Appendix 2.1

PHASE 1 PRELIMINARY GEO-ENVIRONMENTAL RISK ASSESSMENT

NOTE

Jackson's Row Developments Ltd (hereinafter referred to as ‘the Applicant’) is seeking to construct a major development proposal known as St Michael’s, Jackson’s Row, Manchester, UK

The planning application for the development was originally registered in January 2017. Following feedback, the decision was taken to revise the scheme. Revised plans and documents were submitted in November 2017 and the development was granted planning permission in June 2018.

Through the detailed design process, a number of relatively minor improvements to the original scheme have been identified; these will also provide technical and functional improvements through the next stage design process. The Applicant wishes to progress these proposed changes, which are considered to require amendments to the original scheme, through a Section 73 application.

An Environmental Statement, produced in accordance with the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 2011, was submitted in support of the Approved Development in 2017. The 2017 Environmental Statement comprised three volumes, as follows:

Volume 1: Main Text and Figures;
Volume 2: Technical Appendices;
Volume 3: Non-Technical Summary

With reference to Volumes 1 and 2 of the 2017 Environmental Statement, it has been decided that rather than updating and re-submitting the entire Volumes in support the Section 73 application, an ‘Addendum’ to the 2017 Environmental Statement should be submitted. This is because the Proposed Amendments to the scheme are minor in nature and the potential to affect the environmental assessment is limited.

This Environmental Statement Volume 2 (2017) appendix formed part of the application package for the June 2018 approved scheme and remains valid.

REPORT N^{O} 70010925/001/10465

JACKSON'S ROW

PHASE I PRELIMINARY GEO-ENVIRONMENTAL RISK ASSESSMENT

CONFIDENTIAL

JANUARY 2016

WSP | PARSONS BRINCKERHOFF

JACKSON'S ROW

PHASE I PRELIMINARY GEO-ENVIRONMENTAL RISK ASSESSMENT

Jackson's Row Developments Limited

Phase I Preliminary Geo-Environmental Risk Assessment
Confidential

Project no: 70010925/001/10465
Date: January 2016

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QUALITY MANAGEMENT

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1 EXECUTIVE SUMMARY

On the instruction of Jackson's Row Developments Limited., a preliminary Geo-Environmental Risk Assessment has been undertaken for a site located between Jackson's Row, Bootle Street, and South Mill Street in Manchester City Centre. The aim of the assessment is to identify issues associated with soil and groundwater conditions that are likely to impact on the development of the site.

The geological mapping and boreholes from the surrounding area suggest that the site is underlain by Made Ground overlying Chester Pebble Beds sandstone of the Sherwood Sandstone Group.

Historic land use on the site includes a printing works, garage, public house, and police station. Currently, the land use includes car parking and a synagogue. The building that housed the police station is still present but is vacant.

Historical mapping and local records indicate that the site suffered bomb strikes during World War II including damage to the police station in the south-eastern corner and complete ruin of buildings in the north-western corner. A specialist survey has categorised approximately one third of the site as a Medium Risk Zone with respect to unexploded ordnance and the remainder of the site as a Low Risk Zone. Appropriate consideration will need to be given to UXO risk at investigation and construction stage.

Widespread soil and groundwater contamination is not anticipated, however localised contamination associated with former land uses and underground fuel storage tanks may be present. Any demolition derived Made Ground may be a potential source of asbestos.

Waste disposal from the basement excavation will represent a significant cost. Whilst potential markets may exist for processed demolition rubble and as dug bedrock, Made Ground soils will likely need to go to landfill and additional works is required to ensure that disposal costs are minimised as much as practicable.

The presence of shallow bedrock and a deep basement excavation suggest that a raft foundation may be utilised for the proposed towers. The presence of the West Manchester Fault presents the possibly that rock strength may locally be reduced and the need for some additional remedial works at formation level cannot be discounted.

A propped contiguous or secant bored pile wall will likely be required to support the basement excavation, with the rock providing hard digging conditions.

It is anticipated that dewatering may be required to facilitate basement construction. Analysis is required to establish the chemical quality of the groundwater.

It is recommended that an intrusive ground investigation be completed to determine the contamination status of the site and provide geotechnical data to facilitate economic design of foundations and basement retention.

WSP | Parsons Brinckerhoff UK Limited

2 INTRODUCTION

2.1 AUTHORISATION

On the instruction Jackson's Row Developments Limited, WSP | Parsons Brinckerhoff has been commissioned to undertake a Phase I Preliminary Geo-Environmental Risk Assessment for a proposed development at the location of Jackson's Row, Manchester.

2.2 OBJECTIVES

The purpose of this report is to provide details on the potential geotechnical and contamination status of the site and identify associated issues that could impact on redevelopment of the site. The report includes an assessment of the potential risk associated with contamination due to current and historical uses and presents a preliminary conceptual site model.

2.3 BACKGROUND AND DEVELOPMENT PROPOSALS

Three buildings currently occupy the site along with car parking areas. The buildings comprise a public house, the Manchester Reform Synagogue, and a former police station.

The proposed development involves the demolition of the existing structures and construction of a two towers of 21 and 31 storeys in height, with a one level basement, which will occupy the full footprint of the site. The towers will be of mixed use including residential, retail, office space, and gardens.

Development proposals are presented in **Appendix B**.

2.4 INFORMATION SOURCES

The information presented in this report has been collated from the following sources:

- Site walkover completed by WSP | Parsons Brinckerhoff on 14 October 2015;
- Landmark Envirocheck Report: 70010278-100, dated 05 October 2015;
- British Geological Survey (BGS) mapping;
- BGS borehole scans available online at the BGS Geoindex;
- Department of the Environment Industry Profile. Profile of miscellaneous industries, incorporating printing and bookbinding works;
- Department of the Environment Industry Profile. Road vehicle fuelling, service and repair – garages and filling stations;
- WWII bomb damage maps available online at The University of Manchester Library Image Collections;
- Dynasafe BACTEC Explosive Ordnance Desktop Threat Assessment. Site: Jackson's Row. Ref: 6239TA;
- Information available online at the Environment agency (EA) website; and,
- Information available online at the Coal Authority website.

2.5 CONFIDENTIALITY STATEMENT

The report is addressed to and may be relied upon by the following:

Jackson's Row Developments Limited
4 Jordan Street
Manchester
M15 4PY

This assessment has been prepared for the sole use of the above named party. This report shall not be relied upon or transferred to any other parties without the express written authorisation of WSP | Parsons Brinckerhoff. No responsibility will be accepted where this report is used in its entirety, or in part, by any other party.

Information provided by others is taken in good faith as being accurate. WSP | Parsons Brinckerhoff cannot and will not accept liability for any deficiencies in third party information.

General limitations are presented in **Appendix A**.

3 SITE INFORMATION

3.1 SITE LOCATION & DESCRIPTION

The site is located in Manchester City Centre, approximately 100m west of Manchester Library and 100m southwest of the Manchester Town Hall.

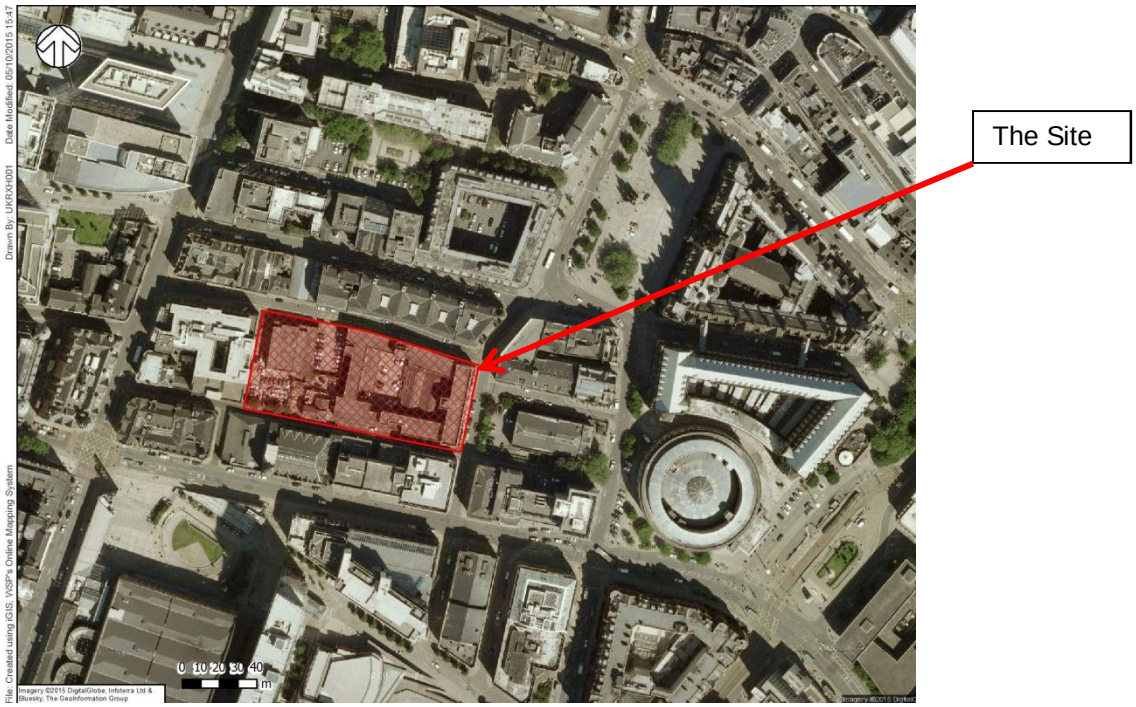
The approximate centre of the site is located at National Grid Reference 383668E, 398023N.

A site location plan is presented as **Figure 1** in **Appendix C** and an aerial photograph of the site is presented below.

The site covers an area approximately 0.6 hectares. A former police station occupies the eastern half of the site. The building is four storeys tall along with a basement and contains a central courtyard area. The western half of the site comprises a public house, the Manchester Reform Synagogue and car parking areas. The elevation on-site gently decreases from approximately 39.5m AOD in the north-east corner to approximately 36.0m AOD in the southwest corner.

The site is bound to the north by Jackson's Row, with a five storey building beyond of mixed use including office space, cafes, a gymnasium, and nightclub. To the south lie Bootle Street and the Albert Hall theatre, an office, restaurants, and a public house. The western boundary is formed by 210 Deansgate, an office building with retail units on the ground floor, with Deansgate itself beyond. To the east lie South Mill Street and the Friends Meeting House Manchester

Aerial Photograph of Site



3.2 BULK HAZARDOUS MATERIALS STORAGE

No bulk materials storage was observed at the time of the site walkover.

4 ENVIRONMENTAL SETTING

4.1 GEOLOGY

Published geological mapping [1] indicates that the eastern half of the site, beneath the former police station, is underlain by Glacial Till and Chester Pebble Beds Formation of the Sherwood Sandstone Group. The western half of the site is indicated to be directly underlain by the Chester Pebble Beds Formation. Glacial Fluvial Sheet Deposits (sand & gravel) are indicated to outcrop immediately to the south of the eastern half of the site.

The conjectured outcrop of the West Manchester Fault is indicated to cross the southwest corner. The fault trends northwest-southeast with the downthrown side to the northeast.

There are no BGS boreholes on the site, however there are several boreholes located within 50m of the site boundary. The boreholes indicate the area to be underlain by Made Ground, deposits of sand and gravel, or stiff clay, and sandstone at depths ranging between 3.5m below ground level (BGL) and 5.0m BGL. The BGS borehole logs are presented in **Appendix D**.

4.2 COAL MINING

According to the Coal Authority website, the site lies within the LANCS Coal Mining Reporting Area. However the Sherwood Sandstone Group is not a coal bearing unit and due to the thickness of the formation, it is considered unlikely that the site will be affected by coal mining.

4.3 GROUND STABILITY HAZARDS

According to the Envirocheck Report [2] the potential for collapsible ground, compressible ground, ground dissolution, running sand, shrinking or swelling clay ground stability hazards are classed as either Very Low or No Hazard.

4.4 HYDROGEOLOGY

The Environment Agency (EA) website indicates the Chester Pebble Beds to be a Principal Aquifer. Principal Aquifers are layers that have high intergranular or fracture permeability meaning that they usually provide a high level of water storage. They may support water supply or river base flow on a strategic scale.

If present on site, the Glacial Fluvial Sheet Deposits have been designated as a Secondary A Aquifer. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases form an important source of base flow to rivers.

The Glacial Till has been classified as Unproductive Strata with low permeability and negligible significance for water supply or river base flow.

BGS hydrogeological maps [3] suggest that the groundwater level lies approximately between 20m AOD and 25m AOD. Groundwater is indicated to lie at approximately 10m BGL in BGS borehole SJ89NW219, which is located approximately 60m north of the site (corner of Albert Square and Lloyd Street).

4.5 HYDROLOGY

The nearest surface water feature is the Rochdale Canal (Western Section), which lies approximately 270m to the south east. According to the EA website, the canal has a Current

Ecological Quality rating of Good Potential. The Current Chemical Quality does not require assessment.

4.6 SENSITIVE LAND USES

According to the Envirocheck Report [2], there are no sensitive land uses on site or within 500m of the site boundary.

4.7 RADON

The Envirocheck Report [2] indicates that the site is located in a lower probability area where less than 1% of homes are above the action level and therefore radon protective measures are not required for developments in this area.

5 HISTORICAL LAND USE

5.1 SITE HISTORY

Historical Ordnance Survey (OS) maps and Insurance Plans included within the Envirocheck Report, bomb damage maps available from the University of Manchester, and historic OS map sheets of the City of Manchester have been reviewed and the history of the site and surrounding area is summarised below in **Table 5.1**. A selection of historical maps is presented in **Appendix E**.

Table 5.1 – Summary of site history

YEAR	ON SITE	SURROUNDING AREA
1848	The map shows Jackson's Row, Bootle Street, and Deansgate to be present and in their current arrangement. Buildings are indicated on the site; although no specific land uses are indicated.	The surrounding area has a high density of buildings. Land uses are not indicated.
1850	Several small courtyards are indicated on the map and in conjunction with the small size of the buildings; this suggests that the site is predominantly residential. Two alleys named Roger's Row and South Sea connect Jackson's Row and Bootle Street in the eastern half of the site. To the east of the South Sea alley a Cotton Dye Works is indicated.	The surrounding land use in the immediate vicinity appears to be mixed residential and industry along with three burial grounds to the west, south, and east. Industrial land use includes a tannery and cotton dye works to the northeast, timber yards to the north and south, a coach manufacturer to the north, and an iron yard to the south.
1894 – 1896	A courtyard at the centre of the site has been created by closing off the southern entry to Roger's Row and demolishing some buildings.	Manchester Town Hall has been built approximately 100m to the northwest of the site. A large railway station has been built approximately 100m south.
1908 – 1909	The public house is marked on the map in its present location. The courtyard on site is marked as a Fire Engine Station. Many of the smaller buildings and courtyards have been replaced by larger structures which are likely small workshops.	Deansgate, Peter Street, Mount Street, and Albert Square have had tramlines built on them. Land use within 100m of the site includes a number of theatres, halls, and offices. The station to the south has expanded to include an additional building and more railway lines. The station now comprises the Central Station building, the Cheshire Lines Railway Good Station, and the G.N.R. Goods Station. A hospital is shown approximately 200m to the east of the site. The Midland hotel is present 100m to the southeast of the site. A gas works and Corporation Yard are shown approximately 500m to the south.
1922 – 1933	The Fire Engine Station is no longer shown and no land use is indicated. No other changes have occurred.	No change of note.
1937	During the site walkover a commemoration stone was noted that indicates the police station was opened in 1937.	-
1938	No change of note.	The Central Public Library has been built approximately 100m to the east. No other changes of note.
1940 - 1941	A high explosive bomb landed on the corner of Bootle Street and South Street damaging the building on the southeast corner of the site. The Public House was also damaged. A building on the northwest corner of the site was destroyed by bomb damage.	A large number of bomb strikes are recorded in the surrounding area. Five fire bombs are indicated to have fallen on the Albert Hall immediately to the south of the site. Reference should be made to the Extract from Bomb Damage Map in **Appendix E**.

1948	The Public House has been repaired and is marked on the map. The bombed building in the northwest corner of the site is marked as a ruin. The police station appears on the map for the first time. The Southsea alley no longer exists.	The tram lines have been removed from the surrounding streets. A Public House is now present on Jackson's Row immediately to the north of the site. A commercial garage has been built on the western boundary of the site. There are several ruined buildings in the surrounding area; including on the corner of Deansgate and Jackson's Row, on the corner of Cumberland Street and Deansgate, and between Queen Street and Lloyd Street Buildings to the south of the Town Hall have been demolished and replaced with an extension to the Town Hall. The stations to the south are now marked as Central Station, Goods Station, and Deansgate Goods Station.
1955	The Reform Synagogue has been built in the place of the ruin in the northwest corner of the site. There are now five buildings remaining on site; the police station, public house, Reform Synagogue, the Manchester Poster Services Ltd print works covering much of the southwest corner, and a Lost Property Depository located between the Synagogue and police station. A sunken petrol tank is noted on the northern border of the police station. The print works includes a garage located immediately to the north of the public house.	Sunken petrol tanks are indicated within the garage immediately to the west of the site.
1958	No changes of note.	Only the ruin between Queen Street and Lloyd Street remains. The surrounding buildings are still used for a mixture of theatres, offices, halls, and public houses.
1962	The Lost Property Depository has become a garage. A sunken petrol tank is indicated within the garage associated with the print works.	No changes of note.
1964	No changes of note.	No changes of note.
1970	The print works and associated garage have been demolished and replaced with car parks.	No changes of note.
1972 – 1973	No changes of note.	The ruin between Queen Street and Lloyd Street has been redeveloped. The Central Station and Goods Station are now disused. The Deansgate Goods Station has been redeveloped as a car park.
1980 – 1981	No changes of note.	No changes of note.
1985	No changes of note.	The Goods Station (disused) has become a car park. Buildings on the corner of Brazennose Street and Albert Square have been demolished and replaced with a car park. Buildings on the corner of Lloyd Street and Albert Square have been demolished.
1986 – 1990	The garage (former Lost Property Depository) has been demolished.	The vacant plot on the corner of Lloyd Street and Albert Square has been developed with a building with a central courtyard. The car park on Brazennose Street has been redeveloped as several buildings. Central Station is now an exhibition and events centre.
1992 – 1995	No changes of note.	No changes of note.
2006	No changes of note.	No changes of note.
2015	No changes of note.	No changes of note.

5.2 ASBESTOS CONTAINING MATERIALS

Given the age of the structures, as detailed in **Table 5.1**, it is considered possible that asbestos containing materials (ACMs) may be present within the construction of the buildings. Any ACM identified should be removed under appropriate controls prior to any work commencing.

The site history reveals that there have been previous phases of demolitions and therefore ACMs may be present in any demolition derived Made Ground.

5.3 UNEXPLODED ORDNANCE (UXO)

Bomb damage maps available online from The University of Manchester show that the Deansgate area was heavily bombed during WWII and the site itself suffered at least one direct hit. On this basis an Explosive Ordnance Threat Assessment [4] (EOTA) was ordered from Dynasafe BACTEC. The assessment is presented in **Appendix F** and an extract of the bomb map is presented below.

Extract of Bomb Damage Map courtesy of the University of Manchester



Key
Red dot = Fire Bomb Strike, Blue dot = High Explosive Bomb Strike
Solid Red = Demolished Building, Hatched red = Damaged Building (Still Standing)

The EOTA [4] states that the site was located in an area of high bombing density and that one High Explosive bomb strike was recorded on the south-eastern corner of the site. The report also notes that a 1kg incendiary bomb shower caused buildings in the north-western corner to be gutted.

The EOTA [4] states that a maximum bomb penetration depth range of 6 – 8m below WWII ground level is possible based on geological mapping [1] and BGS boreholes (**Appendix D**).

A risk map is presented in Annex L of the EOTA [4] (**Appendix F**). The western third of the site has been classified by Dynasafe BACTEC as a Medium Risk Zone based on the bombing density of the area and the possibility that rubble and debris associated with bomb damage to the former structures in this area of the site could have obscured any High Explosive bomb entries at a later date.

The remainder of the site has been classified by Dynasafe BACTEC as a Low Risk Zone. This is based on the fact that the police station and hard standing remained relatively undamaged thus significantly reducing the likelihood of High Explosive bomb entry points being unrecorded.

Risk mitigation measures are presented in **Section 10.3**.

6 REGULATORY INFORMATION & CONSULTATIONS

6.1 POLLUTION INCIDENTS TO CONTROLLED WATERS

The Envirocheck Report [2] records two pollution incidents to controlled waters within 500m of the site boundary. The nearest incident occurred 441m to the north of the site at the River Irwell on 26 May 1992. The incident involved an unknown pollutant and was classified as a Category 3 – Minor Incident.

6.2 DISCHARGE CONSENTS

According to the Envirocheck Report [2] there are five current Discharge Consents within 500m of the site boundary. The closest consent is operated by The Lord Chancellor at the Manchester Civil Justice Centre, approximately 430m to the northwest of the site. The consent relates to the discharge of cooling water into the River Irwell.

6.3 ENFORCEMENT & PROHIBITION NOTICES

One Enforcement Notice has been issued within 500m of the site boundary. This notice regards a breach of conditions relating to accumulation and disposal of radioactive wastes at Manchester Children's Hospital. The enforcement of the notice is dated to 4 August 1995.

6.4 LOCAL AUTHORITY POLLUTION PREVENTION AND CONTROLS

There are two current Local Authority Pollution Prevention and Controls (LAPPC) within 500m of the site boundary. The nearest LAPPC is operated by Johnson Cleaners UK Ltd located approximately 200m to the northeast of the site. The control refers to PG6/46 dry cleaning business operations.

6.5 SUBSTANTIATED POLLUTION INCIDENT REGISTER

According to the Envirocheck Report [2], there have been no Substantiated Pollution Incidents within 1000m of the site boundary.

6.6 WASTE MANAGEMENT / LANDFILLS / MINERAL SITES

According to the Envirocheck Report [2] and the EA website there are no landfills within 500m of the site boundary. There is one Licensed Waste Management Facility within 500m of the site boundary. This is operated by Hillhouse Remediation Ltd 323m to the southeast of the site and is licensed to operate mobile plant for reclamation and restoration.

6.7 CONTEMPORARY TRADE DIRECTORY

According to the Envirocheck Report [2] there are 161 Contemporary Trade Directory Entries within 500m of the site boundary. The two closest entries are located 16m to the northeast of the site. These entries are for Boda Skins and Manchester Chemicals and Pigments Ltd which are respectively, a leather garments and products supplier and chemical distributor and wholesaler.

6.8 HAZARDOUS SUBSTANCES & SITES

According to the Envirocheck Report [2], there are no Control of Major Accident Hazards (COMAH) sites, Explosive Sites, Notifications of Installations Handling Hazardous Substances (NIHHS), Planning Hazardous Substance Consents, or Planning Hazardous Substance Enforcements within 1000m of the site boundary.

6.9 ENVIRONMENT AGENCY

No significant issues have been identified that warrant consultation with the EA.

7 CONCEPTUAL SITE MODEL

7.1 PRELIMINARY GROUND MODEL

Based on the available information, it is anticipated that the site is likely underlain by a sequence of Made Ground underlain by Chester Pebble Beds Formation. Glacial Till may be present beneath any Made Ground over the eastern half of the site. Depth to rockhead is anticipated to be between 3.5m BGL and 5.0m BGL.

7.2 POLLUTANT LINKAGE ASSESSMENT

As detailed in **Table 5.1**, parts of the site have formerly been used as a printing works and a garage. According to the Department of the Environment Industry Profile for printing works [5] the following contaminants are typically associated with printing processes:

- Metals and metalloids including chromium, magnesium, lead, cadmium, copper, and zinc;
- Inorganic ions including silver halides and nitrates;
- Sulphuric and phosphoric acid;
- Asbestos; and,
- Organic compounds including organic dyes, ink solvents, cleaning and degreasing solvents, polychlorinated biphenyls (PCBs), and hydrocarbon fuels.

The Department of the Environment Industry Profile for garages [6] details the following contaminants typical of workshop areas:

- Metals and their compounds, including lead, chromium, zinc, copper, and vanadium;
- Asbestos; and,
- Organic compounds, including polycyclic aromatic hydrocarbons (PAHs), diesel and petrol.

The potential sources, pathways, and receptors relevant to the future land use (residential with no landscaping) have been identified and are presented in **Table 7.1**.

Table 7.1 – Conceptual Site Model

SOURCE	PATHWAY	RECEPTOR
Asbestos associated with the building structures and former structures	▪ Inhalation of asbestos	▪ Construction workers ▪ Local residents
Potential contamination (including asbestos) within Made Ground (demolition waste from former structures and soil bound contaminants from historic land use)	▪ Direct contact, ingestion, inhalation of soil bound contaminants / dust ▪ Inhalation of vapours / ground gas associated with soil contamination ▪ Leaching of contamination into groundwater followed by migration of groundwater to the wider environment or surface waters	▪ Construction workers ▪ Future site users ▪ Future maintenance users ▪ Underlying Principal Aquifer ▪ Local residents

Given that the development will require the removal of all Made Ground soils to facilitate the basement construction, the potentially complete pollutant linkages are considered to be as follows:

- Direct contact with or inhalation / ingestion of shallow soil-bound contaminants including ACM (if present) by construction workers and local residents and business users during redevelopment.
- If significant volumes of ground gas or vapours associated with off-site Made Ground and/or volatile contaminants are present, migration into confined spaces followed by inhalation by construction workers or future site users.
- On-site migration of contaminated groundwater from off-site source(s), this would be particularly associated with dewatering.

8 POTENTIAL GEO-ENVIRONMENTAL CONSTRAINTS

8.1 SOILS

Based on the development proposals and the assumption that Made Ground will be removed for the basement excavation, widespread remediation of soils is considered to be unlikely to be required. However, localised areas of impacted soils (e.g. sites of former garage and print works and sunken fuel tanks) may exist that require treatment prior to removal from site.

The presence of Made Ground, which may contain construction and demolition fill and be potentially associated with ACMs, will require suitable control measures to be in place during construction activities involving earthworks to mitigate the risks to construction workers and the local residents.

8.2 GROUNDWATER

Significant widespread groundwater contamination is not anticipated, however localised contamination associated with on / off-site fuel storage cannot be ruled out. This may have an impact on future dewatering works.

8.3 GROUND GAS

No significant sources of natural (e.g. organic soil deposits) or anthropogenic (e.g. landfill) hazardous ground gases have been identified. However, given the likely presence of Made Ground and the potential that this may contain some materials capable of generating ground gas, it is recommended that basic ground gas protection measures be considered at this time. Intrusive site investigation works should include scope for ground gas monitoring to enable the assessment of the ground gas risk.

8.4 WASTE DISPOSAL

The Made Ground on site will be classified as either Non-Hazardous or Hazardous depending on the contamination status of the site. Any excavated superficial soils and Sherwood Sandstone are likely to be classified inert waste.

The cost of waste disposal from the basement excavation is likely to be significant and site investigation to inform waste classification post demolition, together with the production of a sufficiently robust Materials Management Plan are likely to be necessary in advance of construction (see **Section 9.3**).

Analysis of groundwater will inform disposal options for the dewatering operation.

9 POTENTIAL GEOTECHNICAL CONSTRAINTS

9.1 GROUND CONDITIONS, FOUNDATIONS AND BASEMENT CONSTRUCTION

Based on the available geological information, it is considered likely that the site is underlain by a sequence of Made Ground and Sherwood Sandstone bedrock, which is anticipated to lie between 3.5m BGL and 5.0m BGL. Glacial Till may be present on the eastern half of the site, although these deposits are likely to be relatively thin and may have been excavated during previous stages of development.

Given that the basement excavation will likely be within the region of 11m deep, it is considered at this stage that, the development could in theory be founded on a raft foundation.

The possible presence of the West Manchester Fault on the south western corner of the site is noted in **Section 4.1**. It is possible that the rock mass in the immediate vicinity of the fault may have an increased weathering profile or have a weakened / broken state compared to the typical rock mass. Such zones may be very localised and difficult to locate through investigation, particularly as the position of the fault is conjectured.

If such weathered/weakened zones are encountered during foundation excavation an appropriately qualified engineer should inspect the formation to determine the appropriate remedial action. This may comprise grouting, or the deepening of the foundations locally.

The basement construction will likely require the use of a contiguous or secant bored pile wall. Propping of the basement wall is likely to be required to control deflections and ground movement on the site boundaries. Further details are required as to the nature of the foundations for the structure on the western boundary (210 Deansgate) to determine if any additional remedial works need to be undertaken in advance of basement excavation.

It is anticipated that the groundwater will be encountered for the lower levels of the excavation and dewatering will be required. Groundwater level and the permeability of the bedrock will need to be confirmed as part of any future ground investigation. Analysis is required to establish the chemical quality of the groundwater, which may have an impact on disposal costs.

9.2 OBSTRUCTIONS & EXCAVATABILITY

As well as the existing foundations, below ground obstructions, associated with previous phases of development should be anticipated. Other features, such as underground fuel tanks may also be present.

The majority of the basement excavation will be undertaken through bedrock, which based on past experience, may range between very weak and moderately strong. Discontinuities are typically closely to medium spaced. Rock coring and laboratory strength testing is required to assess the excavation methodology required, but at this stage it is anticipated that hard digging, possibly with the use of hydraulic breakers and ripping techniques may be required to reach formation level.

9.3 MATERIAL REUSE

Following appropriate asbestos removal, the crushed and screened demolition arisings may have some value as a recycled aggregate.

It is anticipated that excavated Made Ground soils will need to go to landfill and as discussed in **Section 8.4**, detailed waste characterisation will be required that disposal cost are appropriately managed.

Sherwood Sandstone is frequently used in the local area as a general fill material and it is possible that a ready market could be found for the arisings from the basement excavation.

9.4 UXO

The site has been divided by Dynasafe BACTEC [4] into a Low Risk Zone and a Medium Risk Zone. The following risk mitigation measures are recommended by Dynasafe BACTEC to support the proposed works:

BOTH RISK ZONES

- Site specific explosive ordnance safety and awareness briefings to all personnel conducting intrusive investigation and contraction works; and,
- The provision of unexploded ordnance site safety instructions to all personnel.

MEDIUM RISK ZONE ONLY

- The presence of an Explosive Ordnance Disposal (EOD) engineer to supervise open excavations; and,
- Intrusive Magnetometer Survey of any borehole locations down to the maximum bomb penetration depth.

It is the responsibility of the principal contractor to ensure that the UXO risk is appropriately addressed and mitigated during the groundworks. In planning mitigation measures, reference should be made to CIRIA 681 [7].

10 CONCLUSIONS & RECOMMENDATIONS

10.1 CONCLUSIONS

- It is considered that the risk of widespread contamination being encountered on the site is low. However localised areas of more contaminated ground may be present at the sites of former industries and around sunken fuel tanks.
- No significant sources of hazardous ground gases have been identified. However, given the absence of any site specific data, it is considered appropriate that basic gas protection measures be allowed for all new structures.
- Significant widespread contamination of groundwater is not anticipated, however localised contamination associated with on / off-site fuel storage cannot be ruled out.
- Waste disposal from the basement excavation will represent a significant cost. Whilst potential markets may exist for processed demolition rubble and as dug bedrock, Made Ground soils will likely need to go to landfill and additional post-demolition works are required to ensure that disposal costs are minimised as much as practicable.
- The presence of shallow bedrock and a deep basement excavation suggest that a raft foundation may be utilised for the proposed towers. The presence of the West Manchester Fault presents the possibility that rock strength may locally be reduced and the need for some additional remedial works at formation level cannot be discounted.
- A propped contiguous or secant bored pile wall will likely be required to support the basement excavation, with the rock providing hard digging conditions.
- It is anticipated that dewatering may be required to facilitate basement construction. Analysis is required to establish the chemical quality of the groundwater.
- Appropriate consideration will need to be given to UXO risk at investigation and construction stage.

10.2 RECOMMENDATIONS

- It is recommended that an intrusive ground investigation be completed to determine the contamination status of the site and provide geotechnical data to facilitate economic design of foundations and basement retention.

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1. British Geological Survey. 2004. Manchester and Salford. Sheet SJ89NW. Solid and Drift Edition. 1:10,000.
2. Landmark Information Group, 2015. Envirocheck Report: Jackson's Row. Report Ref: 73295769_1_1
3. British Geological Survey. 1989. Sheet 19: Hydrogeological Map of Clwyd and the Cheshire Basin. 1:100,00
4. Dynasafe BACTEC Limited. 2015. Explosive Ordnance Desktop Threat Assessment. Site: Jackson's Row, Manchester. Report Ref: 6239TA.
5. Department of the Environment. 1996. DOE Industry Profile, "*Profile of miscellaneous industries, incorporating charcoal works, dry-cleaners, fibreglass and fibreglass resins manufacturing works, glass manufacturing works, photographic processing industry, printing and bookbinding works".*
6. Department of the Environment. 1996. DOE Industry Profile, "*Road vehicle fuelling, service and repair – garages and filling stations".*
7. CIRIA C681. 2009. "*Unexploded Ordnance (UXO): a guide for the construction industry".* UK.

Appendix A

GENERAL LIMITATIONS

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

GENERAL

1. WSP UK Limited has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed and outlined in the body of the report.

2. Unless explicitly agreed otherwise, in writing, this report has been prepared under WSP UK Limited standard Terms and Conditions as included within our proposal to the Client.

3. Project specific appointment documents may be agreed at our discretion and a charge may be levied for both the time to review and finalise appointments documents and also for associated changes to the appointment terms. WSP UK Limited reserves the right to amend the fee should any changes to the appointment terms create an increase risk to WSP UK Limited.

4. The report needs to be considered in the light of the WSP UK Limited proposal and associated limitations of scope. The report needs to be read in full and isolated sections cannot be used without full reference to other elements of the report and any previous works referenced within the report.

PHASE 1 GEO ENVIRONMENTAL AND PRELIMINARY RISK ASSESSMENTS

Coverage: *This section covers reports with the following titles or combination of titles: phase 1; desk top study; geo environmental assessment; development appraisal; preliminary environmental risk assessment; constraints report; due diligence report; geotechnical development review; environmental statement; environmental chapter; project scope summary report (PSSR), program environmental impact report (PEIR), geotechnical development risk register; and, baseline environmental assessment.*

5. The works undertaken to prepare this report comprised a study of available and easily documented information from a variety of sources (including the Client), together with (where appropriate) a brief walk over inspection of the Site and correspondence with relevant authorities and other interested parties. Due to the short timescales associated with these projects responses may not have been received from all parties. WSP UK Limited cannot be held responsible for any disclosures that are provided post production of our report and will not automatically update our report.

6. The opinions given in this report have been dictated by the finite data on which they are based and are relevant only for the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, WSP UK Limited reserves the right to review such information and, if warranted, to modify the opinions accordingly.

7. It should be noted that any risks identified in this report are perceived risks based on the information reviewed. Actual risks can only be assessed following intrusive investigations of the site.

8. WSP UK Limited does not warrant work / data undertaken / provided by others.

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

INTRUSIVE INVESTIGATION REPORTS

Coverage: *The following report titles (or combination) may cover this category of work: geo environmental site investigation; geotechnical assessment; GIR (Ground Investigation reports); preliminary environmental and geotechnical risk assessment; and, geotechnical risk register.*

9. The investigation has been undertaken to provide information concerning either:

- **i.** The type and degree of contamination present at the site in order to allow a generic quantitative risk assessment to be undertaken; or
- **ii.** Information on the soil properties present at the site to allow for geotechnical development constraints to be considered.

10. The scope of the investigation was selected on the basis of the specific development and land use scenario proposed by the Client and may be inappropriate to another form of development or scheme. If the development layout was not known at the time of the investigation the report findings may need revisiting once the development layout is confirmed.

11. For contamination purposes, the objectives of the investigation are limited to establishing the risks associated with potential contamination sources with the potential to cause harm to human health, building materials, the environment (including adjacent land), or controlled waters.

12. For geotechnical investigations the purpose is to broadly consider potential development constraints associated with the physical property of the soils underlying the site within the context of the proposed future or continued use of the site, as stated within the report.

13. The amount of exploratory work, soil property testing and chemical testing undertaken has necessarily been restricted by various factors which may include accessibility, the presence of services; existing buildings; current site usage or short timescales. The exploratory holes completed assess only a small percentage of the area in relation to the overall size of the Site, and as such can only provide a general indication of conditions.

14. The number of sampling points and the methods of sampling and testing do not preclude the possible existence of contamination where concentrations may be significantly higher than those actually encountered or ground conditions that vary from those identified. In addition, there may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been taken into account in this report.

15. The inspection, testing and monitoring records relate specifically to the investigation points and the timeframe that the works were undertaken. They will also be limited by the techniques employed. As part of this assessment, WSP UK Limited has used reasonable skill and care to extrapolate conditions between these points based upon assumptions to develop our interpretation and conclusions. The assumption made in forming our conclusions is that the ground and groundwater conditions (both chemically and physically) are the same as have been encountered during the works undertaken at the specific points of investigation. Conditions can change between investigation points and these interpretations should be considered indicative.

16. The risk assessment and opinions provided are based on currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective

effects of any future changes or amendments to these values. Specific assumptions associated with the WSP UK Limited risk assessment process have been outlined within the body or associated appendix of the report.

17. Additional investigations may be required in order to satisfy relevant planning conditions or to resolve any engineering and environmental issues.

18. Where soil contamination concentrations recorded as part of this investigation are used for commentary on potential waste classification of soils for disposal purposes, these should be classed as indicative only. Due consideration should be given to the variability of contaminant concentrations taken from targeted samples versus bulk excavated soils and the potential variability of contaminant concentrations between sampling locations. Where major waste disposal operations are considered, targeted waste classification investigations should be designed.

19. The results of the asbestos testing are factually reported and interpretation given as to how this relates to the previous use of the site, the types of ground encountered and site conceptualisation. This does not however constitute a formal asbestos assessment. These results should be treated cautiously and should not be relied upon to provide detailed and representative information on the delineation, type and extent of bulk ACMs and / or trace loose asbestos fibres within the soil matrix at the site.

20. If costs have been included in relation to additional site works, and / or site remediation works these must be considered as indicative only and must be confirmed by a qualified quantity surveyor.

EUROCODE 7: GEOTECHNICAL DESIGN

21. On 1st April 2010, BS EN 1997-1:2004 (Eurocode 7: Geotechnical Design – Part 1) became the mandatory baseline standard for geotechnical ground investigations.

22. In terms of geotechnical design for foundations, slopes, retaining walls and earthworks, EC7 sets guidance on design procedures including specific guidance on the numbers and spacings of boreholes for geotechnical design, there are limits to methods of ground investigation and the quality of data obtained and there are also prescriptive methods of assessing soil strengths and methods of design. Unless otherwise explicitly stated, the work has not been undertaken in accordance with EC7. A standard geotechnical interpretative report will not meet the requirements of the Geotechnical Design Report (GDR) under Eurocode 7. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. The report is likely to represent a Ground Investigation Report (GIR) under the Eurocode 7 guidance.

