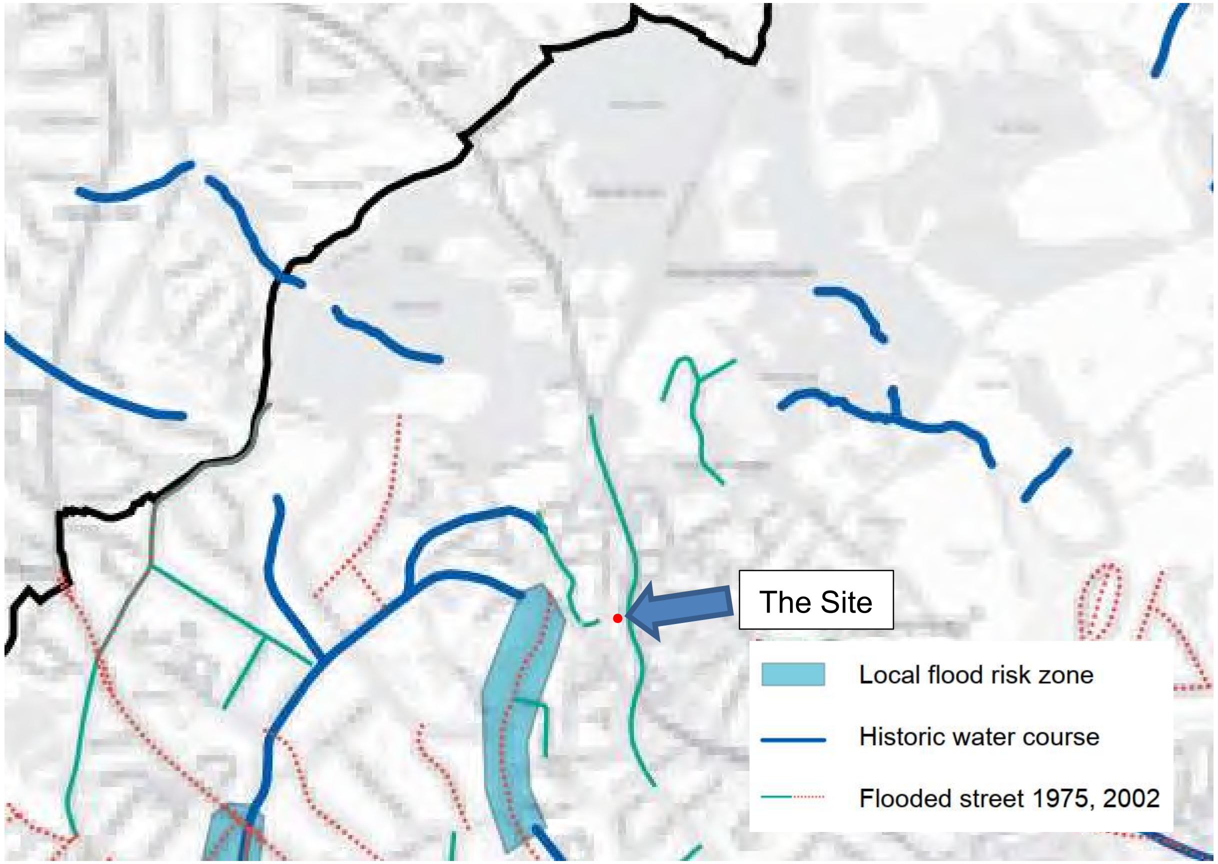
Source: EA Flood Risk Maps



Source: LB Camden Local Plan, Map 6

Figure 9 – Historic Flooding and Local Flood Risk Zones

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Figure 10 – TFL Asset Map

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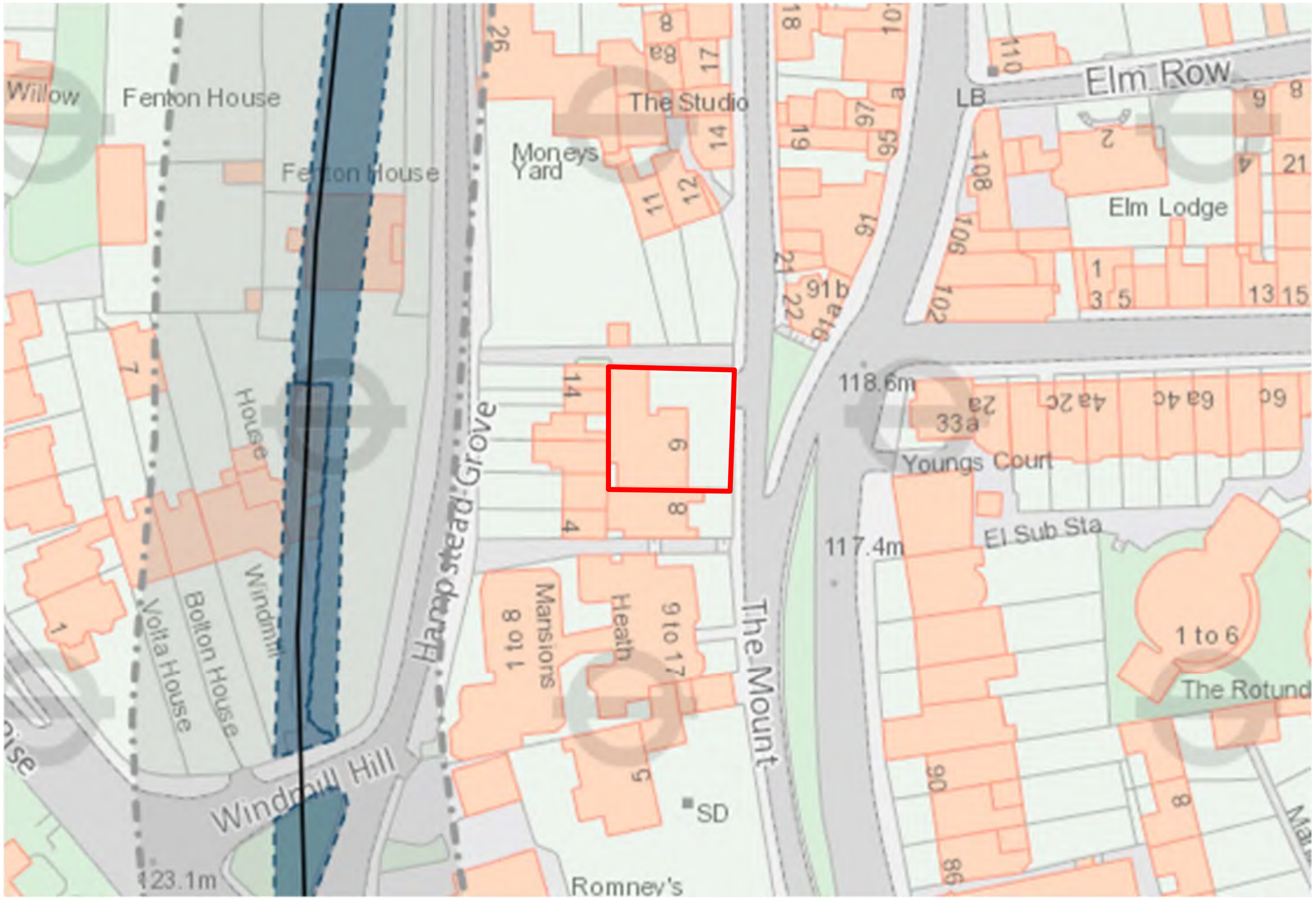

Source: TFL Asset Map

Figure 11 – UXO Map

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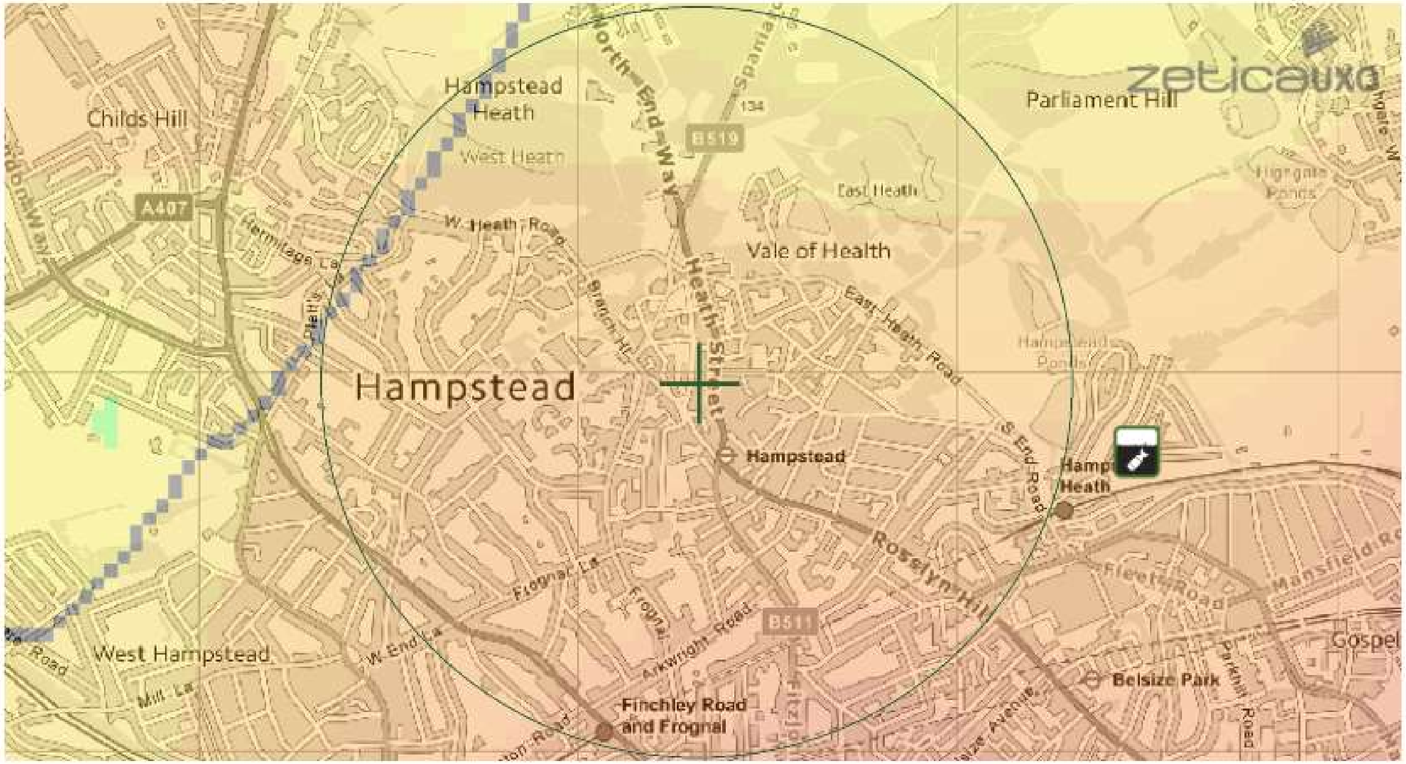
SITE LOCATION

Location: NW3 6SZ,
Map Centre: 526328,185975



LEGEND

London Bomb Risk

miltary, transport, utilities, industry, dock, abandoned bombs, UXO find, Luftwaffe targets, Bombing decoy, Other

Source: Zetica Bomb Risk Maps

Figure 12 – Critical Sections

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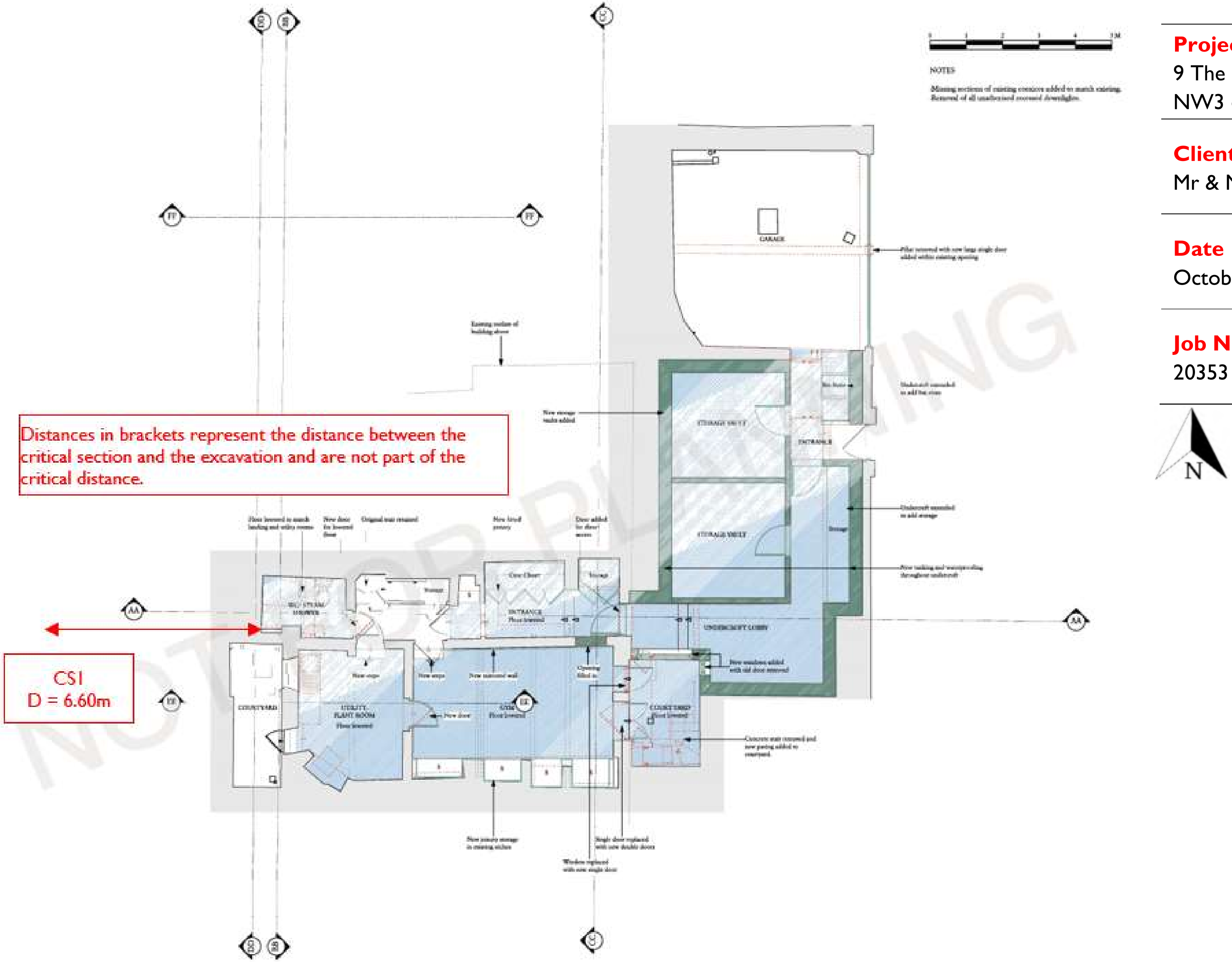