DETAILED QUANTITATIVE RISK ASSESSMENTS AND REMEDIAL STRATEGY REPORTS

23. These reports build upon previous report versions and associated notes. The scope of the investigation, further testing and monitoring and associated risk assessments were selected on the basis of the specific development and land use scenario proposed by the Client and may not be appropriate to another form of development or scheme layout. The risk assessment and opinions provided are based on currently available approaches in the generation of Site Specific Assessment Criteria relating to contamination concentrations and are not considered to represent a risk in a specific land use scenario to a specific receptor. No liability can be

accepted for the retrospective effects of any future changes or amendments to these values, associated models or associated guidance.

24. The outputs of the Detailed Quantitative Risk Assessments are based upon WSP UK Limited manipulation of standard risk assessment models. These are our interpretation of the risk assessment criteria.

25. Prior to adoption on site they will need discussing and agreeing with the Regulatory Authorities prior to adoption on site. The regulatory discussion and engagement process may result in an alternative interpretation being determined and agreed. The process and timescales associated with the Regulatory Authority engagement are not within the control of WSP UK Limited. All costs and programmes presented as a result of this process should be validated by a quantity surveyor and should be presumed to be indicative.

GEOTECHNICAL DESIGN REPORT (GDR)

26. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. All the relevant information needs to be provided to allow for a GDR to be produced.

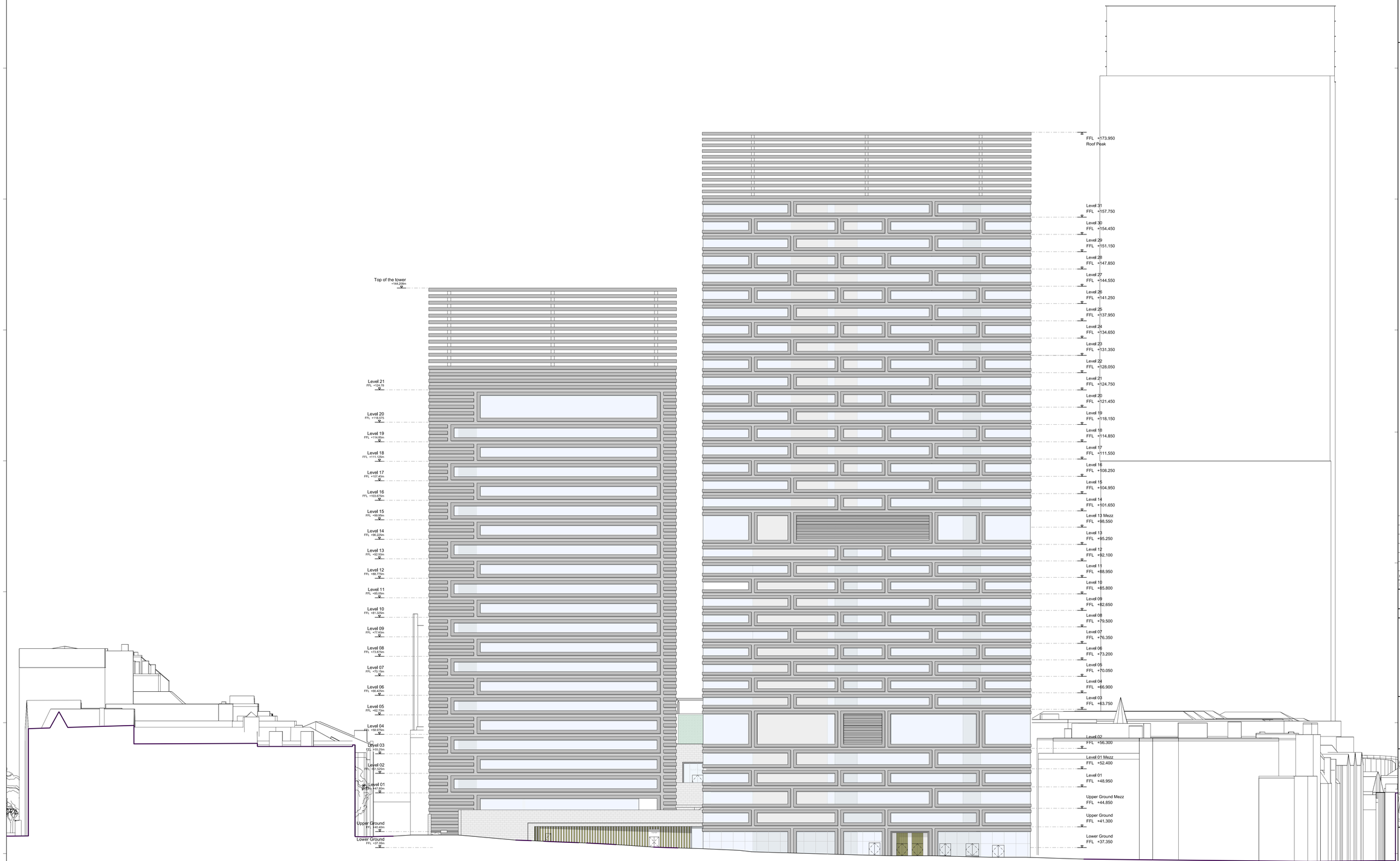
MONITORING (INCLUDING REMEDIATION MONITORING REPORTS)

27. These reports are factual in nature and comprise monitoring, normally groundwater and ground gas and data provided by contractors as part of an earthworks or remedial works.

28. The data is presented and will be compared with assessment criteria.

Appendix B

DEVELOPMENT PROPOSALS



General Notes

1. Dimensions are in millimetres unless stated otherwise.
2. Levels are in metres AOD unless stated otherwise.
3. Dimensions govern. Do not scale off drawing.
4. All dimensions to be verified on site before proceeding.
5. All discrepancies to be notified in writting to Make Limited.

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Rev	Date	Reason For Issue	Chk
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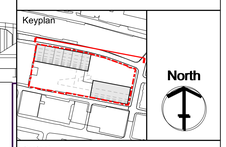
13 Fitzroy Street,
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Client
Jacksons Row Developments

Keyplan

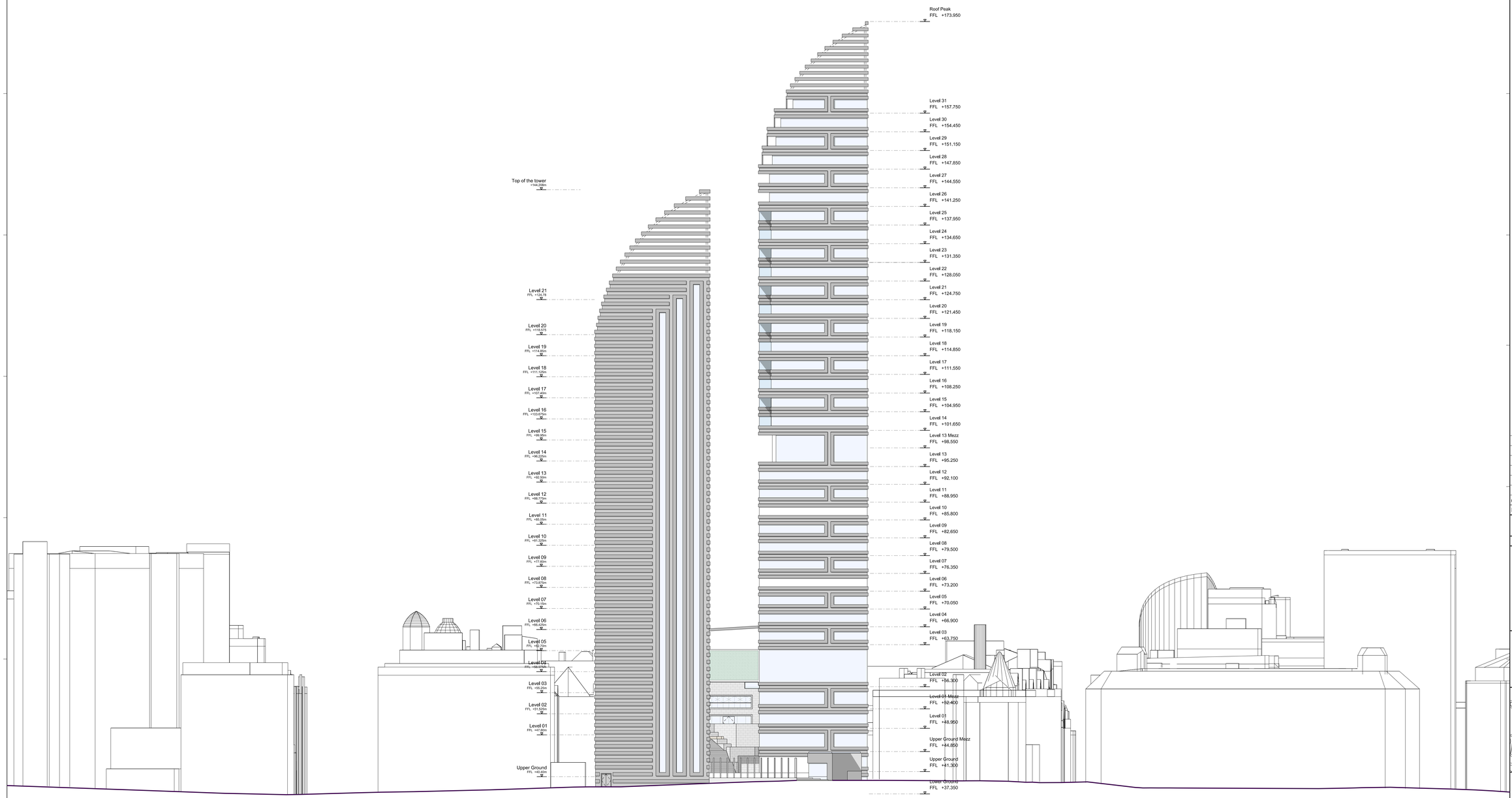


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Drawing Title
Proposed
North Elevation

Scale	Paper Size	Date
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Project No.	Draw No.	Rev No.
0853	P2100	00



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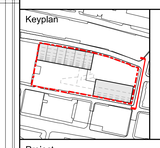
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Client
Jacksons Row Developments

Keyplan

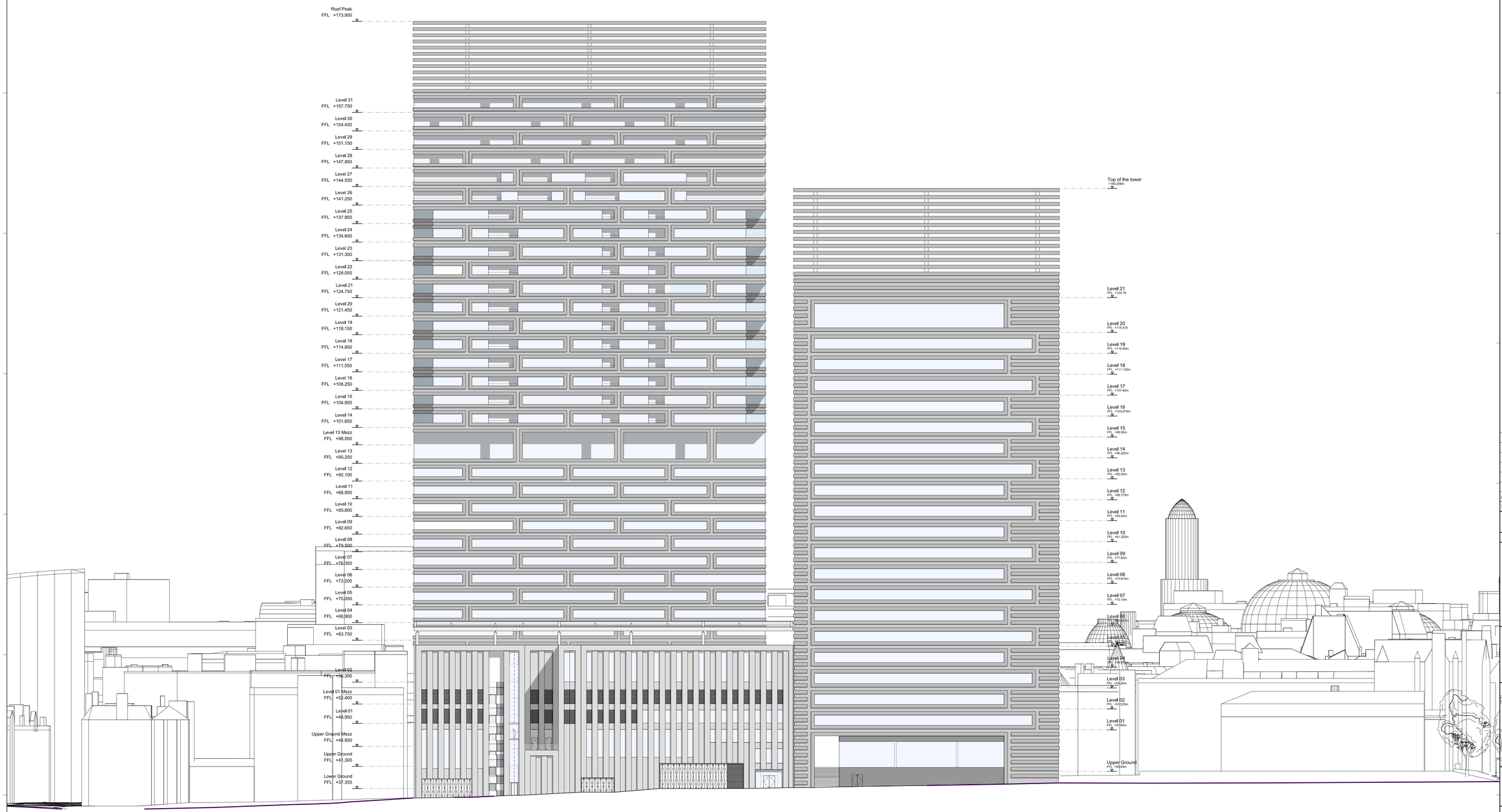


Project
Jacksons Row, Manchester

Drawing Title
Proposed
East Elevation

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Project No.	Draw No.	Rev No.
0853	P2101	00



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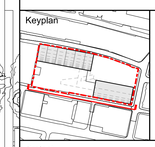
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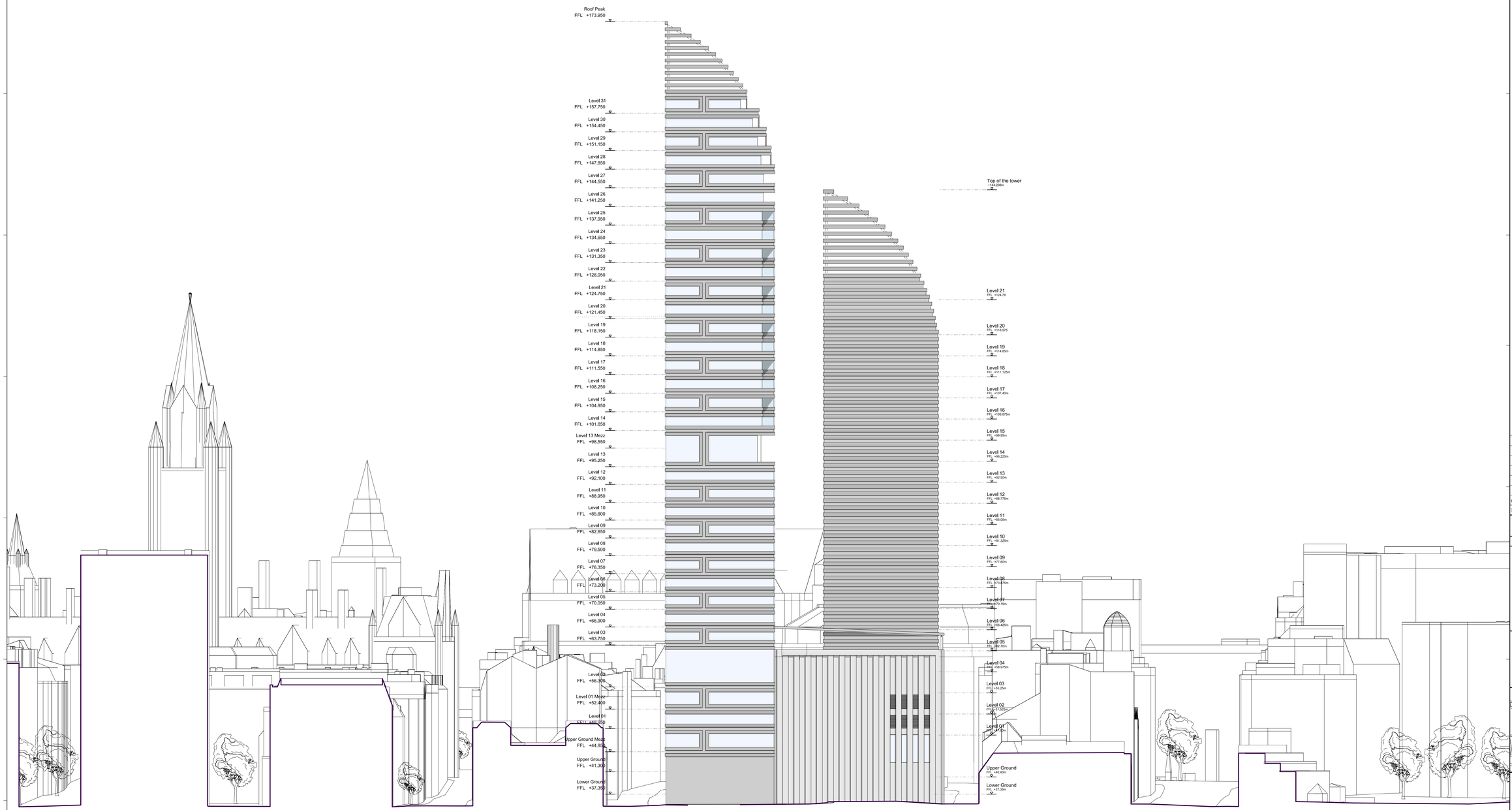
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Project
Jacksons Row, Manchester

Drawing Title
Proposed
South Elevation

Scale	Paper Size	Date
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Project No.	Draw No.	Rev No.
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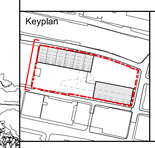
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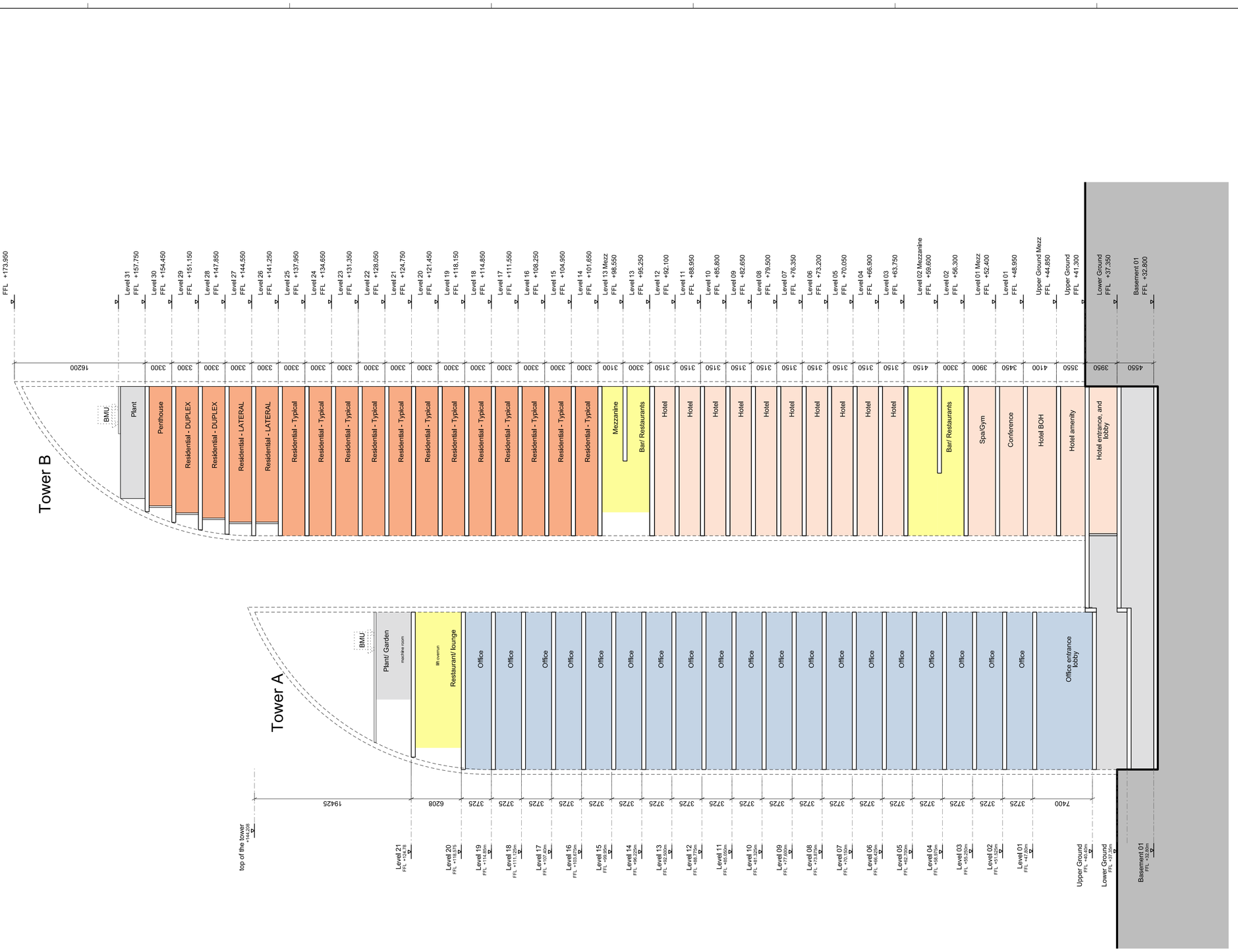


Project
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Proposed
West Elevation

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Project No.	Draw No.	Rev No.
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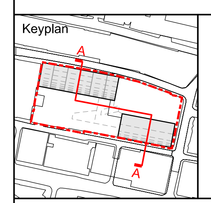
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Client
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Keyplan



North

Project
Jacksons Row, Manchester

Drawing Title
Proposed
Section AA

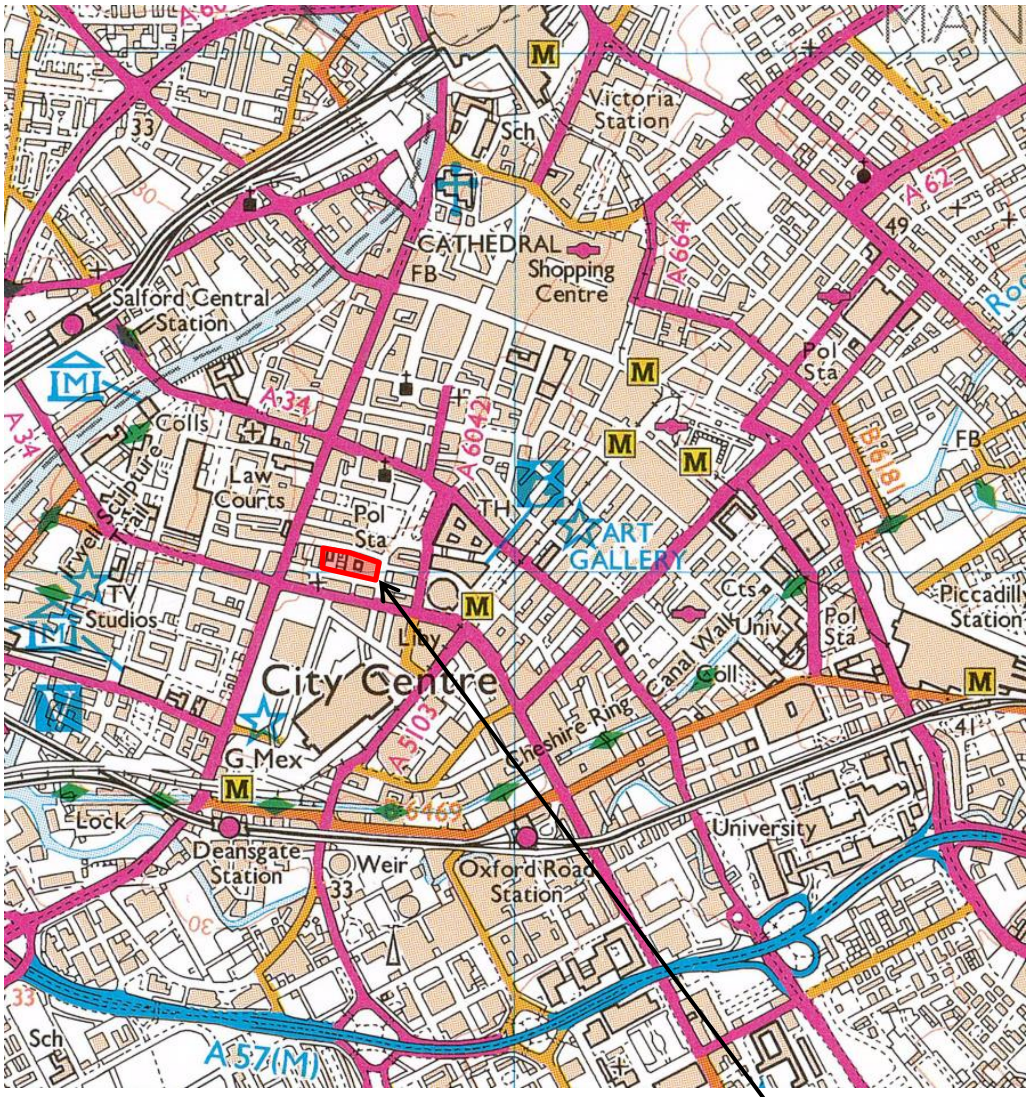
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Project No.	Draw No.	Rev No.
0853	P2201	00

Appendix C

FIGURES

N



REPRODUCED FROM THE ORDNANCE SURVEY MAP WITH THE PERMISSION OF THE CONTROLLER OF HER MAJESTY'S STATIONERY OFFICE. CROWN COPYRIGHT RESERVED, LICENSE NO. 100048755

The Site

WSP | PARSONS BRINCKERHOFF

Site: Jackson's Row
Ref: 70010925/001/10465
Title: Figure 1 – Site Location Plan
Scale: NTS

Appendix D

BGS BOREHOLES

MANCHESTER CITY COUNCIL

CITY ENGINEER AND SURVEYORS DEPARTMENT

SITE INVESTIGATION FOR	Main Drainage	DATE COMMENCED	13.11.83
LOCATION	Lloyd Street REF:	BORING METHOD	Cable Percussive
BOREHOLE No.	3	BORING DIAMETER	150mm 383593
GRID REFERENCE		SCALE:	1:50 approx. 398098

DATE	CASING DEPTH (m)	WATER LEVEL MORNING & EVENING	DEPTH OF STRATA BELOW GL	Reduced Level	DESCRIPTION	No. and Type of Sample	SAMPLE DEPTH PENETRATION From	To	No. of Blows	Legend
13.11.83			0.05		Bituminous Surfacing					
			0.20		Setts					
			0.50		Ashes, bricks etc.	D1	0.5			
			0.70		Clay, bricks, gravel etc.					
			2.2		Firm brown silty and sandy CLAY with stone inclusions.	D2 P1 D3	1.0 1.35 1.7	1.65	4	
			3.50		Dense SAND and GRAVEL	U2 D4 P2 B1 B2	2.2 2.5 2.75 2.6 3.20	2.45 3.05	29	
13.11.83	4.0	Dry	5.0		Very dense red/brown silty fine/medium SANDSTONE	P3 D5 P4	3.70 4.0 4.55	3.825 4.80	50 50	

WATER OBSERVATIONS DURING BORING

DEPTH OF WATER ENTRY (m)	ESTIMATED SEE PAGE	STANDING LEVEL (m)	DEPTH OF CASING WHEN SEALED (m)

WATER LEVEL IN CASED/UNCASED BOREHOLE ON COMPLETION

DATE	WATER LEVEL	DEPTH OF CASING

REMARKS:-

SAMPLE TEST KEY

D – DISTURBED SAMPLE B – BULK SAMPLE U – UNDISTURBED SAMPLE
P – SPT SAMPLE W – WATER SAMPLE

NOTE: WHERE FULL 0.3 PENETRATION HAS NOT BEEN ACHIEVED, THE NUMBER OF BLOWS FOR THE QUOTED PENETRATION IS GIVEN (NOT N – VALUE)

ALL DEPTHS AND REDUCED LEVELS IN (m) UNLESS OTHERWISE STATED

REMARKS

Trial hole excavated to 1.20m below ground level, laid brickwork located at 1.0m below ground level in southern edge of trial hole.

Borehole backfilled on completion, no final overnight water level observed.

M/c 5931

(8214) Wt. 5993—5/33 2000 6/22 Gp. 147 M.K.Co.Ltd.

SECTION OF Borehole at Messrs. Blackburn Bro, [illegible] Albert Square, Manch[illegible]

SJ89NW219

Maps: One-inch ..... Six-inch 104 S.W.E. County Lancs.

Height above O.D. 120. Latitude ..... Longitude .....

Communicated by Sir. Wm. Boyd Dawkins. Date of sinking 1885.

Made by ..... Dip of Strata .....

Hickling's 68. Trans. Inst. Min. E. Vol. LIV. 1918.

M/c 6 8

	Thickness.			Depth from Surface.		
Water level 39 feet from surface.						
Alluvium (approx. thickness)	4·57	15	–	4·57	15	–
Red sandstone	51·85	170	–	56·39	185	–

Synopsis, App. III as above.

Yield 14,000 g/day.

MANCHESTER CITY COUNCIL

CITY ENGINEER AND SURVEYORS DEPARTMENT

SITE INVESTIGATION FOR	Main Drainage	DATE COMMENCED	6.11.83
LOCATION	Lloyd Street REF:	BORING METHOD	Cable Percussive
BOREHOLE No.	2	BORING DIAMETER	150mm 383669
GRID REFERENCE		SCALE:	1:50 approx. 398084

DATE	CASING DEPTH (m)	WATER LEVEL MORNING & EVENING	DEPTH OF STRATA BELOW GL	Reduced Level	DESCRIPTION	No. and Type of Sample	SAMPLE DEPTH PENETRATION From	SAMPLE DEPTH PENETRATION To	No. of Blows	Legend
6.11.83			0.15		Bituminous Surfacing onto Setts					
			1.2		Ashes and Bricks.					
			2.2		Soft/firm brown silty and sandy CLAY with sand lenses Stone and coal inclusions and brick pieces.	U1 D1 U2	1.2 1.7 2.0	1.65 2.45		
			4.9		Compact to dense silty SAND and GRAVEL. X	D2 P1 D3 P2 D4	2.5 31.5 3.5 4.15 4.5	 3.45 4.45 	 25 35 	
					Very dense red/brown fine/medium grained SANDSTONE.	P3 P4	5.15 6.50	5.30 6.63	67 50	
6.11.83	5.0	Dry	6.5							

WATER OBSERVATIONS DURING BORING			
DEPTH OF WATER ENTRY (m)	ESTIMATED SEE PAGE	STANDING LEVEL (m)	DEPTH OF CASING WHEN SEALED (m)
—			

WATER LEVEL IN CASED/UNCASED BOREHOLE ON COMPLETION		
DATE	WATER LEVEL	DEPTH OF CASING

REMARKS:–

SAMPLE TEST KEY: D – DISTURBED SAMPLE; P – SPT SAMPLE; B – BULK SAMPLE; W – WATER SAMPLE; U – UNDISTURBED SAMPLE

NOTE: WHERE FULL 0.3 PENETRATION HAS NOT BEEN ACHIEVED, THE NUMBER OF BLOWS FOR THE QUOTED PENETRATION IS GIVEN (NOT N – VALUE)

ALL DEPTHS AND REDUCED LEVELS IN (m) UNLESS OTHERWISE STATED

REMARKS

Trial hole excavated to 1.20m below ground level
Borehole backfilled on completion, no final standing water level observed.
SPT sample P4 recorded 50 blows for 127mm penetration within the initial 150mm penetration.

M/c 5931

4th G.S.M. Nos. 75-79

(D11857) W.L. [illegible]—5144—5,000 12/20 Gp. 160. O.A.

SJ 89 NW 64-68

SECTION OF Sewer Shafts at Deansgate, Manchester

Maps; One-inch 85 Six-inch 104 S.W.E. County Lancs.

Height above O.D. Latitude Longitude

Communicated by Manchester Corporation Date of Sinking

Made by Dip of Strata

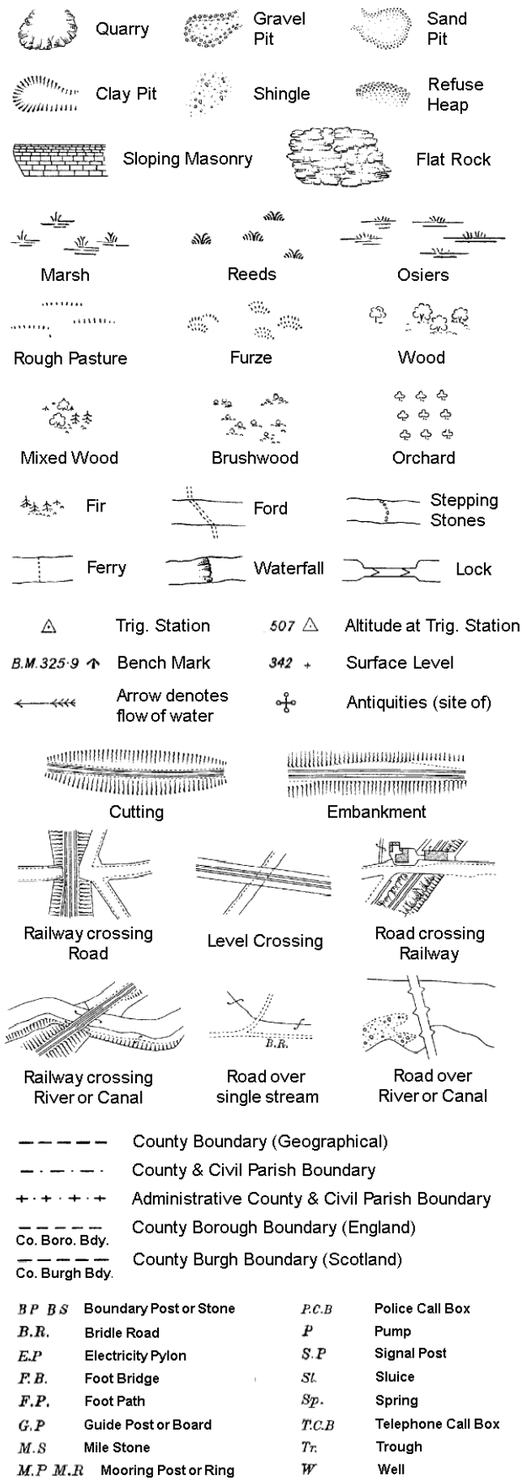
		Thickness.			Depth from Surface.		
		Metres			Metres		
No. 68 / 68	Deansgate. Corner of Lombard St.						
	Made ground,	3·66	12	–	3·66	12	–
	Sandstone	7·01	23	–	10·67	35	–
No. 76 / 67	02. Deansgate opposite Camp St. Corner.						
	Ballast & made ground.	2·13	7	–	2·13	7	–
	Sandstone.	11·28	37	–	13·41	44	–
No. 77 / 66	03. Deansgate. opposite St. John's Street corner.						
	Ballast & loose ground.	3·66	12	–	3·66	12	–
	Ballast & loose ground	4·27	14	–	7·93	26	–
	Sandstone.	5·18	17	–	13·11	43	–
No. 78 / 65	05. Deansgate, Jackson's Row Corner.						
	Ballast & loose ground	3·66	12	–	3·66	12	–
	Sandstone.	9·14	30	–	12·80	42	–
No. 79 / 64	No. 07. Deansgate, Corner of John Dalton Street.						
	Made ground }						
	Ballast & gravel }	3·35	11	–	3·35	11	–
	Gravel, sand, & marl.	3·05	10	–	6·40	21	–
	Sandstone	7·32	24	–	13·72	45	–

Appendix E

HISTORICAL OS MAPS & INSURANCE PLANS

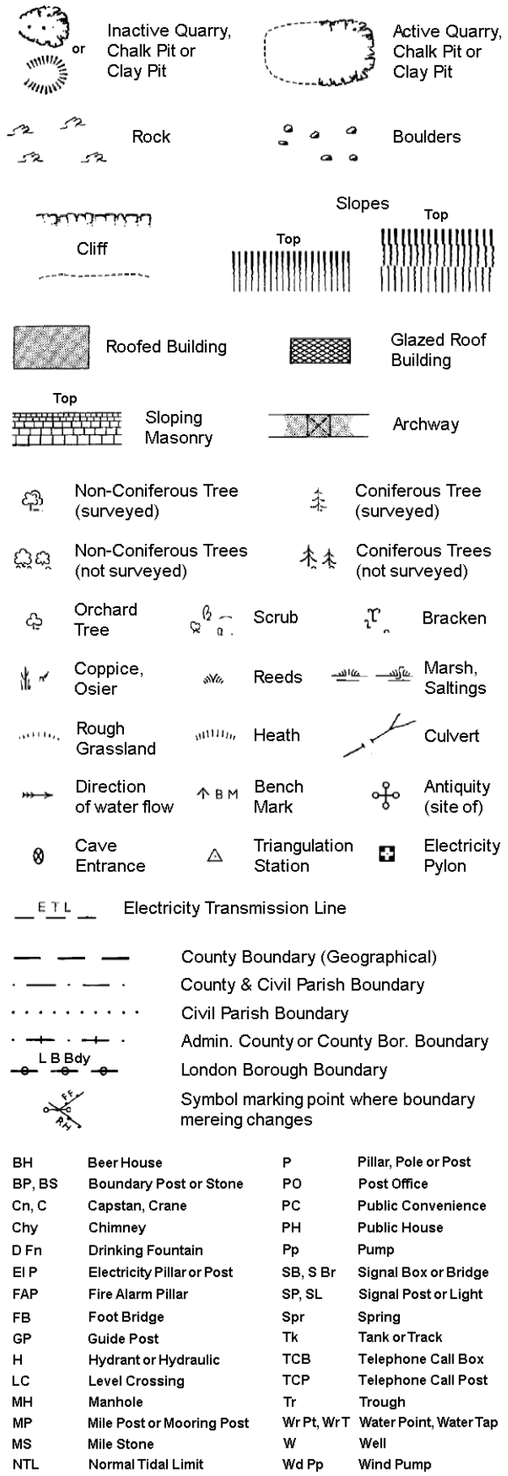
Historical Mapping Legends

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



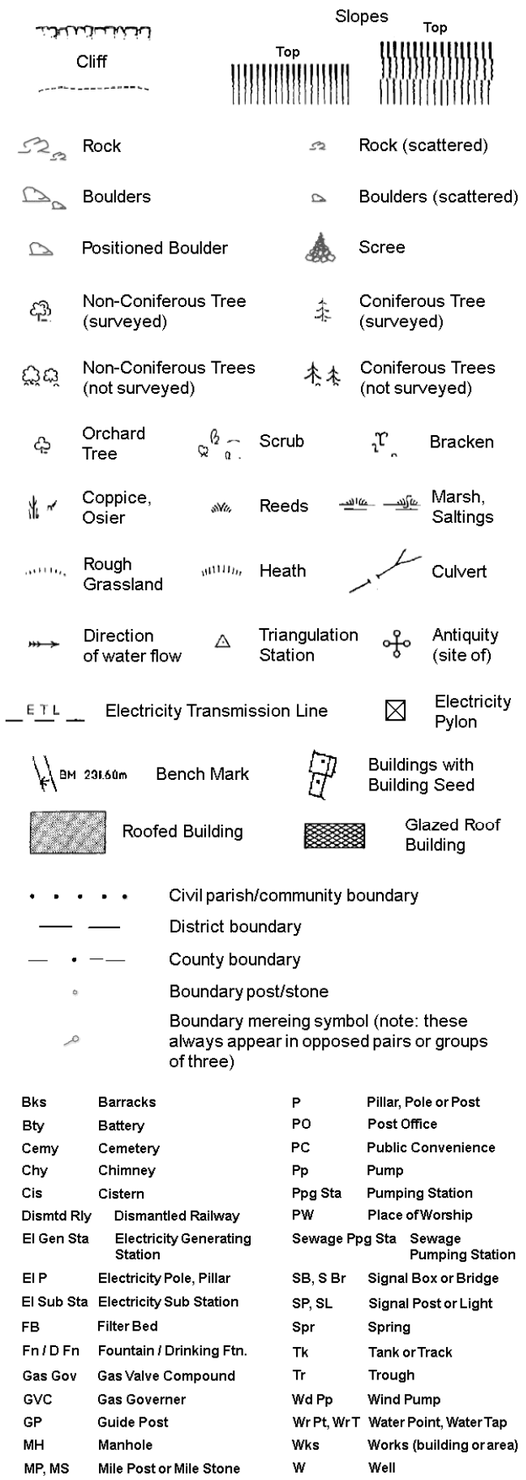
B P B S	Boundary Post or Stone	P.C.B	Police Call Box
B.R.	Bridle Road	P	Pump
E.P	Electricity Pylon	S.P	Signal Post
F.B.	Foot Bridge	St.	Sluice
F.P.	Foot Path	Sp.	Spring
G.P	Guide Post or Board	T.C.B	Telephone Call Box
M.S	Mile Stone	Tr.	Trough
M.P M.R	Mooring Post or Ring	W	Well