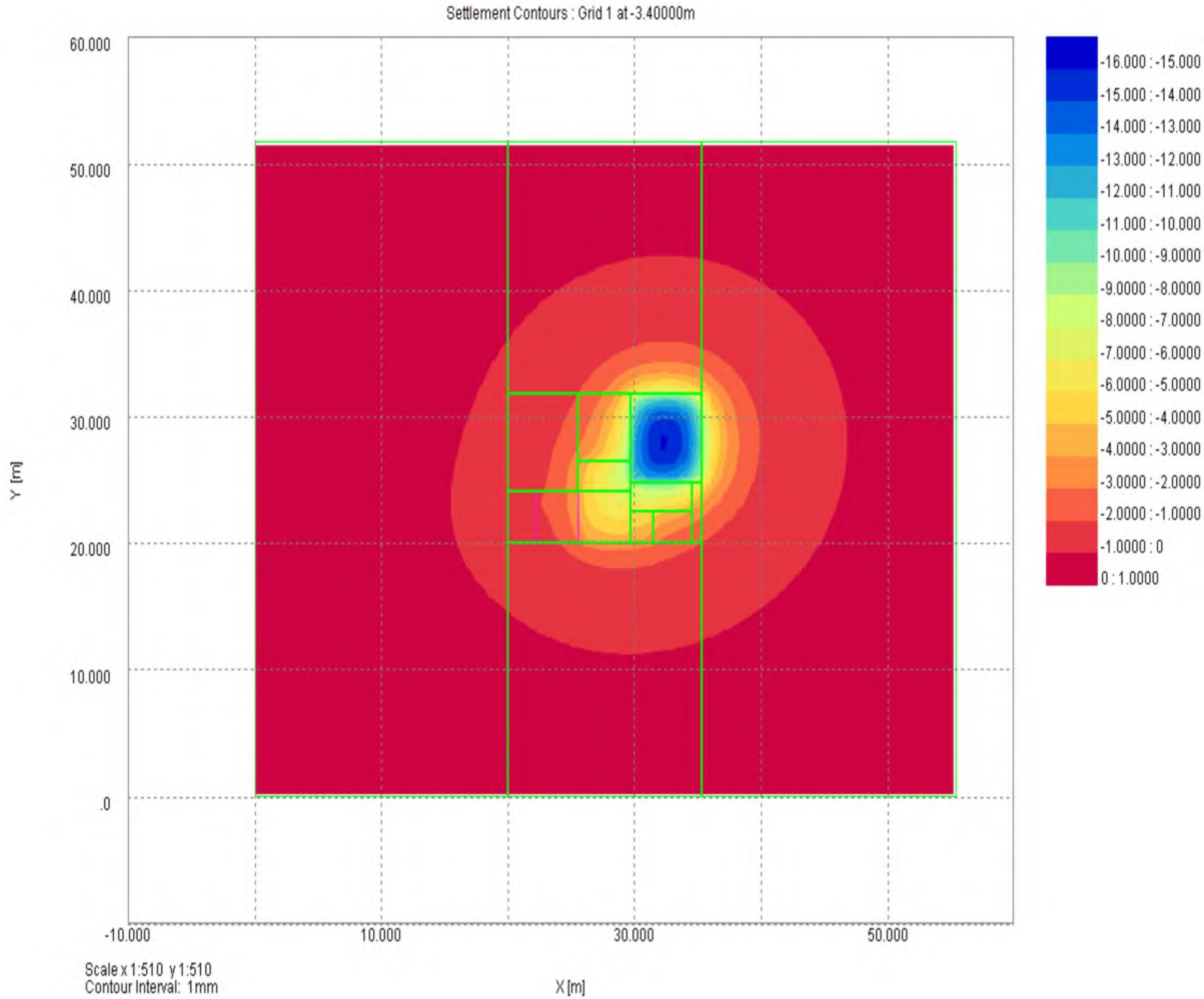

Figure 13 – GMA, Short-Term Heave Contour Plot

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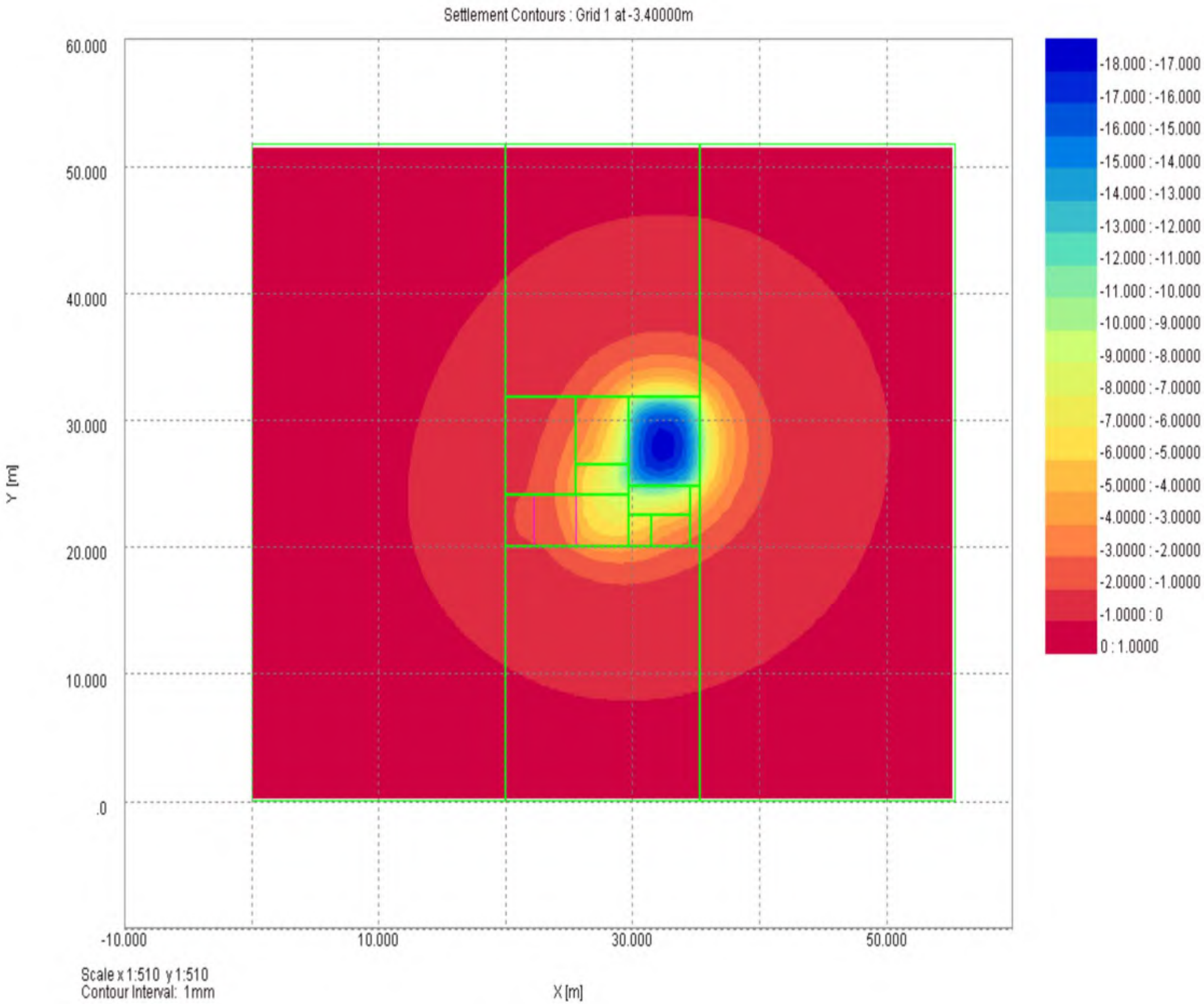

Figure 14 – GMA, Long-Term Heave Contour Plot

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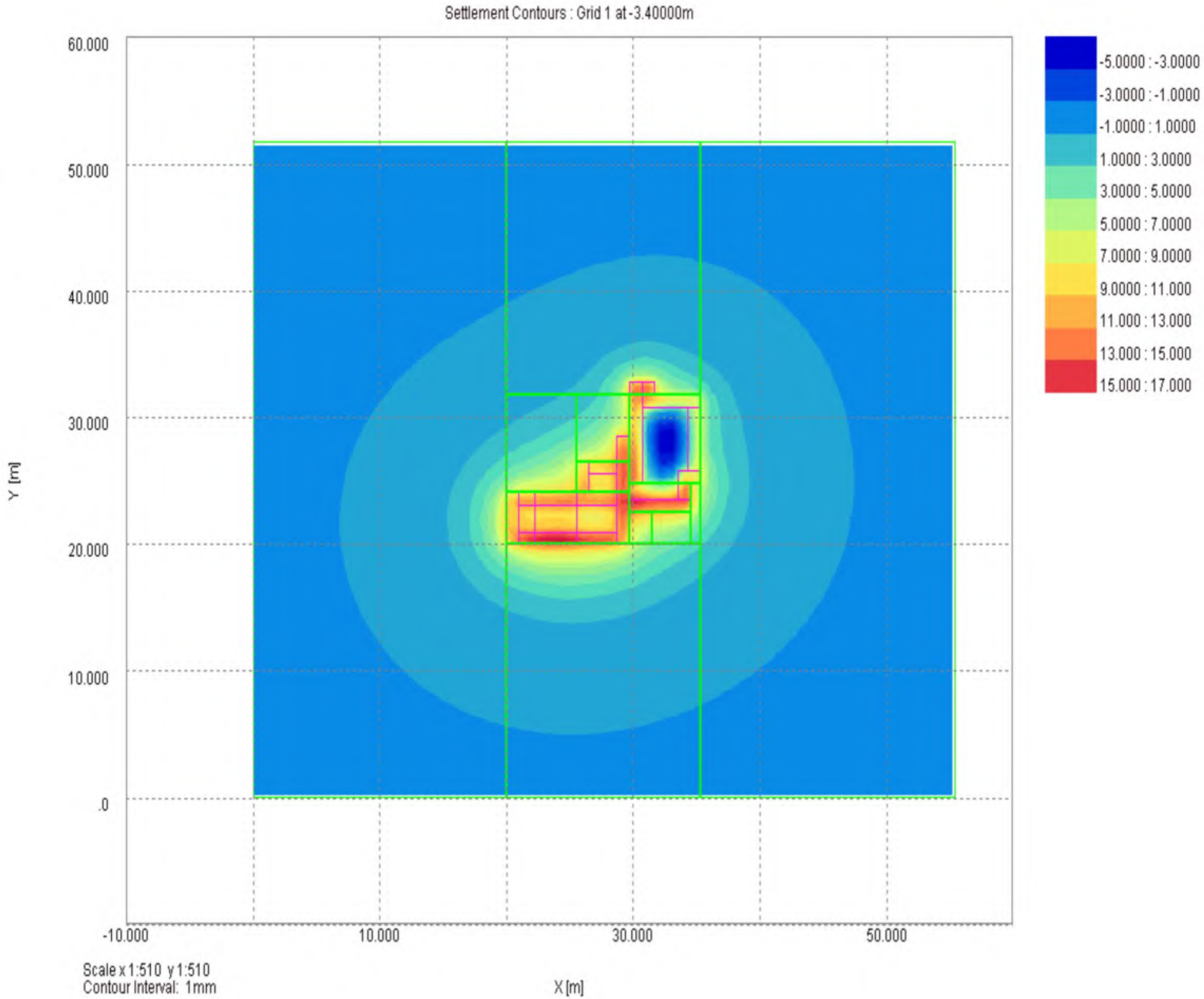

Figure 15 – GMA, Long-Term Movements Contour Plot

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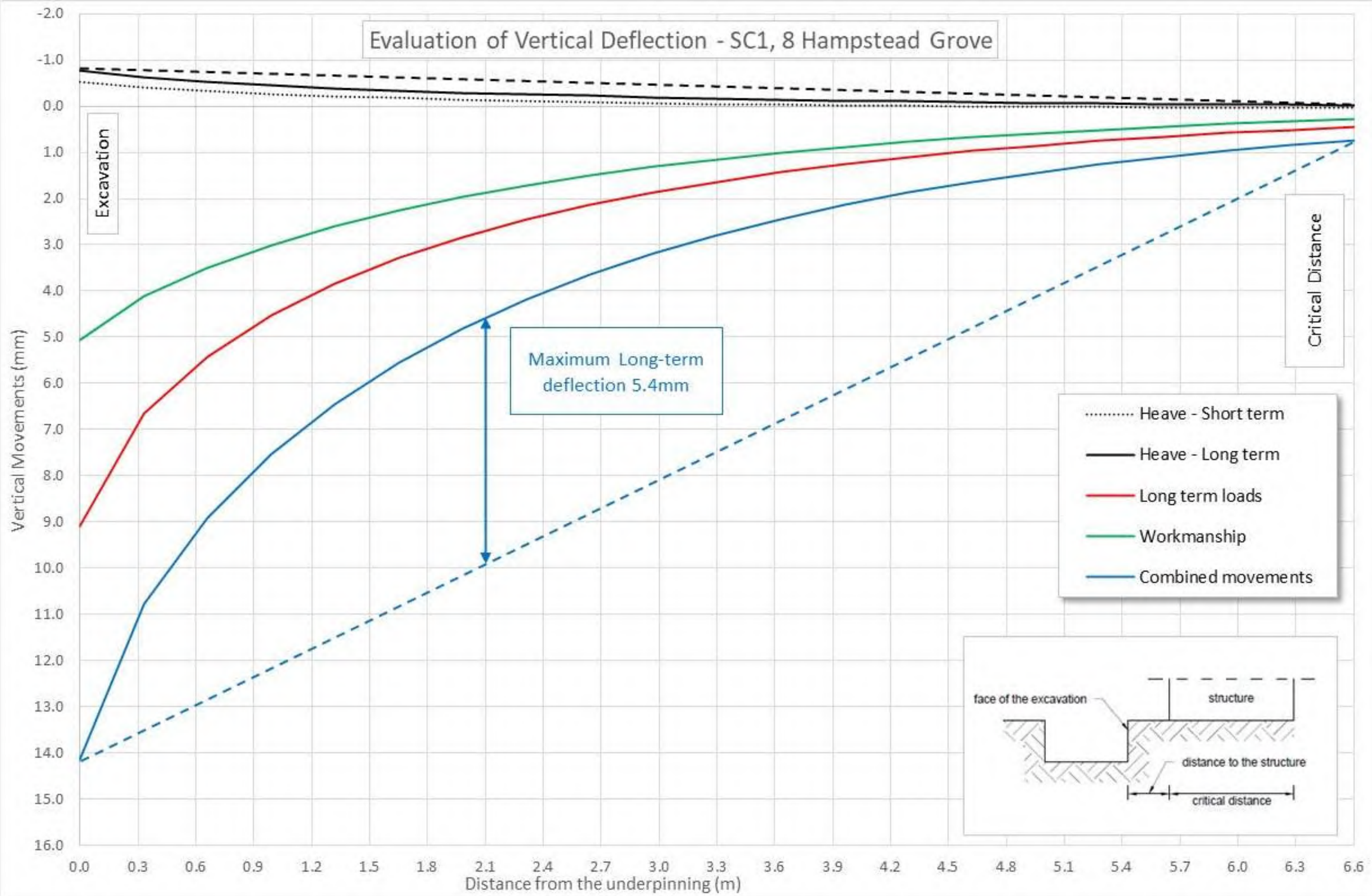