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



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



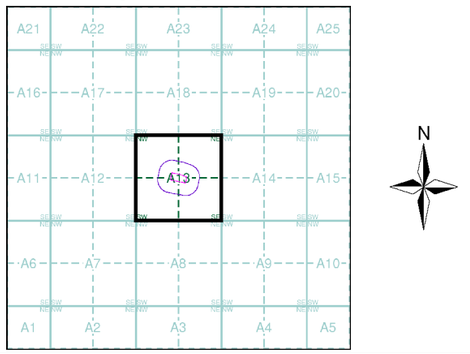
Bks	Barracks	P	Pillar, Pole or Post
Bty	Battery	PO	Post Office
Cemy	Cemetery	PC	Public Convenience
Chy	Chimney	Pp	Pump
Cis	Cistern	Ppg Sta	Pumping Station
Dismtd Rly	Dismantled Railway	PW	Place of Worship
El Gen Sta	Electricity Generating Station	Sewage Ppg Sta	Sewage Pumping Station
El P	Electricity 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, Wr T	Water Point, Water Tap
MH	Manhole	Wks	Works (building or area)
MP, MS	Mile Post or Mile Stone	W	Well

WSP

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Lancashire And Furness	1:2,500	1892	2
Lancashire And Furness	1:2,500	1908	3
Lancashire And Furness	1:2,500	1922 - 1933	4
Ordnance Survey Plan	1:1,250	1948	5
Ordnance Survey Plan	1:2,500	1950 - 1951	6
Ordnance Survey Plan	1:1,250	1951 - 1964	7
Ordnance Survey Plan	1:2,500	1955 - 1958	8
Ordnance Survey Plan	1:1,250	1962 - 1973	9
Ordnance Survey Plan	1:2,500	1963 - 1965	10
Ordnance Survey Plan	1:2,500	1969 - 1971	11
Ordnance Survey Plan	1:1,250	1973 - 1988	12
Supply of Unpublished Survey Information	1:1,250	1974 - 1975	13
Additional SIMs	1:1,250	1980 - 1985	14
Additional SIMs	1:1,250	1986 - 1990	15
Additional SIMs	1:1,250	1990	16
Large-Scale National Grid Data	1:1,250	1992	17
Large-Scale National Grid Data	1:1,250	1994 - 1995	18
Large-Scale National Grid Data	1:1,250	1995	19
Large-Scale National Grid Data	1:1,250	1996	20
Large-Scale National Grid Data	1:1,250	1996	21

Historical Map - Segment A13



Order Details

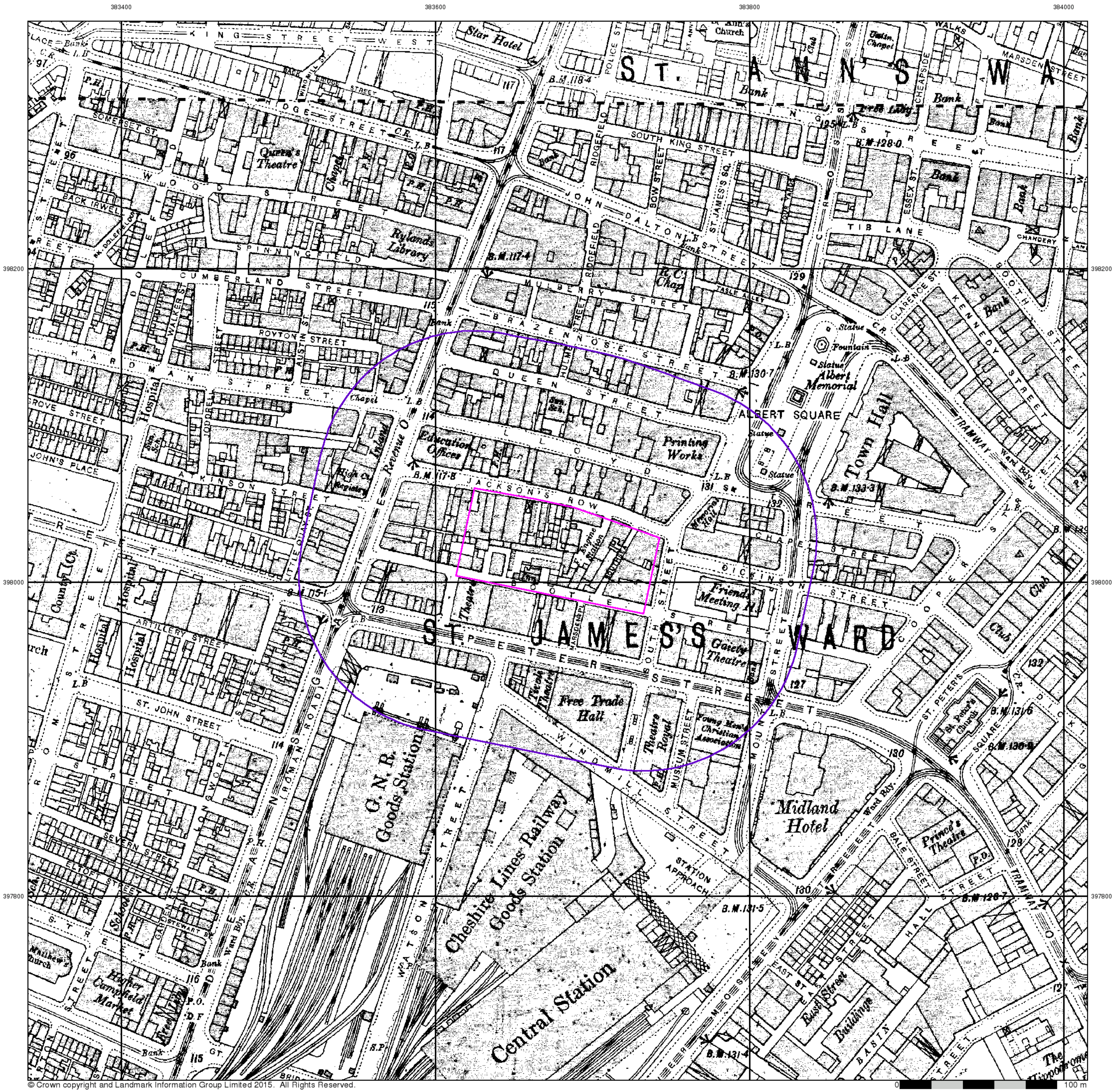
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Site Area (Ha):	0.68
Search Buffer (m):	100

Site Details

Jacksons Row, MANCHESTER, M2 5WD

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0 100 m

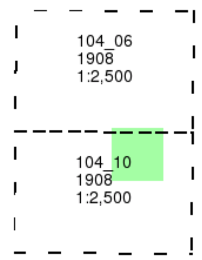
Lancashire And Furness

Published 1908

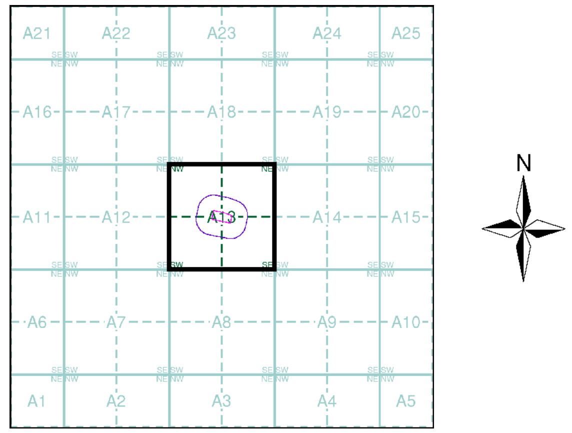
Source map scale - 1:2,500

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

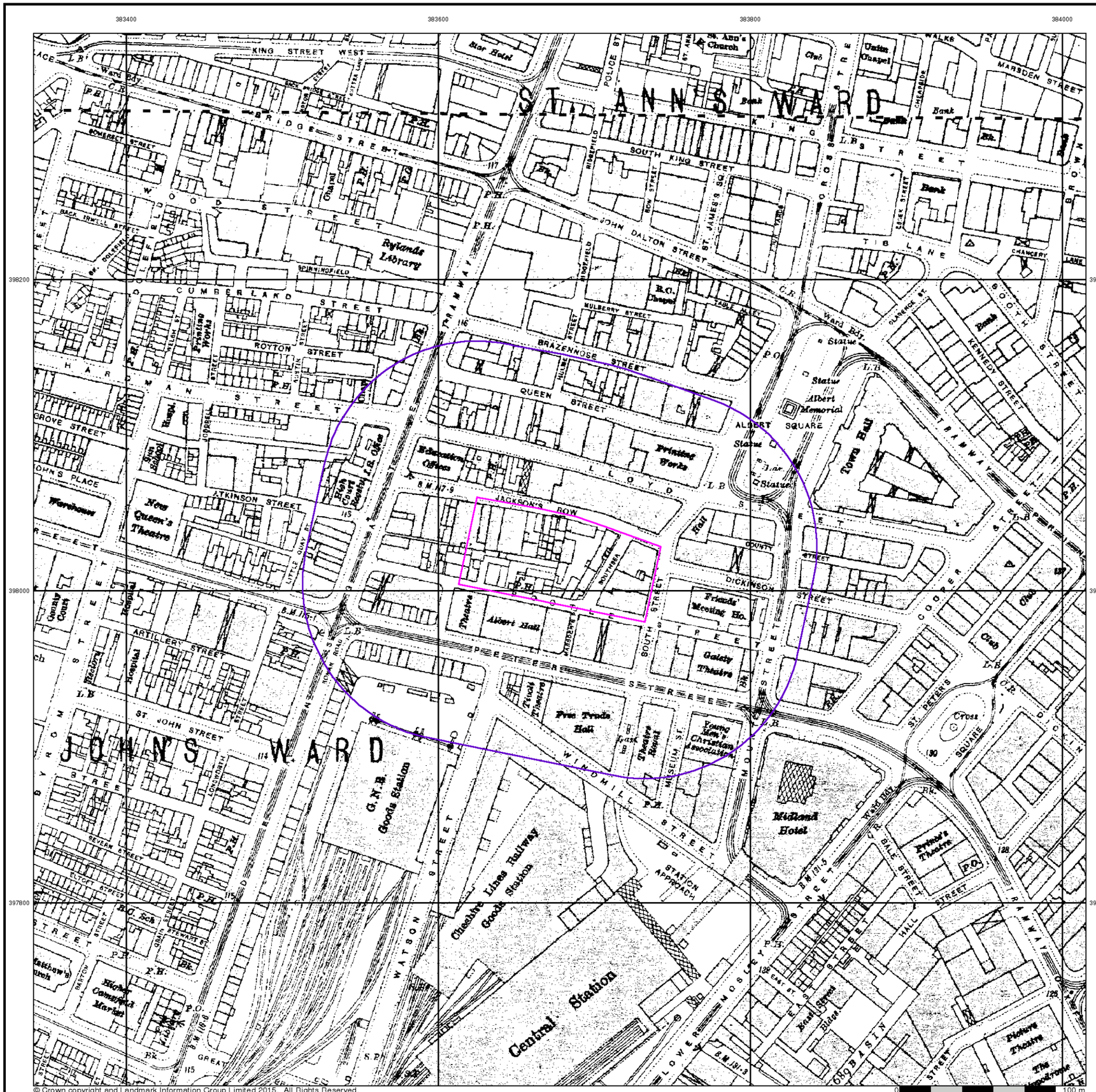


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Site Area (Ha):	0.68
Search Buffer (m):	100

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WSP

Lancashire And Furness

Published 1922 - 1933

Source map scale - 1:2,500

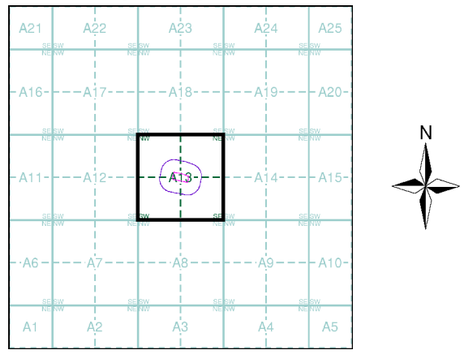
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. 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)

104_06
1933
1:2,500

104_10
1922
1:2,500

Historical Map - Segment A13



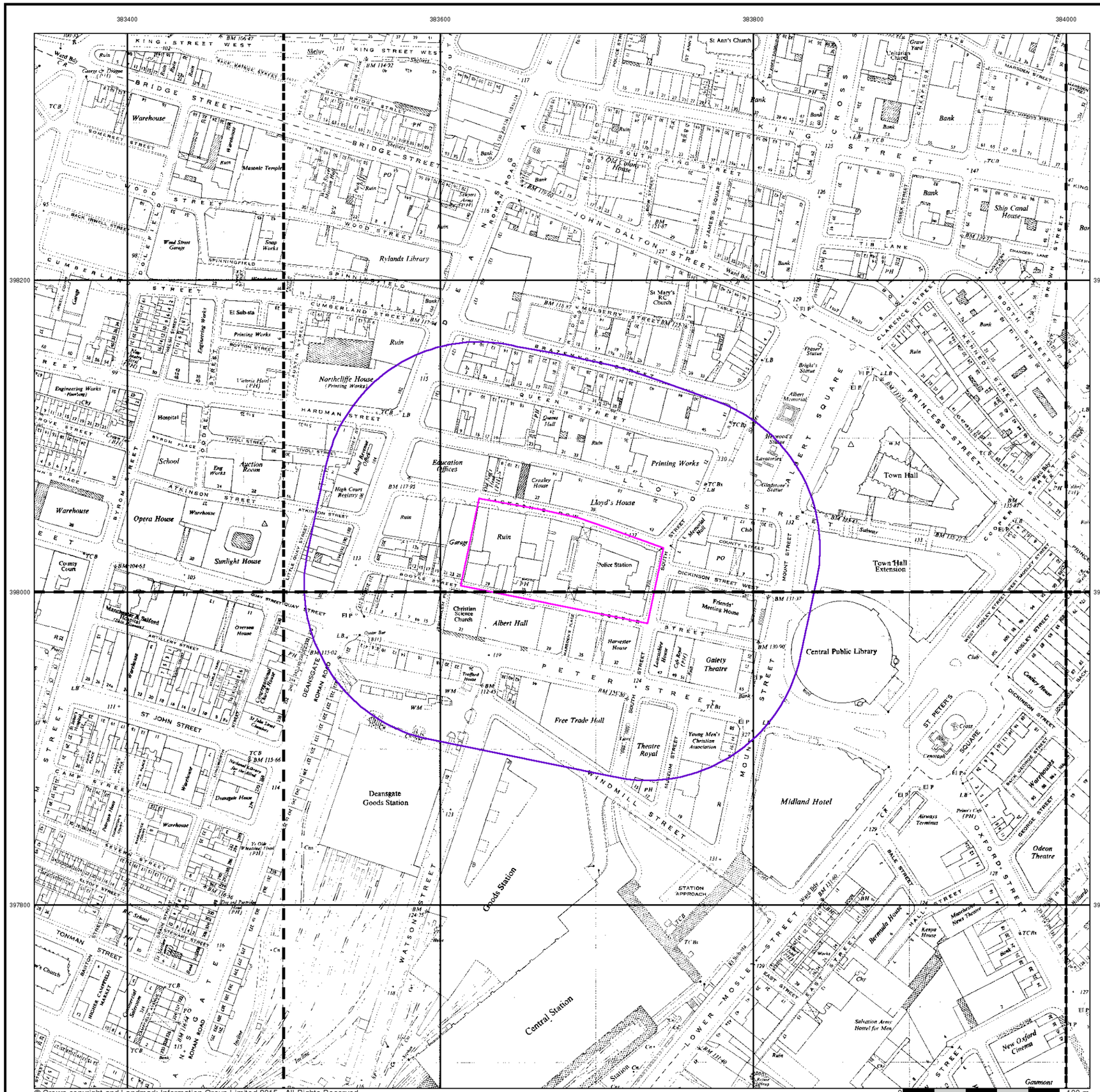
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Customer Ref:	70010278-100
National Grid Reference:	383680, 398020
Slice:	A
Site Area (Ha):	0.68
Search Buffer (m):	100

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Ordnance Survey Plan

Published 1948

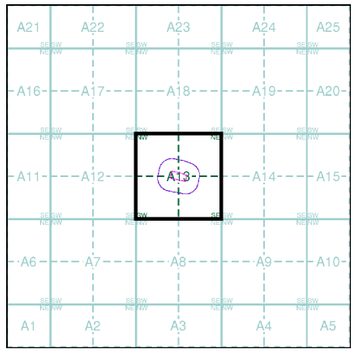
Source map scale - 1:1,250

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)

SJ8398SW 1948 1:1,250	SJ8398SE 1948 1:1,250	SJ8498SW 1948 1:1,250
SJ8397NW 1948 1:1,250	SJ8397NE 1948 1:1,250	SJ8497NW 1948 1:1,250

Historical Map - Segment A13



Order Details

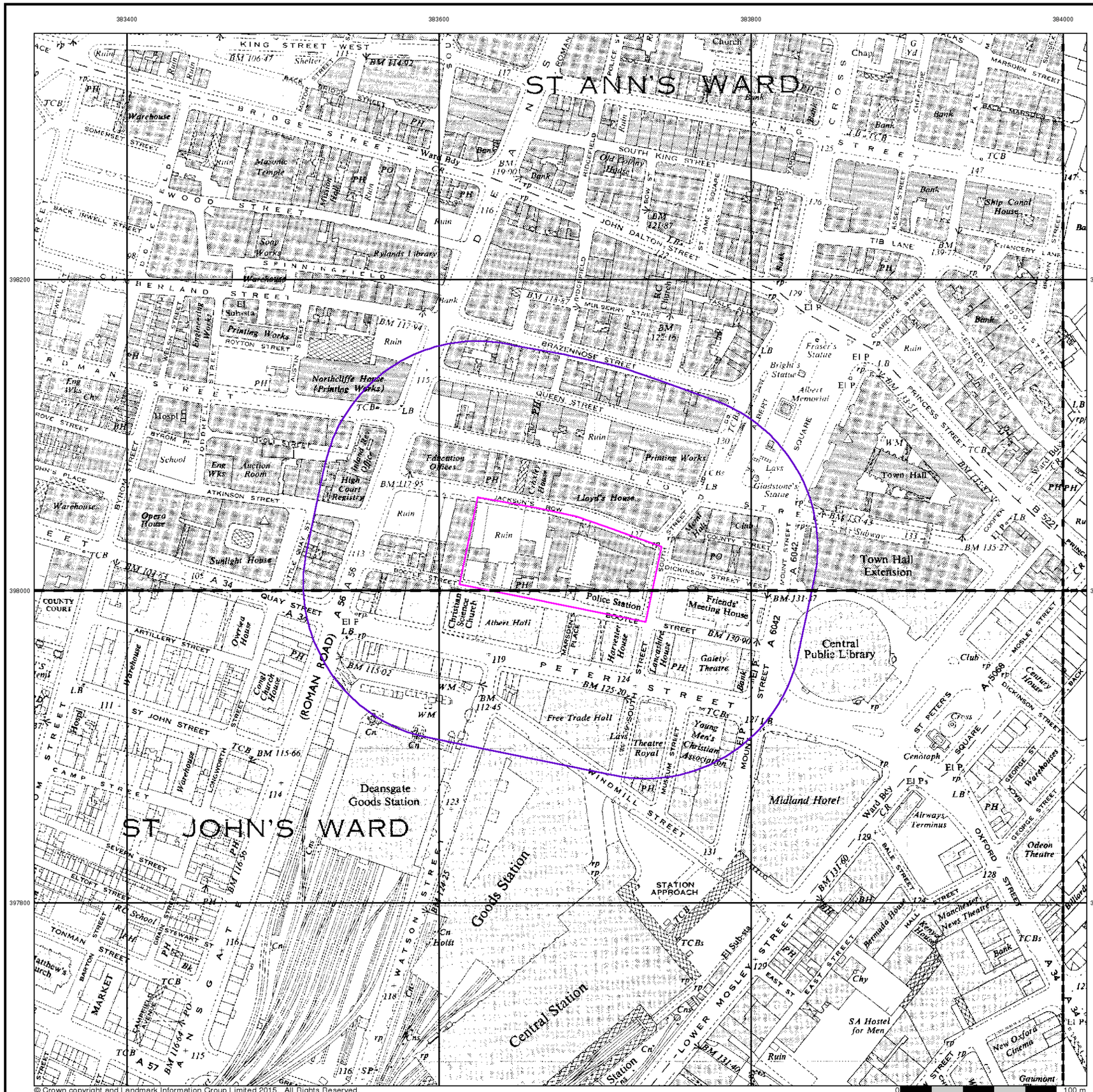
Order Number:	73295769_1_1
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National Grid Reference:	383680, 398020
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Site Area (Ha):	0.68
Search Buffer (m):	100

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Ordnance Survey Plan

Published 1950 - 1951

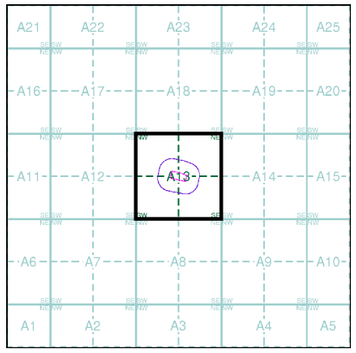
Source map scale - 1:2,500

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)

SJ8398 1951 1:2,500	SJ8498 1951 1:2,500
SJ8397 1950 1:2,500	SJ8497 1950 1:2,500

Historical Map - Segment A13



Order Details

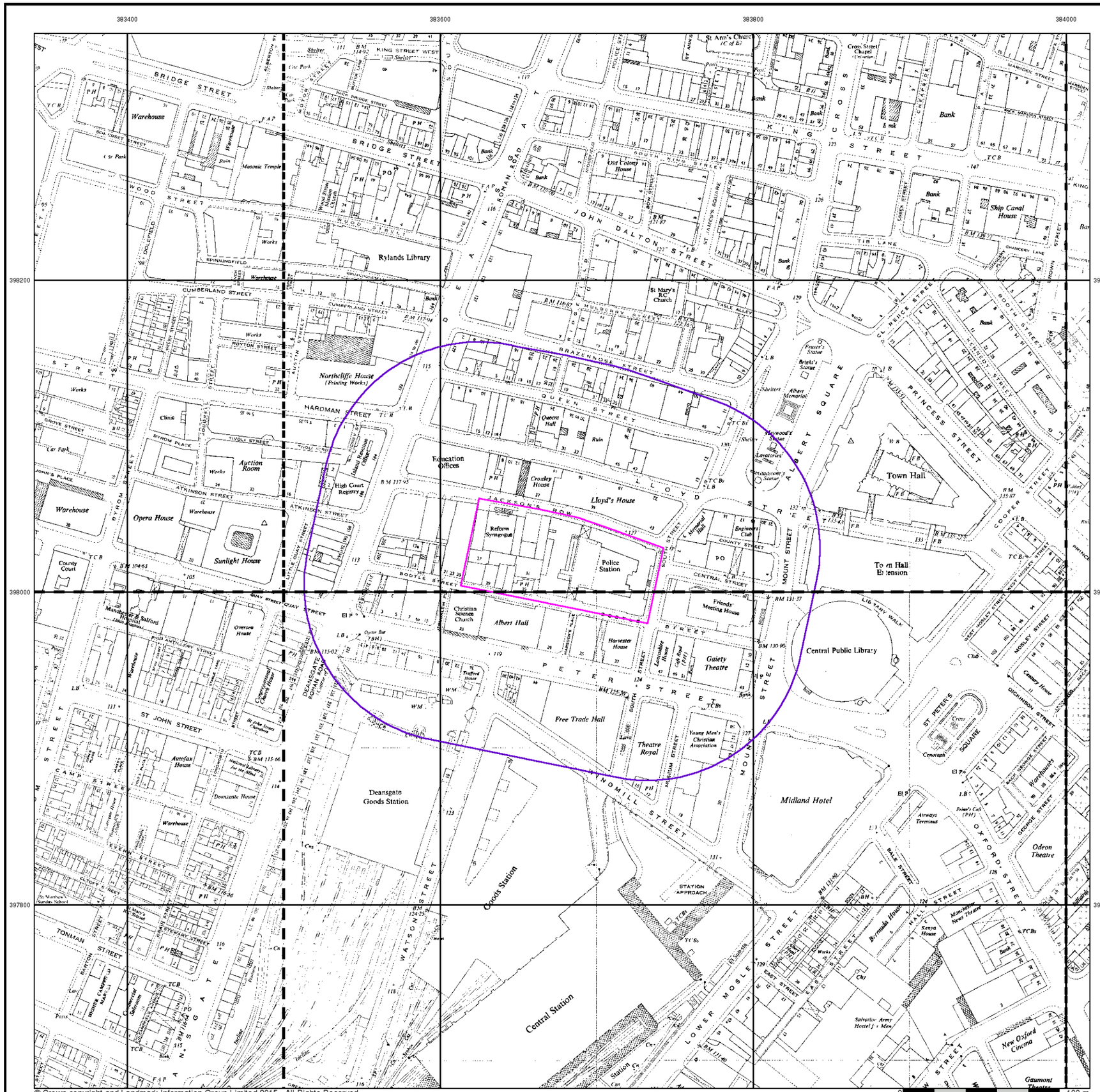
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Customer Ref:	70010278-100
National Grid Reference:	383680, 398020
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Site Area (Ha):	0.68
Search Buffer (m):	100

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0 100 m

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Ordnance Survey Plan

Published 1951 - 1964

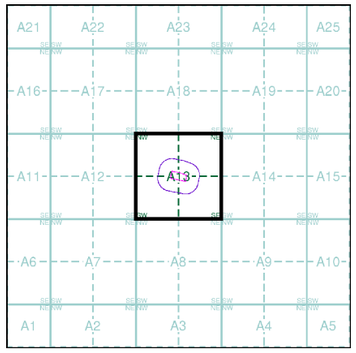
Source map scale - 1:1,250

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)

SJ8398SW 1957 1:1,250	SJ8398SE 1956 1:1,250	SJ8498SW 1951 1:1,250
SJ8397NW 1955 1:1,250	SJ8397NE 1951 1:1,250	SJ8497NW 1964 1:1,250

Historical Map - Segment A13



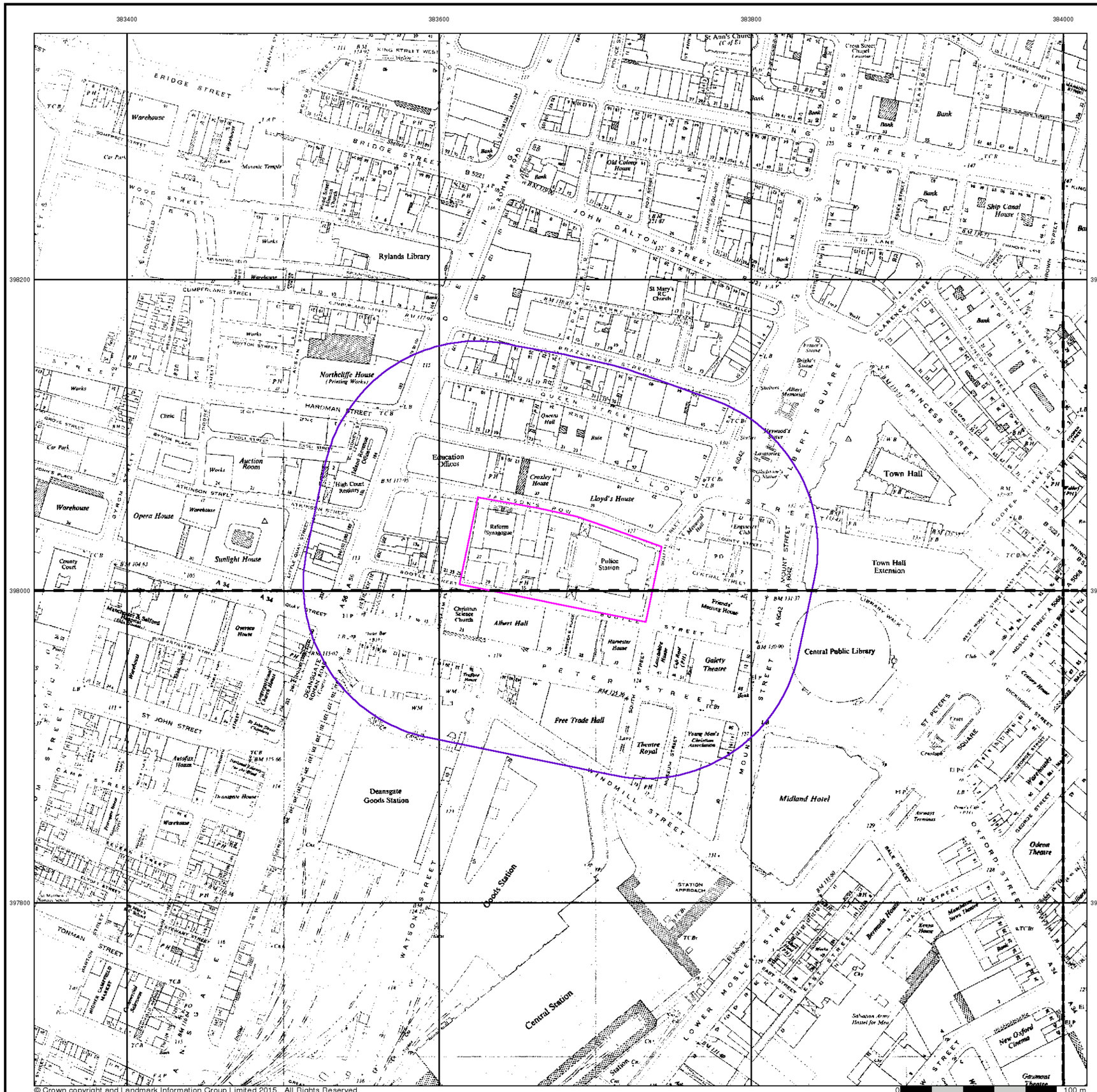
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Site Area (Ha):	0.68
Search Buffer (m):	100

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Ordnance Survey Plan

Published 1955 - 1958

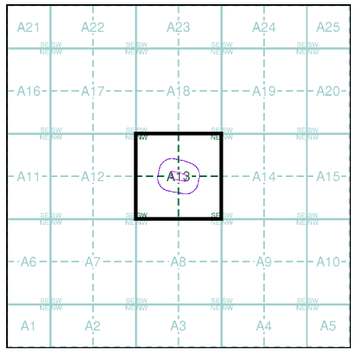
Source map scale - 1:2,500

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)

SJ8398 1958 1:2,500	SJ8498 1955 1:2,500
SJ8397 1956 1:2,500	SJ8497 1955 1:2,500

Historical Map - Segment A13



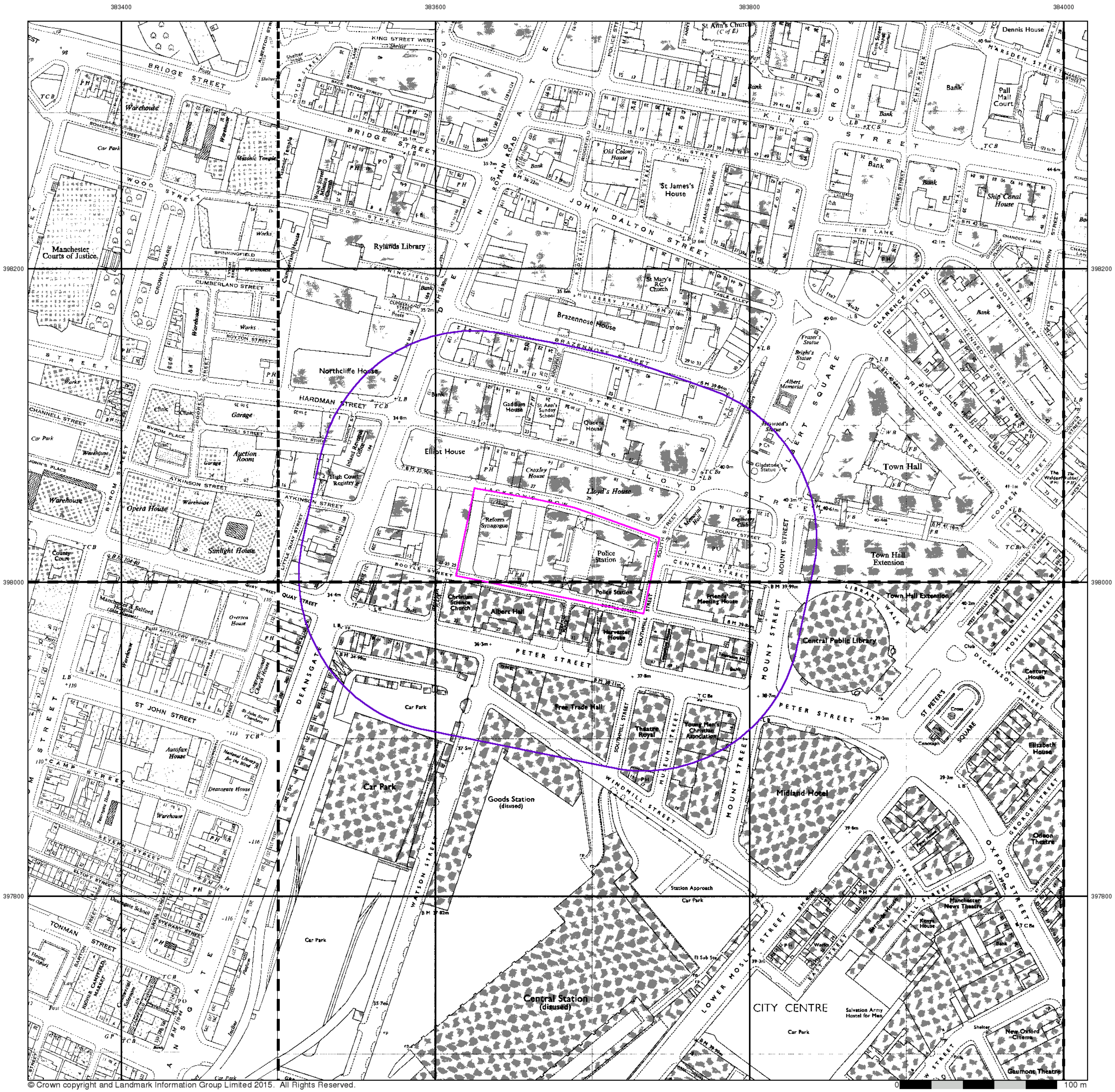
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National Grid Reference:	383680, 398020
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Site Area (Ha):	0.68
Search Buffer (m):	100

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Ordnance Survey Plan

Published 1962 - 1973

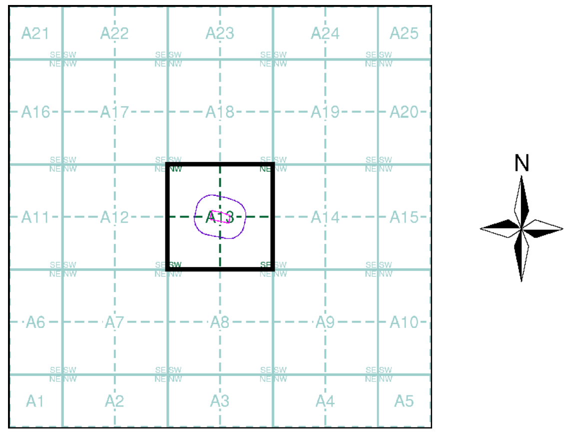
Source map scale - 1:1,250

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)

SJ8398SW 1962 1:1,250	SJ8398SE 1970 1:1,250	SJ8498SW 1968 1:1,250
SJ8397NW 1963 1:1,250	SJ8397NE 1973 1:1,250	

Historical Map - Segment A13



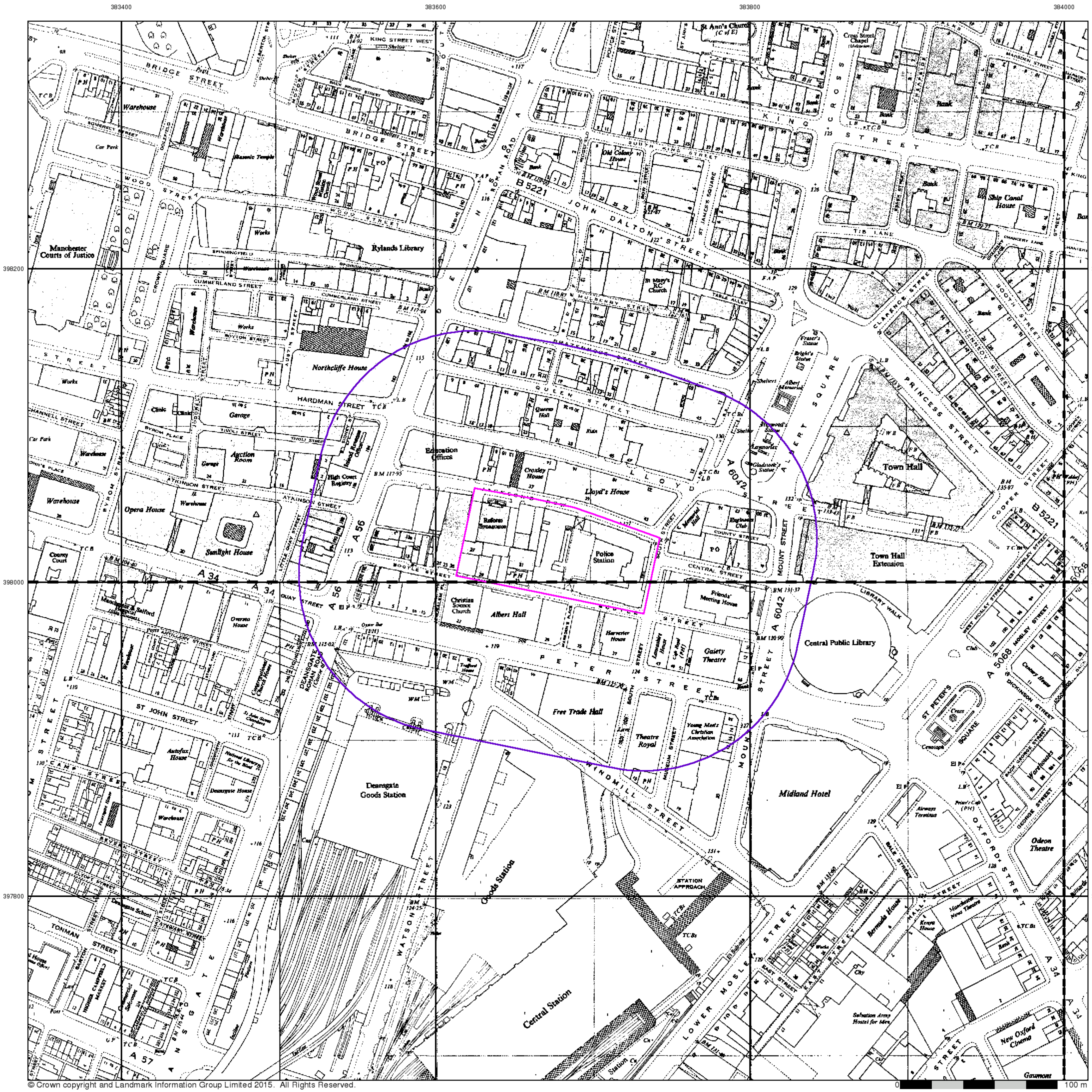
Order Details

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Site Area (Ha): 0.68
Search Buffer (m): 100

Site Details

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Ordnance Survey Plan

Published 1963 - 1965

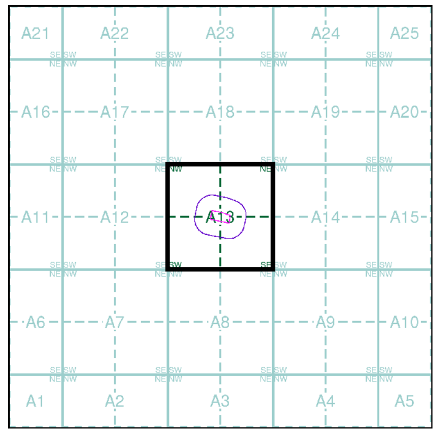
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Map Name(s) and Date(s)

SJ8398 1963 1:2,500	SJ8498 1965 1:2,500
SJ8397 1965 1:2,500	SJ8497 1965 1:2,500

Historical Map - Segment A13



N

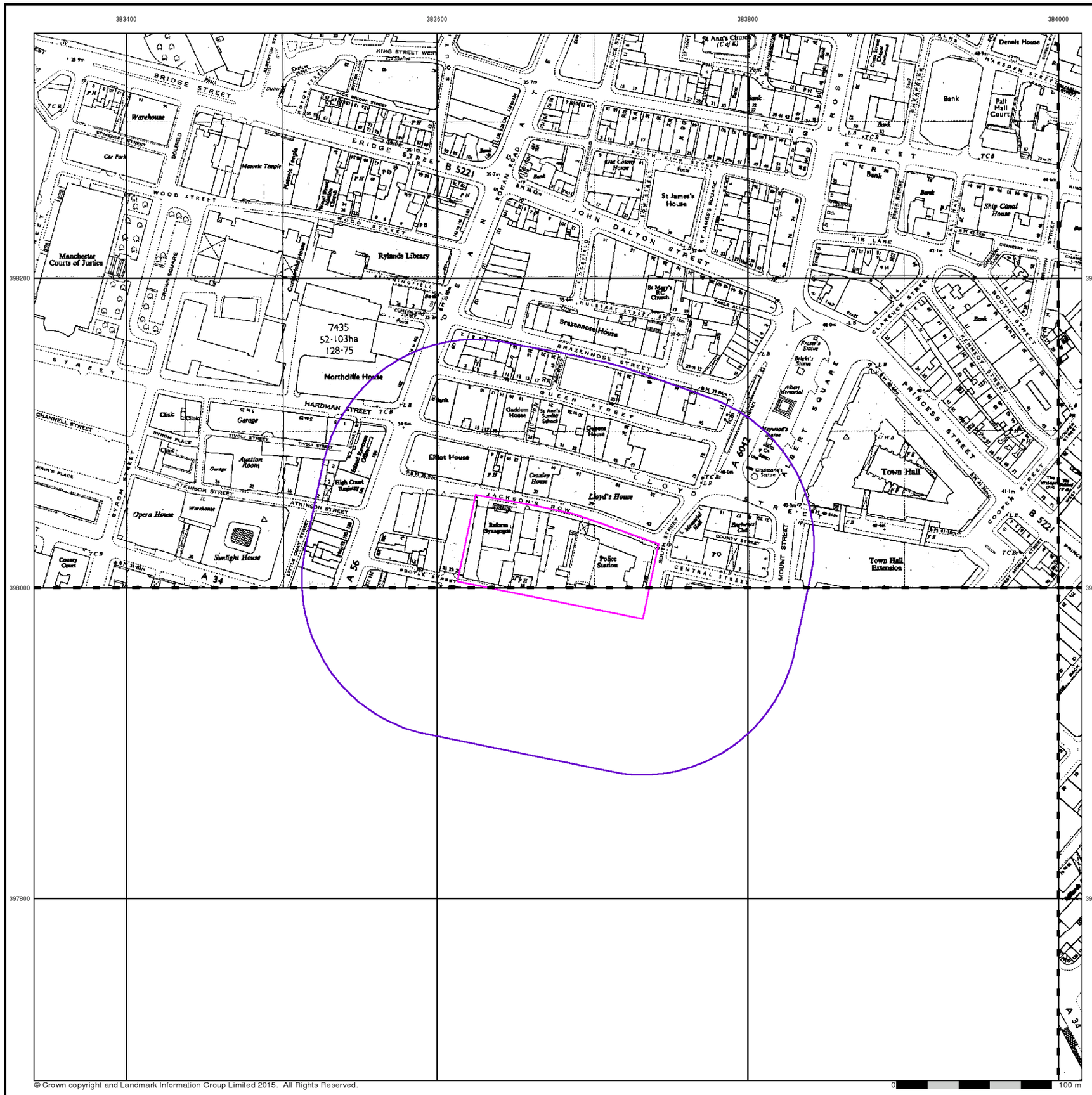
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Site Area (Ha):	0.68
Search Buffer (m):	100

Site Details

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0 100 m

WSP

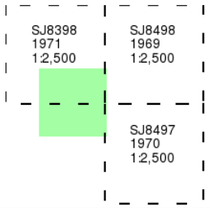
Ordnance Survey Plan

Published 1969 - 1971

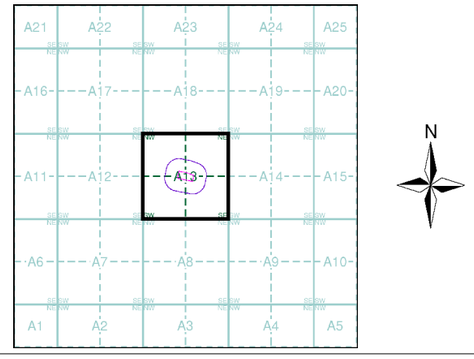
Source map scale - 1:2,500

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

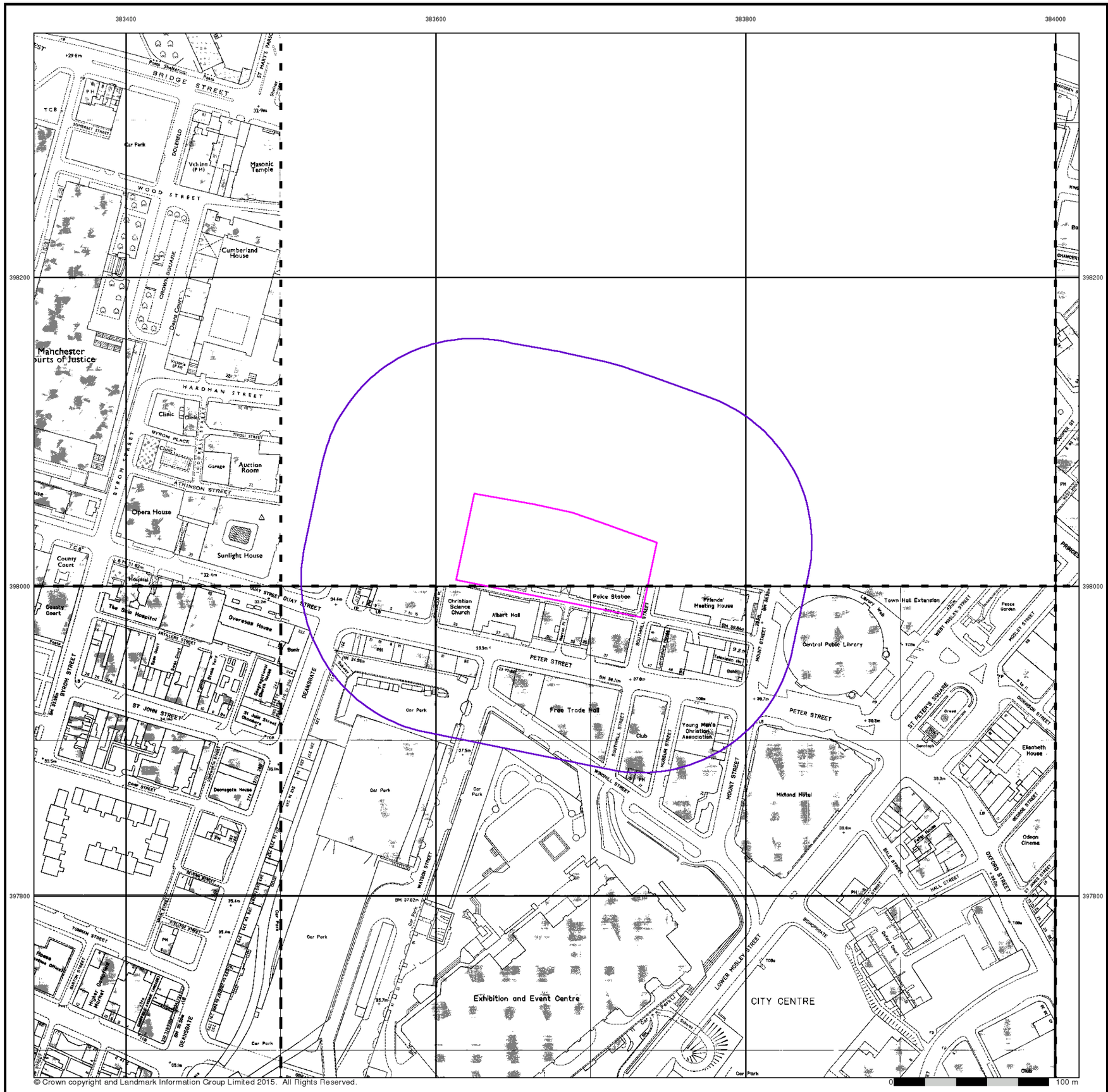
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National Grid Reference:	383680, 398020
Slice:	A
Site Area (Ha):	0.68
Search Buffer (m):	100

Site Details

Jacksons Row, MANCHESTER, M2 5WD

Landmark Information Group

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



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WSP

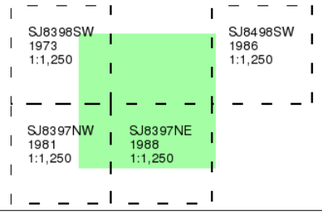
Ordnance Survey Plan

Published 1973 - 1988

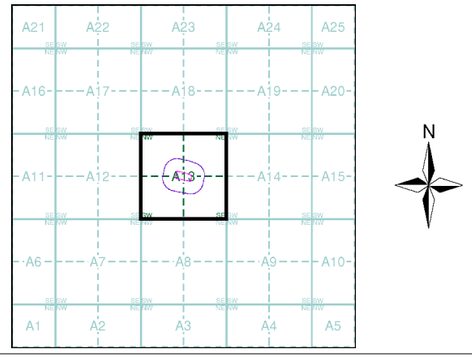
Source map scale - 1:1,250

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



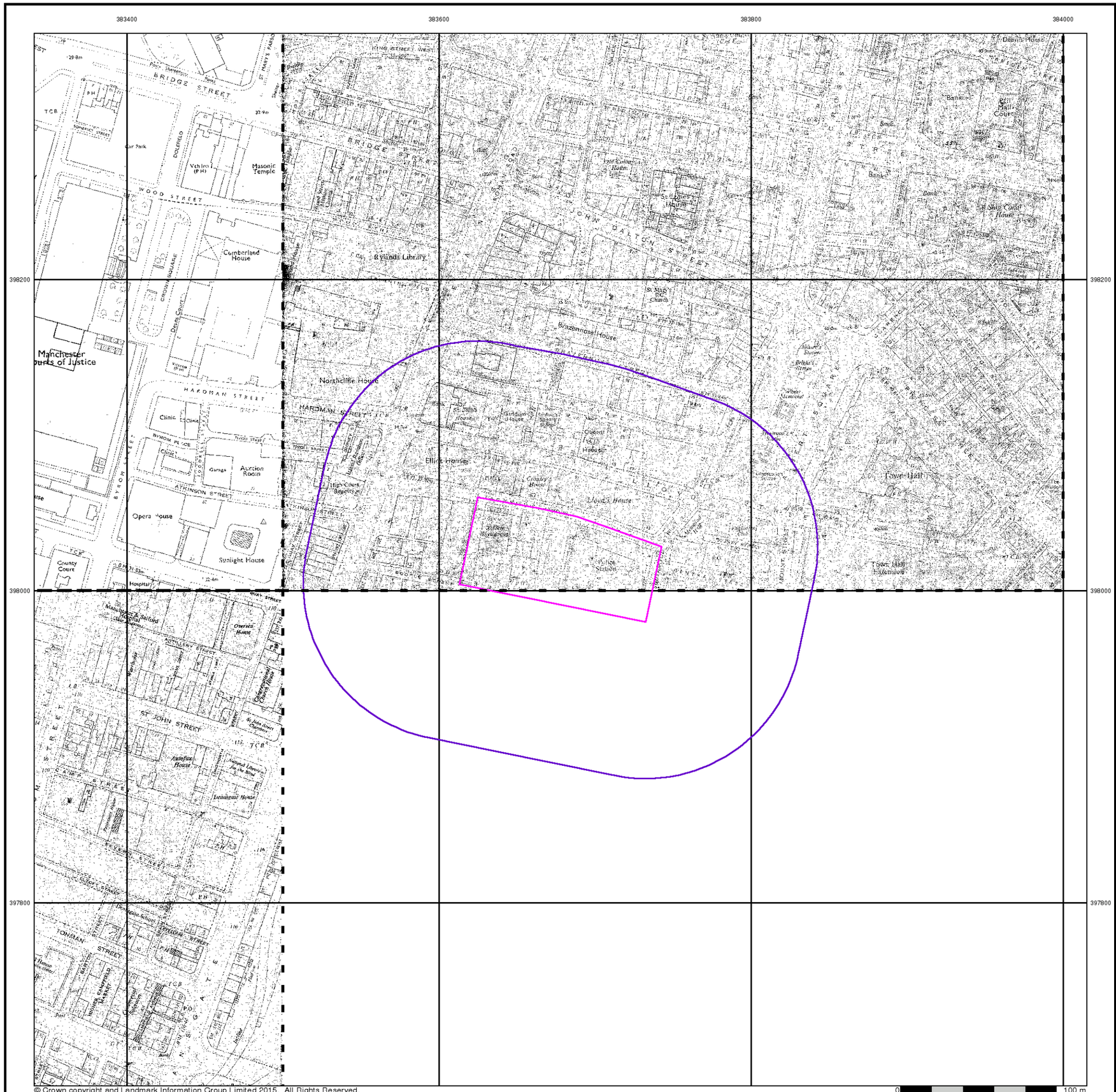
Order Details

Order Number:	73295769_1_1
Customer Ref:	70010278-100
National Grid Reference:	383680, 398020
Slice:	A
Site Area (Ha):	0.68
Search Buffer (m):	100

Site Details

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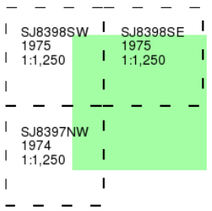
Supply of Unpublished Survey Information

Published 1974 - 1975

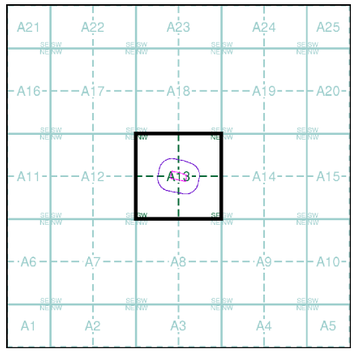
Source map scale - 1:1,250

SUSI maps (Supply of Unpublished Survey Information) were produced between 1972 and 1977, mainly for internal use at Ordnance Survey. These were more of a `work-in-progress' plan as they showed updates of individual areas on a map. These maps were unpublished, and they do not represent a single moment in time. They were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



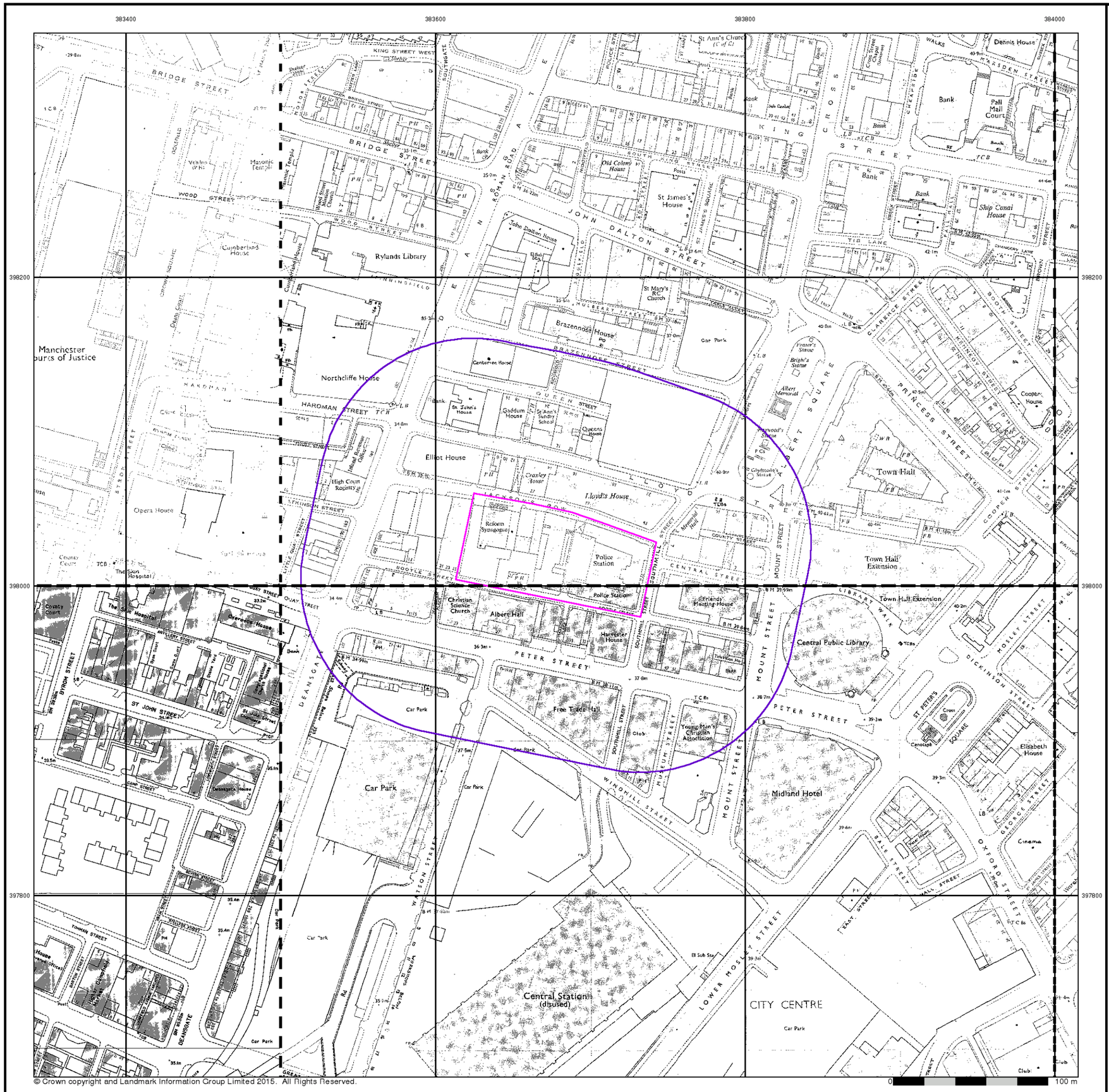
Order Details

Order Number:	73295769_1_1
Customer Ref:	70010278-100
National Grid Reference:	383680, 398020
Slice:	A
Site Area (Ha):	0.68
Search Buffer (m):	100

Site Details

Jacksons Row, MANCHESTER, M2 5WD

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WSP

Additional SIMs

Published 1980 - 1985

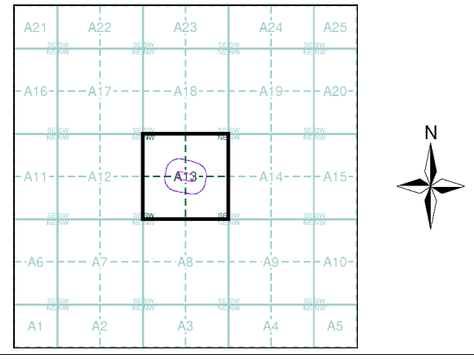
Source map scale - 1:1,250

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)

SJ8398SW 1984 1:1,250	SJ8398SE 1980 1:1,250	SJ8498SW 1980 1:1,250
SJ8397NW 1981 1:1,250	SJ8397NE 1985 1:1,250	SJ8497NW 1985 1:1,250

Historical Map - Segment A13



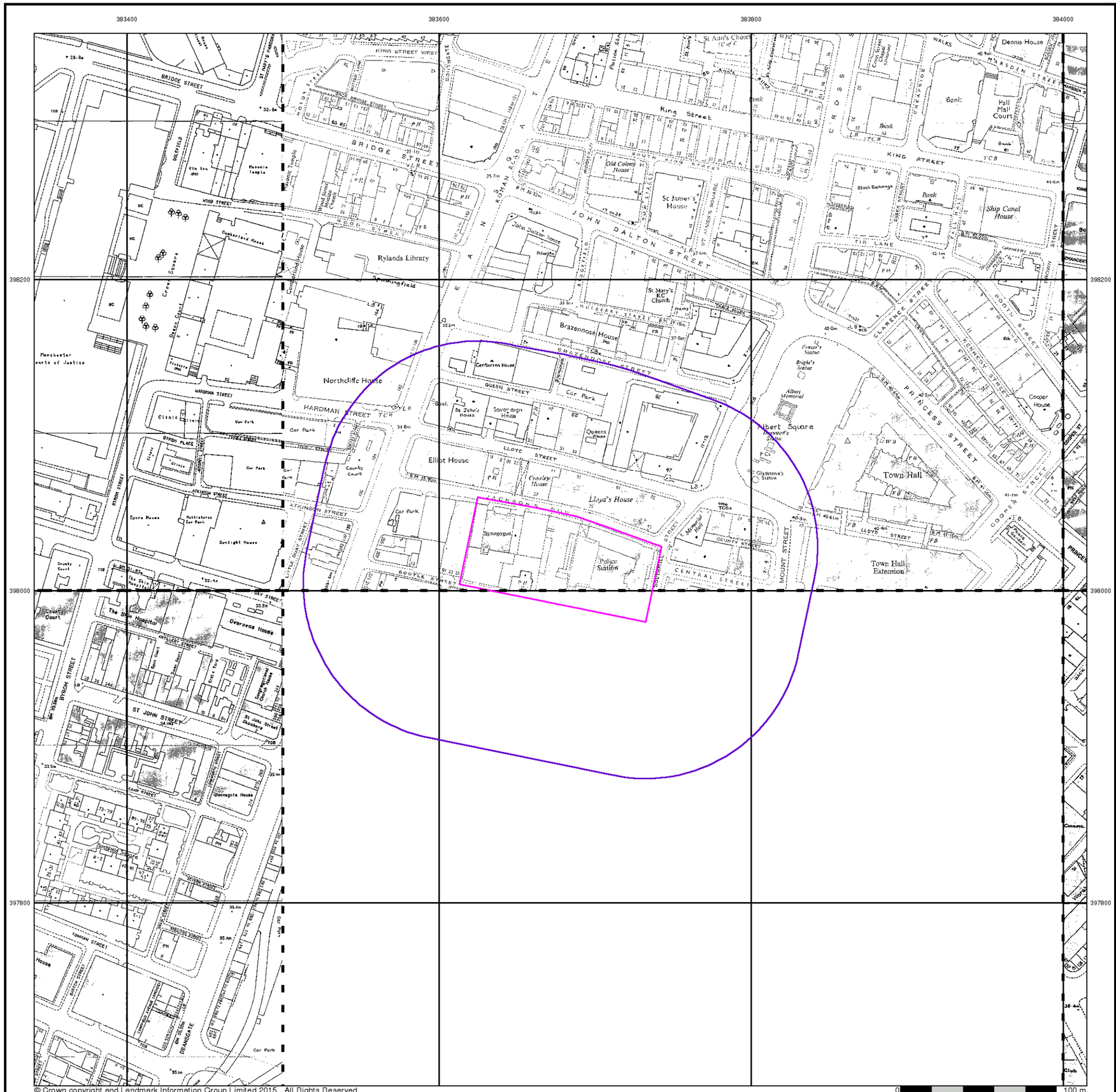
Order Details

Order Number:	73295769_1_1
Customer Ref:	70010278-100
National Grid Reference:	383680, 398020
Slice:	A
Site Area (Ha):	0.68
Search Buffer (m):	100

Site Details

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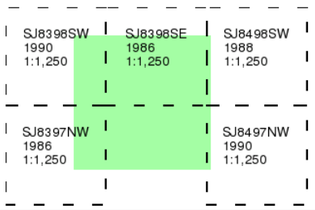
Additional SIMs

Published 1986 - 1990

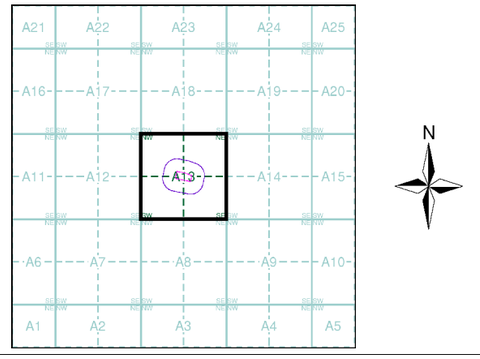
Source map scale - 1:1,250

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



Order Details

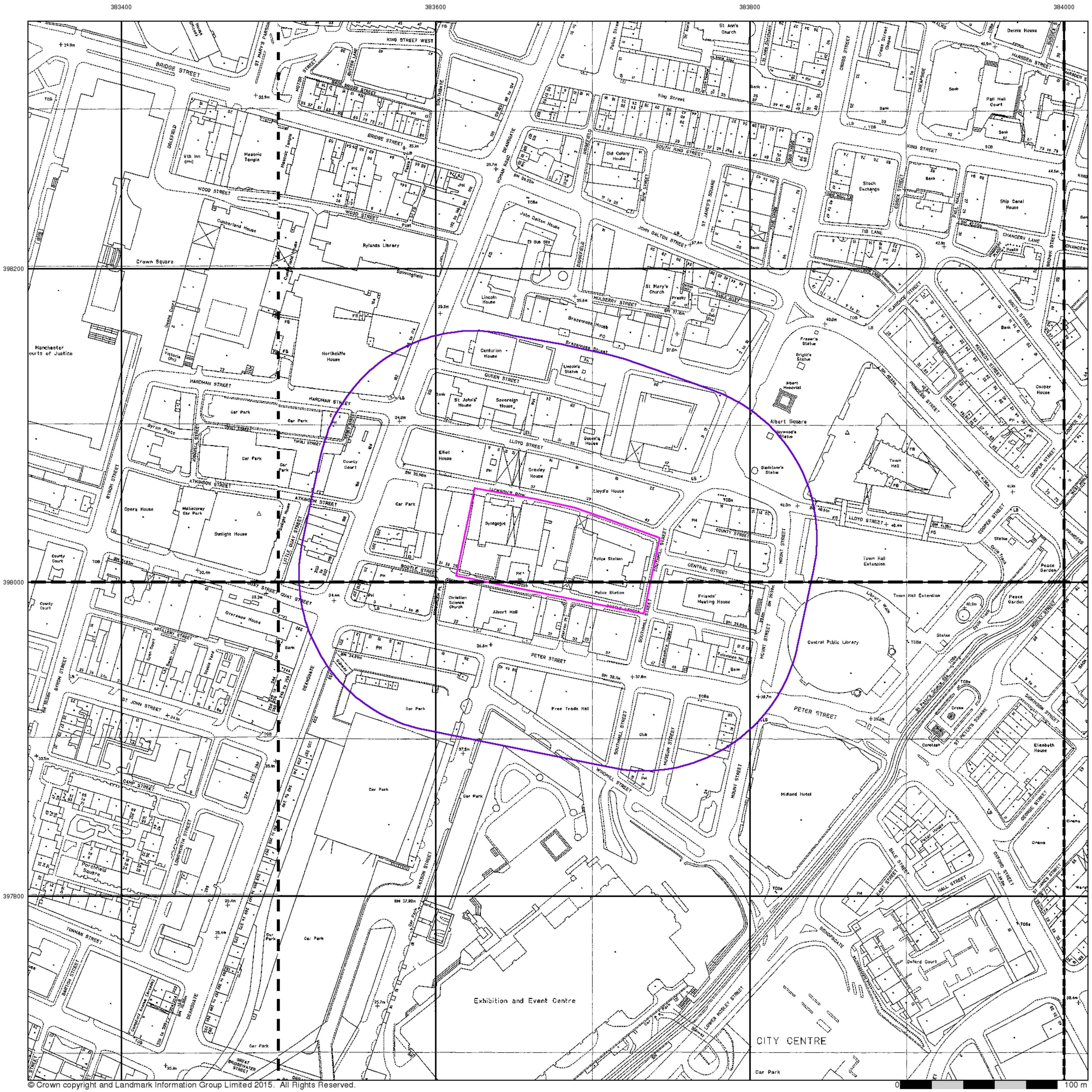
Order Number:	73295769_1_1
Customer Ref:	70010278-100
National Grid Reference:	383680, 398020
Slice:	A
Site Area (Ha):	0.68
Search Buffer (m):	100

Site Details

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Large-Scale National Grid Data

Published 1992

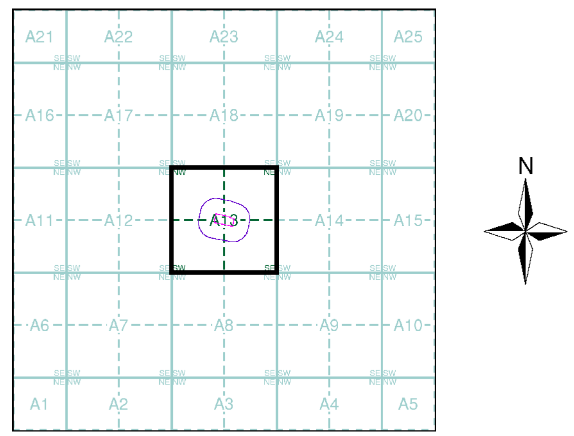
Source map scale - 1:1,250

'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)

SJ8398SW 1992 1:1,250	SJ8398SE 1992 1:1,250	SJ8498SW 1992 1:1,250
SJ8397NW 1992 1:1,250	SJ8397NE 1992 1:1,250	SJ8497NW 1992 1:1,250

Historical Map - Segment A13



Order Details

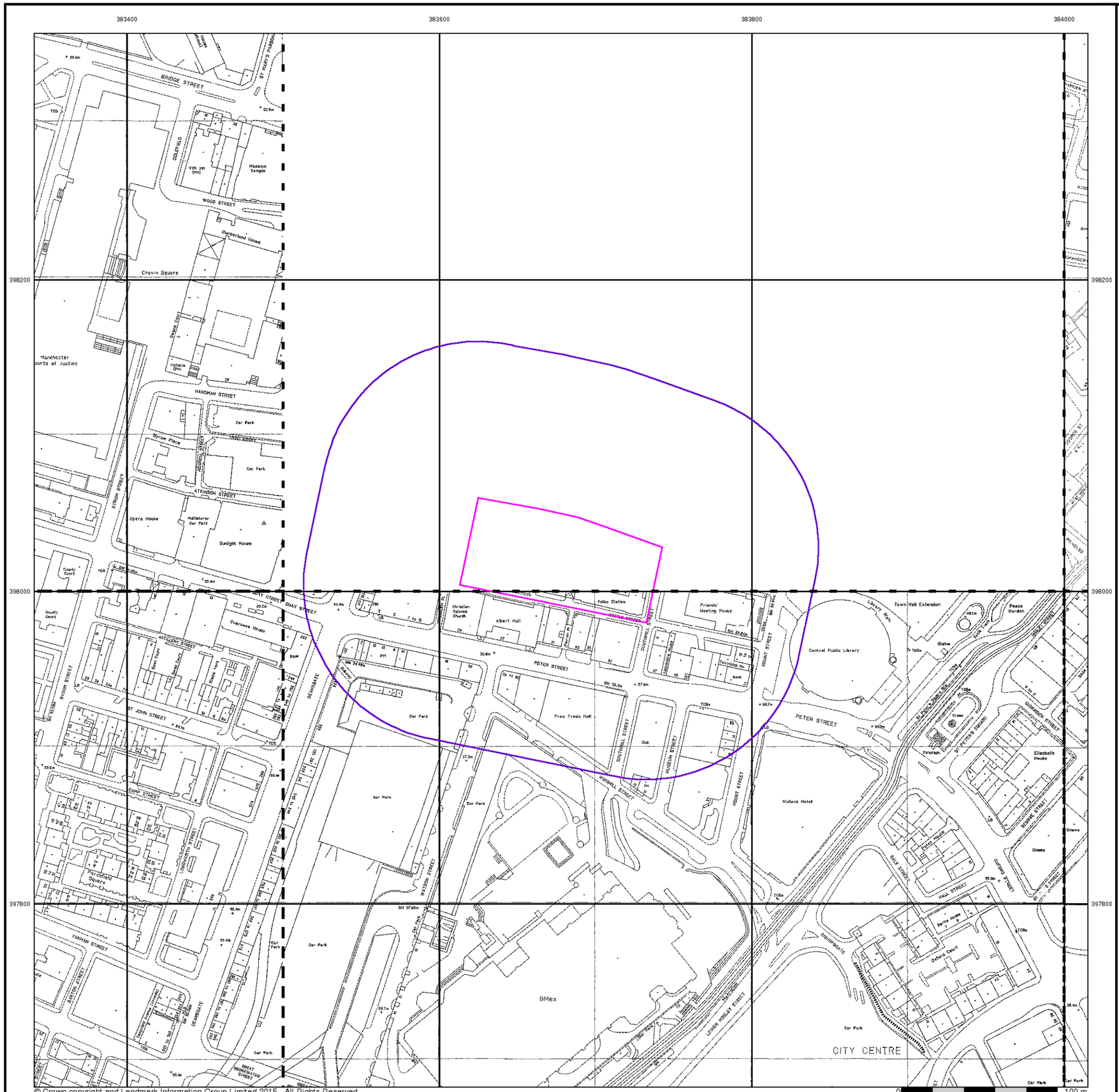
Order Number: 73295769_1_1
Customer Ref: 70010278-100
National Grid Reference: 383680, 398020
Slice: A
Site Area (Ha): 0.68
Search Buffer (m): 100

Site Details

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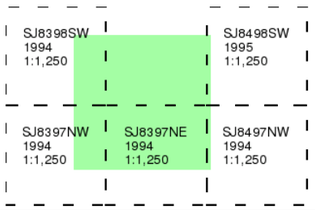
Large-Scale National Grid Data