Figure 16 – GMA, Scenario CS1 – Vertical Deflection

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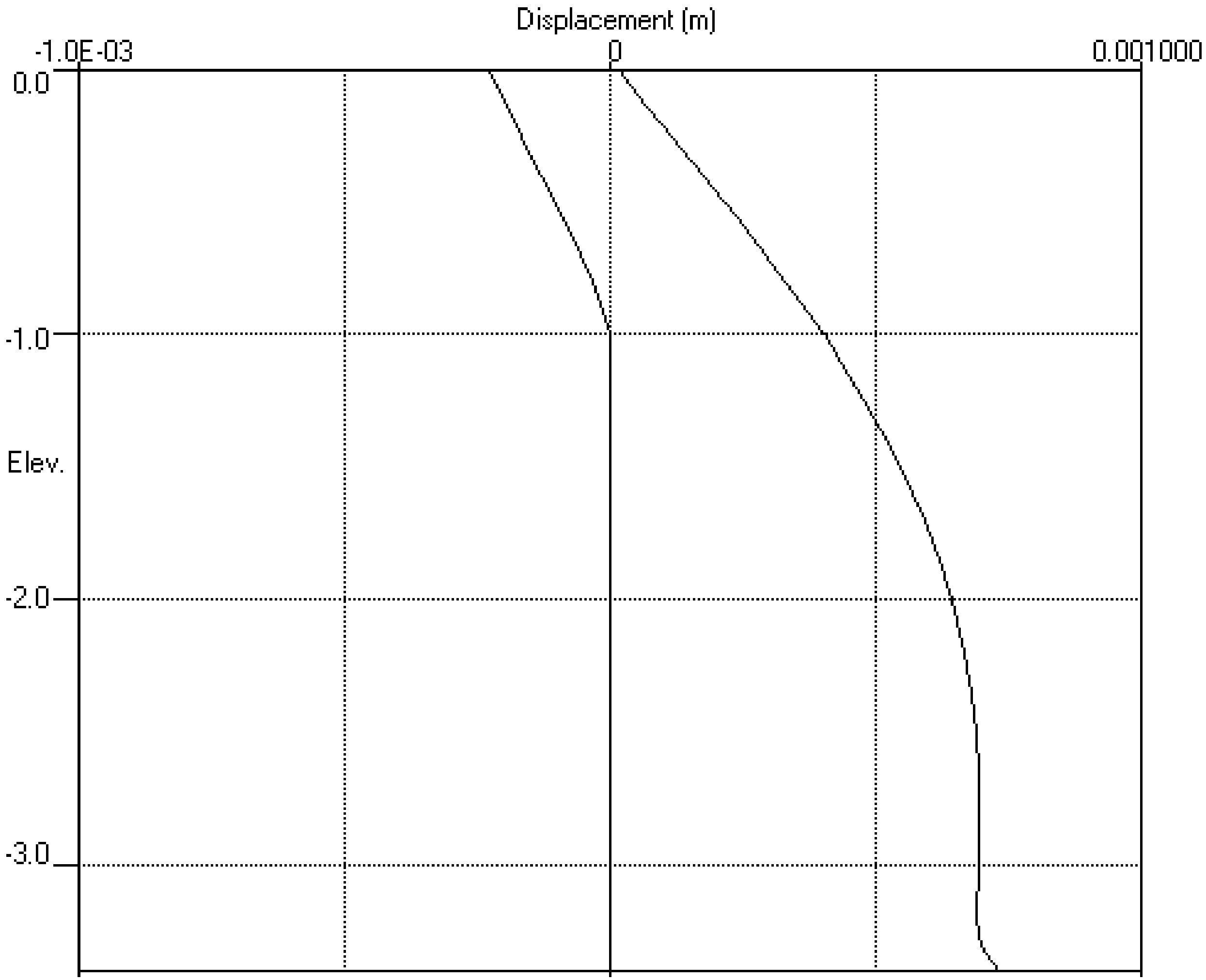

Figure 17 – GMA, Horizontal Deflection at the Excavation

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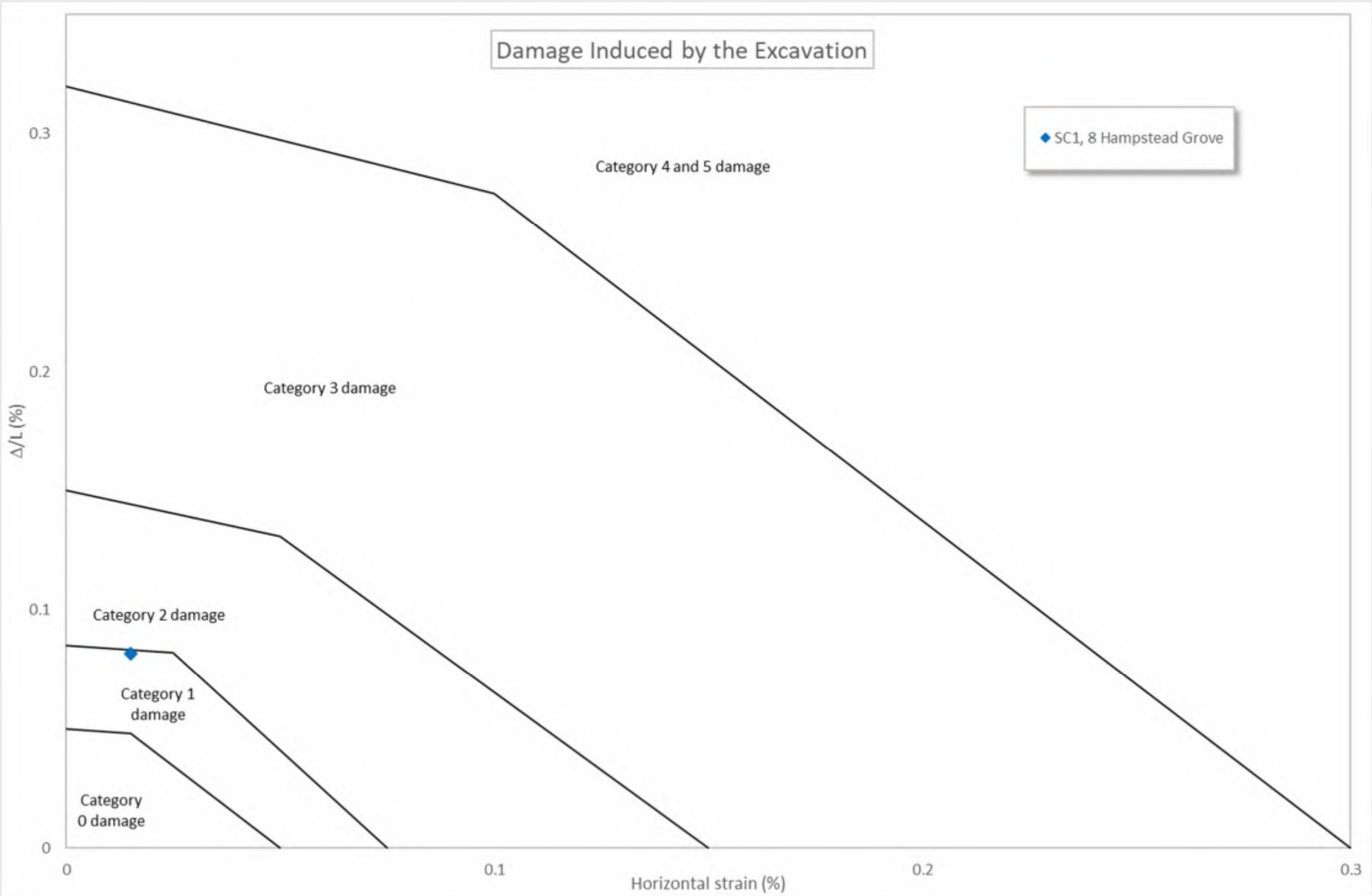

Figure 18 – GMA, Damage Category

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Appendix A Standards and Resources

The site works, soil descriptions and geotechnical testing was undertaken in accordance with the following standards were applicable:

- BS 5930:2015 and BS EN ISO 22476-2 2005+A1:2011
- BS 5930:2015 and BS EN ISO 22476-2&3:2005+A1:2011
- BS 5930:2015 and BS EN ISO 22476-3:2005+A1:2011
- BS EN 1997-1:2004+A1:2013 Eurocode 7. Geotechnical design
- BS EN ISO 14688-1:2018 - Geotechnical investigation and testing - Identification and description
- BS EN ISO 14688-2:2018 - Geotechnical investigation and testing - Principles for a classification
- BS 10175:2011+A2:2017 - Investigation of potentially contaminated sites
- LCRM 2021 Environment Agency
- BS 8004:2015 – Code of practice for foundations
- BS 1377:1990 Parts 1 to 8
- BRE Digest 241 “Low-rise buildings on shrinkable clay soils: Part 2
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- CIRIA C574, Engineering in Chalk; 2002
- Google Earth
- British Geological Survey Website & iGeology App

Appendix B Historic Maps

Historical Mapping Legends

Ordnance Survey County Series and Ordnance Survey Plan 1:2,500

Quarry · Gravel Pit · Sand Pit
Clay Pit · Shingle · Refuse Heap
Sloping Masonry · Flat Rock
Marsh · Reeds · Osiers
Rough Pasture · Furze · Wood
Mixed Wood · Brushwood · Orchard
Fir · Ford · Stepping Stones
Ferry · Waterfall · Lock
Trig. Station · 507 Altitude at Trig. Station
B.M.325·9 Bench Mark · 342 + Surface Level
Arrow denotes flow of water · Antiquities (site of)
Cutting · Embankment
Railway crossing Road · Level Crossing · Road crossing Railway
Railway crossing River or Canal · Road over single stream · Road over River or Canal

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)

B.P. B.S.	Boundary Post or Stone	P.C.B	Police Call Box
B.R.	Bridle Road	P	Pump
E.P	Electricity Pylon	S.P	Signal Post
F.B.	Foot Bridge	Sl.	Sluice
F.P.	Foot Path	Sp.	Spring
G.P	Guide Post or Board	T.C.B	Telephone Call Box
M.S	Mile Stone	Tr.	Trough
M.P M.R	Mooring Post or Ring	W	Well

Ordnance Survey Plan, Additional SIMs and Supply of Unpublished Survey Information 1:2,500 and 1:1,250

Inactive Quarry, Chalk Pit or Clay Pit · Active Quarry, Chalk Pit or Clay Pit
Rock · Boulders
Cliff · Slopes (Top)
Roofed Building · Glazed Roof Building
Sloping Masonry (Top) · Archway
Non-Coniferous Tree (surveyed) · Coniferous Tree (surveyed)
Non-Coniferous Trees (not surveyed) · Coniferous Trees (not surveyed)
Orchard Tree · Scrub · Bracken
Coppice, Osier · Reeds · Marsh, Saltings
Rough Grassland · Heath · Culvert
Direction of water flow · B M Bench Mark · Antiquity (site of)
Cave Entrance · Triangulation Station · Electricity Pylon
E T L Electricity Transmission Line

County Boundary (Geographical)
County & Civil Parish Boundary
Civil Parish Boundary
Admin. County or County Bor. Boundary
L B Bdy London Borough Boundary
Symbol marking point where boundary mereing changes

BH	Beer House	P	Pillar, Pole or Post
BP, BS	Boundary Post or Stone	PO	Post Office
Cn, C	Capstan, Crane	PC	Public Convenience
Chy	Chimney	PH	Public House
D Fn	Drinking Fountain	Pp	Pump
El P	Electricity Pillar or Post	SB, S Br	Signal Box or Bridge
FAP	Fire Alarm Pillar	SP, SL	Signal Post or Light
FB	Foot Bridge	Spr	Spring
GP	Guide Post	Tk	Tank or Track
H	Hydrant or Hydraulic	TCB	Telephone Call Box
LC	Level Crossing	TCP	Telephone Call Post
MH	Manhole	Tr	Trough
MP	Mile Post or Mooring Post	Wr Pt, Wr T	Water Point, Water Tap
MS	Mile Stone	W	Well
NTL	Normal Tidal Limit	Wd Pp	Wind Pump

Large-Scale National Grid Data 1:2,500 and 1:1,250

Cliff · Slopes (Top)
Rock · Rock (scattered)
Boulders · Boulders (scattered)
Positioned Boulder · Scree
Non-Coniferous Tree (surveyed) · Coniferous Tree (surveyed)
Non-Coniferous Trees (not surveyed) · Coniferous Trees (not surveyed)
Orchard Tree · Scrub · Bracken
Coppice, Osier · Reeds · Marsh, Saltings
Rough Grassland · Heath · Culvert
Direction of water flow · Triangulation Station · Antiquity (site of)
E T L Electricity Transmission Line · Electricity Pylon
BM 231.60m Bench Mark · Buildings with Building Seed
Roofed Building · Glazed Roof Building

Civil parish/community boundary
District boundary
County boundary
Boundary post/stone
Boundary mereing symbol (note: these always appear in opposed pairs or groups of three)

Bks	Barracks	P	Pillar, Pole or Post
Bty	Battery	PO	Post Office
Cemy	Cemetery	PC	Public Convenience
Chy	Chimney	Pp	Pump
Cis	Cistern	Ppg Sta	Pumping Station
Dismtd Rly	Dismantled Railway	PW	Place of Worship
El Gen Sta	Electricity Generating Station	Sewage Ppg Sta	Sewage Pumping Station
El P	Electricity Pole, Pillar	SB, S Br	Signal Box or Bridge
El Sub Sta	Electricity Sub Station	SP, SL	Signal Post or Light
FB	Filter Bed	Spr	Spring
Fn / D Fn	Fountain / Drinking Ftn.	Tk	Tank or Track
Gas Gov	Gas Valve Compound	Tr	Trough
GVC	Gas Governer	Wd Pp	Wind Pump
GP	Guide Post	Wr Pt, WrT	Water Point, Water Tap
MH	Manhole	Wks	Works (building or area)
MP, MS	Mile Post or Mile Stone	W	Well