Published 1994 - 1995

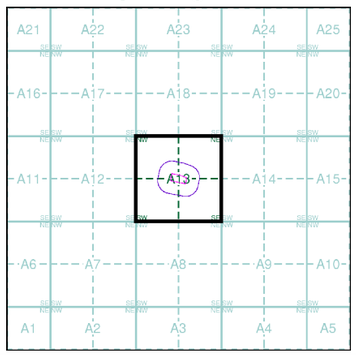
Source map scale - 1:1,250

'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

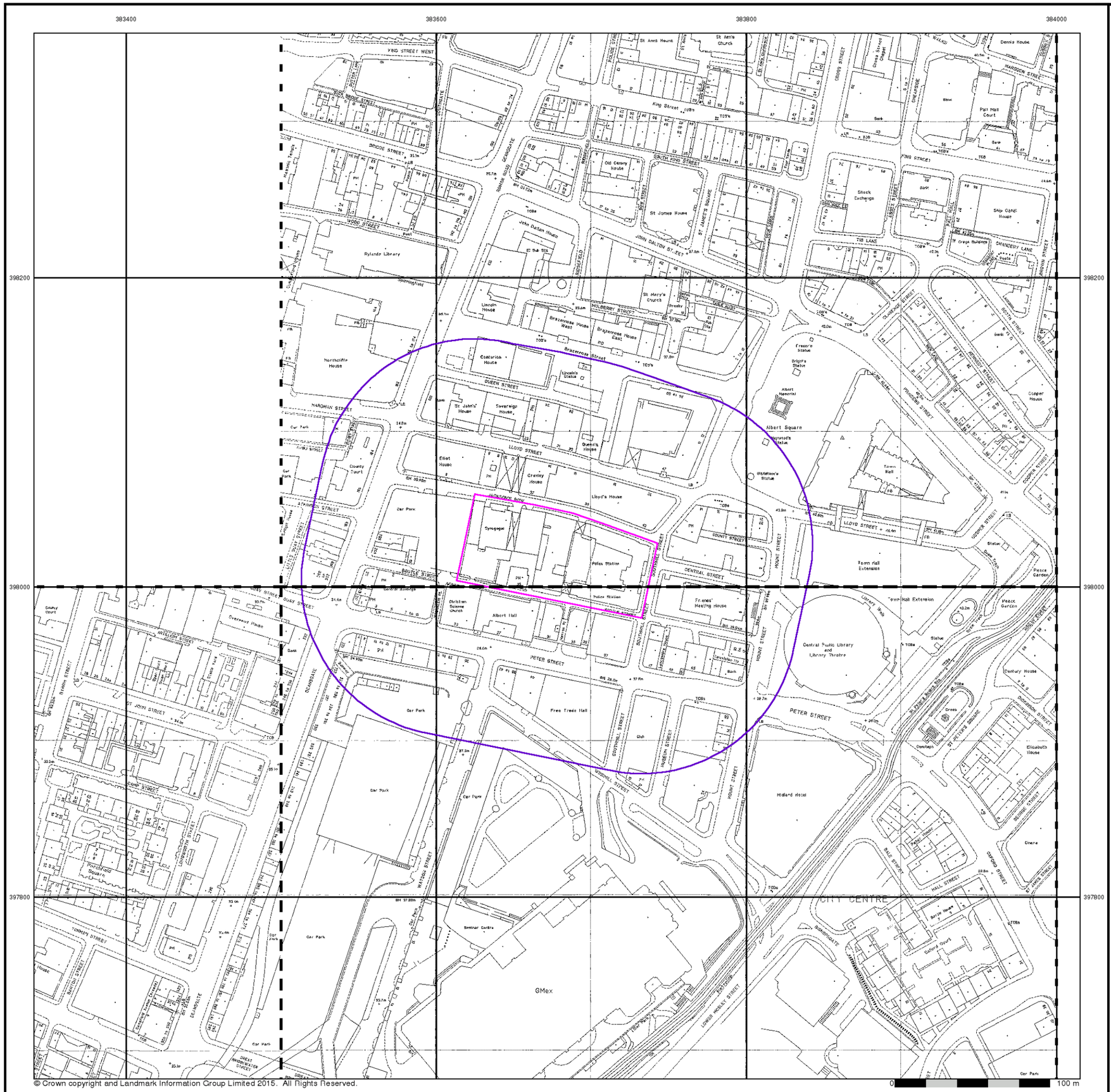


Order Details

Order Number:	73295769_1_1
Customer Ref:	70010278-100
National Grid Reference:	383680, 398020
Slice:	A
Site Area (Ha):	0.68
Search Buffer (m):	100

Site Details

Jacksons Row, MANCHESTER, M2 5WD



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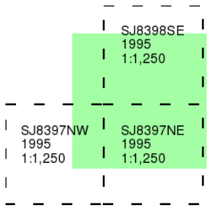
Large-Scale National Grid Data

Published 1995

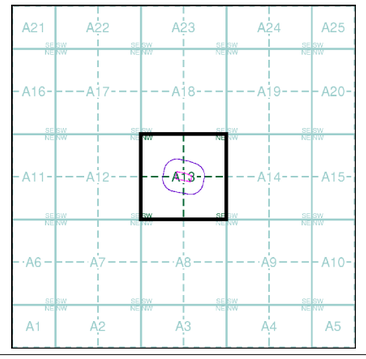
Source map scale - 1:1,250

'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



Order Details

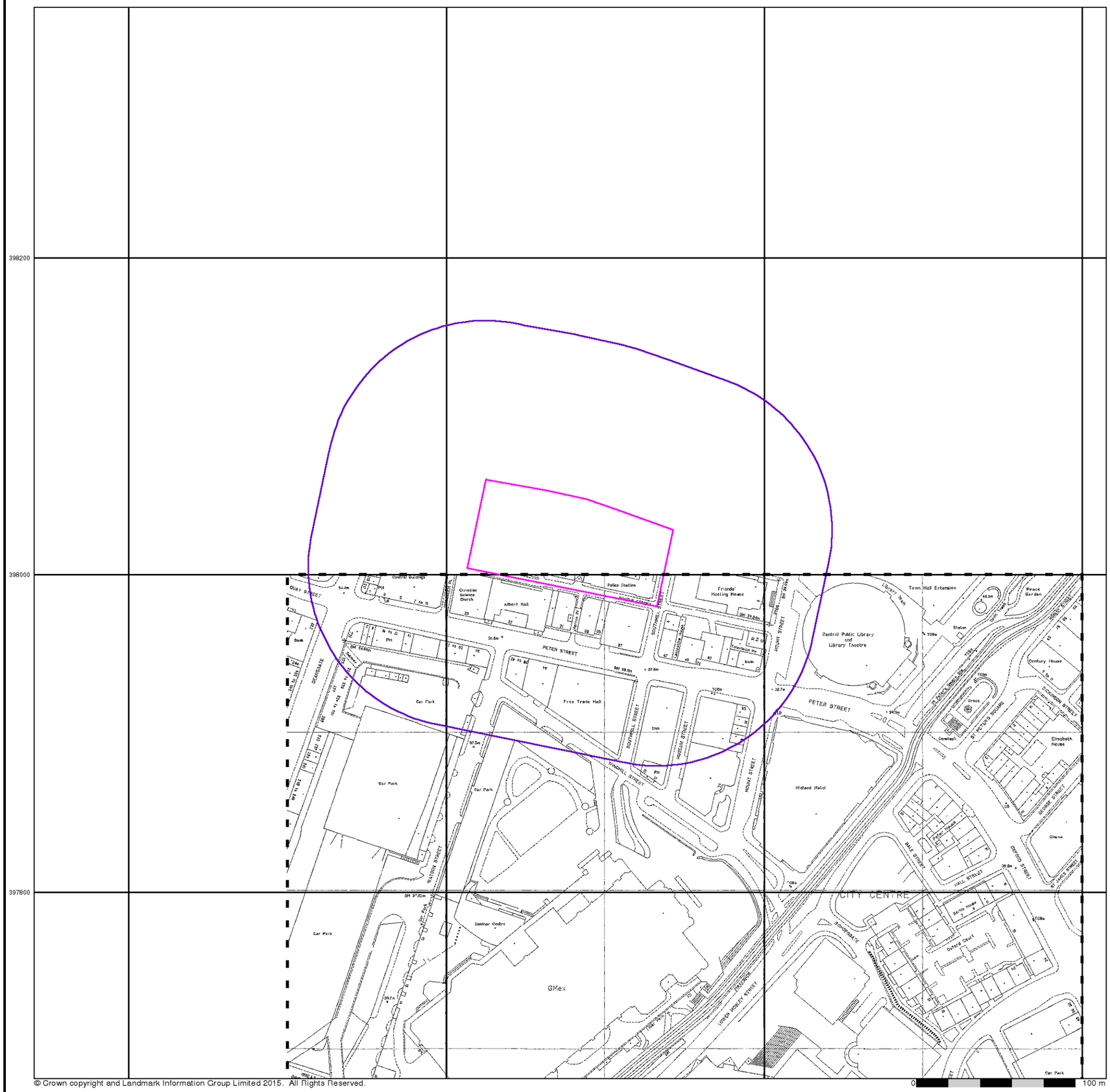
Order Number:	73295769_1_1
Customer Ref:	70010278-100
National Grid Reference:	383680, 398020
Slice:	A
Site Area (Ha):	0.68
Search Buffer (m):	100

Site Details

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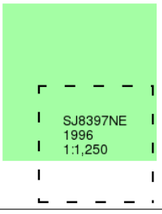
Large-Scale National Grid Data

Published 1996

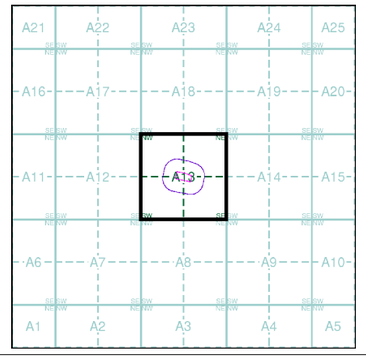
Source map scale - 1:1,250

'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



Order Details

Order Number:	73295769_1_1
Customer Ref:	70010278-100
National Grid Reference:	383680, 398020
Slice:	A
Site Area (Ha):	0.68
Search Buffer (m):	100

Site Details

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Historical Mapping Legends

Ordnance Survey County Series 1:10,560

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

Ordnance Survey Plan 1:10,000

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

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

1:10,000 Raster Mapping

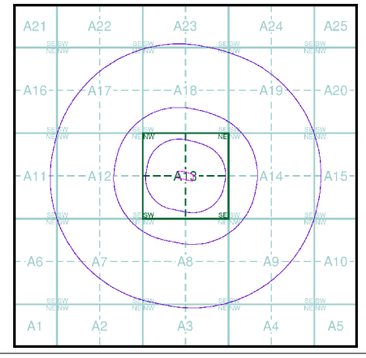
Gravel Pit
Refuse tip or slag heap
Rock
Rock (scattered)
Boulders
Boulders (scattered)
Shingle
Mud
Mud
Sand
Sand
Sand Pit
Slopes
Top of cliff
General detail
Underground detail
Overhead detail
Narrow gauge railway
Multi-track railway
Single track railway
County boundary (England only)
Civil, parish or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

WSP

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Lancashire And Furness	1:10,560	1848	3
Cheshire	1:10,560	1882	4
Lancashire And Furness	1:10,560	1894 - 1896	5
Lancashire And Furness	1:10,560	1909	6
Lancashire And Furness	1:10,560	1923	7
Lancashire And Furness	1:10,560	1931 - 1933	8
Lancashire And Furness	1:10,560	1938	9
Ordnance Survey Plan	1:10,000	1956	10
Ordnance Survey Plan	1:10,000	1968	11
Ordnance Survey Plan	1:10,000	1972	12
Manchester	1:25,000	1975	13
Ordnance Survey Plan	1:10,000	1980 - 1981	14
Ordnance Survey Plan	1:10,000	1985 - 1987	15
Ordnance Survey Plan	1:10,000	1989	16
Ordnance Survey Plan	1:10,000	1993 - 1994	17
10K Raster Mapping	1:10,000	2006	18
VectorMap Local	1:10,000	2015	19

Historical Map - Slice A



Order Details

Order Number:	73295769_1_1
Customer Ref:	70010278-100
National Grid Reference:	383680, 398020
Slice:	A
Site Area (Ha):	0.68
Search Buffer (m):	1000

Site Details

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Russian Military Mapping Legends

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

a. Not drawn to scale b. Drawn to scale

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

243,8 — Values for prominent elevations

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

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

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

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

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

1:25,000 mapping

a. Not drawn to scale b. Drawn to scale

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

Key to Numbers on Mapping

SJ89_Manchester

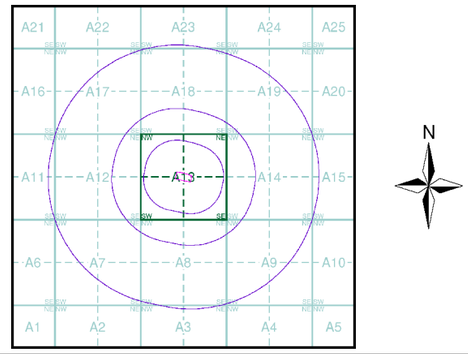
No.	Description
1	Airfield/Airport
6	Railway Station
62	Factory (Gas)
66	Factory (Gas)
168	Post Office
197	Railway Station

WSP

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Lancashire And Furness	1:10,560	1848	3
Cheshire	1:10,560	1882	4
Lancashire And Furness	1:10,560	1894 - 1896	5
Lancashire And Furness	1:10,560	1909	6
Lancashire And Furness	1:10,560	1923	7
Lancashire And Furness	1:10,560	1931 - 1933	8
Lancashire And Furness	1:10,560	1938	9
Ordnance Survey Plan	1:10,000	1956	10
Ordnance Survey Plan	1:10,000	1968	11
Ordnance Survey Plan	1:10,000	1972	12
Manchester	1:25,000	1975	13
Ordnance Survey Plan	1:10,000	1980 - 1981	14
Ordnance Survey Plan	1:10,000	1985 - 1987	15
Ordnance Survey Plan	1:10,000	1989	16
Ordnance Survey Plan	1:10,000	1993 - 1994	17
10K Raster Mapping	1:10,000	2006	18
VectorMap Local	1:10,000	2015	19

Russian Map - Slice A



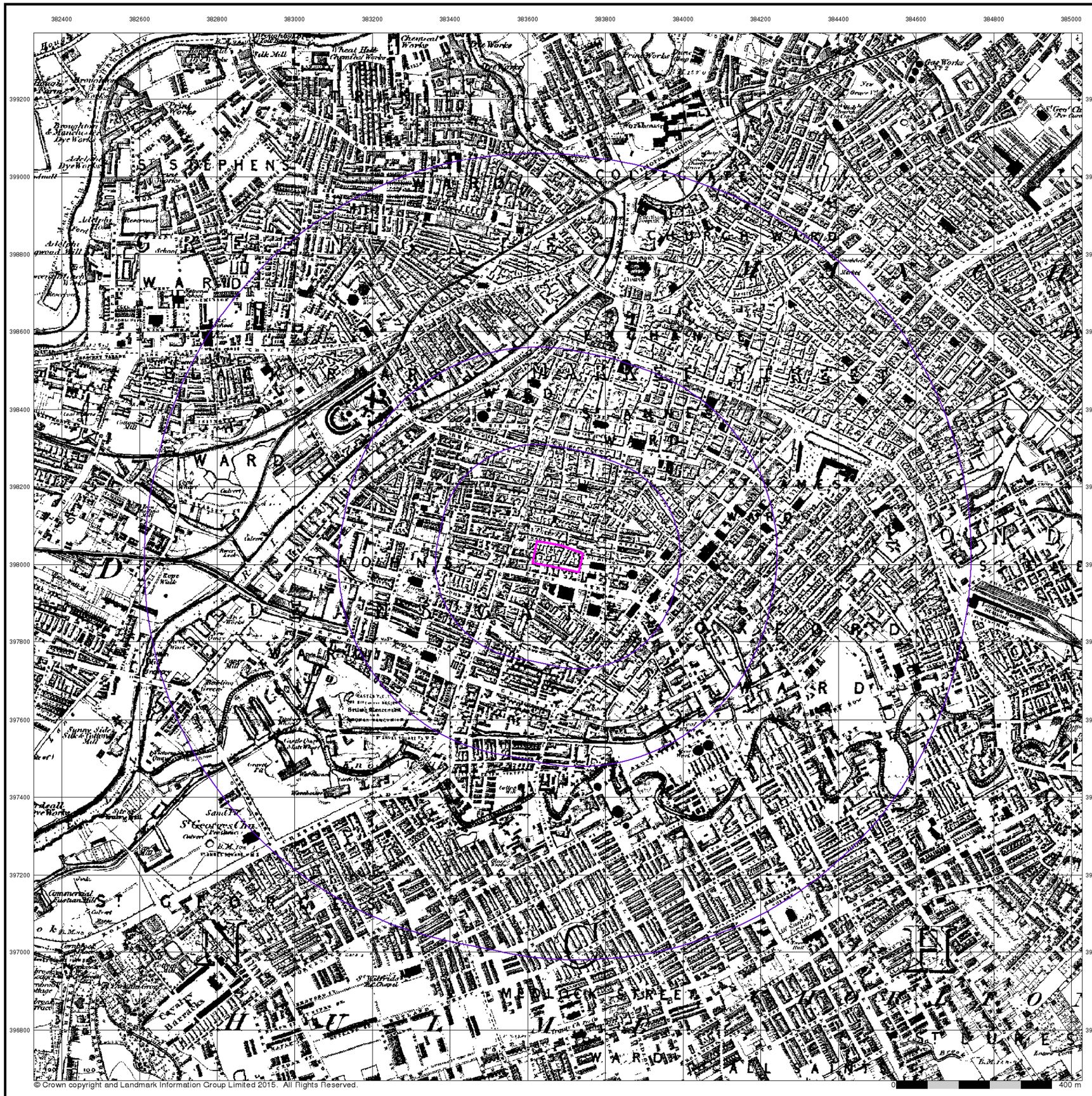
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Site Details

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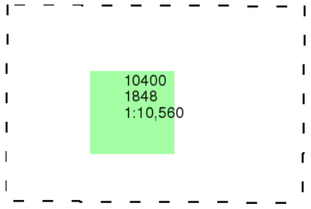
Lancashire And Furness

Published 1848

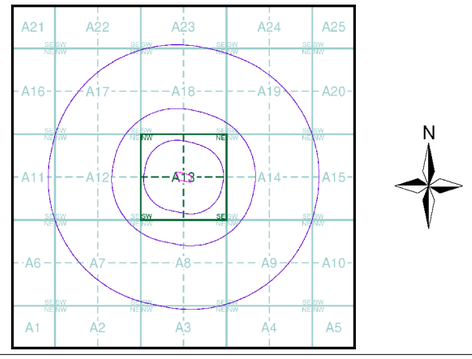
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Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

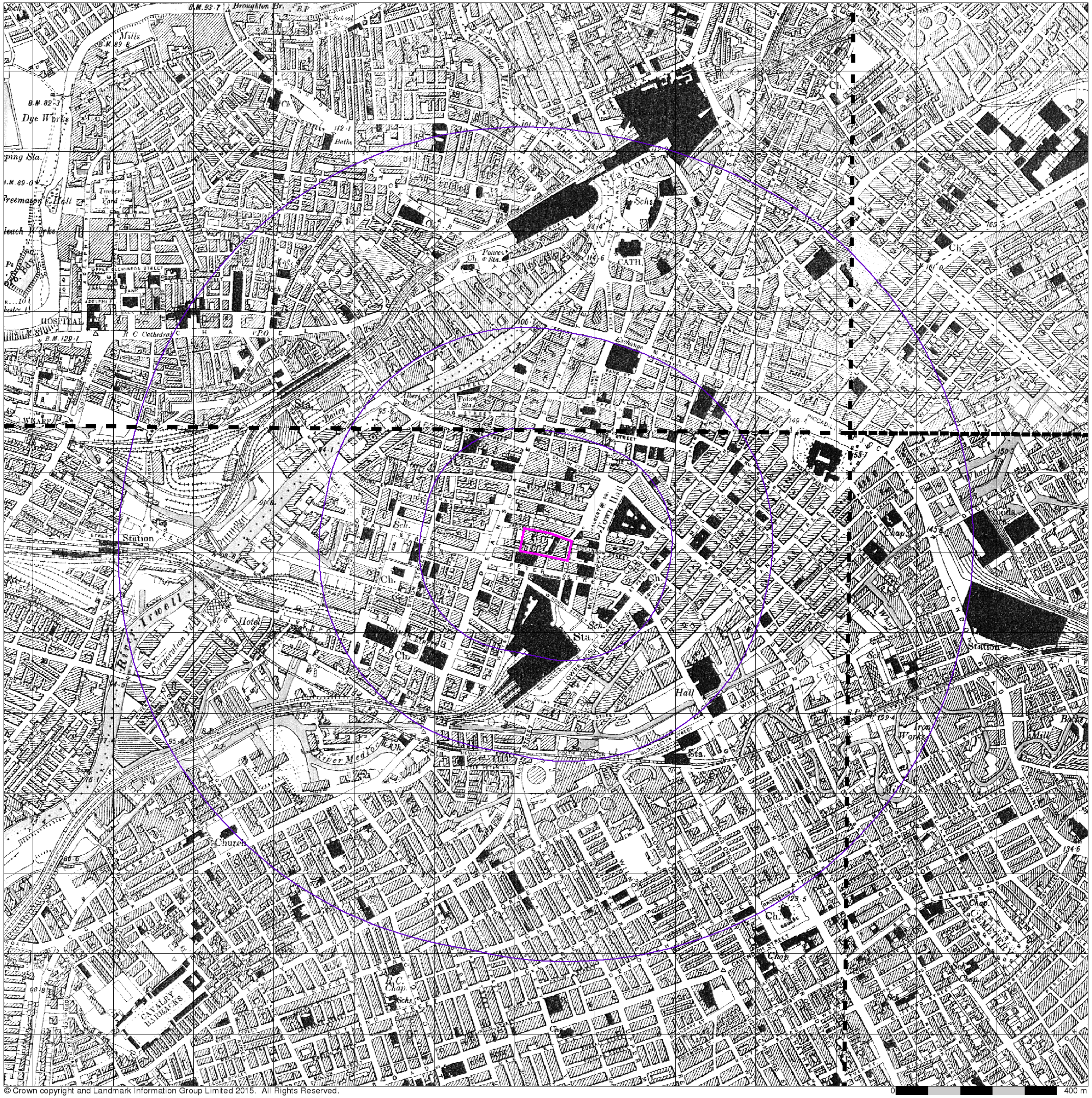
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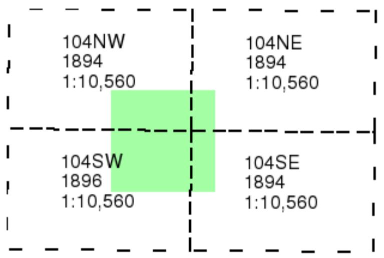
Lancashire And Furness

Published 1894 - 1896

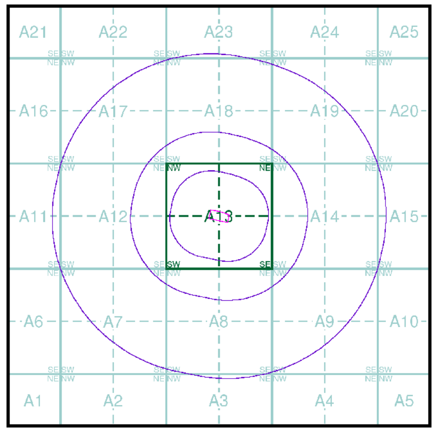
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Map Name(s) and Date(s)



Historical Map - Slice A



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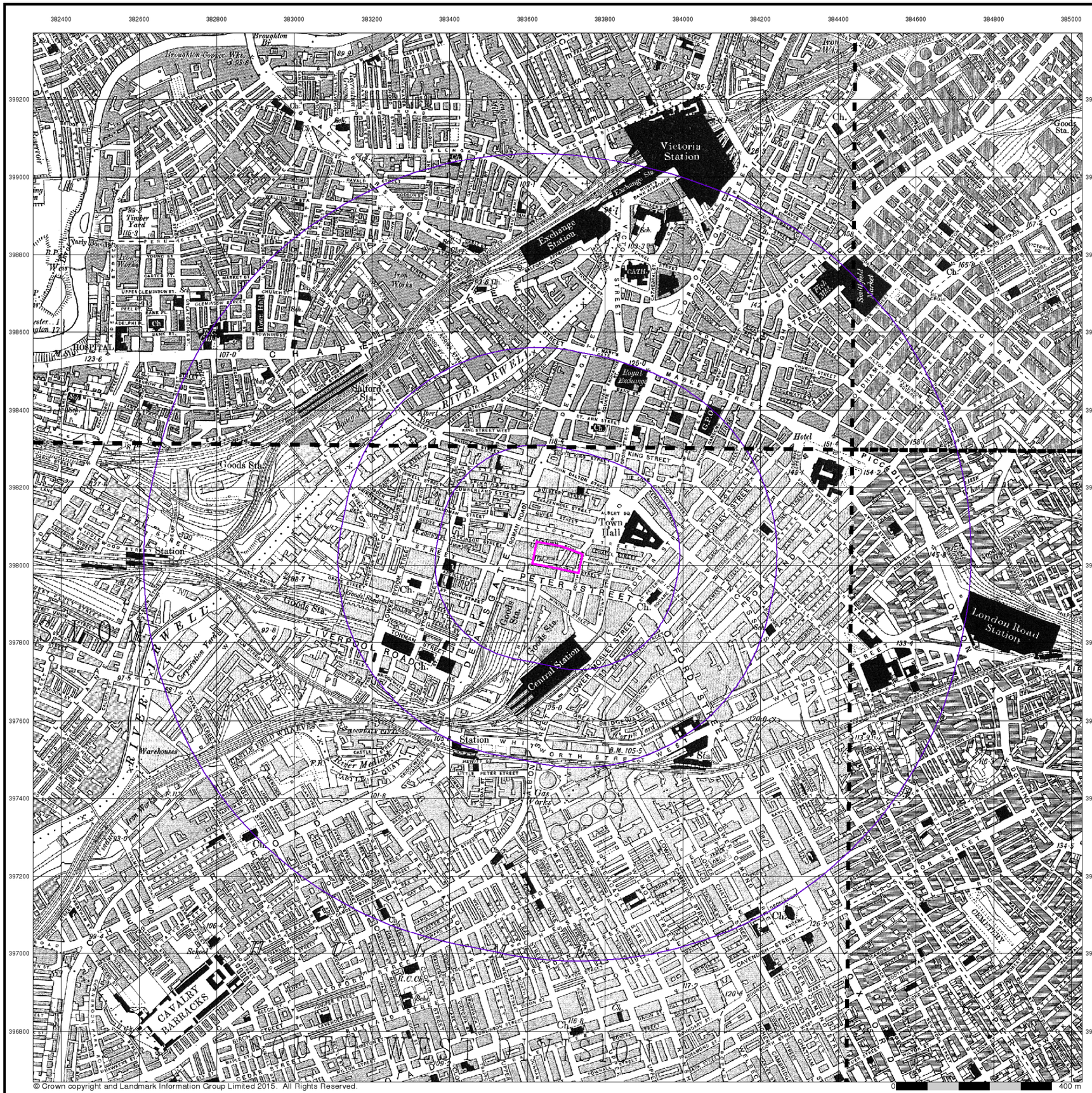
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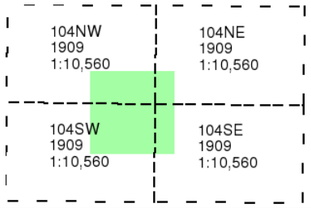
Lancashire And Furness

Published 1909

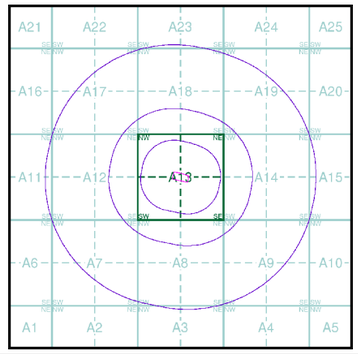
Source map scale - 1:10,560

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Map Name(s) and Date(s)



Historical Map - Slice A



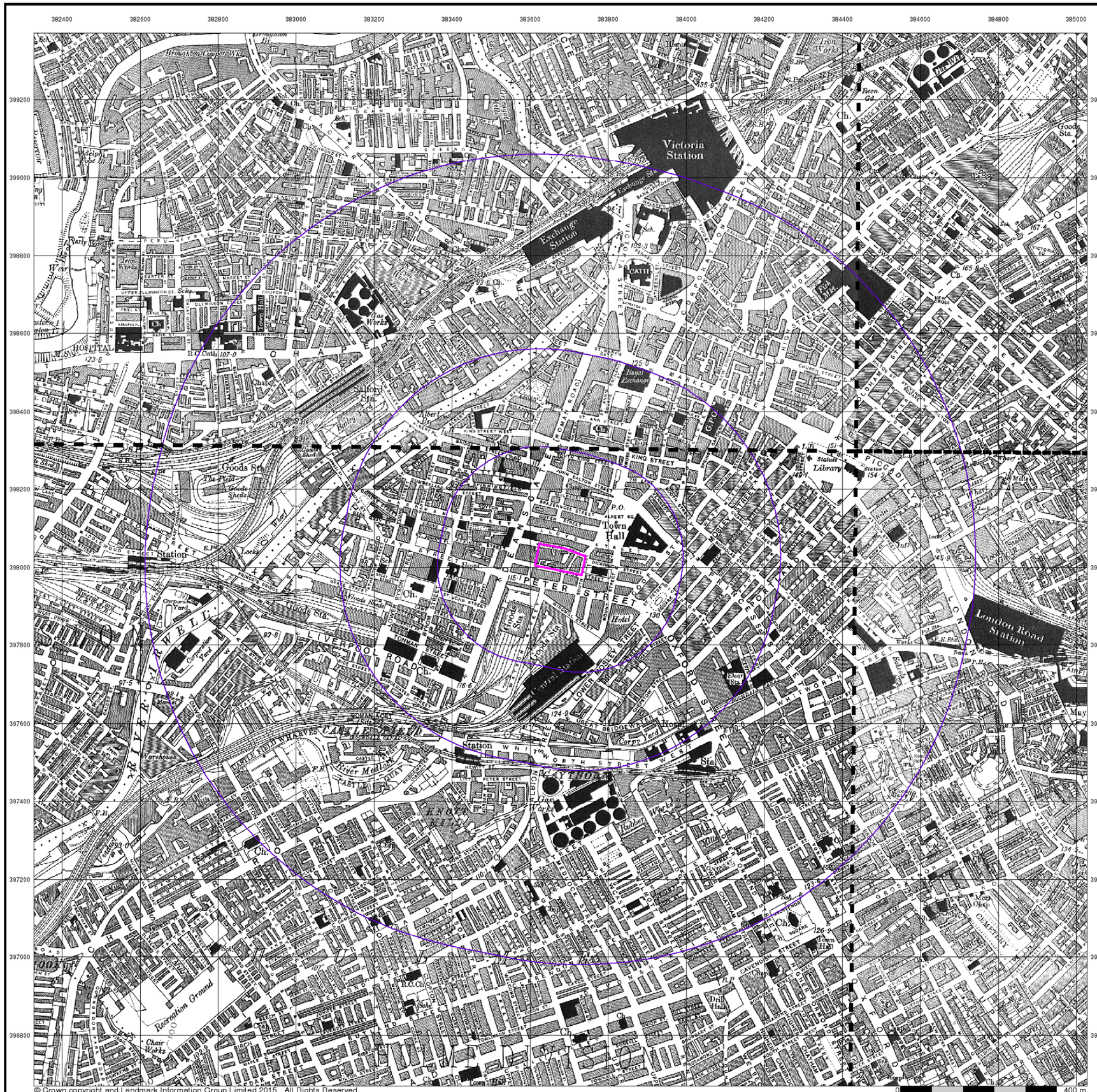
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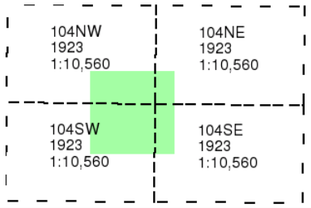
Lancashire And Furness

Published 1923

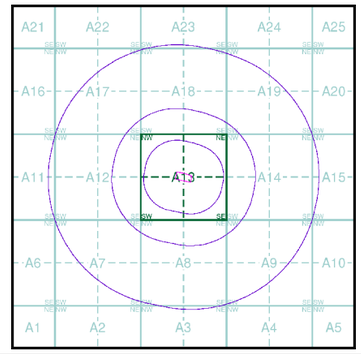
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Map Name(s) and Date(s)



Historical Map - Slice A



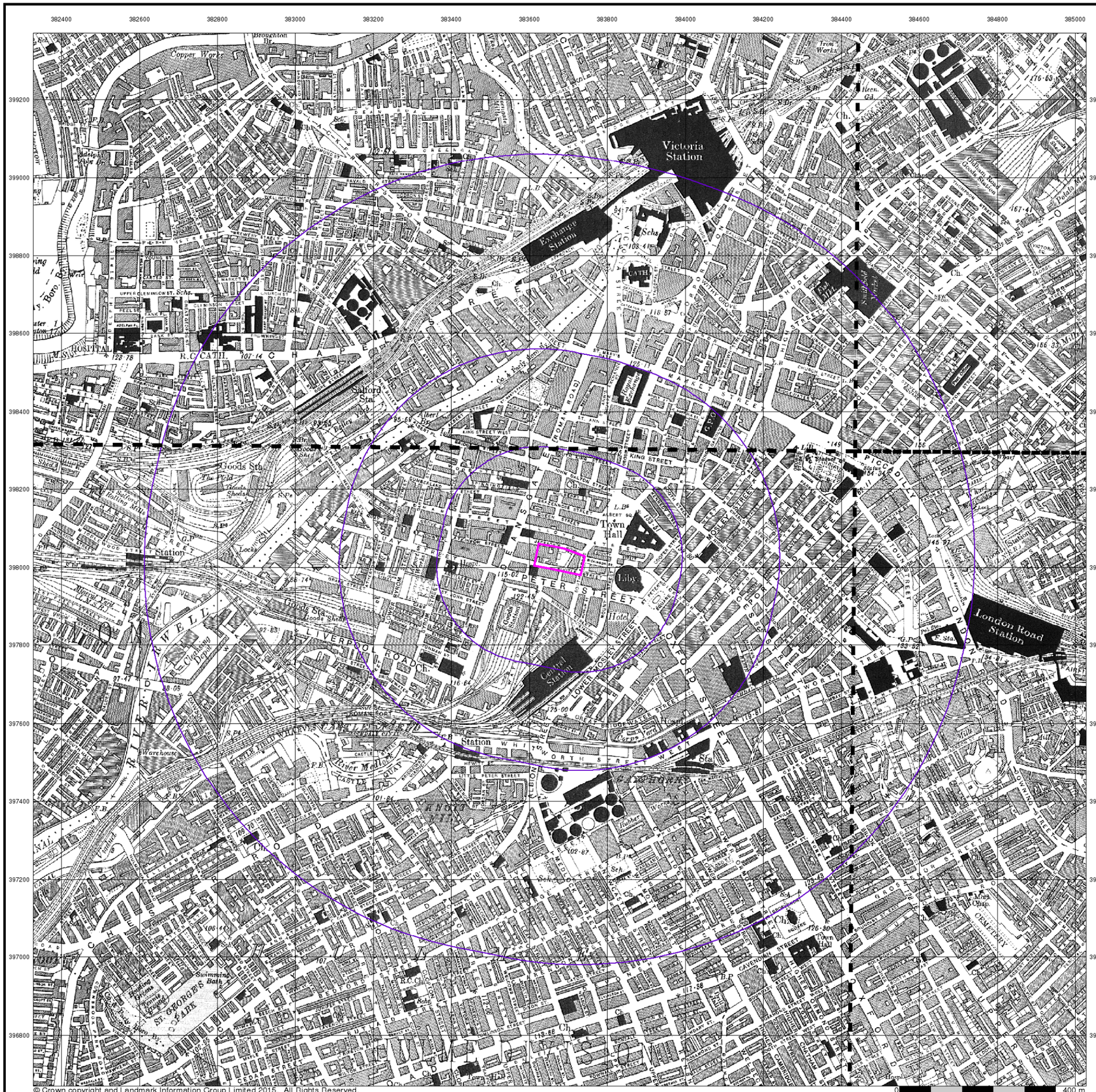
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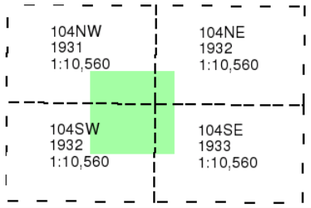
Lancashire And Furness

Published 1931 - 1933

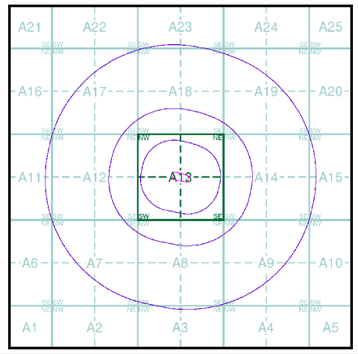
Source map scale - 1:10,560

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Map Name(s) and Date(s)



Historical Map - Slice A



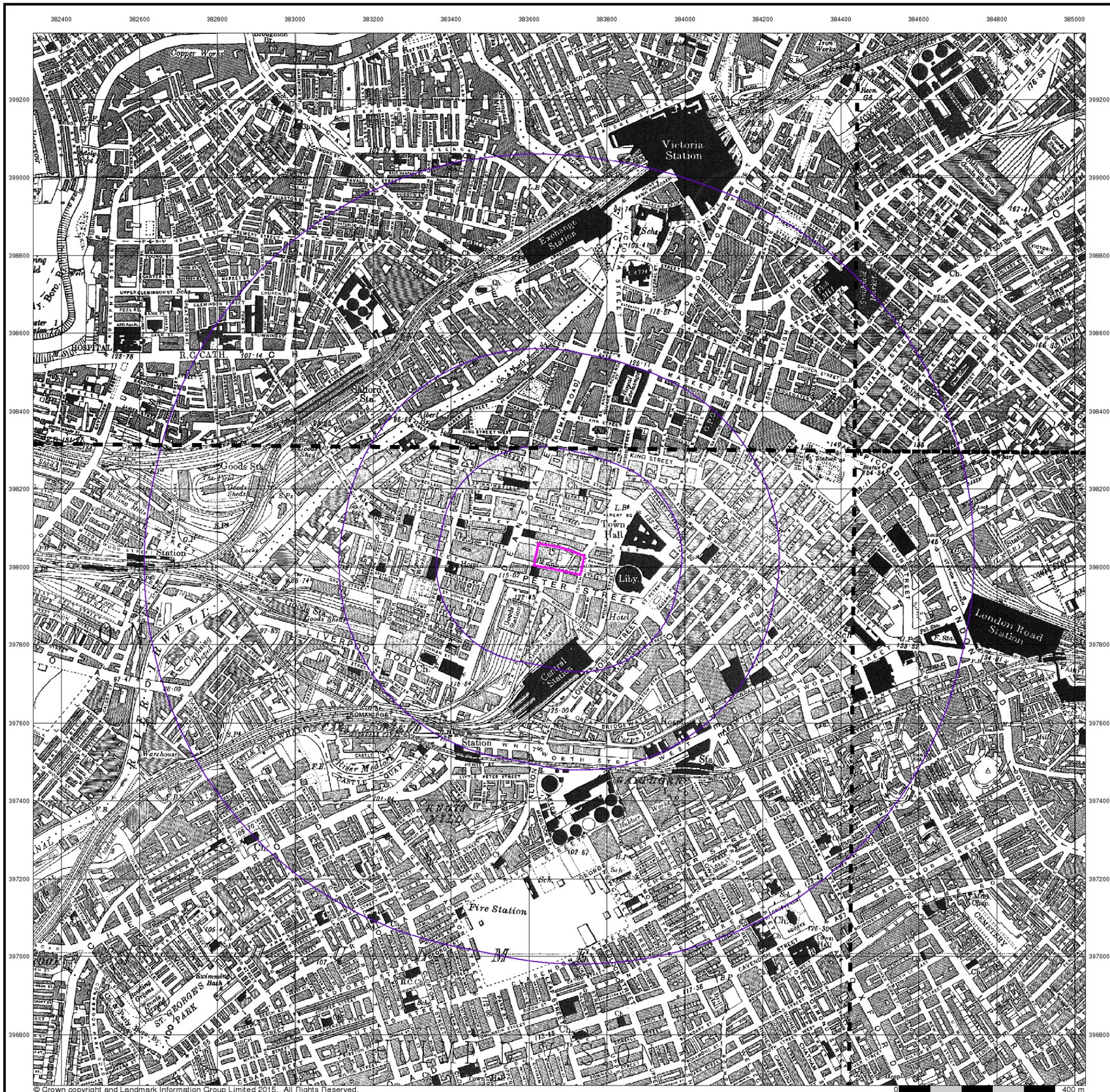
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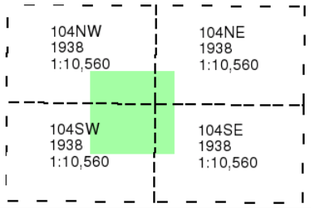
Lancashire And Furness