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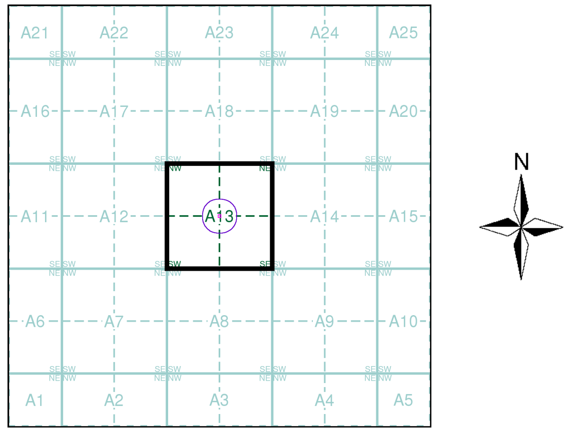
Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Middlesex	1:2,500	1864	2
London	1:2,500	1879	3
London	1:2,500	1896	4
London	1:2,500	1915	5
London	1:2,500	1934	6
Historical Aerial Photography	1:1,250	1946 - 1949	7
Ordnance Survey Plan	1:1,250	1954	8
Ordnance Survey Plan	1:2,500	1954 - 1955	9
Additional SIMs	1:1,250	1954 - 1987	10
Additional SIMs	1:2,500	1954 - 1955	11
Ordnance Survey Plan	1:1,250	1966 - 1973	12
Ordnance Survey Plan	1:2,500	1969 - 1970	13
Ordnance Survey Plan	1:1,250	1973 - 1981	14
Additional SIMs	1:1,250	1986 - 1987	15
Large-Scale National Grid Data	1:1,250	1991	16
Large-Scale National Grid Data	1:1,250	1991	17
Historical Aerial Photography	1:2,500	1999	18

Historical Map - Segment A13



Order Details

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Customer Ref: 20353
National Grid Reference: 526330, 185990
Slice: A
Site Area (Ha): 0.04
Search Buffer (m): 100

Site Details

9, The Mount, LONDON, NW3 6SZ

Landmark INFORMATION GROUP

Tel: 0844 844 9952
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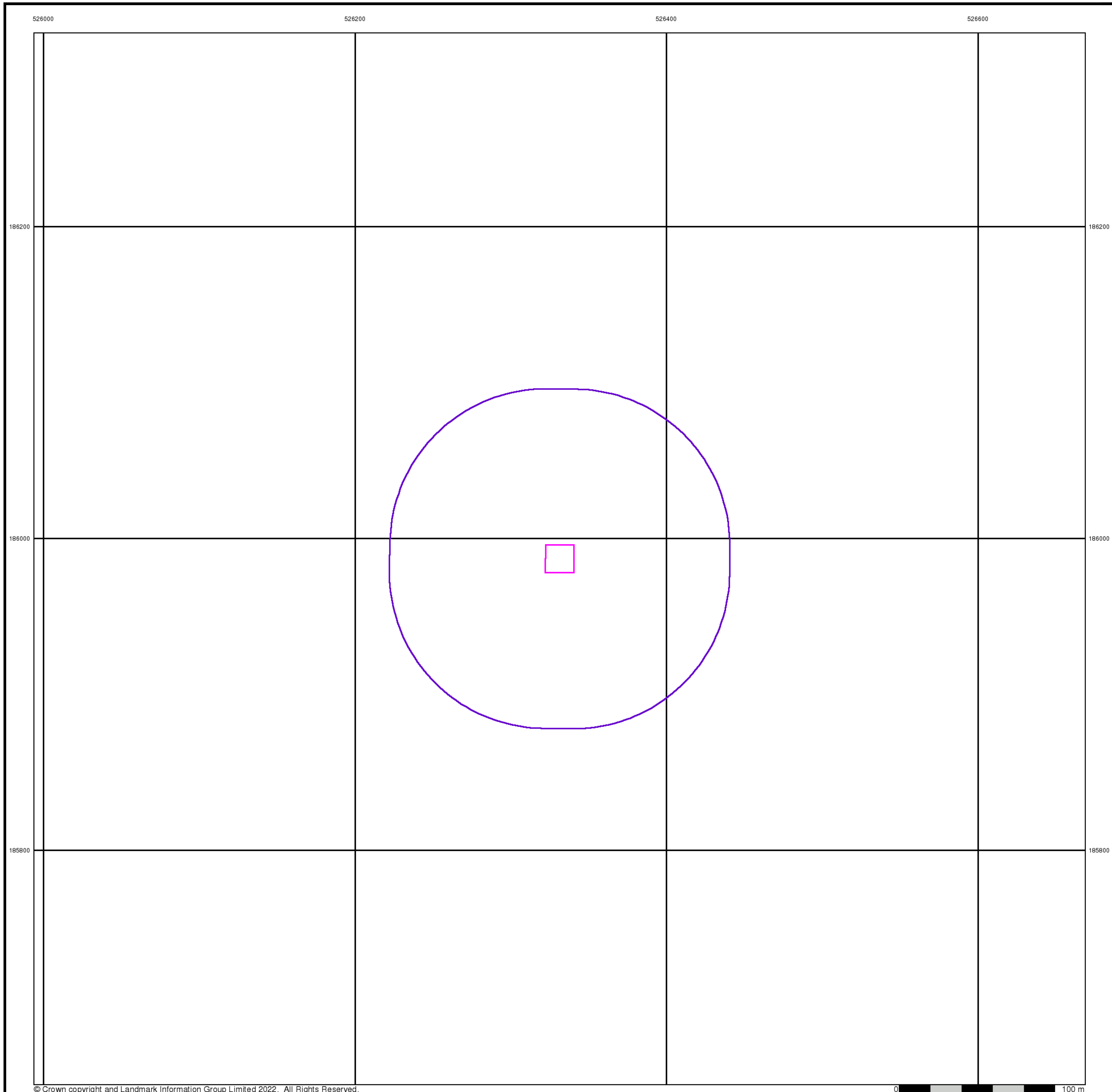

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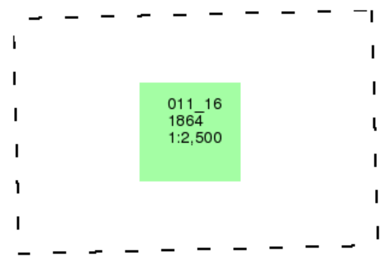
Middlesex

Published 1864

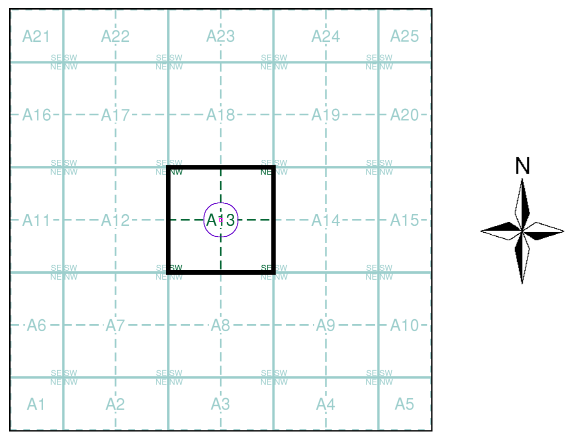
Source map scale - 1:2,500

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 and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below 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.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

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Site Area (Ha):	0.04
Search Buffer (m):	100

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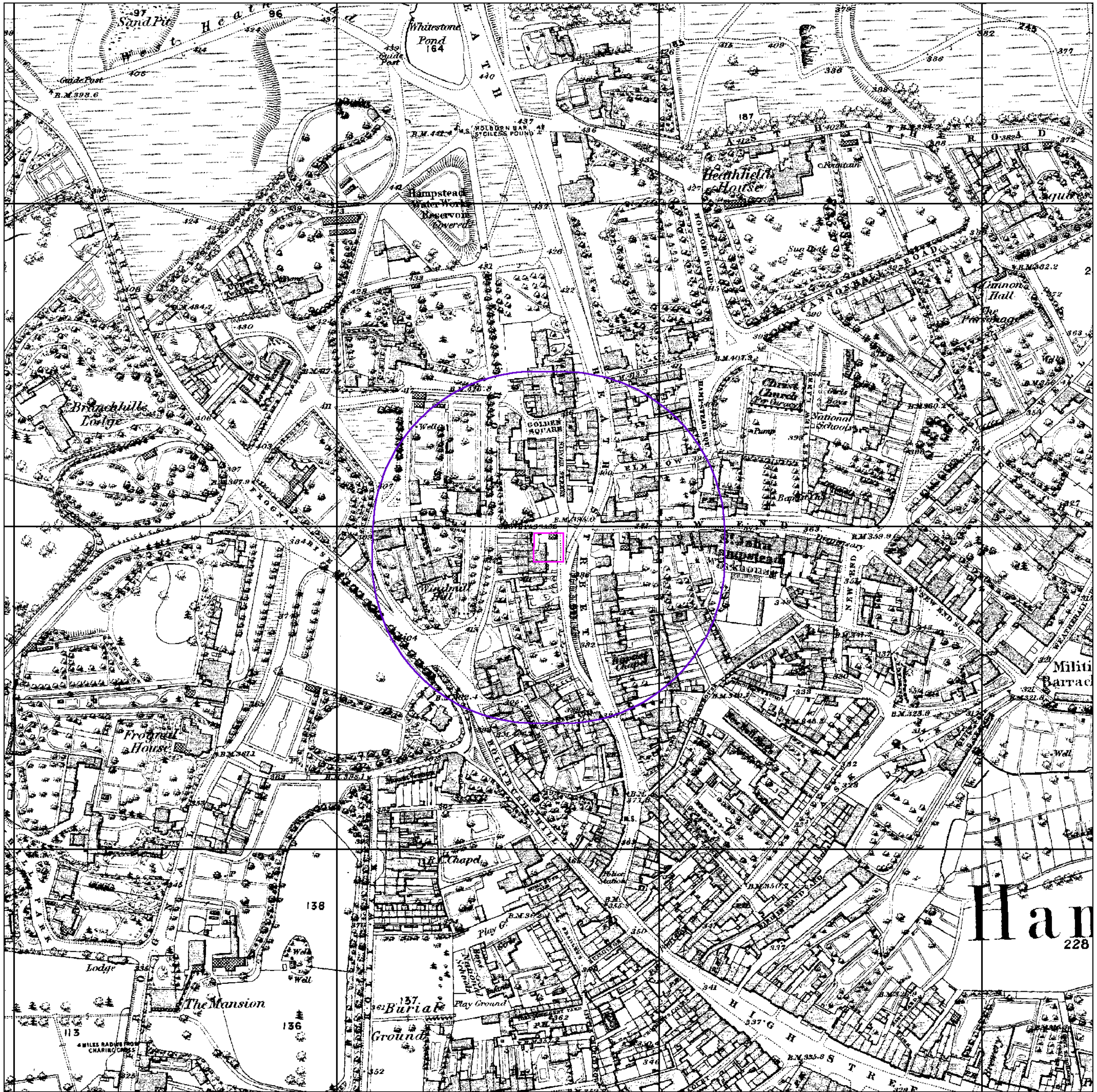

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London

Published 1879

Source map scale - 1:2,500

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Map Name(s) and Date(s)

007_00
1879
1:2,500

Historical Map - Segment A13

A21	A22	A23	A24	A25
A16	A17	A18	A19	A20
A11	A12	A13	A14	A15
A6	A7	A8	A9	A10
A1	A2	A3	A4	A5

N

Order Details

Order Number: 302163780_1_1
Customer Ref: 20353
National Grid Reference: 526330, 185990
Slice: A
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0 100 m

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Published 1896

Source map scale - 1:2,500

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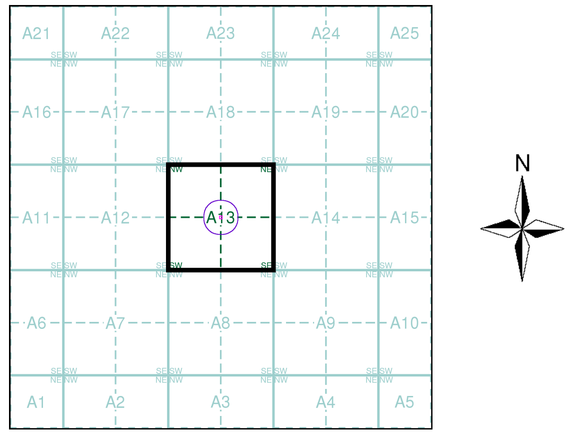
Map Name(s) and Date(s)

027_00
1896
1:2,500

Historical Map - Segment A13



Order Details

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Customer Ref: 20353
National Grid Reference: 526330, 185990
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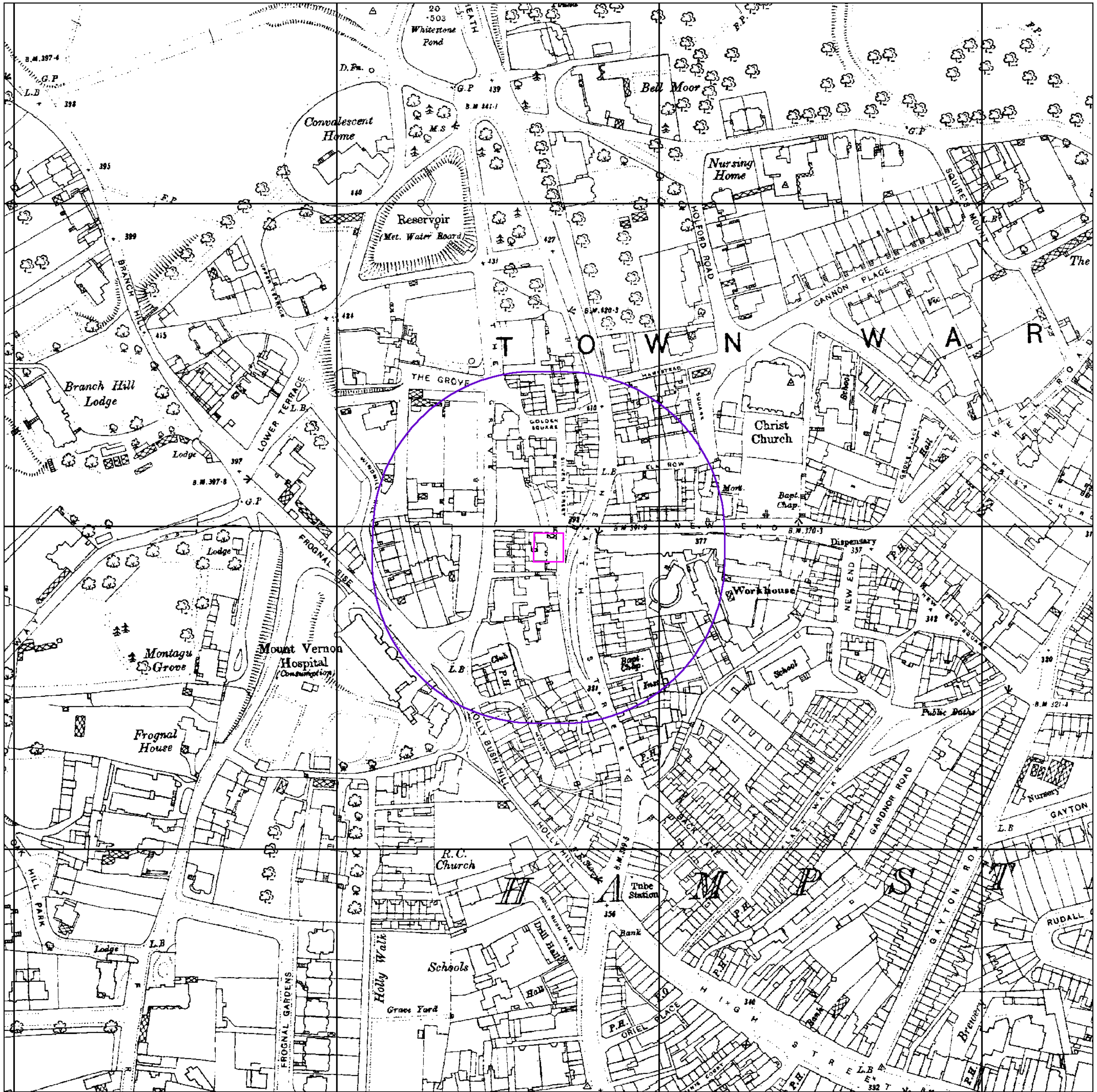

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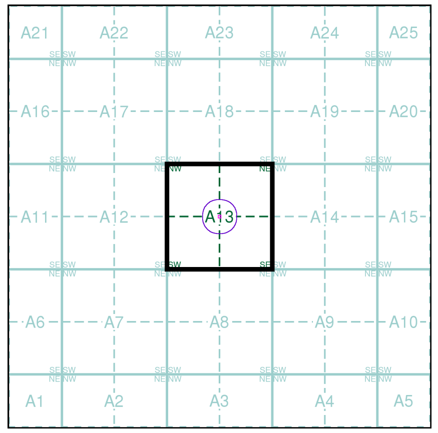
London
Published 1915
Source map scale - 1:2,500

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 and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below 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.

Map Name(s) and Date(s)

001_16
1915
1:2,500

Historical Map - Segment A13



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Order Details

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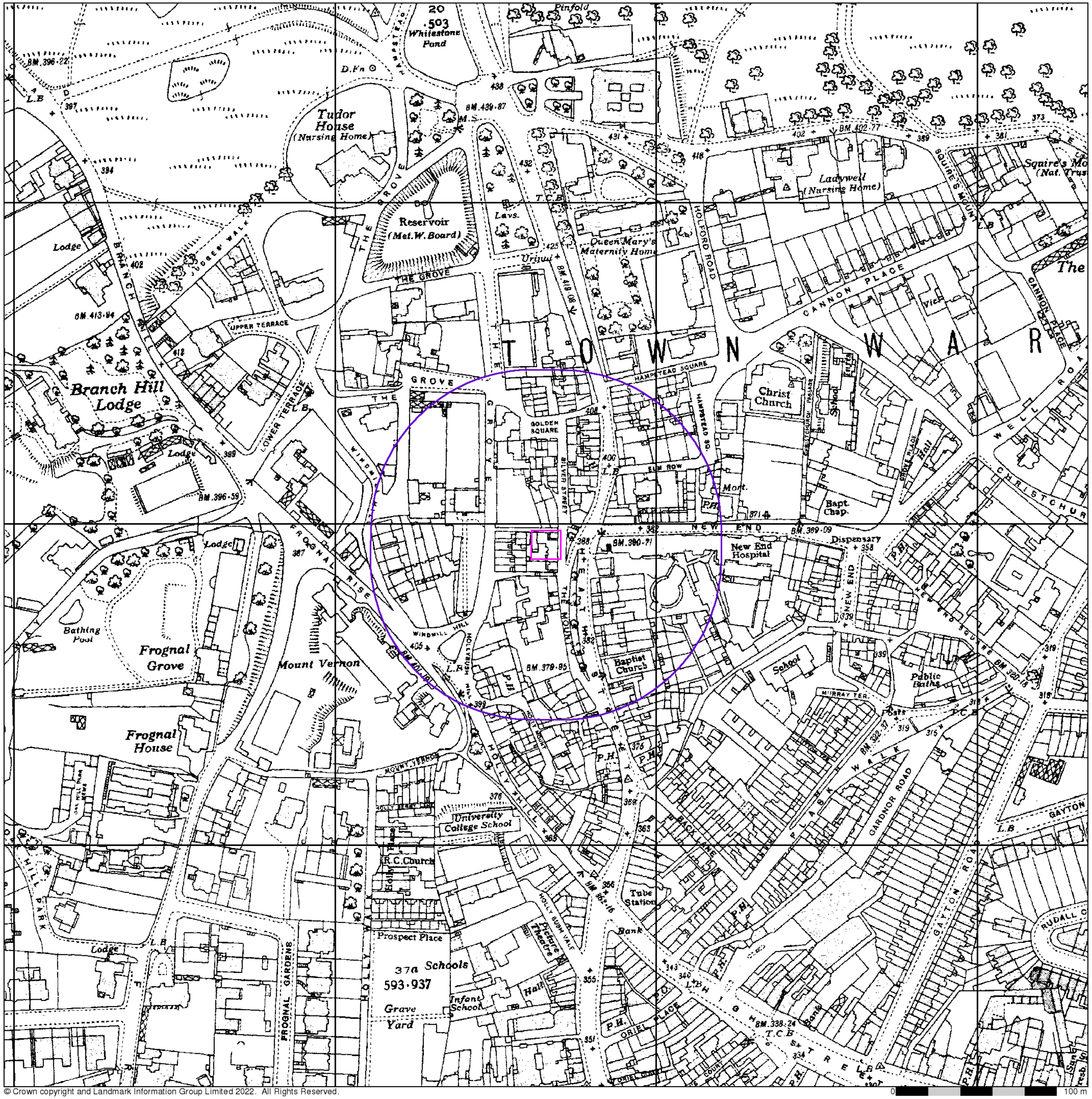

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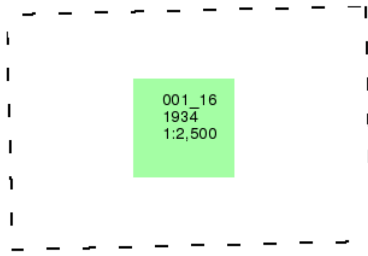
London

Published 1934

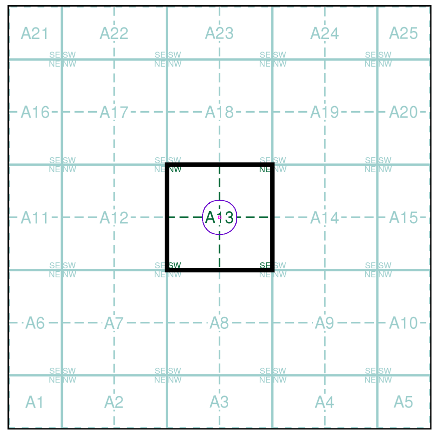
Source map scale - 1:2,500

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 and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below 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.

Map Name(s) and Date(s)



Historical Map - Segment A13



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Order Details

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Customer Ref:	20353
National Grid Reference:	526330, 185990
Slice:	A
Site Area (Ha):	0.04
Search Buffer (m):	100

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Historical Aerial Photography

Published 1946 - 1949

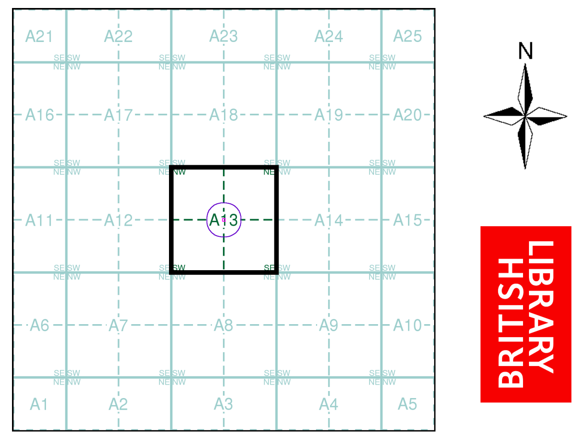
Source map scale - 1:1,250

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)

TQ2586SE 1949 1:1,250	TQ2686SW 1946 1:1,250	TQ2686SE 1949 1:1,250
TQ2585NE 1948 1:1,250	TQ2685NW 1949 1:1,250	TQ2685NE 1949 1:1,250

Historical Aerial Photography - Segment A13



BRITISH LIBRARY

Order Details

Order Number: 302163780_1_1
Customer Ref: 20353
National Grid Reference: 526330, 185990
Slice: A
Site Area (Ha): 0.04
Search Buffer (m): 100

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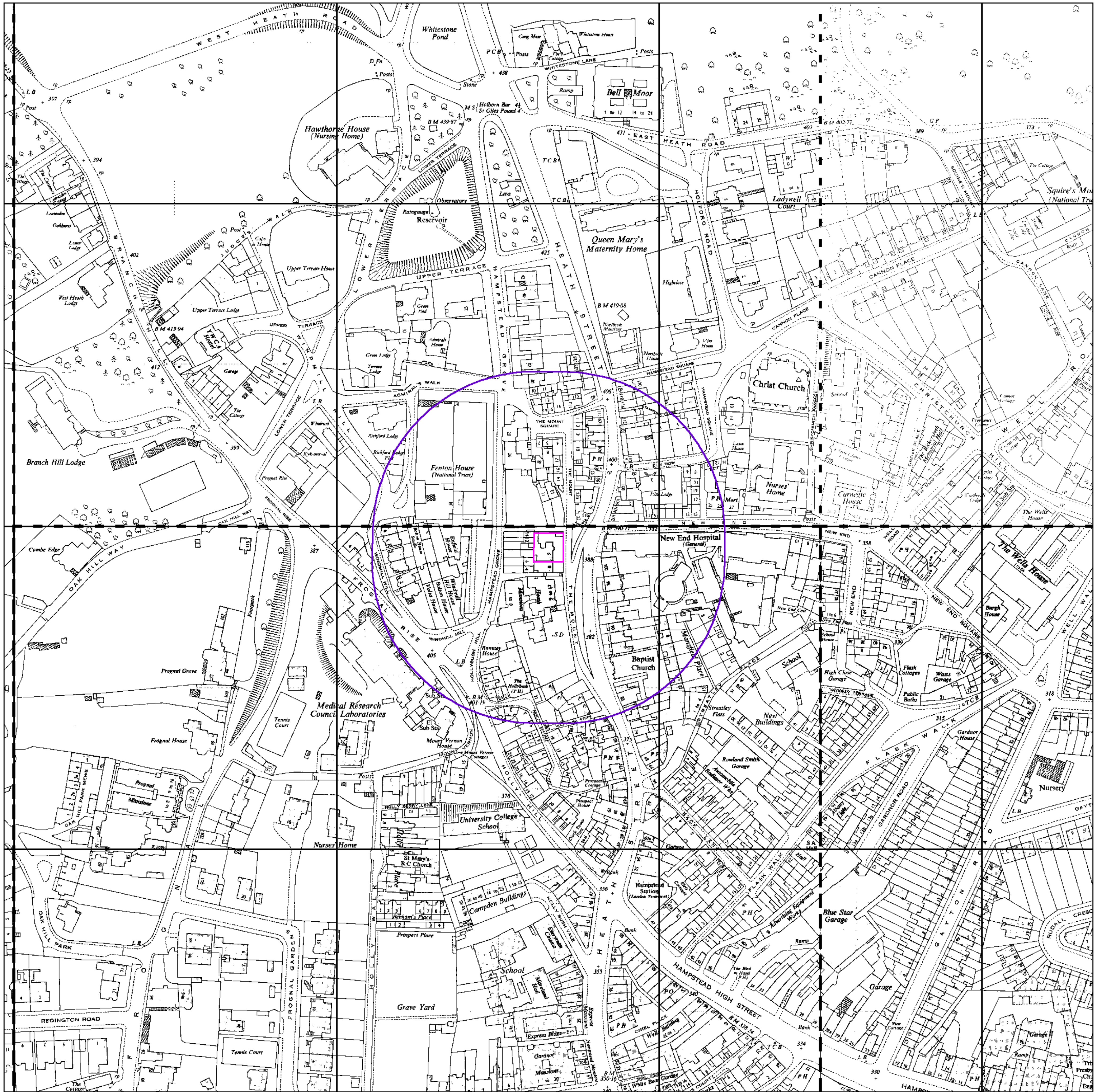

0 100 m

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Ordnance Survey Plan

Published 1954

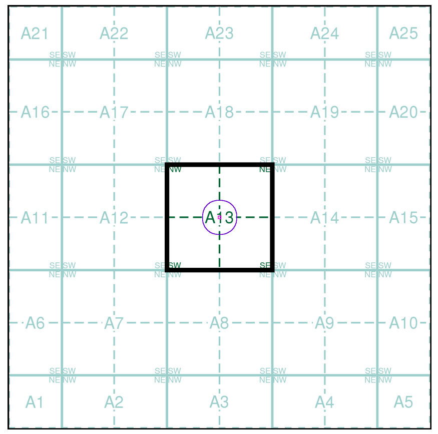
Source map scale - 1:1,250

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 and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below 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.