Published 1938

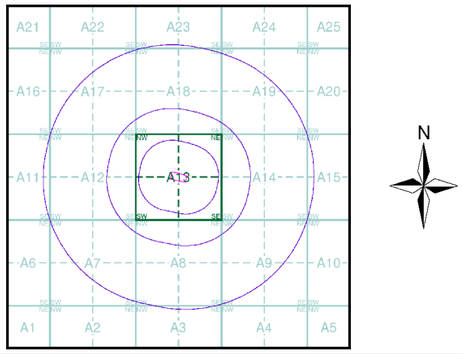
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Map Name(s) and Date(s)



Historical Map - Slice A

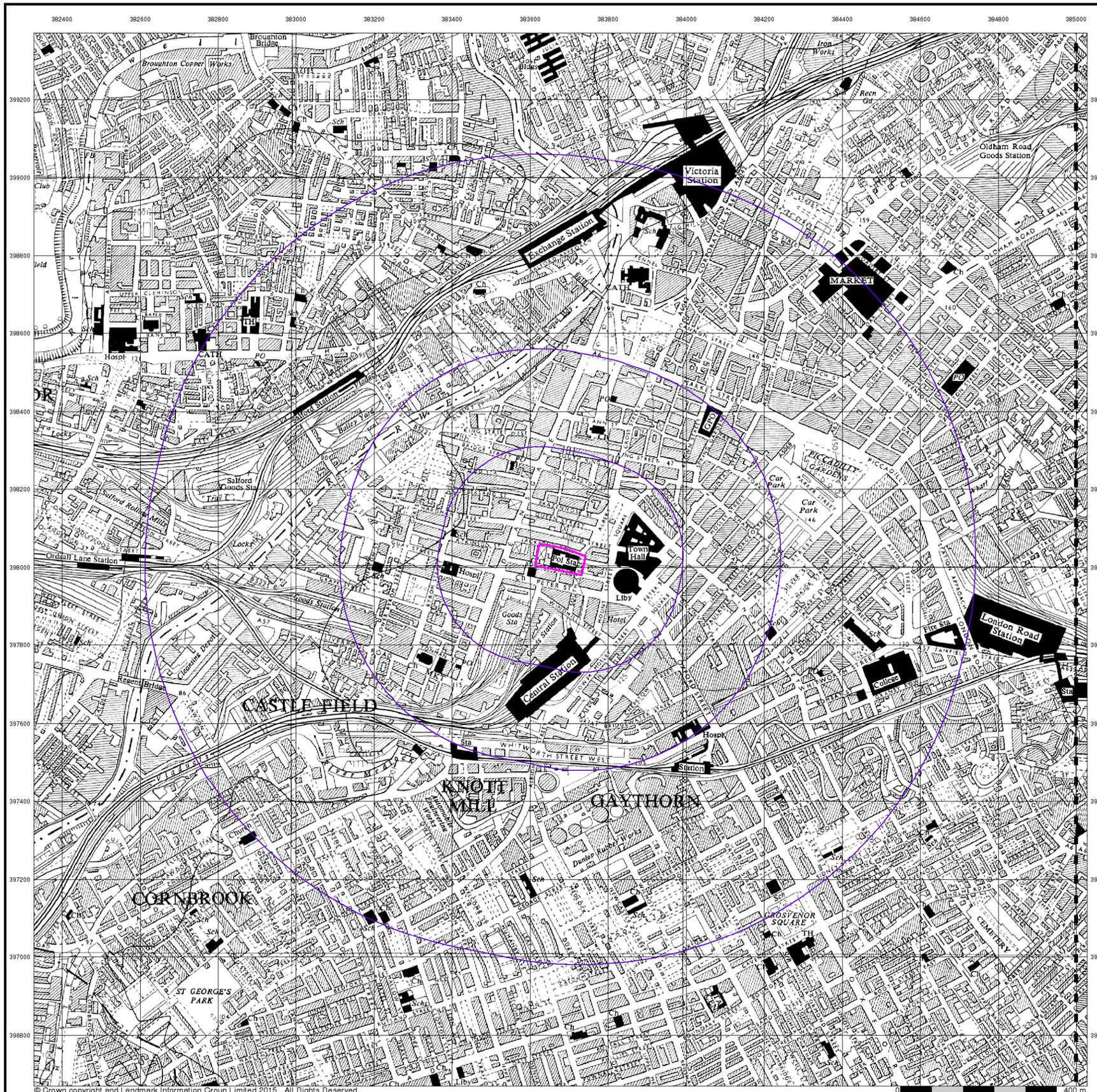


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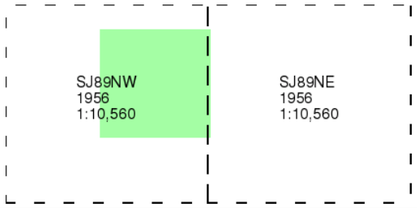
Ordnance Survey Plan

Published 1956

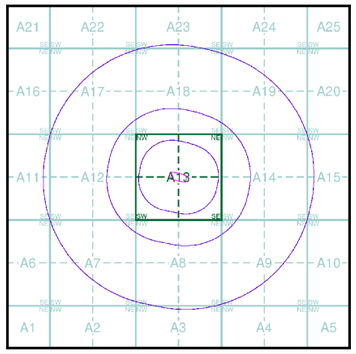
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Map Name(s) and Date(s)



Historical Map - Slice A



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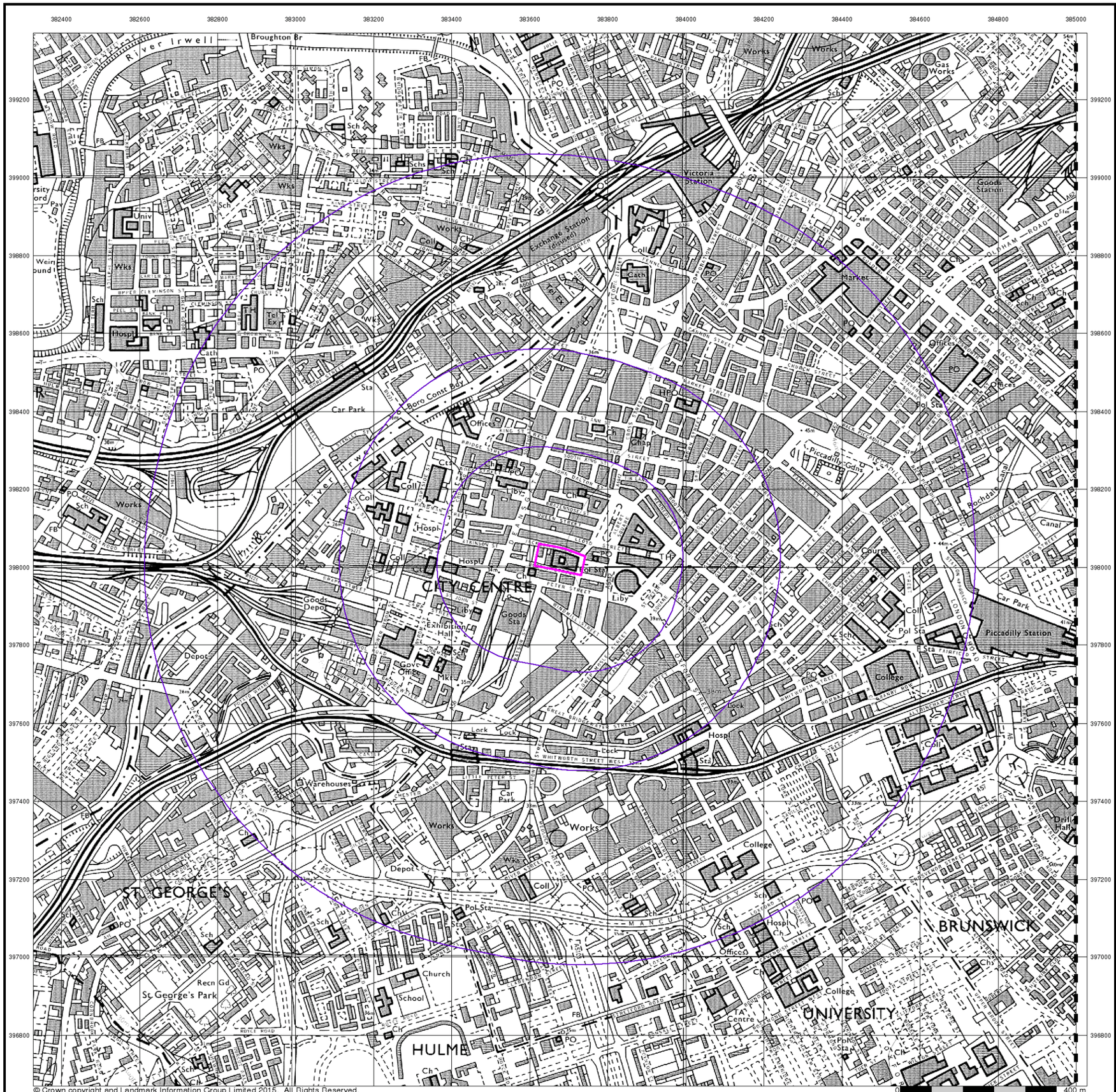
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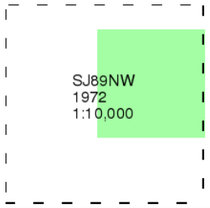
Ordnance Survey Plan

Published 1972

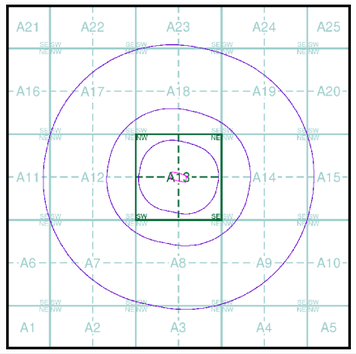
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Historical Map - Slice A



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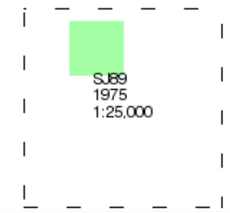
Manchester

Published 1975

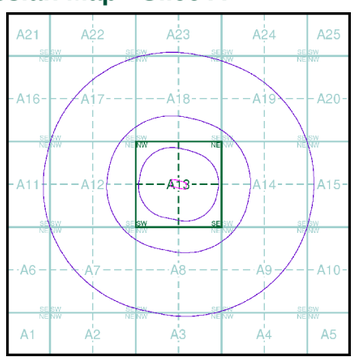
Source map scale - 1:25,000

These maps were produced by the Russian military during the Cold War between 1950 and 1997, and cover 103 towns and cities throughout the U.K. The maps are produced at 1:25,000, 1:10,000 and 1:5,000 scale, and show detailed land use, with colour-coded areas for development, green areas, and non-developed areas. Buildings are coloured black and important building uses (such as hospitals, post offices, factories etc.) are numbered, with a numbered key describing their use.
They were produced by the Russians for the benefit of navigation, as well as strategic military sites and transport hubs, for use if they were to have invaded the U.K. The detailed information provided indicates that the areas were surveyed using land-based personnel, on the ground, in the cities that are mapped.

Map Name(s) and Date(s)



Russian Map - Slice A



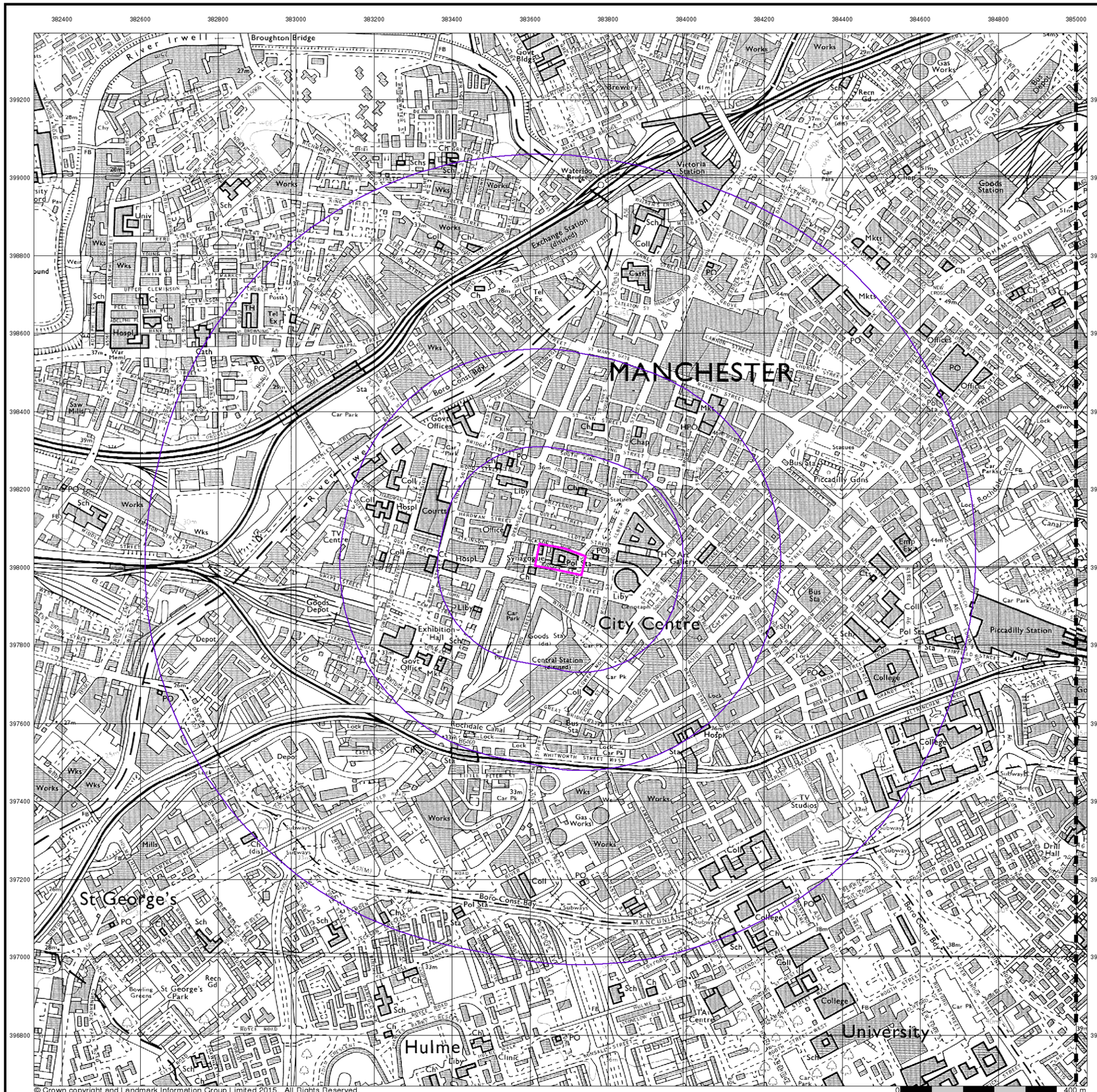
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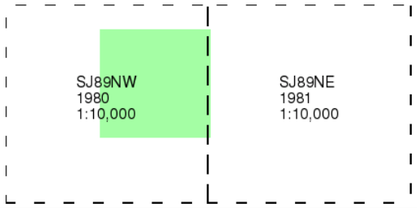
Ordnance Survey Plan

Published 1980 - 1981

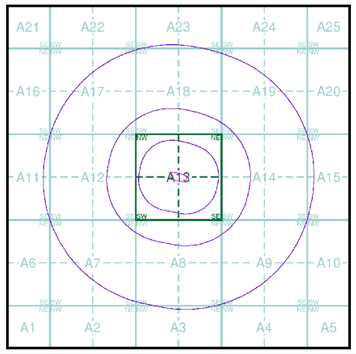
Source map scale - 1:10,000

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Historical Map - Slice A



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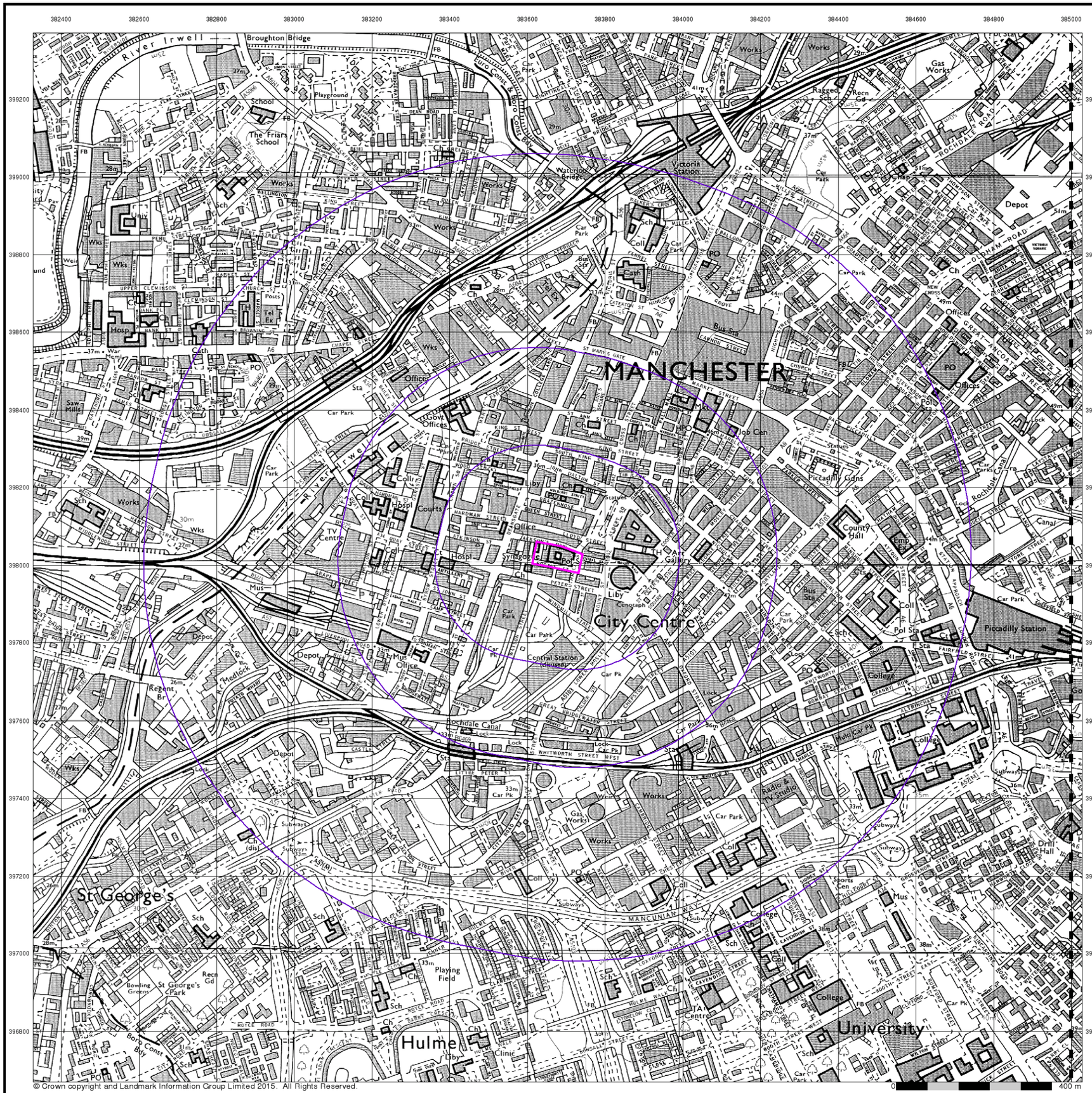
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Landmark Information Group

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WSP

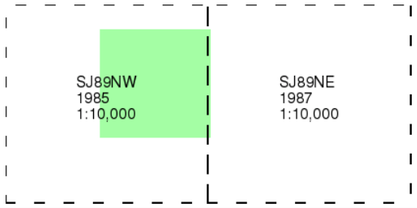
Ordnance Survey Plan

Published 1985 - 1987

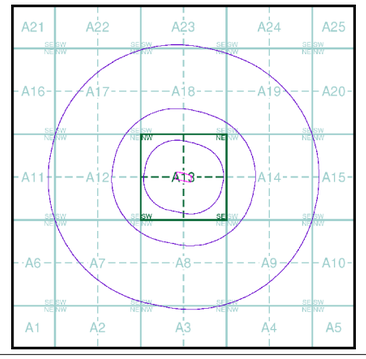
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Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

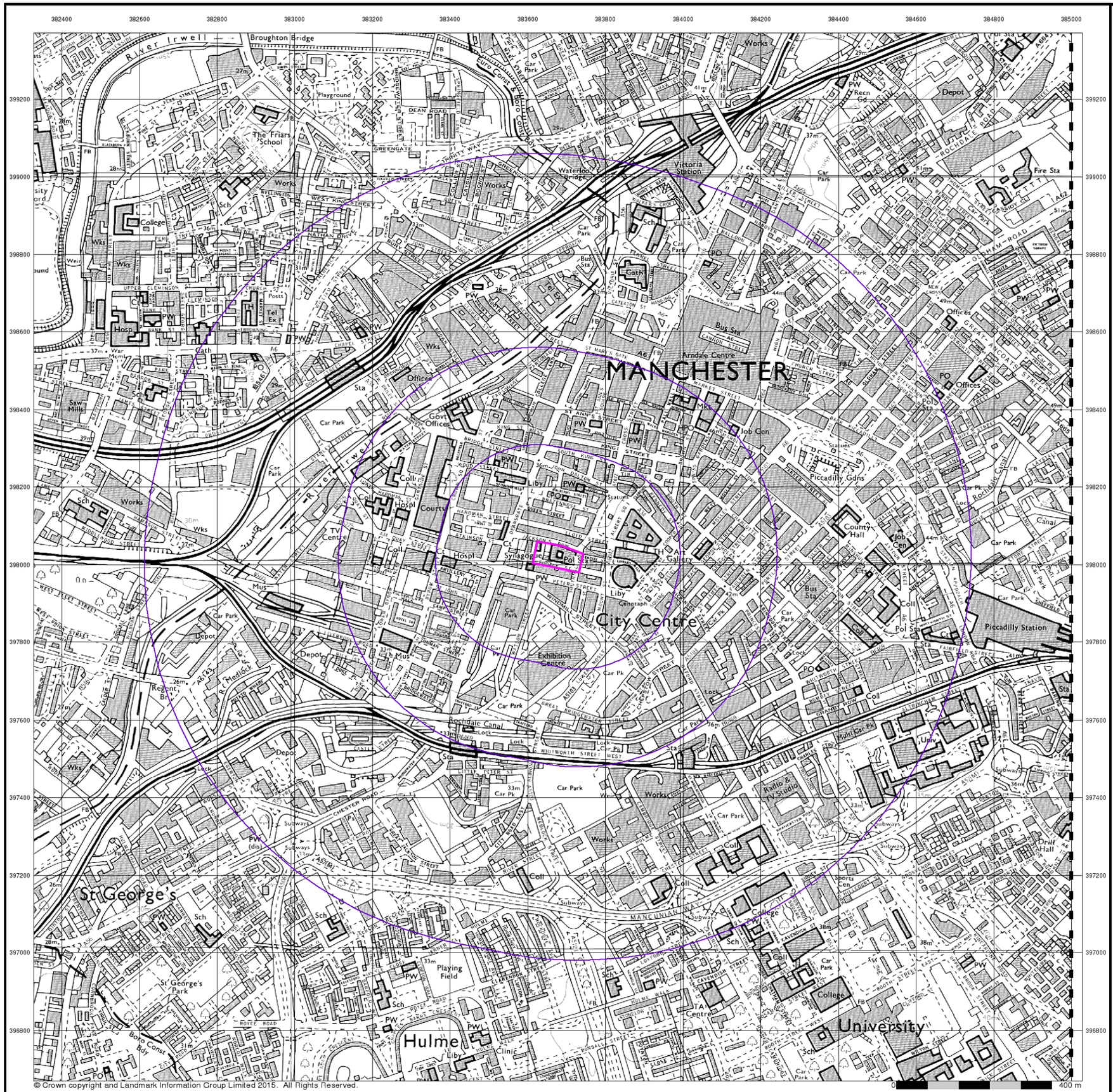
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National Grid Reference:	383680, 398020
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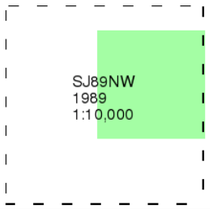
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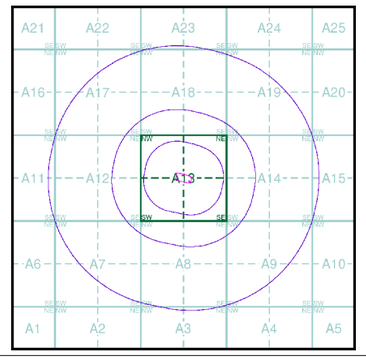
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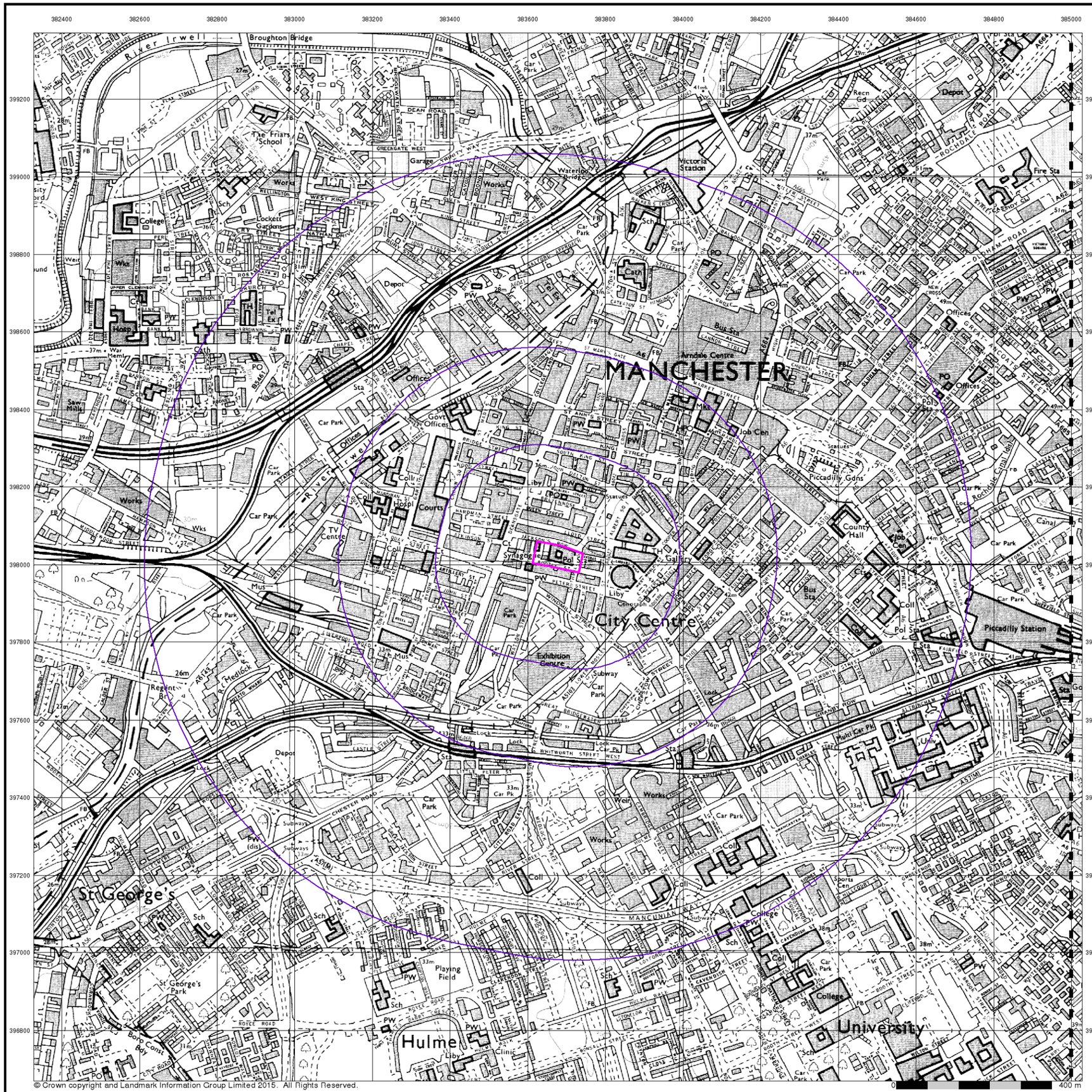
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0 400 m

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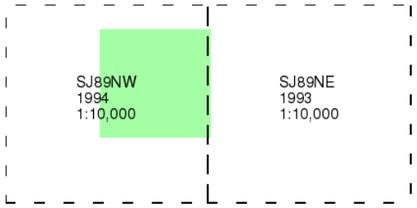
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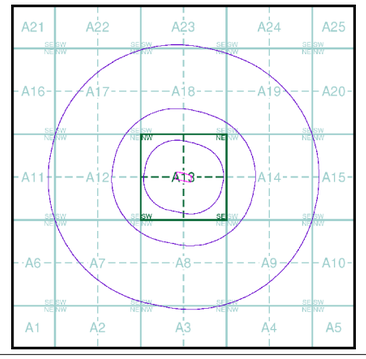
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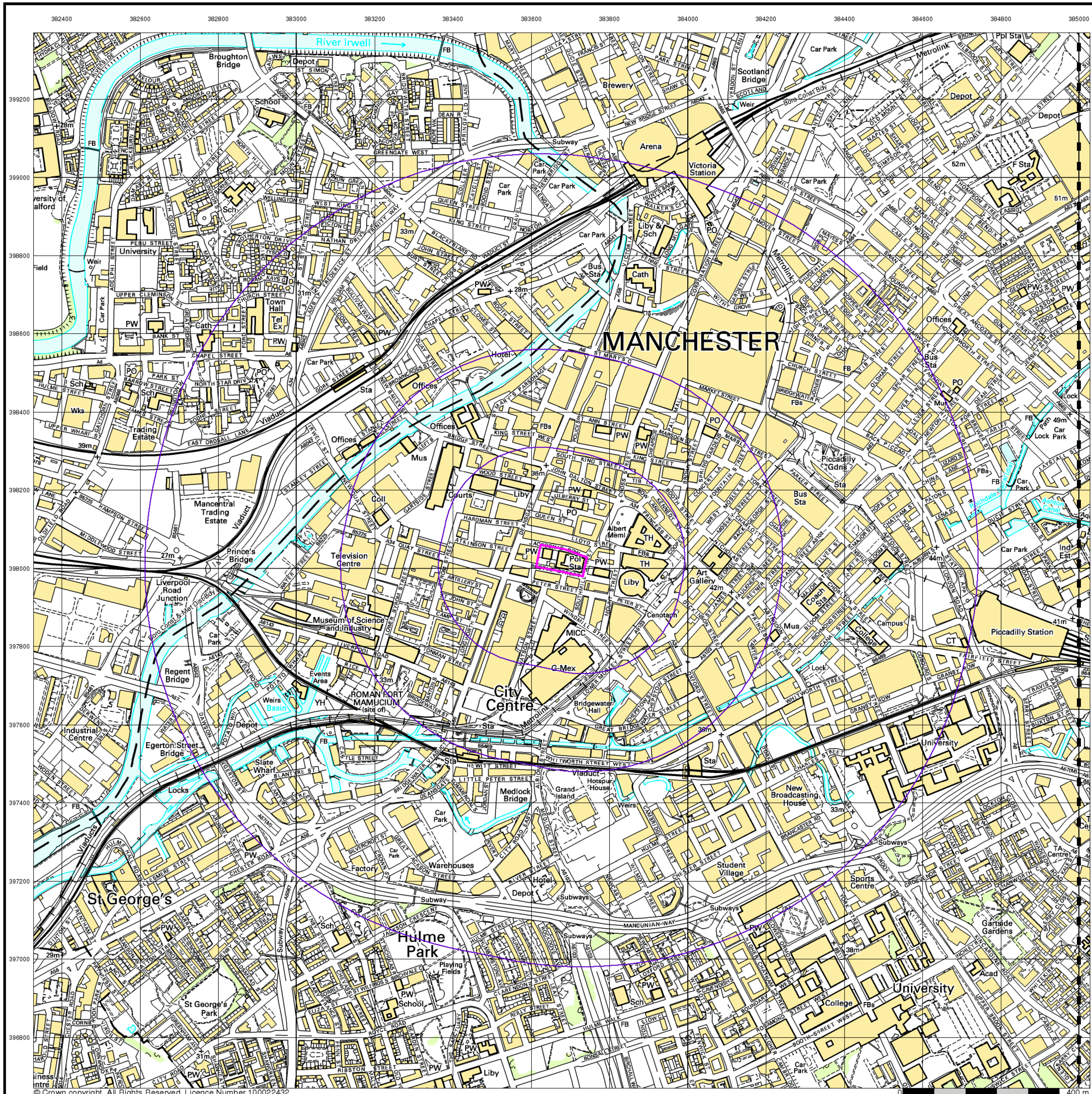
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10k Raster Mapping

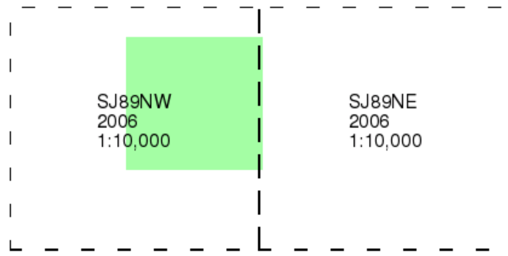
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Source map scale - 1:10,000

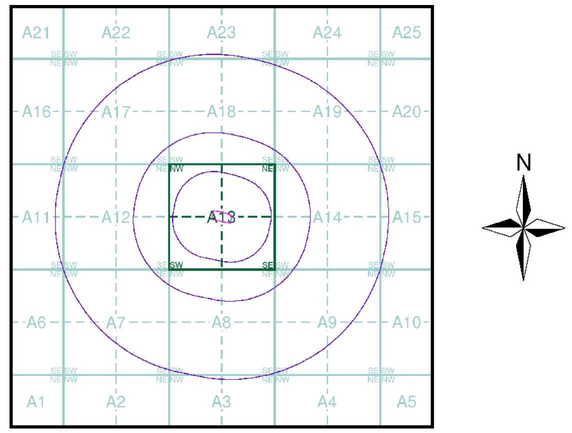
The historical maps shown were produced from the Ordnance Survey`s 1:10,000 colour raster mapping. These maps are derived from Landplan which replaced the old 1:10,000 maps originally published in 1970. The data is highly detailed showing buildings, fences and field boundaries as well as all roads, tracks and paths. Road names are also included together with the relevant road number and classification. Boundary information depiction includes county, unitary authority, district, civil parish and constituency.



Map Name(s) and Date(s)



Historical Map - Slice A



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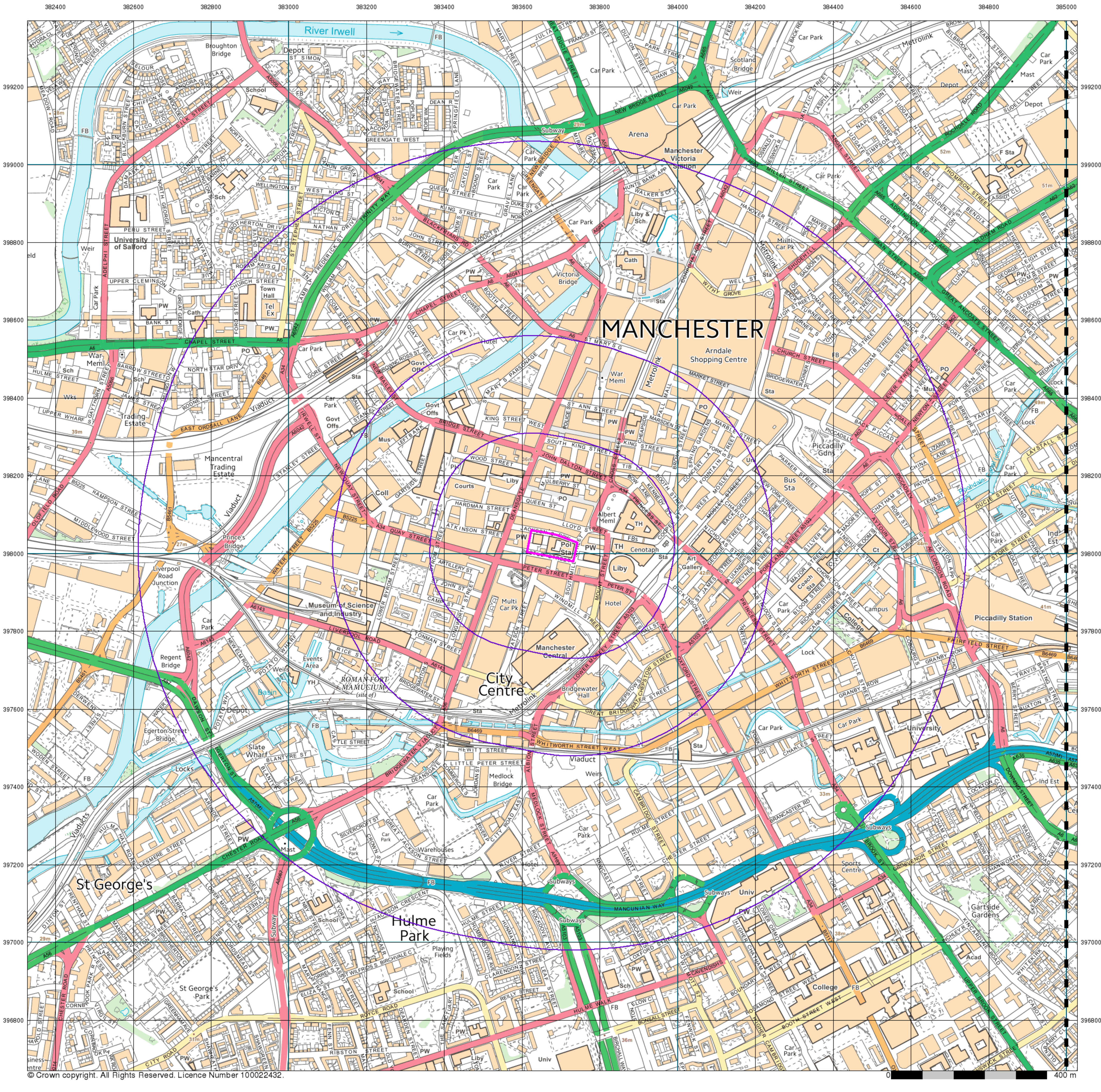
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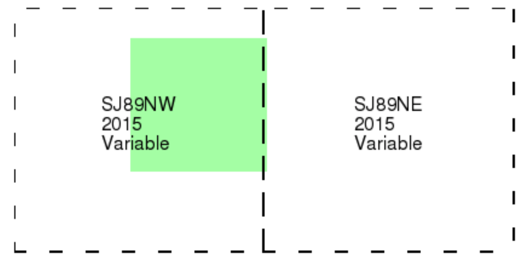
VectorMap Local

Published 2015

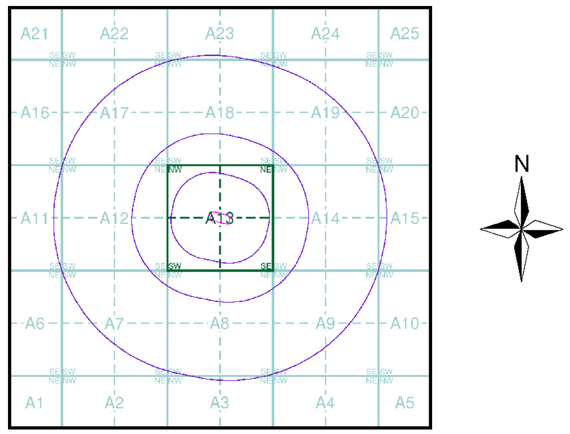
Source map scale - 1:10,000

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

Map Name(s) and Date(s)



Historical Map - Slice A



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EXPLANATION OF SIGNS
USED ON
INSURANCE PLANS OF TOWNS & CITIES

CHAS. E. GOAD, LTD. CIVIL ENGINEERS — 56 CROUCH HILL LONDON N.4.