Map Name(s) and Date(s)

TQ2586SE 1954 1:1,250	TQ2686SW 1954 1:1,250	TQ2686SE 1954 1:1,250
TQ2585NE 1954 1:1,250	TQ2685NW 1954 1:1,250	TQ2685NE 1954 1:1,250

Historical Map - Segment A13



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Order Details

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Site Area (Ha): 0.04
Search Buffer (m): 100

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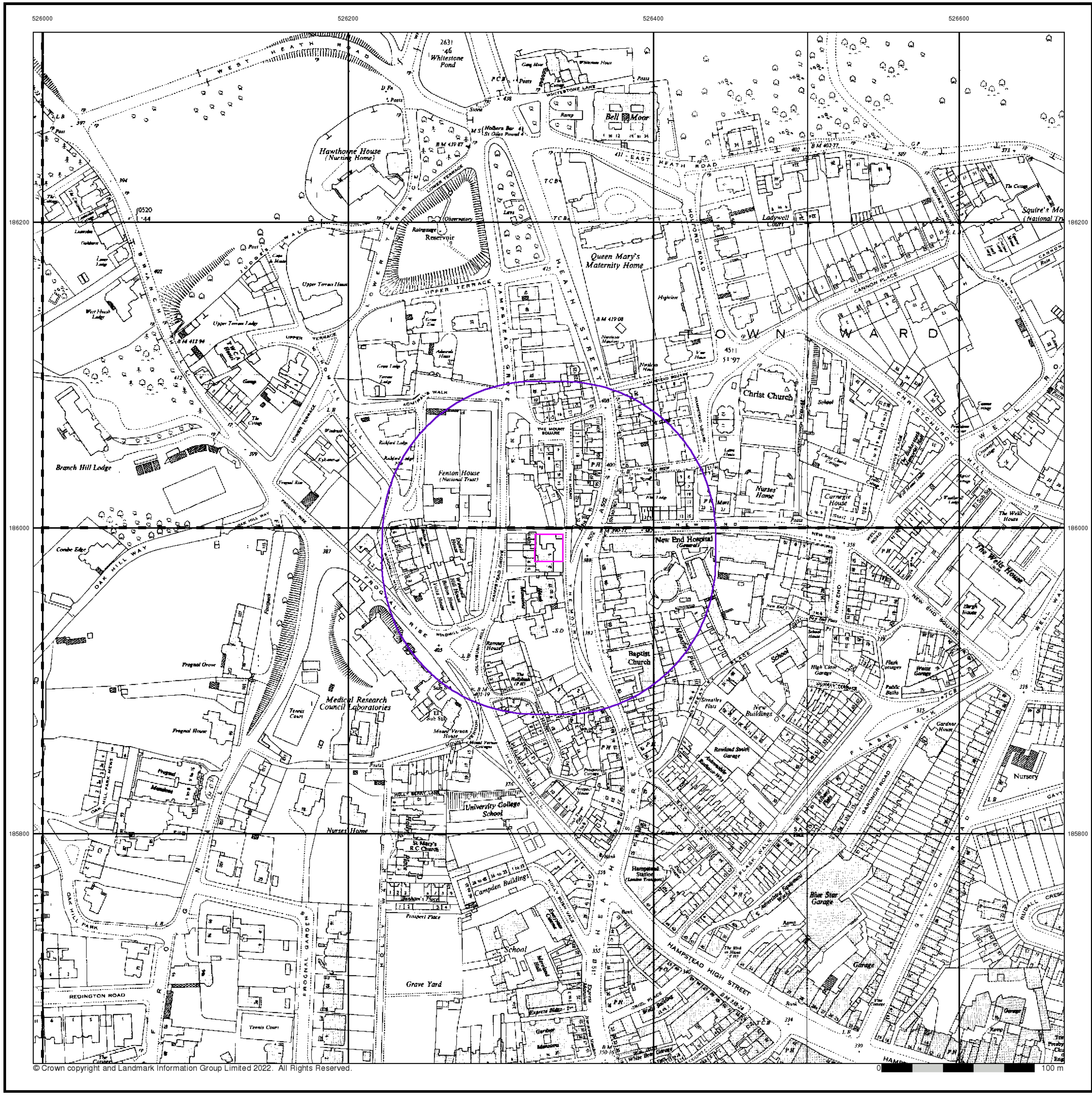

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Ordnance Survey Plan
Published 1954 - 1955
Source map scale - 1:2,500

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 and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below 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.

Map Name(s) and Date(s)

TQ2586 1955 1:2,500	TQ2686 1954 1:2,500
TQ2585 1955 1:2,500	TQ2685 1955 1:2,500

Historical Map - Segment A13

A21	A22	A23	A24	A25
A16	A17	A18	A19	A20
A11	A12	A13	A14	A15
A6	A7	A8	A9	A10
A1	A2	A3	A4	A5

N

Order Details

Order Number: 302163780_1_1
Customer Ref: 20353
National Grid Reference: 526330, 185990
Slice: A
Site Area (Ha): 0.04
Search Buffer (m): 100

Site Details

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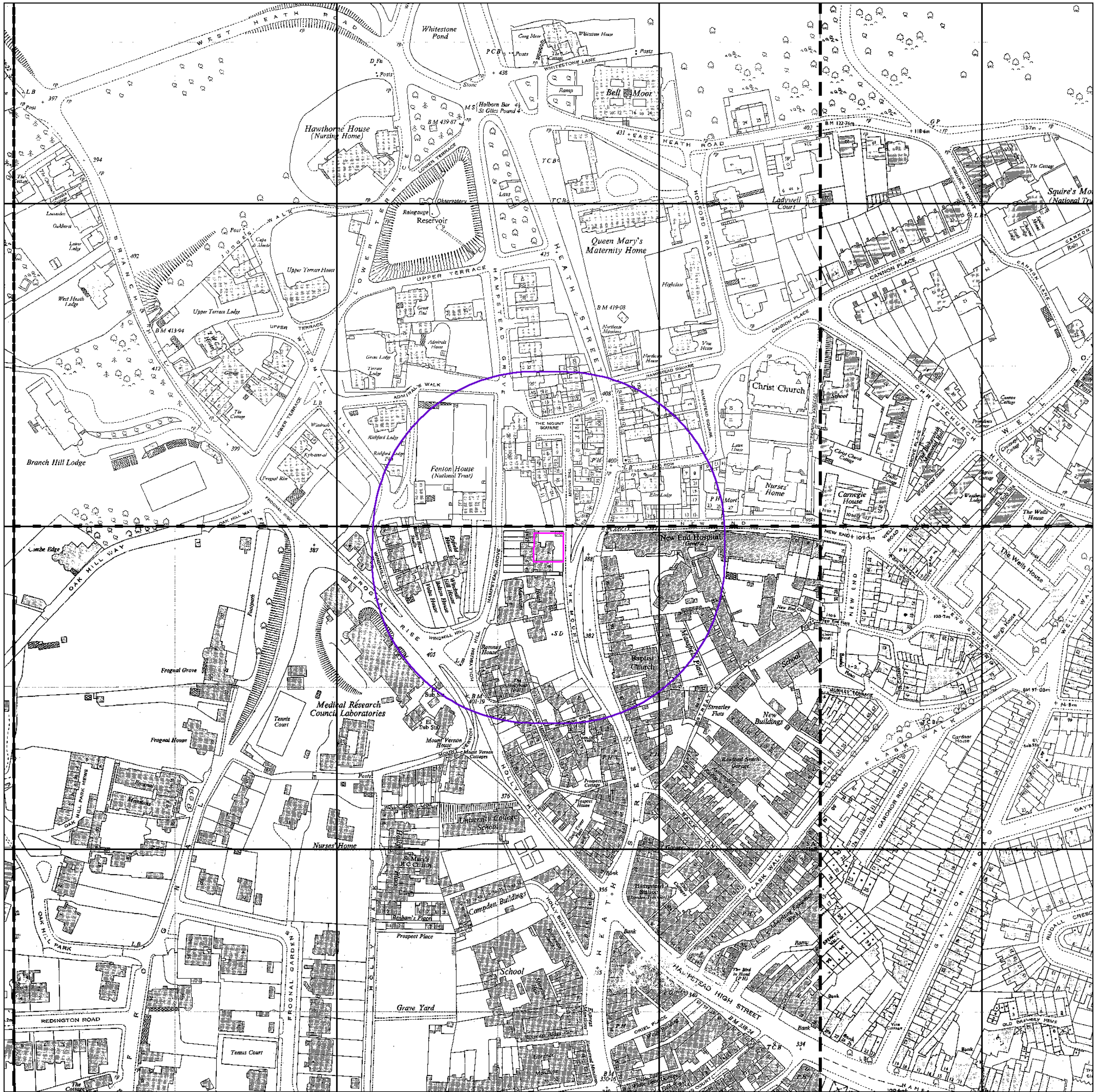

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Additional SIMs

Published 1954 - 1987

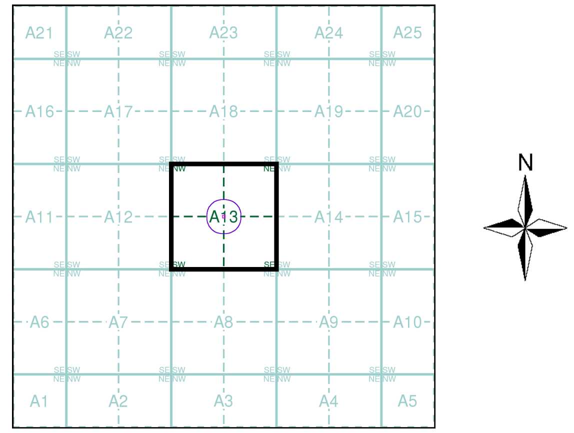
Source map scale - 1:1,250

The SIM cards (Ordnance Survey's `Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

TQ2586SE 1954 1:1,250	TQ2686SW 1954 1:1,250	TQ2686SE 1954 1:1,250
TQ2585NE 1966 1:1,250	TQ2685NW 1954 1:1,250	TQ2685NE 1987 1:1,250

Historical Map - Segment A13



Order Details

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Customer Ref: 20353
National Grid Reference: 526330, 185990
Slice: A
Site Area (Ha): 0.04
Search Buffer (m): 100

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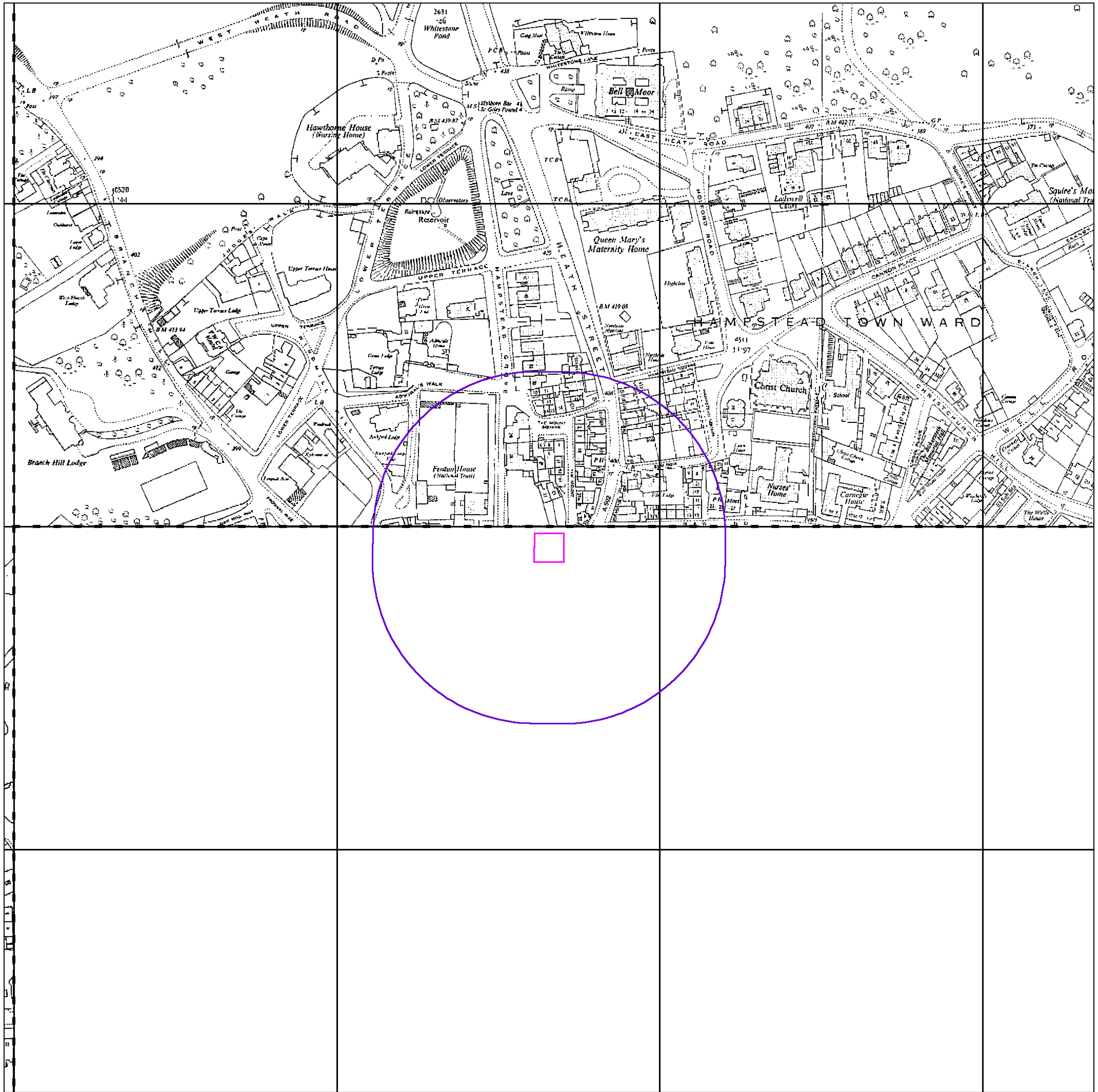

0 100 m

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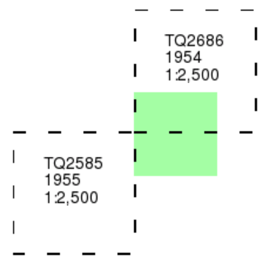
Additional SIMs

Published 1954 - 1955

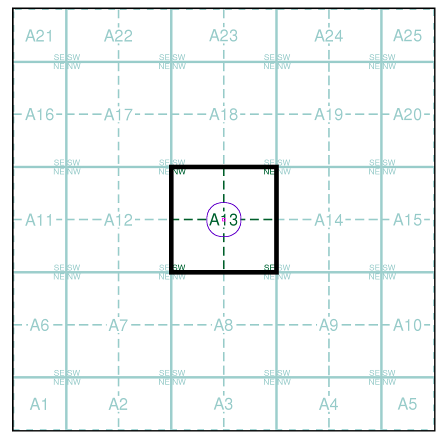
Source map scale - 1:2,500

The SIM cards (Ordnance Survey's `Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



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Order Details

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Customer Ref: 20353
National Grid Reference: 526330, 185990
Slice: A
Site Area (Ha): 0.04
Search Buffer (m): 100

Site Details

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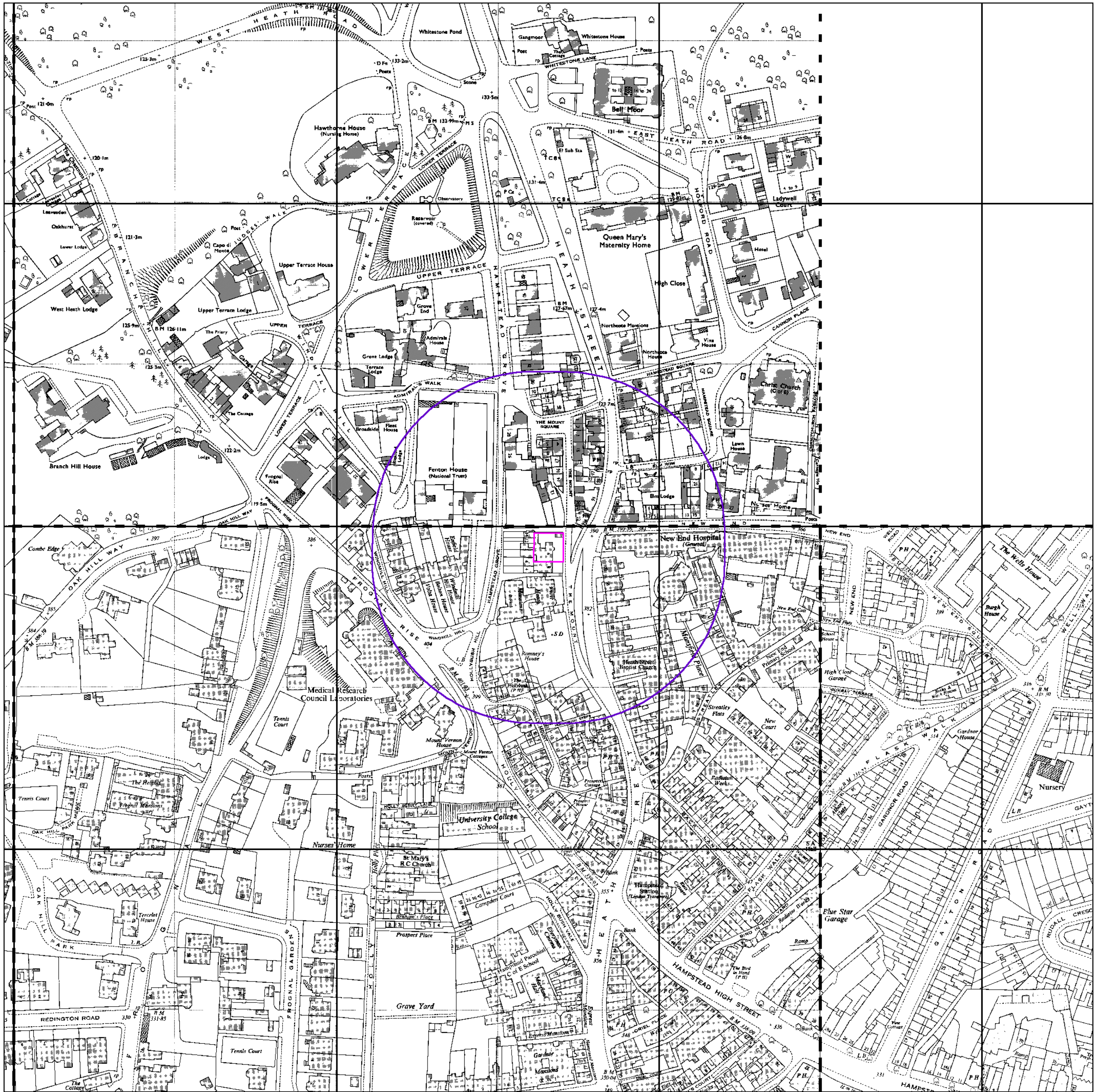

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Ordnance Survey Plan

Published 1966 - 1973

Source map scale - 1:1,250

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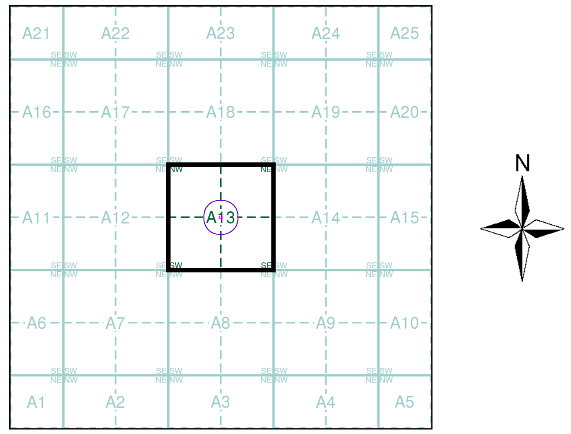
Map Name(s) and Date(s)

TQ2586SE 1972 1:1,250	TQ2686SW 1973 1:1,250	
TQ2585NE 1966 1:1,250	TQ2685NW 1966 1:1,250	TQ2685NE 1966 1:1,250

Historical Map - Segment A13



Order Details

Order Number: 302163780_1_1
Customer Ref: 20353
National Grid Reference: 526330, 185990
Slice: A
Site Area (Ha): 0.04
Search Buffer (m): 100

Site Details

9, The Mount, LONDON, NW3 6SZ

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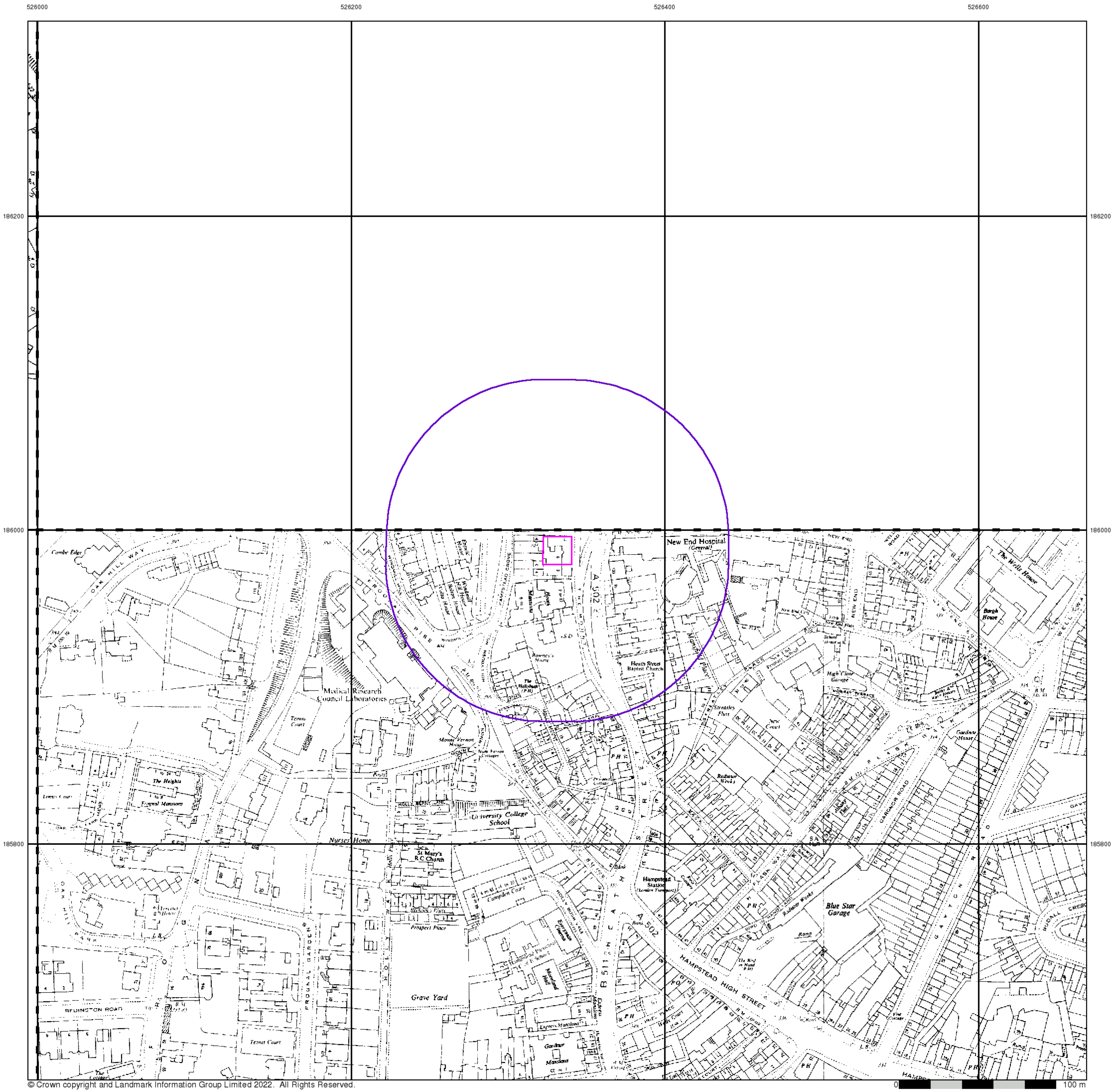

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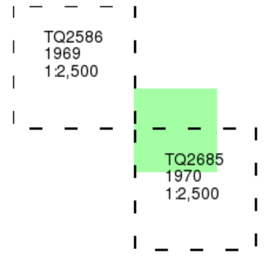
Ordnance Survey Plan

Published 1969 - 1970

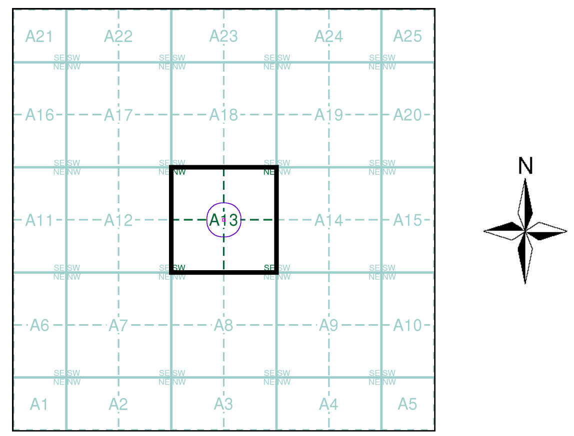
Source map scale - 1:2,500

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 and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below 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.

Map Name(s) and Date(s)



Historical Map - Segment A13



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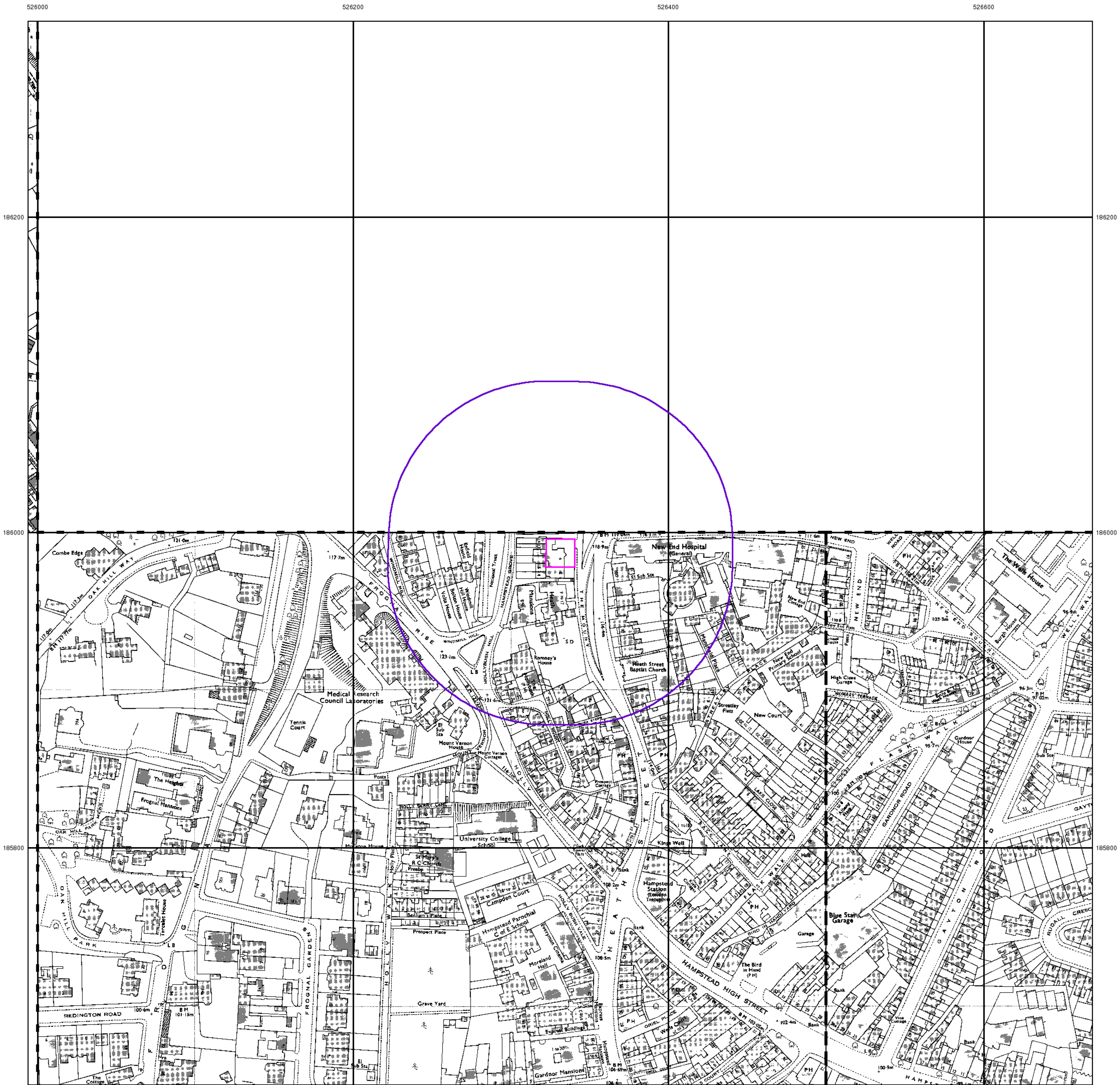

0 100 m

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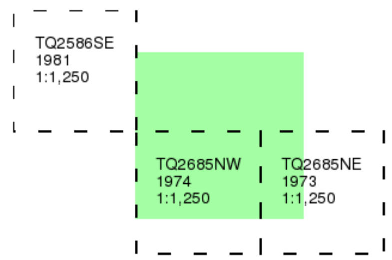
Ordnance Survey Plan

Published 1973 - 1981

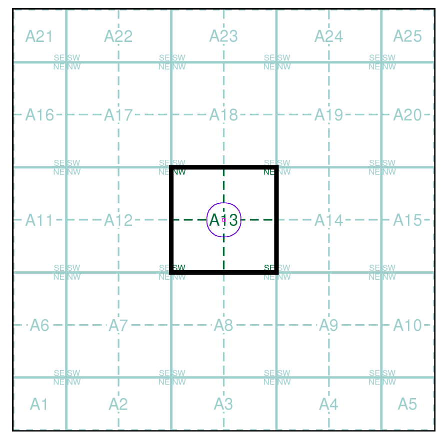
Source map scale - 1:1,250

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 and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below 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.