ABBREVIATIONS

ASB.	ASBESTOS
CORR.	CORRUGATED IRON
D.I.D.	DOUBLE IRON DOORS
DRA.	DRAPERY
D	DWELLING
ELECT.	ELECTRICIAN
(E.M.)	ELECTRIC MOTORS
(ENG.)	STEAM ENGINE
FURNE.	FURNITURE
GAR	GARAGE
(G.E.)	GAS ENGINE
H.W.	HARDWARE
I.COLS.	IRON COLUMNS OR STEEL STANCHIONS
JWLY.	JEWELLERY
M.CL.	METAL CLAD
M.W.	MANCHESTER WAREHOUSE
m.l.	MATCH (OR WOOD) LINED
OIL	OIL & COLOR
(O.E.)	OIL ENGINE
P.H.	PUBLIC HOUSE
S.	SHOP
S.I.D.	SINGLE IRON DOORS
S.I.S.	SINGLE IRON SHUTTERS
TAI.	TAILORS
TENS.	TENEMENTS
W.G.	WIRED GLASS
W.N.	WIRE NETTING OVER GLASS.

COLORS

- BRICK, STONE OR CONCRETE
- WOOD
- AREAS CLEARED DUE TO ENEMY ACTION
- SKYLIGHTS ON 1 & 2 STORY BUILDINGS
- SKYLIGHTS ON HIGHER BUILDINGS
- METAL BUILDINGS.
- TIMBER PILED OR STACKED

WALLS

- PARTY WALL 2 STORIES OR OVER, A PROBABLE FIRE CUT OFF
- ENTIRE WALL, BUT DOUBTFUL AS FIRE CUT OFF
- DEFECTIVE WALL — IMPERFECT
- WALL ABOVE, IRON COLS: UNDER
- WALL SOME FLOORS ONLY (OR WOOD OR PLASTER PARTITION)
- ABOVE ROOF 6" TO 1'-6"
- — Dº — 1'-6" TO 2'-6"
- m.l. MATCH OR WOOD LINED
- WOOD CLAD WITH CORRUGATED IRON

OPENINGS

- PASSAGE UNDER
- ON ALL FLOORS
- SOME FLOORS ONLY — UNPROTECTED
- ALL FLOORS (PROTECTED)
- ALL FLOORS (SOME PROTECTED) — SINGLE IRON DOORS
- SOME FLOORS ONLY (PROTECTED)
- ALL FLOORS (SOME PROTECTED)
- ALL FLOORS (PROTECTED) — DOUBLE IRON DOORS
- SOME FLOORS ONLY (PROTECTED)
- WOOD LOADING DOOR
- IRON LOADING DOOR

WINDOWS

- ON ALL OR MOST FLOORS
- MORE THAN USUAL
- OVERLOOKING — UNPROTECTED
- NEARLY ALL GLASS
- OPENINGS THRO' & WINDOWS OVER
- ON SOME FLOORS ONLY
- PROTECTED BY WIRED GLASS
- PROTECTED BY SINGLE IRON SHUTTERS
- PROTECTED BY DOUBLE IRON SHUTTERS.
- WINDOWS IN FRONT & REAR OF BUILDINGS UNDERSTOOD UNLESS OTHERWISE SHOWN

FLOORS

1.2.3.3½ &c ON BUILDINGS ARE NUMBER OF STORIES ABOVE GROUND (3½=3 FLOORS & ATTIC)

2&2B MEANS 2 STORIES & 2 BASEMENTS BASE & SUB-BASEMENT.

SKYLIGHTS

- ^ LESS THAN 50 SQUARE FEET (SAY 10'x5', OR 7'x7')
- ^ ^ OPENINGS THROUGH 2 FLOORS UNDER (EACH STROKE DENOTES AN OPENING.)
- WITH WELL HOLE THROUGH 3 FLOORS
- LANT. LANTERN LIGHT, SIDES ONLY GLASS. OR VENT. OR RAISED VENTILATOR — OVER 50 SQ: FT. TO SCALE

HOISTS & LIFTS

- H OPEN
- H OPEN (WOOD FLAPS TO FLOORS)
- H ENCLOSED WOOD OR PLASTER
- W H OPEN TO STREET
- H ENCLOSED BRICK OR FIRE RESISTING WIRED GLASS DOORS

IRON DOORS SHOWN AS EXPLAINED UNDER "OPENINGS"

ROOFS

ASB	ASBESTOS
C	CONCRETE
CORR:	CORRUGATED IRON
¬	METAL
P	PATENT (FELT &c)
O	SLATE
T	TILE

PROFILES

WITH NORTH LIGHTS

SUNDRIES

- STEAM BOILERS
- —"— BOILER SET IN BRICK
- FACTORY CHIMNEYS
- (ENG.) STEAM ENGINE
- OVERHANGING WOOD CORNICE
- FIRE ALARM BOX
- —— Dº —— ON KEY PLAN
- HYDRANT
- H HYDRAULIC HYDRANT
- PRIVATE HYDRANT OR STAND PIPE
- D DOUBLE HYDRANT
- S SALT WATER HYDRANT
- SPRINKLER OR AUTO ALARM BELL

REFERENCE NUMBERS

NUMBERS PARALLEL WITH STREET ARE EXISTING STREET Nºs

WHERE TWO SETS OF STREET Nºs IN SAME BLOCK COINCIDE, ADDITIONAL ARBITRARY Nºs ARE GIVEN TO ONE SET (500 & UPWARDS)

WHERE BUILDINGS TO WHICH THEY APPLIED ARE DEMOLISHED, STREET & ARBITRARY Nºs ARE SHOWN & CROSSED THROUGH ON REVISION

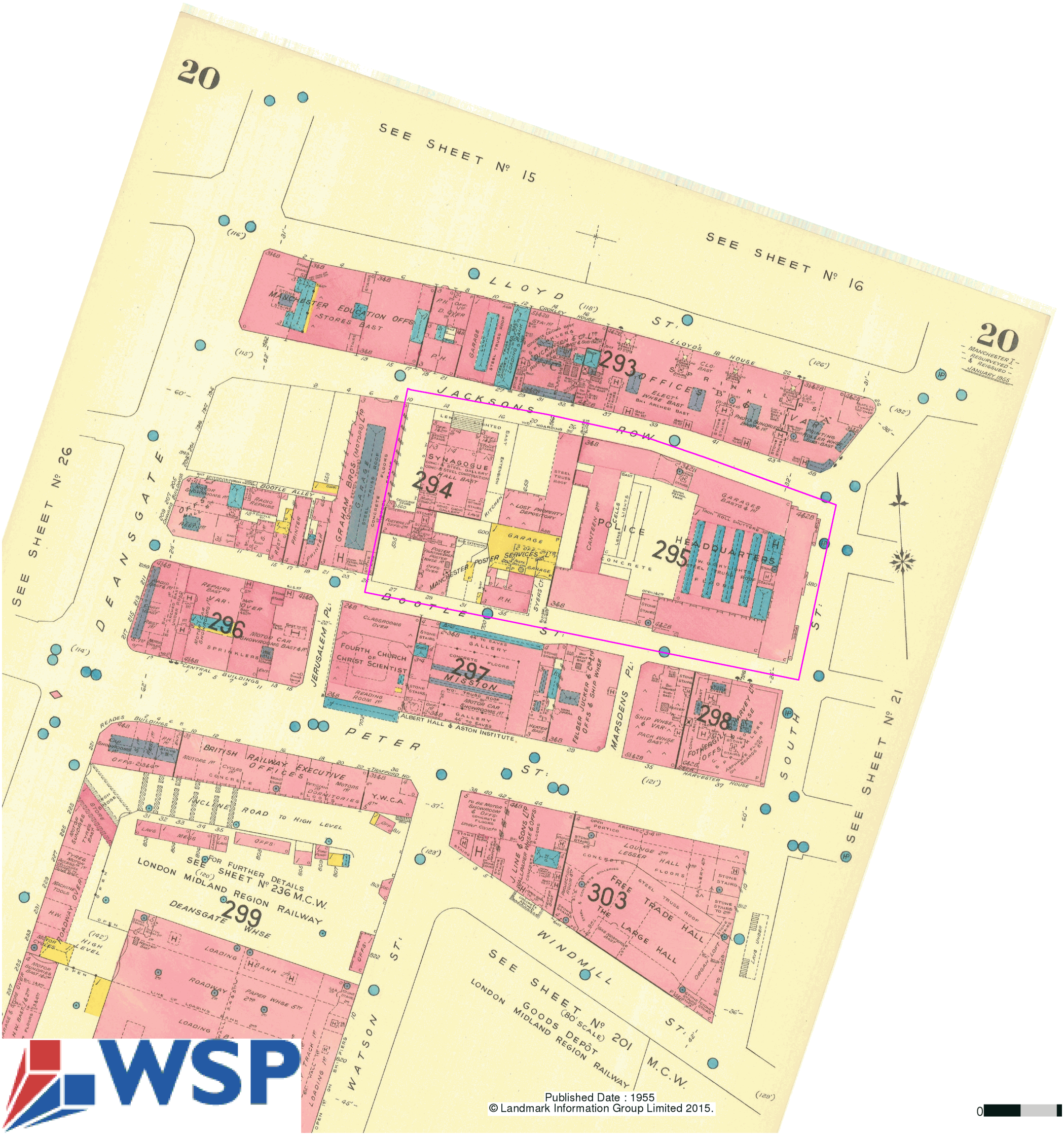
—48'— ARE STREET WIDTHS.

(37') ARE HEIGHTS OF GROUND ABOVE ORDNANCE DATUM

HEIGHT IN FEET OF ADJOINING BUILDINGS WHERE STORIES DIFFER IN HEIGHT

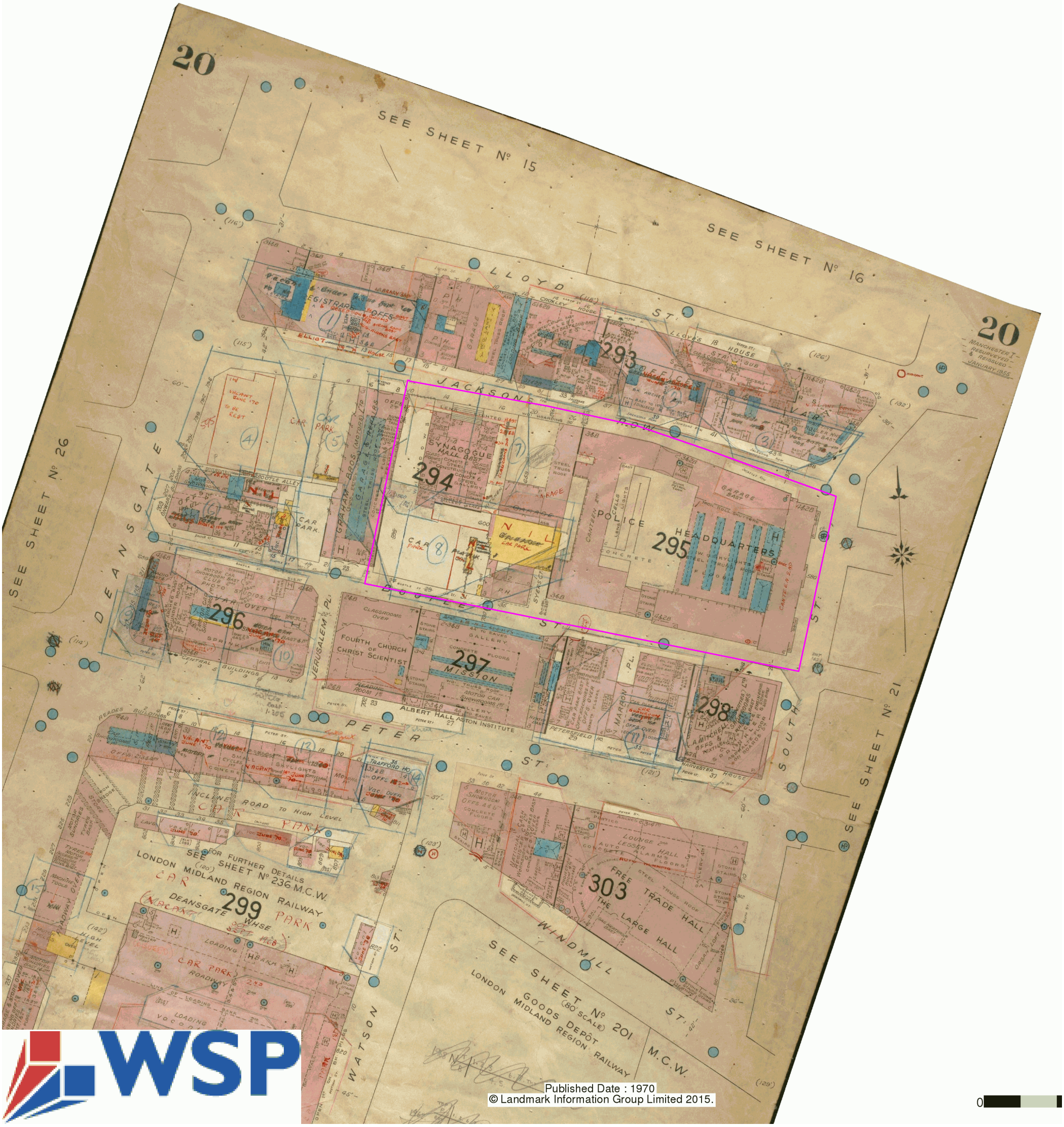
SIZES OF WATER MAINS SUPPLYING HYDRANTS

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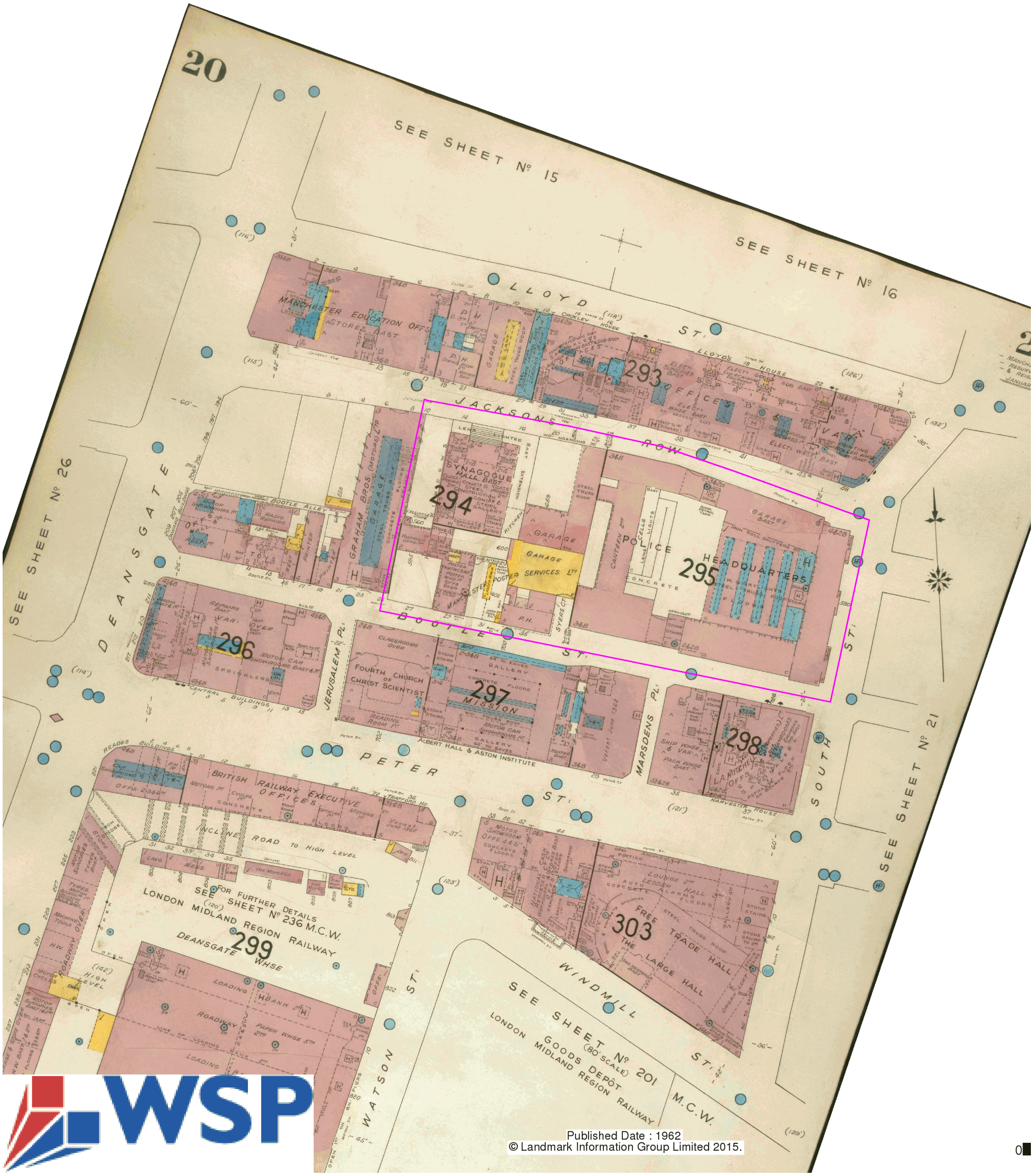
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Published Date : 1962

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TO THE

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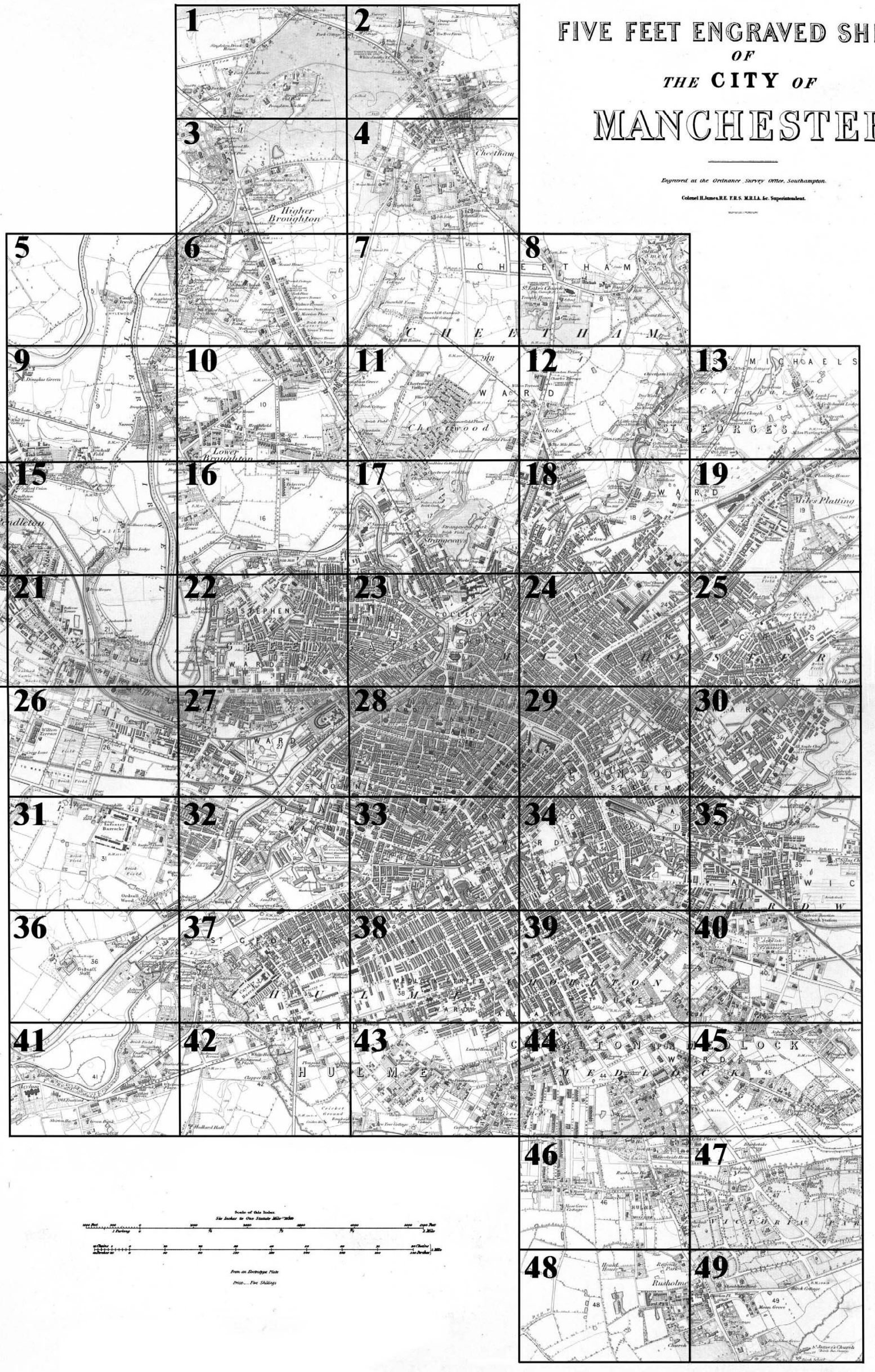
OF

THE CITY OF

MANCHESTER

Engraved at the Ordnance Survey Office, Southampton.

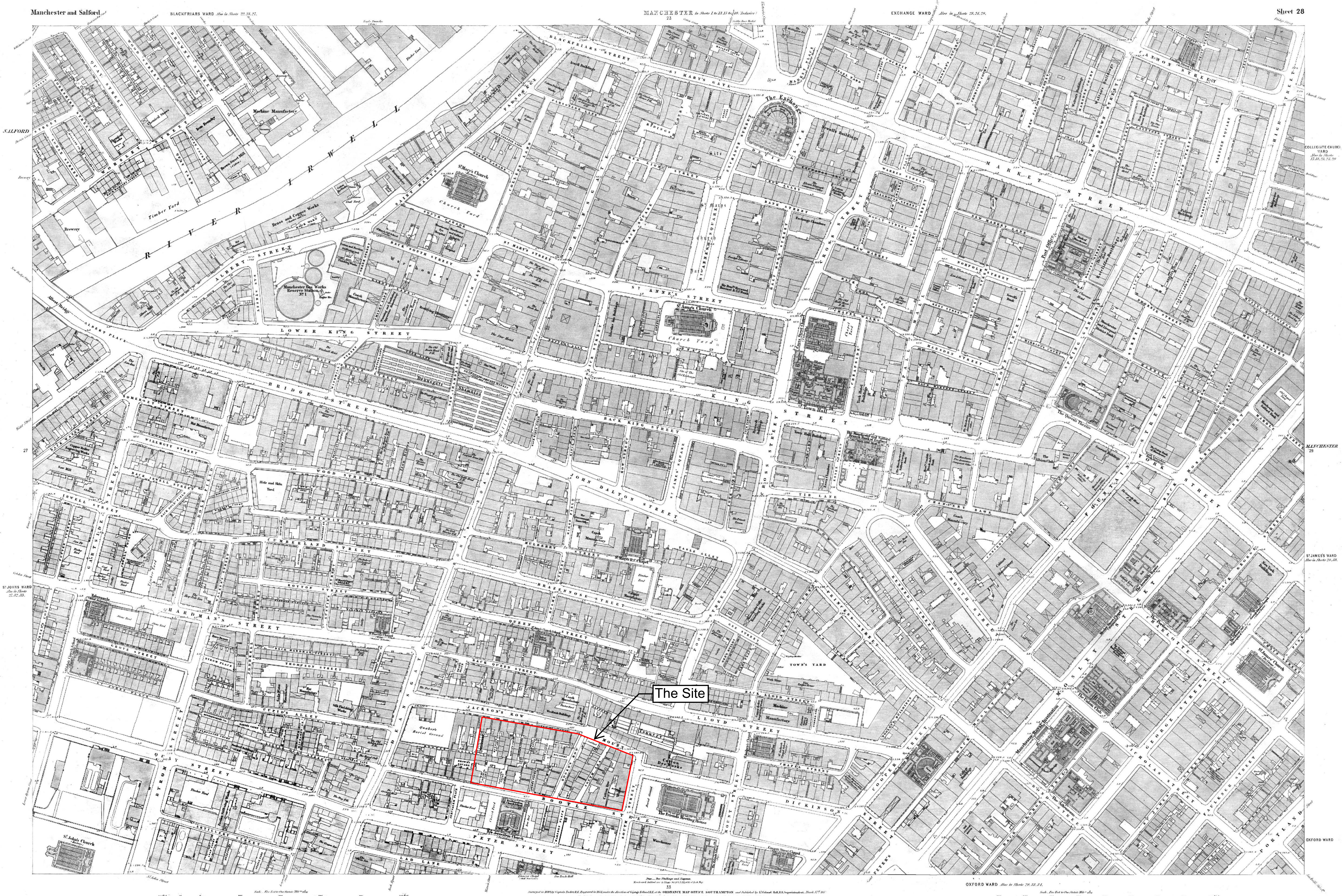
Colonel H.James,R.E. F.R.S. M.R.I.A. &c. Superintendent.



Scale of this Index.
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ST JAMES'S WARD Also in Sheets 29.33.
OXFORD WARD
OXFORD WARD Also in Sheets 29.33.34.
33
Surveyed in 1849 by Captain Tucker R.E. Engraved in 1851 under the direction of Captain Yolland R.E. at the ORDNANCE MAP OFFICE SOUTHAMPTON and Published by Lt Colonel Hall, R.E. Superintendent, March 17th 1851
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Scale _ Five Feet to One Statute Mile = 1/1056
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BLACKFRIARS STREET
St MARY'S GATE
The Exchange
MARKET STREET
CANNON STREET
St Mary's Church
Church Yard
Manchester Gas Works Reserve Station No 1
LOWER KING STREET
BRIDGE STREET
DEANSGATE
St Anne's Church
ST ANNE'S STREET
KING STREET
Town Hall
Post Office
The Queen's Theatre
JOHN DALTON STREET
MOSLEY STREET
YORK STREET
PORTLAND STREET
The Union Club
Manchester Royal Institution
The Athenæum
St James' Church
CHARLOTTE STREET
GEORGE STREET
WOOD STREET
SPINNINGFIELD
HARDMAN'S STREET
QUAY STREET
BYROM STREET
PETER STREET
St John's Church
Quaker's Burial Ground
JACKSON'S ROW
LLOYD STREET
BOOTLE STREET
MOUNT STREET
Cotton Dye Works
The Friends Meeting House
DICKINSON STREET
COOPER STREET
TOWN'S YARD
The Site

Appendix F

DYNASAFE BACTEC EXPLOSIVE ORDNANCE THREAT ASSESSMENT

Explosive Ordnance Desktop Threat Assessment

Site: **Jacksons Row, Manchester**

Client: **WSP UK Limited**

Ref: **6239TA**

Date: **26th October 2015**

Dynasafe BACTEC Limited
9, Waterside Court, Galleon Boulevard, Crossways Business Park, Dartford, Kent, DA2 6NX, UK
Office: +44 (0) 1322 284 550 **www.bactec.com**

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Date of Issue: 26th October 2015 Copy no. 1

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This Report has been produced in compliance with the Construction Industry Research and Information Association guidelines for the preparation of Detailed Risk Assessments in the management of UXO risks in the construction industry.

Glossary of Terms

AAA	Anti-Aircraft Artillery
ARP	Air-raid Precautions
BDO	Bomb Disposal Officer
EOD	Explosive Ordnance Disposal (current term for "bomb" disposal)
HE	High Explosive
HG	Home Guard
IB	Incendiary Bomb
kg	Kilogram
LCC	London County Council
LM	Land Mine
LSA	Land Service Ammunition (includes grenades, mortars, etc.)
Luftwaffe	German Air Force
m bgl	Metres Below Ground Level
MoD	Ministry of Defence
OB	Oil Bomb
PM	Parachute Mine
RAF	Royal Air Force
SI	Site Investigation
SAA	Small Arms Ammunition (small calibre cartridges used in rifles & machine guns)
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V-1	"Doodlebug" the first cruise type missile, used against London from June 1944. Also known as 'Flying Bomb'.
V-2	The first ballistic missile, used against London from September 1944
WWI	First World War (1914 -1918)
WWII	Second World War (1939 – 1945)

Executive Summary

The Site: The site, centred on the approximate OS National Grid Reference: 383682, 398018, is located in Manchester, approximately 520m north-east of Deansgate Railway Station. It is bound to the north by Jackson's Row (road), to the east by Southmill Street, to the south by Bootle Street and to the west by neighbouring properties.

Situated within the eastern half of the site is the City Police Headquarters, a five-storey building of pre-WWII construction. At the centre of this development is a large hard-surfaced courtyard accessed via gates to the north and south. The south-western section is occupied by the Sir Ralph Abercromby Public House, which includes a car-park to the rear and garden to the west. Located within the north-western corner is the Manchester Reform Synagogue, a large brick built structure of post-war construction. The remainder of the site is laid to hard-standing and is used for car parking.

Proposed Works: It is understood that a tower is to be constructed on site. The proposed intrusive works will include excavations to 13.5m bgl and raft foundations.

Risk Assessment Methodology: In accordance with CIRIA guidelines this assessment has carried out research, analysed the evidence and considered the risks that the site has been contaminated with unexploded ordnance; that such items remained on site; that they could be encountered during any intrusive works and the consequences that could result. Appropriate risk mitigation measures have been proposed.

Explosive Ordnance Risk Assessment: Dynasafe BACTEC considers the risk on the site to be heterogeneous and can therefore be divided into ***Low*** and ***Medium*** Risk Zones. This is based on the following:

- Manchester was the eleventh most heavily bombed city / town in Britain during WWII. The site is located within the city centre which experienced a high bombing density, as confirmed by official statistics.
- Original bombing records, sought from two separate sources, plot one HE bomb strike to the Police Station. This resulted in damage to the upper two floors of the building, leaving the lower two floors intact.
- A 1kg incendiary bomb shower is known to have gutted some buildings at the north-western corner of the site as well as causing minor / moderate damage to a small building at the southern site boundary.
- Therefore it can be assumed that at these localities, heaps of rubble would have persisted, and debris would have been strewn across the site. Consequently, had a subsequent HE UXB fallen in these areas, it may have become obscured from view within the ruins. This is especially pertinent as nearly all German air raids on Manchester occurred at night, increasing the likelihood of a UXB falling unobserved and going unreported.
- Furthermore, such an incident could conceivably have resulted in the UXB coming to rest beneath neighbouring undamaged buildings / hard-staining, due to the 'J' Curve Effect.
- However note that as the lower two floors of the Police Station remained intact, it is highly unlikely that a subsequent UXB could have fallen within this ruin and passed through the ground floor without leaving any obvious evidence of its presence. Furthermore the station remained in use throughout the remainder of the war, further decreasing the likelihood of such a scenario taking place.
- Those structures which survived the Blitz undamaged will likely have remained inhabited / in use, thereby increasing the likelihood of any air-delivered UXO being observed here. Furthermore a UXB strike to these buildings will have caused significant damage, even without detonating. Following any such incident, the damage would have been observed and the UXB exhumed / removed.
- No evidence has been located to suggest that the site formerly had any British / Allied military occupation or usage that could have led to contamination with items of UXO.

Following WWII, a large proportion of the site has been redeveloped. Within the footprints of the post-war buildings and hard-standing, the risk from shallow-buried UXO (AA projectiles and 1kg incendiary bombs) will have been largely mitigated, as any such items will likely have been exhumed and removed during excavations for foundations, as well as levelling and re-surfacing works.

The risk from deep-buried German HE UXBs will have only been mitigated within the volume of any post-war bulk excavations (for basement levels) and at the precise locations of any pile foundations. This risk will therefore remain within virgin geology, beneath the post-war construction works and amongst any pile layouts, down to the maximum bomb penetration depth.

Bomb Penetration Assessment: It has been assessed that a 500kg bomb would have had an approximate maximum bomb penetration depth of **6-8m** below WWII ground level. Penetration depth could potentially have been greater if the UXB was larger (though only 4% of German bombs used in WWII over Britain were of that size). Note that UXBs may be found at any depth between just below the WWII ground level and the maximum penetration depth. This assessment has been made using generic geological information.

Risk Mitigation Measures: Dynasafe BACTEC believes the following risk mitigation measures should be deployed to support the proposed works at the Jacksons Row site.

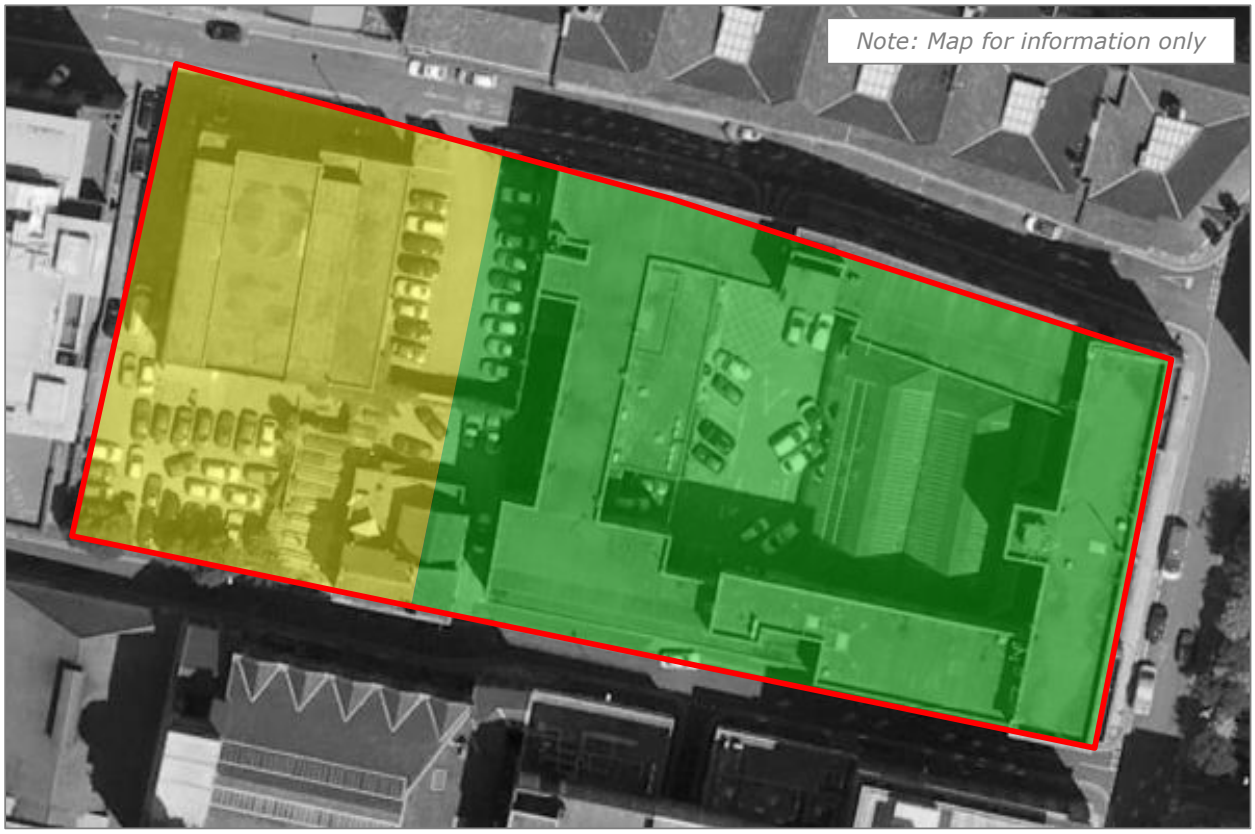
Both Risk Zones

- Explosive Ordnance Safety and Awareness Briefings to all personnel conducting intrusive works.
- The Provision of Unexploded Ordnance Site Safety Instructions.

Medium Risk Zones Only

- Explosive Ordnance Disposal (EOD) Engineer presence on site to supervise open excavations
- Intrusive Magnetometer Survey of any pile / boreholes locations down to the maximum bomb penetration depth.

Risk Map



Low Risk Zone

Relatively undamaged buildings and hard-standing during WWII.

Medium Risk Zone

a) Buildings which sustained serious bomb damage during WWII

b) Buffer area to account for the J-Curve Effect

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Explosive Ordnance Threat Assessment

In Respect of

Jacksons Row, Manchester

1. Introduction

1.1. Background

WSP UK Limited has commissioned Dynasafe BACTEC Limited to conduct an Explosive Ordnance Threat Assessment for the Jacksons Row site, Manchester.

Unexploded Ordnance (UXO) presents a significant threat to construction projects in parts of the UK as a result of enemy actions during the two 20th Century World Wars and historic British and Allied military activity.

The most intensive period of bombing over Manchester was the nine months between October 1940 and May 1941 which became known as "The Blitz". During this period the Luftwaffe attempted to overwhelm Britain's air defences, destroy key industries and infrastructure and break the country's morale ahead of invasion.

One of the legacies of this conflict is buried unexploded air-dropped bombs or anti-aircraft projectiles resulting from the failure of a proportion of the weapons to function as designed. It is commonly accepted that the failure rate of these munitions was approximately 10% and, depending on their shape, weight, velocity and ground conditions, many penetrated the ground and came to rest at depth.

Intensive efforts were made during and after the war to locate and render safe all UXO but, unsurprisingly, not all were found and dealt with. This is evidenced by the regular, on-going discoveries of UXO during construction-related intrusive ground works.