Map Name(s) and Date(s)



Historical Map - Segment A13



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Order Details

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Site Details

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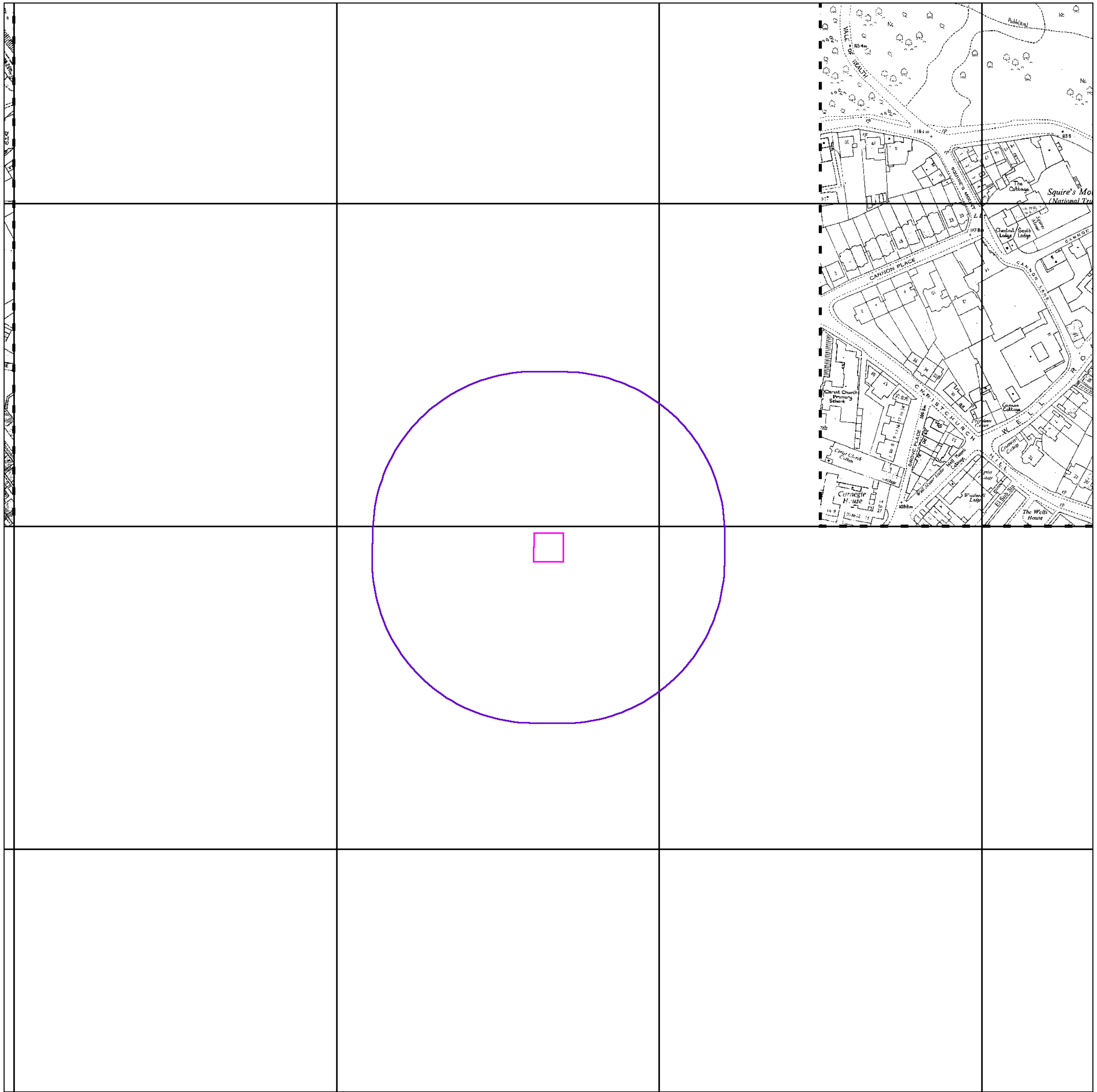

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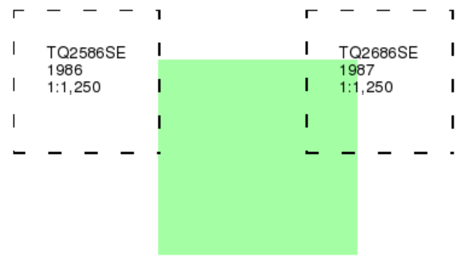
Additional SIMs

Published 1986 - 1987

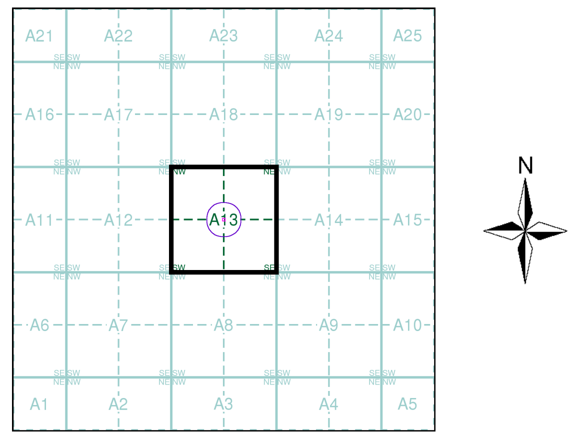
Source map scale - 1:1,250

The SIM cards (Ordnance Survey's `Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



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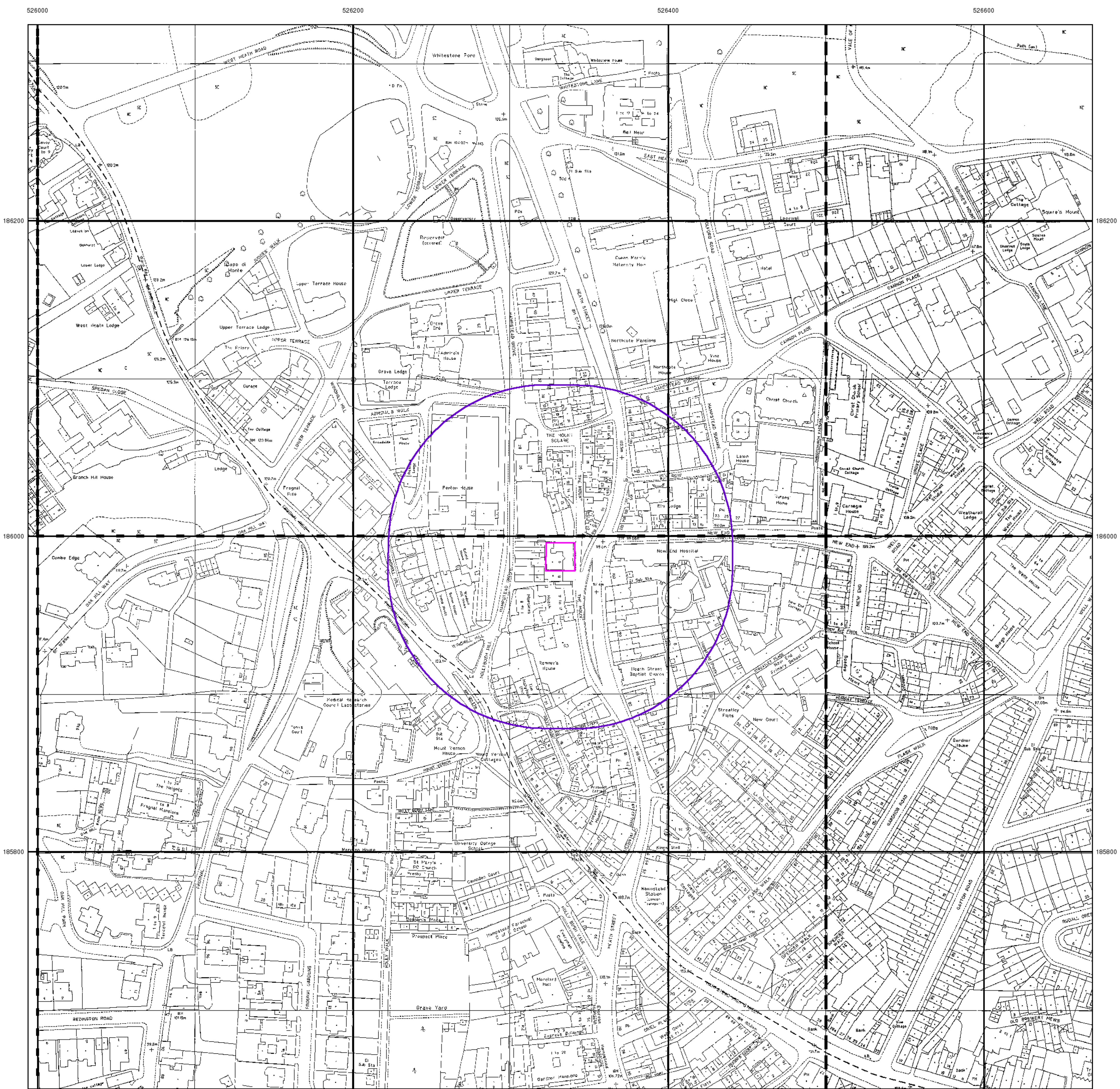

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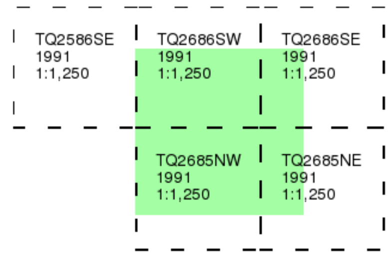
Large-Scale National Grid Data

Published 1991

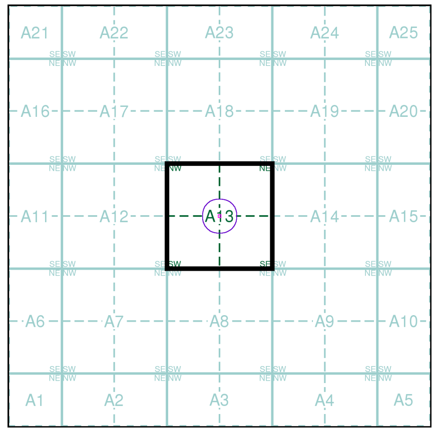
Source map scale - 1:1,250

'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



N

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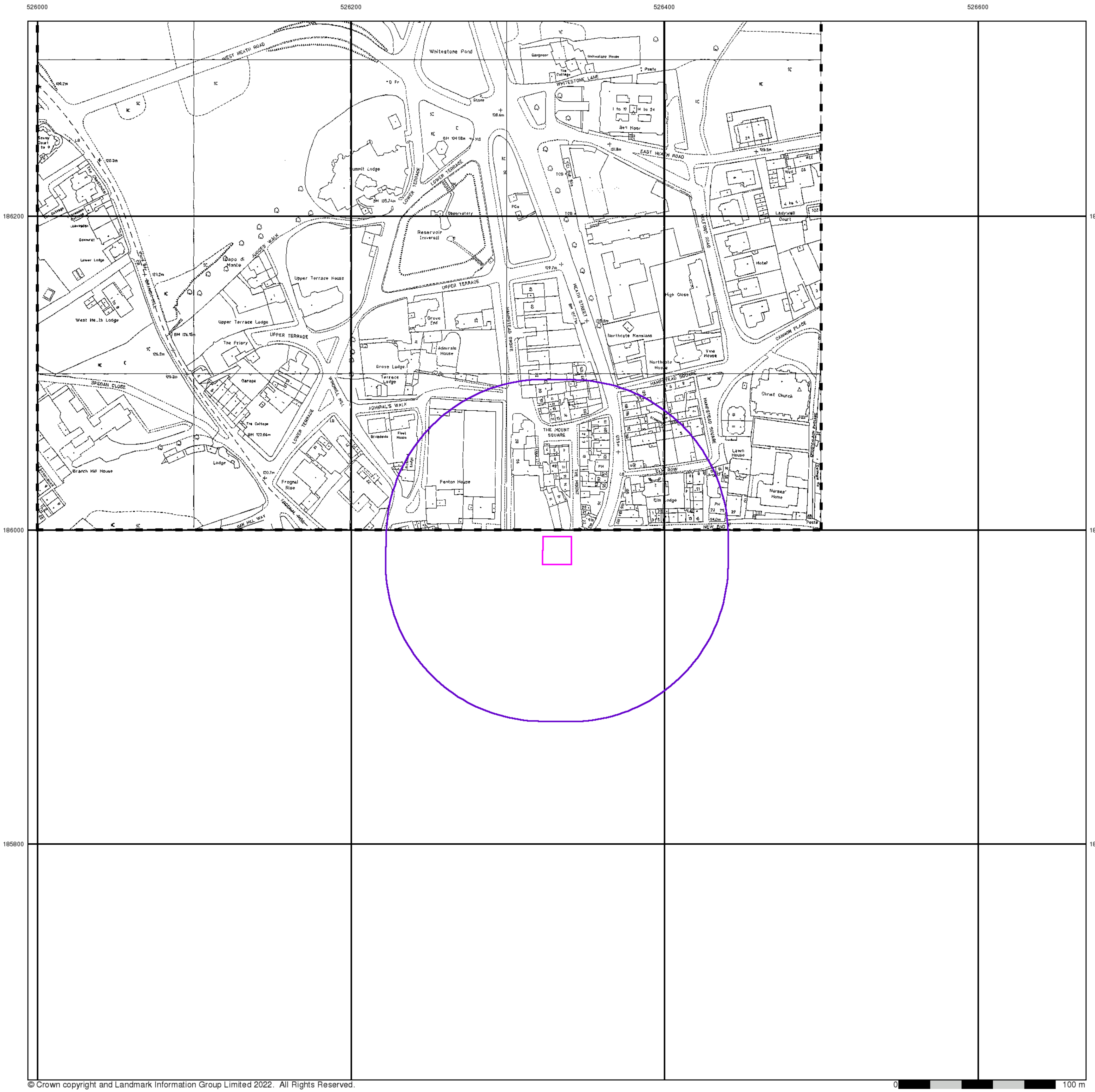

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Large-Scale National Grid Data

Published 1991

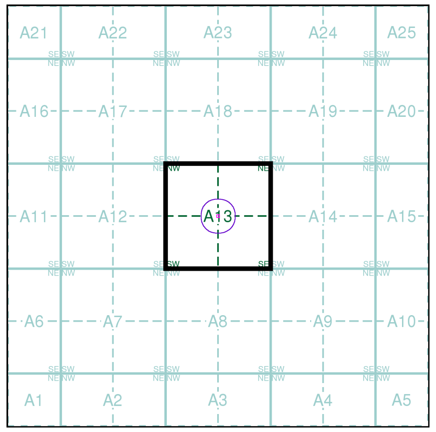
Source map scale - 1:1,250

'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

TQ2686SW
1991
1:1,250

Historical Map - Segment A13



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