As a result of a generally increased risk awareness amongst professionals involved in ground engineering works and proactive health and safety measures, the threat to life and limb from UXO has been minimised. However even the simple discovery of a suspected device during on-going works can cause considerable disruption to production and cause unwanted delays and expense.

Such risks can be more fully addressed by a better understanding of the site-specific threat and the implementation of appropriate risk mitigation measures.

2. Construction Industry Duties and Responsibilities

2.1. The UK Regulatory Environment

There is no specific legislation covering the management and control of the UXO risk in the UK construction industry but issues regarding health and safety are addressed under a number of regulatory instruments, as outlined below.

In practice the regulations impose a responsibility on the construction industry to ensure that they discharge their obligations to protect those engaged in ground-intrusive operations (such as archaeology, site investigation, drilling, piling or excavations) from any reasonably foreseeable UXO risk.

2.2. The Health and Safety at Work Act, 1974

The Act places a duty of care on an employer to put in place safe systems of work to address, as far as is reasonably practicable, all risks (to employees and the general public) that are reasonably foreseeable.

2.3. Construction (Design and Management) Regulations 2015

This legislation defines the responsibilities of all parties (primarily the client, the CDM Co-ordinator, the Designer and the Principal Contractor) involved with works.

Although UXO issues are not specifically addressed the regulations effectively place obligations on all these parties to:

- Ensure that any potential UXO risk is properly assessed
- Put in place appropriate risk mitigation measures if necessary
- Keep all parties affected by the risk fully informed
- Prepare a suitably robust emergency response plan

2.4. Other Legislation

Other relevant legislation includes the "Management of Health and Safety at Work Regulations 1999" and "The Corporate Manslaughter and Corporate Homicide Act 2007".

3. The Role of the Authorities and Commercial Contractors

3.1. The Authorities

The Police have the responsibilities for co-ordinating the emergency services in the case of an ordnance-related incident on a construction site. They will make an initial assessment (i.e. is there a risk that the find is ordnance or not?) and if they judge necessary impose a safety cordon and/or evacuation and call the military authorities (JSEODOC - Joint Services Explosive Ordnance Disposal Operations Centre) to arrange for investigation and/or disposal. In the absence of an EOD specialist on site many Police Officers will use the precautionary principle, impose cordon(s)/evacuation and await advice from the JSEODOC.

The priority given to the request by JSEODOC will depend on their judgement of the nature of the threat (ordnance, location, people and assets at risk) and the availability of resources. They will respond immediately or as resources are freed up. Depending on the on-site risk assessment the item of ordnance may be removed or demolished (by controlled explosion) in situ. In the latter case additional cordons and/or evacuations may be necessary.

Note that the military authorities will only carry out further investigations or clearances in very high profile or high risk situations. If there are regular ordnance finds on a site the JSEODOC may not treat each occurrence as an emergency and will encourage the construction company to put in place alternative procedures (i.e. the appointment of a commercial contractor) to manage the situation and relieve pressure from the JSEOD disposal teams.

3.2. Commercial Contractors

In addition to pre-construction site surveys and follow-on clearance work, a commercial contractor is able to provide a reactive service on construction sites. The presence of a qualified EOD Engineer with ordnance recognition skills will avoid unnecessary call-outs to the authorities and the Contractor will be able to arrange for the removal and disposal of low risk ordnance. If high risk ordnance is discovered actions will be co-ordinated with the authorities with the objective of causing the minimum possible disruption to site operations whilst putting immediate, safe and appropriate measures in place.

4. This Report

4.1. Aims and Objectives

The aim of this report is to examine the possibility of encountering any explosive ordnance during any intrusive works at the Jacksons Row site. Risk mitigation measures will be recommended, if deemed necessary, to eliminate or reduce the threat from explosive ordnance during the envisaged works. The report follows the CIRIA Guidelines.

4.2. Risk Assessment Methodology

The following issues will be addressed in the report:

- The risk that the site was contaminated with unexploded ordnance.
- The risk that UXO remains on site.
- The risk that ordnance may be encountered during any intrusive works.
- The risk that ordnance may be initiated.
- The consequences of initiating or encountering ordnance.

Risk mitigation measures, appropriate to the assessed level of risk and site conditions, will be recommended if required.

4.3. Approach

In preparing this Explosive Ordnance Threat Assessment Report, BACTEC has considered general and, as far as possible, site specific factors including:

- Evidence of German bombing and delivery of UXBs.
- Site history, occupancy and conditions during WWII.
- The legacy of Allied military activity.
- Details of any known EOD clearance activity.
- The extent of any post war redevelopment.
- Scope of the current proposed works.

4.4. Sources of Information

Dynasafe BACTEC has carried out detailed historical research for this Explosive Ordnance Threat Assessment including accessing military records and archived material held in the public domain and in the MoD.

Material from the following sources has been consulted:

- The National Archives.
- Historic England.
- Britain From Above.
- Greater Manchester County Record Office.
- University of Manchester Library.
- Relevant information supplied by WSP UK Limited.
- Available material from 33 Engineer Regiment (EOD) Archive.
- Dynasafe BACTEC's extensive archives built up over many years of research and hands-on Explosive Ordnance Disposal activities in the UK.
- Open sources such as published books, local historical records and the internet.

4.5. Reliability of Historical Records

4.5.1. General Considerations

This report is based upon research of historical evidence. Whilst every effort has been made to locate all relevant material BACTEC cannot be held responsible for any changes to the assessed level of risk or risk mitigation measures based on documentation or other information that may come to light at a later date.

The accuracy and comprehensiveness of wartime records is frequently difficult or impossible to verify. As a result conclusions as to the exact location, quantity and nature of the ordnance threat can never be definitive but must be based on the accumulation and careful analysis of

all accessible evidence. BACTEC cannot be held responsible for inaccuracies or gaps in the available historical information.

4.5.2. Bombing Records

During WWII considerable efforts were expended in recording enemy air raids. Air Raid Precautions (ARP) wardens were responsible for making records of bomb strikes either through direct observation or by post-raid surveys. However their immediate priority was to deal with casualties and limit damage, so it is to be expected that records are often incomplete and sometimes contradictory. Record keeping in the early days of bombing was not comprehensive and details of bombing in the early part of the war were sometimes destroyed in subsequent attacks. Some reports may cover a single attack, others a period of months or the entire war.

Records of raids that took place on sparsely or uninhabited areas were often based upon third party or hearsay information and are not always reliable; records of attacks on military or strategic targets were often maintained separately from the general records and have not always survived.

5. The Site

5.1. Site Location

The site is located in Manchester, approximately 520m north-east of Deansgate Railway Station. It is bound to the north by Jackson's Row (road), to the east by Southmill Street, to the south by Bootle Street and to the west by neighbouring properties.

The site is centred on the approximate OS National Grid Reference: 383682, 398018.

Site Location Maps are presented in ***Annex A***.

5.2. Site Description

Situated within the eastern half of the site is the City Police Headquarters, a five-storey building of pre-WWII construction. At the centre of this development is a large hard-surfaced courtyard accessed via gates to the north and south.

The south-western section is occupied by the Sir Ralph Abercromby Public House, which includes a car-park to the rear and garden to the west. Located within the north-western corner is the Manchester Reform Synagogue, a large brick built structure of post-war construction. The remainder of the site is laid to hard-standing and is used for car parking.

A Recent Aerial Photograph of the site is presented in ***Annex B***.

6. Scope of the Proposed Works

It is understood that a tower is to be constructed on site. The proposed intrusive works will include excavations to 13.5m bgl and raft foundations.

A Current Site Plan is presented in ***Annex C***.

7. Ground Conditions

Published BGS data for a borehole sunk approximately 60m to the west of the site records the following shallow geological sequence in the vicinity:

- 3.66m of BALLAST (loose ground).
- 9.14m of SANDSTONE.

8. Site History

8.1. Historical OS Mapping

Latest available pre and earliest available post-WWII OS maps were provided by *WSP UK Limited*. These are presented in ***Annex D*** and described below.

8.1.1. Pre-WWII

The 1922-33 (1:1,250 scale) map shows the site to be occupied by a number of densely packed buildings with associated courtyards and access, including a *Public House* adjacent with the southern boundary. Running north-east to south-west, across the eastern half of the site, is *Southsea* (road).

The immediate surrounding area is commercial in nature.

8.1.2. Post-WWII

The 1948 (1:1,250 scale) map records significant changes across the entirety of the site. Within the eastern half the pre-WWII structures and roadway have been cleared and a *Police Station* constructed in their place. Further research indicates this station opened immediately prior to WWII, in 1937.[1]

However situated in the north-western corner is a large *Ruin.* Such an observation is usually indicative of serious bomb damage on early post-WWII Manchester OS maps.

In the immediate surrounding area, further evidence of possible bomb damage, including *Ruins* and redevelopment, has been highlighted.

9. The Threat from Aerial Bombing

9.1. General Bombing History of the North-West

9.1.1. First World War

A series of bombing raids took place in the UK during WWI. Zeppelin airships, "Gotha" and "Giant" bombers conducted a succession of attacks in which high explosive bombs and incendiary devices were dropped. Although Zeppelin airship raids were recorded in the north-west region, no raids were recorded across the Manchester region specifically.

Consequently the threat from WWI German UXBs is considered negligible and will not be further addressed in this report.

9.1.2. Second World War

At the start of WWII, the Luftwaffe planned to destroy key military installations, including RAF airfields and Royal Navy bases, during a series of daylight bombing raids in 1940. After the Battle of Britain in the south-east, these tactics were modified to include both economic and industrial sites throughout the UK.

In the north-west the Merseyside and Greater Manchester areas were heavily bombed during late 1940 / early 1941 with targets including dock facilities, railway infrastructure, power stations, weapon manufacturing plants and gas works. As a result of aircraft losses, daylight raids were reduced in favour of attacking targets under the cover of darkness.

After June 1941 when the bulk of the Luftwaffe (based in France) had been redeployed to the Russian Front, attacks were only sporadic and much smaller in scale.

From mid-1944 the "V-weapon" (for Vengeance) campaign, using unmanned rockets and missiles, represented Hitler's final attempt to reverse Germany's imminent defeat. The V1 (Flying Bomb or Doodlebug) and the V2 (Long Range Rocket) were launched from bases in

[1] *http://manchesterhistory.net/manchester/tours/tour6/centralpolice.html*

occupied France, Belgium and Holland as well as from Germany itself. Although these weapons caused considerable destruction their relatively low numbers allowed accurate records of strikes to be maintained and these records have mostly survived.

In December 1944, after a two-year lull in bombing, several aircraft-delivered V1 flying bombs fell in Greater Manchester. One landed in Oldham killing 27 people, the region's last bombing casualties of the war.

There is a negligible risk from unexploded V-weapons today since even if an unexploded 1,000kg warhead had survived impact the remains of the munition's body would have left incontrovertible evidence of the strike, and it would have been dealt with at the time.

9.2. Aerial Delivered Ordnance in the Second World War

9.2.1. Generic Types of WWII German Air-delivered Ordnance

The nature and characteristics of the ordnance used by the Luftwaffe allows an informed assessment of the hazards posed by any unexploded items that may remain today. Detailed illustrations of German air delivered ordnance are presented at ***Annex E***.

- HE Bombs: In terms of weight of ordnance dropped, HE bombs were the most frequent weapon deployed. Most bombs were 50kg, 250kg or 500kg (overall weight, about half of which was the high explosive) though large bombs of up to 2,000kg were also used. HE bombs had the weight, velocity and shape to easily penetrate the ground intact if they failed to explode. Post-raid surveys would not always have spotted the entry hole or other indications that a bomb penetrated the ground and failed to explode and contemporary ARP documents describe the danger of assuming that damage, actually caused by a large UXB, was due to an exploded 50kg bomb. Unexploded HE bombs therefore present the greatest risk to present–day intrusive works.
- Blast Bombs/Parachute Mines: Blast bombs generally had a slow rate of descent and were extremely unlikely to have penetrated the ground. Non-retarded mines would have shattered on most ground types, if they had failed to explode. There have been extreme cases when these items have been found unexploded, but this was where the ground was either very soft or where standing water had reduced the impact. BACTEC does not consider there to be a significant threat from this type of munition on land.
- Large incendiary bombs: This type of bomb ranged in size from 36kg to 255kg and had a number of inflammable fill materials (including oil and white phosphorus), and a small explosive charge. They were designed to explode and burn close to the surface but their shape and weight meant that they did have penetration capability. If they penetrated the ground complete combustion did not always occur and in such cases they remain a risk to intrusive works.
- 1kg Incendiary Bombs (IB): These bombs, which were jettisoned from air-dropped containers, were unlikely to penetrate the ground and in urban areas would usually have been located in post-raid surveys. However, if bombs did not initiate and fell in water or dense vegetation, or became mixed with rubble in bomb damaged areas they could have been overlooked. Some variants had explosive heads and these present a risk of detonation during intrusive works.
- Anti-personnel (AP) Bomblets: AP bombs had little ground penetration ability and should have been located by the post-raid survey unless they fell into water, dense vegetation or bomb rubble.
- Specialist Bombs (smoke, flare, etc): These types do not contain high explosive and therefore a detonation consequence is unlikely. They were not designed to penetrate the ground.

9.2.2. German Air-delivered Ordnance Failure Rate

Based on empirical evidence, it is generally accepted that 10% of the German HE bombs dropped during WWII failed to explode as designed. This estimate is probably based on the statistics of wartime recovered UXBs and therefore will not have taken account of the unknown numbers of UXBs that were not recorded at the time, and is probably an underestimate.

The reasons for failures include:

- Fuze or gaine malfunction due to manufacturing fault, sabotage (by forced labour) or faulty installation.
- Clockwork mechanism failure in delayed action bombs.
- Failure of the bomber aircraft to arm the bombs (charge the electrical condensers which supplied the energy to initiate the detonation sequence) due to human error or equipment defect.
- Jettison of the bomb before it was armed or from a very low altitude. Most likely if the bomber was under attack or crashing.

War Office Statistics document that a daily average of 84 bombs which failed to function were dropped on civilian targets in Great Britain between 21st September 1940 and 5th July 1941. 1 in 12 of these (probably mostly fitted with time delay fuzes) exploded sometime after they fell - the remainder were unintentional failures.

From 1940 to 1945 bomb disposal teams dealt with a total of 50,000 explosive items of 50kg and over (i.e. German bombs), 7,000 AAA shells and 300,000 beach mines. These operations resulted in the deaths of 394 officers and men. However, UXO is still regularly encountered across the UK (see recent press articles, ***Annex F-1***).

9.2.3. UXB Ground Penetration

9.2.3.1. General Considerations

The actual penetration depth of aerial delivered bombs into the ground will have been determined by the mass and shape of the bomb, the velocity and angle of the bomb on impact (dependent on the height of release) and the nature of the ground and ground cover; the softer the ground, the greater the potential penetration. Peat, alluvium and soft clays are easier to penetrate than gravel and sand. Bombs are brought to rest or are commonly deflected by bedrock or large boulders.

9.2.3.2. The "j" Curve Effect

An air-dropped bomb falling from normal bombing altitude (say 5,000m) into homogeneous ground will continue its line of flight but turn in an upwards curve towards the surface as it comes to rest. This offset from vertical is generally thought to be about one third of the penetration depth, but can be up to 15m depending on ground conditions or the bomb's angle of impact.

9.2.3.3. Second World War Bomb Penetration Studies

During WWII the Ministry of Home Security undertook a major study on actual bomb penetration depths, carrying out statistical analysis on the measured depths of 1,328 bombs as reported by Bomb Disposal, mostly in the London area. They then came to conclusions as to the likely average and maximum depths of penetration of different sized bombs in different geological strata.

The median penetration of 430 x 50kg German bombs in London Clay was 4.6m and the maximum penetration observed for the SC50 bomb was 9m.

They concluded that the largest common German bomb, 500kg, had a likely penetration depth of 6m in sand or gravel but 8.7m in clay. The maximum observed depth for a 500kg bomb was 10.2m and for a 1,000kg bomb 12.7m. Theoretical calculations suggested that significantly greater penetration depths were probable.

9.2.4. Initiation of Unexploded Bombs

Unexploded bombs do not spontaneously explode. All high explosive requires significant energy to create the conditions for detonation to occur. In the case of unexploded German bombs discovered within the construction site environment, there are a number of potential initiation mechanisms:

- Direct impact onto the main body of the bomb: Unless the fuze or fuze pocket is struck, there needs to be a significant impact (e.g. from piling or large and violent mechanical excavation) to initiate a buried iron bomb. Such violent action can cause the bomb to detonate.
- Re-starting the clock timer in the fuze: Only a small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion has taken place within the fuze mechanism over the last 60 years that would prevent clockwork mechanisms from functioning, nevertheless it was reported that the fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did re-commence.
- Induction of a static charge, causing a current in an electric fuze: The majority of German WWII bombs employed electric fuzes. It is probable that significant corrosion has taken place within the fuze mechanism over the last 60 years such that the fuze circuit could not be activated.
- Friction impact initiating the (shock-sensitive) fuze explosive: This is the most likely scenario resulting in the bomb detonating.

Annex F-2 details UXB incidents where intrusive works have caused UXBs to detonate, resulting in death or injury and damage to plant.

9.3. Bombing History of Manchester

9.3.1. Second World War Overview

During WWII Manchester was heavily bombed by the Luftwaffe due primarily to the industry located within the city. The importance of the Manchester Ship Canal and Manchester Docks to the Allied war effort was also not overlooked and this infrastructure was heavily targeted along with railway stations. Many Manchester companies were involved in vital war production work; putting the city's docks and industry out of action would have had serious consequences for the Allied war effort.

The Luftwaffe target map, presented in ***Annex G***, shows the areas of Manchester highlighted for attack. It earmarks the railway infrastructure, approximately 80m to the south of the site, for destruction.

Between July 1940 and July 1942, Manchester suffered repeated and widespread bombing. The Luftwaffe mounted consecutive heavy attacks on the nights of the 22/23rd and 23/24th December 1940 leaving large areas of Manchester, Salford and Stretford devastated.

In total these two successive nights involved a total of 441 German bombers and became known as the 'Manchester Blitz'. During these attacks seven conflagrations and numerous smaller fires were reported. This, coupled with concentrated HE bombing, resulted in the total destruction of over 4,000 houses as well as serious damage to a further 12,000.

During 1941 two more large scale raids occurred on the 9th January and 1st June. Although each involved half as many aircraft as the 22nd December 1940 raid, these two attacks still delivered a further 208 tonnes of HE bombs onto Manchester, in total.

After June 1941, the raids became much more infrequent, but by this time serious damage had been caused to the docks, industrial premises and railway infrastructure of the city centre, within which the site was located.

For security reasons, the media was instructed to downplay the Manchester raids in public reports; for example, all damage sustained to Trafford Park went unreported. Records of bombing incidents in the civilian areas of Manchester were collected by the Air Raid Precautions wardens and collated by the Civil Defence Office. Some other organisations, such as RAF stations, hospitals and railways, maintained separate records. Records would be in the form of typed or hand written incident notes, maps and statistics.

These various types of records of bombing incidents for the region of the site are presented in the following sections.

9.4. Second World War Bombing Statistics

The following table summarises the quantity of German bombs (excluding 1kg incendiaries and anti-personnel bombs) falling on the County Borough of Manchester between 1940 and 1945:

Record of German Ordnance Dropped on the County Borough of Manchester	
Area Acreage	27,255
High Explosive Bombs (all types)	712
Parachute Mines	18
Oil Bombs	7
Phosphorus Bombs	0
Pilotless Aircraft (V1)	1
Fire Pot	0
Long Range Rocket (V2)	0
Total	738
Items Per 1,000 Acres	**27.1**

Source: Home Office Statistics

Note this table does not include UXO found during or after WWII.

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record. It is known however that by the end of WWII over 128,000 1kg IBs had been dropped on Manchester.

Although the incendiaries are not particularly significant in the threat they pose, they nevertheless are items of ordnance that were designed to cause damage and inflict injury and should not be overlooked in assessing the general risk to personnel and equipment. The anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous. This table does not include UXO found during or after WWII.

The following table summarises the quantity of German HE Parachute Mines and HE bombs falling on the County Borough of Manchester during the two heaviest air raids:

Record of German Ordnance Dropped on the County Borough of Manchester: 22nd – 24th December 1940				
District	High Explosive Parachute Mines		High Explosive Bombs	
	Exploded	Unexploded	Exploded	Unexploded
Manchester	27	5	296	341
Salford	23	3	235	299
Stretford	21	6	124	148
Manchester Docks	0	1	16	17
Total	**71**	**15**	**671**	**805**

9.5. Site Specific WWII Bombing Records

9.5.1. Manchester Bomb Plot / Damage Map

WWII bomb damage maps of Manchester, compiled by Manchester City Council, showing HE strikes and the extent of damage caused to properties, were obtained from the University of Manchester Library. A section of the covering the site is presented in ***Annex H***.

Note that as this map is undated it is not known whether it represents a complete record of all bombing over Manchester during WWII.

The map records a HE bomb strike to the south-eastern corner of the site, resulting in minor to moderate damage to the Police Headquarters situated within the study area.

Several neighbouring buildings occupying the north-western corner sustained serious damage while a small area of lesser damage is highlighted along the southern boundary. Note the lack of potted HE bomb strikes indicates this may be the result of 1kg incendiary bomb showers causing fires.

9.5.2. WWII-era RAF Aerial Photography

RAF aerial photographs of the site and surrounding area were obtained from the Britain From Above Project and Historic England. These images are presented in ***Annex I*** and described below.

9.5.2.1. May 1946

This photograph, taken approximately two years after the cessation of bombing in Manchester, confirms that the Police Headquarters, situated in the eastern half of the site, survived largely intact. However significant bomb damage is apparent in the north-western section of the study area, with only the outer walls of the structures left standing. Bordering the Police Station to the west is a smaller two storey building which appears to be in ruin.

Note a hard-surfaced courtyard within the Police Station.

9.5.2.2. May 1948

While this is image is of small scale and low resolution it confirms that the damage to the Police Headquarters was relatively minor, as it appears to have been already repaired.

9.5.3. Secondary Source Evidence

Anecdotal accounts of local bombing incidents were sought from web resources and publications. A review of a local history publication[2] resulted in the following:

- 23/12/1940 - Eastern side of Deansgate, **Jackson's Row** and St Anne's Square were hit by a shower of [1kg] incendiaries, causing extensive damage to shops and businesses.
- 01/06/1941 - **Bootle Street Police HQ** had its upper floors wrecked and two civil defence messengers were killed, but police work nevertheless continued.

9.5.4. Abandoned Bombs

A post-air raid survey of buildings, facilities and installations would have included a search for evidence of bomb entry holes. If evidence were encountered, Bomb Disposal Officer teams would normally have been requested to attempt to locate, render safe and dispose of the bomb. Occasionally evidence of UXBs was discovered but due to a relatively benign position, access problems or a shortage of resources the UXB could not be exposed and rendered safe. Such an incident may have been recorded and noted as an Abandoned Bomb.

Given the inaccuracy of WWII records and the fact that these bombs were 'abandoned', their locations cannot be considered definitive, nor the lists exhaustive. The MoD states that 'action to make the devices safe would be taken only if it was thought they were unstable'. It should be noted that other than the 'officially' abandoned bombs, there will inevitably be UXBs that were never recorded. Dynasafe BACTEC holds no records of officially registered abandoned bombs at or near the site.

9.6. Site Specific Bomb Penetration Considerations

When considering an assessment of the bomb penetration at the Jacksons Row site the following parameters would be used:

- Geology – 3.66m of BALLAST, 9.14m of SANDSTONE.

[2] *G. Phythian, Blitz Britain: Manchester and Salford, 2015*

- Impact Angle and Velocity – 80-90° from horizontal and 267 metres per second.
- Bomb Mass and Configuration – The 500kg SC (General Purpose) HE bomb, without retarder units or armour piercing nose. This was the largest of the common bombs used against Britain.

Taking into account the above-mentioned factors, it has been assessed that a 500kg bomb would have had an approximate maximum bomb penetration depth of **6-8m** below WWII ground level. Penetration depth could potentially have been greater if the UXB was larger (though only 4% of German bombs used in WWII over Britain were of that size). Note that UXBs may be found at any depth between just below the WWII ground level and the maximum penetration depth.

9.7. Likelihood of Post-raid UXO Detection

Utilising the available historical bombing records as reviewed in *Sections 9.1 to 9.5*, it is possible to make an assessment of the likelihood that evidence of UXO would have been noted on a site during the war and the incident dealt with or recorded at the time. Factors such as bombing density, frequency of access, ground cover, damage and failure rate have been taken into consideration.

9.7.1. Density of Bombing

Bombing density is an important consideration for assessing the possibility that UXBs remain in an area. A very high density of bombs can for example result in increased levels of damage sustained to structures, greater likelihood of errors in record keeping and a higher risk that UXBs fell over the area.

Bombing statistics record a high bombing density over central Manchester during WWII. Available bomb plot maps record one HE bomb strike to the south-eastern corner of the study area and a 1kg incendiary bomb shower is known to have gutted some adjacent buildings at the north-western corner of the site.

9.7.2. Damage

If structures on a site have been subject to significant bomb or fire damage, rubble and debris are likely to have been present; similarly a HE bomb strike on open ground is likely to have resulted in a degree of soil disturbance. Under such conditions there is a greater risk of the entry holes of UXBs dropped during subsequent raids being obscured and going unnoticed.

The structures located within the north-western section of the site suffered damage so severe that either the affected buildings were instantly destroyed or they were subsequently demolished by the authorities, on account of being damaged beyond repair. At these locations it can be assumed that large quantities of rubble persisted for a time and debris will likely have been strewn across neighbouring, undamaged areas.

Had a subsequent UXB then fallen within such ground cover, it is likely to have become immediately obscured from view within the ruins and wreckage. This scenario is illustrated by a photograph of local bomb damage, see ***Annex J***.

However anecdotal accounts and WWII-era aerial photographs confirm that the damage to the police headquarters, located in the eastern half the site, was confined largely to the two upper floors. As the lower two floors of the building remained intact, the degree of damage caused will not have been sufficient enough to obscure the passage of a subsequent HE UXB through the entire building and into the ground.

9.7.3. Frequency of Access

UXO at sites where human access was infrequent would have a higher chance of being overlooked than at those sites which were subject to greater occupancy. The importance of a site or facility to the war effort is also an important consideration as such sites are likely to have been both frequently accessed and are also likely to have been subject to post-raid checks for evidence of UXO.

As a developed site within a densely populated urban environment, the study area in general would have been frequently accessed. Some of the buildings survived the Blitz largely intact and therefore will likely have remained inhabited / in use, thereby increasing the likelihood of any air-delivered UXO being observed here.

However, following the serious bomb damage, the affected buildings would have been abandoned until repairs were made or the ruins cleared, increasing the possibility of subsequent UXO falling on site unnoticed. This is especially pertinent as many German air raids on Manchester occurred at night.

9.7.4. Ground Cover

The degree and type of groundcover present during WWII would have a significant effect on the visual evidence at ground level which may have indicated the presence of buried UXO.

Evidence of UXO will have been obvious within undamaged parts of the study area, as a UXB strike to the unaffected buildings and hard-standing will still have caused significant damage, even without detonating. Following any such incident, the damage would have been observed and the UXB exhumed / removed.

9.7.5. Bomb Failure Rate

There is no evidence to suggest that the bomb failure rate in the vicinity of the site would have been different from the "approximately 10%" figure normally used.

10. The Threat from Allied Military Ordnance

10.1. General

BACTEC has identified evidence of domestic military related activity in the local area, which could have led to UXO contamination.

The following historical and modern facilities / activities / incidents have been considered:

- Army, Navy and RAF Bases / Installations
- Military Training Areas / Weapons Ranges
- Ordnance / Explosives Factories and Storage Depots
- Sites requisitioned for military use
- Military Fortifications and Coastal Defences
- Locations of Army Explosive Ordnance Clearance Tasks
- WWII Anti-Aircraft Batteries
- WWII Pipe Mined Locations and Beach Minefields

The most likely source of British / Allied ordnance is anti-aircraft fire, as discussed in the following section.

10.1.1. Anti-Aircraft Artillery and Projectiles

At the start of the war two types of AAA guns were deployed: Heavy Anti-Aircraft Artillery (HAA), using large calibre weapons such as the 3.7" QF (Quick Firing) gun and Light Anti-Aircraft Artillery (LAA) using smaller calibre weapons such as 40mm Bofors gun.

During the early war period there was a severe shortage of AAA available and older WWI 3" and modified naval 4.5" guns were deployed alongside those available 3.7" weapons. The maximum ceiling height of fire at that time was around 11,000m (for the 3.7" gun and less for other weapons). As the war progressed improved variants of the 3.7" gun were introduced and, from 1942, large 5.25 inch weapons began to be brought into service. These had significantly improved ceiling heights of fire reaching over 18,000m.

The LAA batteries were intended to engage fast low flying aircraft and were typically deployed around airfields or strategic installations. These batteries were mobile and could be moved to new positions with relative ease when required. The most numerous of these was the 40mm Bofors gun which could fire up to 120 x 40mm HE shells per minute to over 1800m.

The HAA projectiles were high explosive shells, usually fitted with a time delay or barometric pressure fuze to make them explode at a pre-determined height. Before the war all the clockwork fuses used by the Royal Artillery had come from Switzerland. When that source of supply was cut off, Britain had been forced to make its own. After four years of war, the country still lacked the engineering skills to produce a reliable fuse.

This resulted in a considerable number of AA projectiles either exploding prematurely, killing the gunners or failing to explode at all; falling to the ground as UXBs. In January 1944 more people in London were killed by HAA shells than by German bombs. Details of the most commonly deployed WWII AAA projectiles are shown below:

Gun type	Calibre	Shell Dimensions	Shell Weight	HE Fill Weight
3.7 Inch	94mm	94mm x 438mm	12.7kg	1.1kg
4.5 Inch	114mm	114mm x 578mm	24.7kg	1.7kg
40mm	40mm	40mm x 311mm	0.84kg	70g

Although the larger unexploded projectiles could enter the ground they did not have great penetration ability and are therefore likely to be found close to WWII ground level. These shells are frequently mistakenly identified as small German air-delivered bombs, but are differentiated by the copper driving band found in front of the base. With a high explosive fill and fragmentation hazard these items of UXO present a significant risk if encountered. The smaller 40mm projectiles are similar in appearance and effect to small arms ammunition and, although still dangerous, present a lower risk.

Five HAA batteries were located within a 5km radius of the site during WWII. Numerous unexploded AAA shells were recovered during and following WWII and are still occasionally encountered on sites today. Illustrations of Anti-Aircraft artillery, projectiles and rockets are presented at ***Annex K***.

11. Ordnance Clearance and Post-WWII Ground Works

11.1. General

The extent to which any ordnance clearance activities have taken place on site or extensive ground works have occurred is relevant since on the one hand they may indicate previous ordnance contamination but also may have reduced the risk that ordnance remains undiscovered.

11.2. EOD Bomb Disposal and Clearance Tasks

BACTEC holds a number of official records of explosive ordnance disposal operations during and following WWII, obtained from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD). No records could be found to indicate that any EOD tasks have taken place on or within very close proximity to the site.

11.3. Post War Redevelopment

Between 1951 and 1964 the present day Synagogue was constructed in the north-western corner of the site while minor redevelopment immediate to the east also took place. Additional phases of redevelopment have taken place in subsequent years across the western half of the site.

Note however no significant intrusive works are believed to have taken place across the eastern half of the site in the post-war period.

12. The Overall Explosive Ordnance Threat Assessment

12.1. General Considerations

Taking into account the quality of the historical evidence, the assessment of the overall threat to any intrusive works from UXO must evaluate the following risks:

- That the site was contaminated with unexploded ordnance
- That UXO remains on site
- That such items could be encountered during any intrusive works
- That ordnance may be activated by the works operations
- The consequences of encountering or initiating ordnance

12.2. The Risk that the Site was Contaminated with Unexploded Ordnance

For the reasons discussed in *Section 9* BACTEC believes that there is a risk that UXO contaminated the study area. This is based on the following:

- Manchester was the eleventh most heavily bombed city / town in Britain during WWII. The site is located within the city centre which experienced a high bombing density, as confirmed by official statistics.
- Original bombing records, sought from two separate sources, plot one HE bomb strike to the Police Station. This resulted in damage to the upper two floors of the building, leaving the lower two floors intact.
- A 1kg incendiary bomb shower is known to have gutted some buildings at the north-western corner of the site as well as causing minor / moderate damage to a small building at the southern site boundary.
- Therefore it can be assumed that at these localities, heaps of rubble would have persisted, and debris would have been strewn across the site. Consequently, had a subsequent HE UXB fallen in these areas, it may have become obscured from view within the ruins. This is especially pertinent as nearly all German air raids on Manchester occurred at night, increasing the likelihood of a UXB falling unobserved and going unreported.
- Furthermore, such an incident could conceivably have resulted in the UXB coming to rest beneath neighbouring undamaged buildings / hard-staining, due to the 'J' Curve Effect.
- However note that as the lower two floors of the Police Station remained intact, it is highly unlikely that a subsequent UXB could have fallen within this ruin and passed through the ground floor without leaving any obvious evidence of its incidence. Furthermore the station remained in use throughout the remainder of the war, further decreasing the likelihood of such a scenario taking place.
- Those structures which survived the Blitz undamaged will likely have remained inhabited / in use, thereby increasing the likelihood of any air-delivered UXO being observed here. Furthermore a UXB strike to these buildings will have caused significant damage, even without detonating. Following any such incident, the damage would have been observed and the UXB exhumed / removed.

No evidence has been located to suggest that the site formerly had any British / Allied military occupation or usage that could have led to contamination with items of UXO.

12.3. The Risk that Unexploded Ordnance Remains on Site

Following WWII a large proportion of the site has been redeveloped. Within the footprints of the post-war buildings and hard-standing, the risk from shallow-buried UXO (AA projectiles and 1kg incendiary bombs) will have been largely mitigated, as any such items will likely have been exhumed and removed during excavations for foundations, as well as levelling and re-surfacing works.

The risk from deep-buried German HE UXBs will have only been mitigated within the volume of any post-war bulk excavations (for basement levels) and at the precise locations of any pile

foundations. This risk will therefore remain within virgin geology, beneath the post-war construction works and amongst any pile layouts, down to the maximum bomb penetration depth.

12.4. The Risk that Ordnance may be Encountered during the Works

The most likely scenarios under which UXO could be encountered during construction works is during piling, drilling operations or bulk excavations for basement levels. The overall risk will depend on the extent of the works, such as the numbers of boreholes/piles (if required) and the volume of the excavations.

Since an air-dropped bomb may come to rest at any depth between just below ground level and its maximum penetration depth there is also a chance that such an item could be encountered during shallow excavations (for services or site investigations) into the original WWII ground level. A risk of encountering UXO will only present itself if intrusive work is carried out into virgin geology (or WWII-era made ground), outside the volume of post-war foundations.

12.5. The Risk that Ordnance may be Initiated

The risk that UXO could be initiated if encountered will depend on its condition, how it is found and the energy with which it is struck. The most violent activity on most construction sites is percussive piling. As a result items that are shallow buried present a slightly lower risk than those that are deep buried, since the force of impact is usually lower and they are more likely to be observed – when immediate mitigating actions can be taken.

12.6. The Consequences of Encountering or Initiating Ordnance

Clearly the consequences of an inadvertent detonation of UXO during construction operations would be catastrophic with a serious risk to life, damage to plant and a total site shutdown during follow-up investigations.

Since the risk of initiating ordnance is significantly reduced if appropriate mitigation measures are undertaken, the most important consequence of the discovery of ordnance will be economic. This would be particularly so in the case of high profile locations and could involve the evacuation of the public.

The unexpected discovery of ordnance may require the closing of the site for any time between a few hours and a week with a potentially significant cost in lost time. Note also that the suspected find of ordnance, if handled solely through the authorities, may also involve loss of production since the first action of the Police in most cases will be to isolate the locale whilst awaiting military assistance, even if this turns out to have been unnecessary.

12.7. Dynasafe BACTEC's Assessment

Taking into consideration the findings of this study, Dynasafe BACTEC considers the risk on the site to be heterogeneous and can therefore be divided into ***Low*** and ***Medium*** Risk Zones. These are described below and illustrated on a Risk Map, presented in ***Annex L***.

Low Risk Zone: Relatively undamaged buildings and hard-standing during WWII.

	Level of Risk			
Type of Ordnance	**Negligible**	**Low**	**Medium**	**High**
German High Explosive Bombs		✓		
German 1kg Incendiary Bombs		✓		
British AA Shells		✓		
British / Allied SAA and LSA	✓			

Medium Risk Zone:

a) Buildings which sustained serious bomb damage during WWII.

b) Buffer area to account for the 'J-Curve Effect'

	Level of Risk			
Type of Ordnance	**Negligible**	**Low**	**Medium**	**High**
German High Explosive Bombs			✓	
German 1kg Incendiary Bombs		✓		
British AA Shells		✓		
British / Allied SAA and LSA	✓			

13. Proposed Risk Mitigation Methodology

13.1. General

Dynasafe BACTEC believes the following risk mitigation measures should be deployed to support the proposed works at the Jacksons Row site.

13.2. Recommended Risk Mitigation Measures

Both Risk Zones

- ***Site Specific Explosive Ordnance Safety and Awareness Briefings to all personnel conducting intrusive works:*** A specialised briefing is always advisable when there is a possibility of explosive ordnance contamination. It is an essential component of the Health & Safety Plan for the site and conforms to requirements of CDM Regulations 2007. All personnel working on the site should be instructed on the identification of UXB, actions to be taken to alert site management and to keep people and equipment away from the hazard. Posters and information of a general nature on the UXB threat should be held in the site office for reference and as a reminder.
- ***The Provision of Unexploded Ordnance Site Safety Instructions:*** These written instructions contain information detailing actions to be taken in the event that unexploded ordnance is discovered. They are to be retained on site and will both assist in making a preliminary assessment of a suspect object and provide guidance on the immediate steps to be taken in the event that ordnance is believed to have been found.

Medium Risk Zone Only

- ***Explosive Ordnance Disposal (EOD) Engineer presence on site to supervise open excavations:*** When on site the role of the EOD Engineer would include; monitoring works using visual recognition and instrumentation and immediate response to reports of suspicious objects or suspected items of ordnance that have been recovered by the ground workers on site; providing Explosive Ordnance Safety and Awareness briefings to any staff that have not received them earlier and advise staff of the need to modify working practices to take account of the ordnance threat, and finally to aid Incident Management which would involve liaison with the local authorities and Police should ordnance be identified and present an explosive hazard.
- ***Intrusive Magnetometer Survey of any pile / boreholes locations down to the maximum bomb penetration depth:*** BACTEC can deploy a range of intrusive magnetometry techniques to clear ahead of all the pile locations. The appropriate technique is governed by a number of factors, but most importantly the site's ground conditions. The appropriate survey methodology would be confirmed once the enabling works have been completed. A site meeting would be required between BACTEC and the client to determine the methodology suitable for this site. Target investigation or avoidance will be recommended as appropriate.

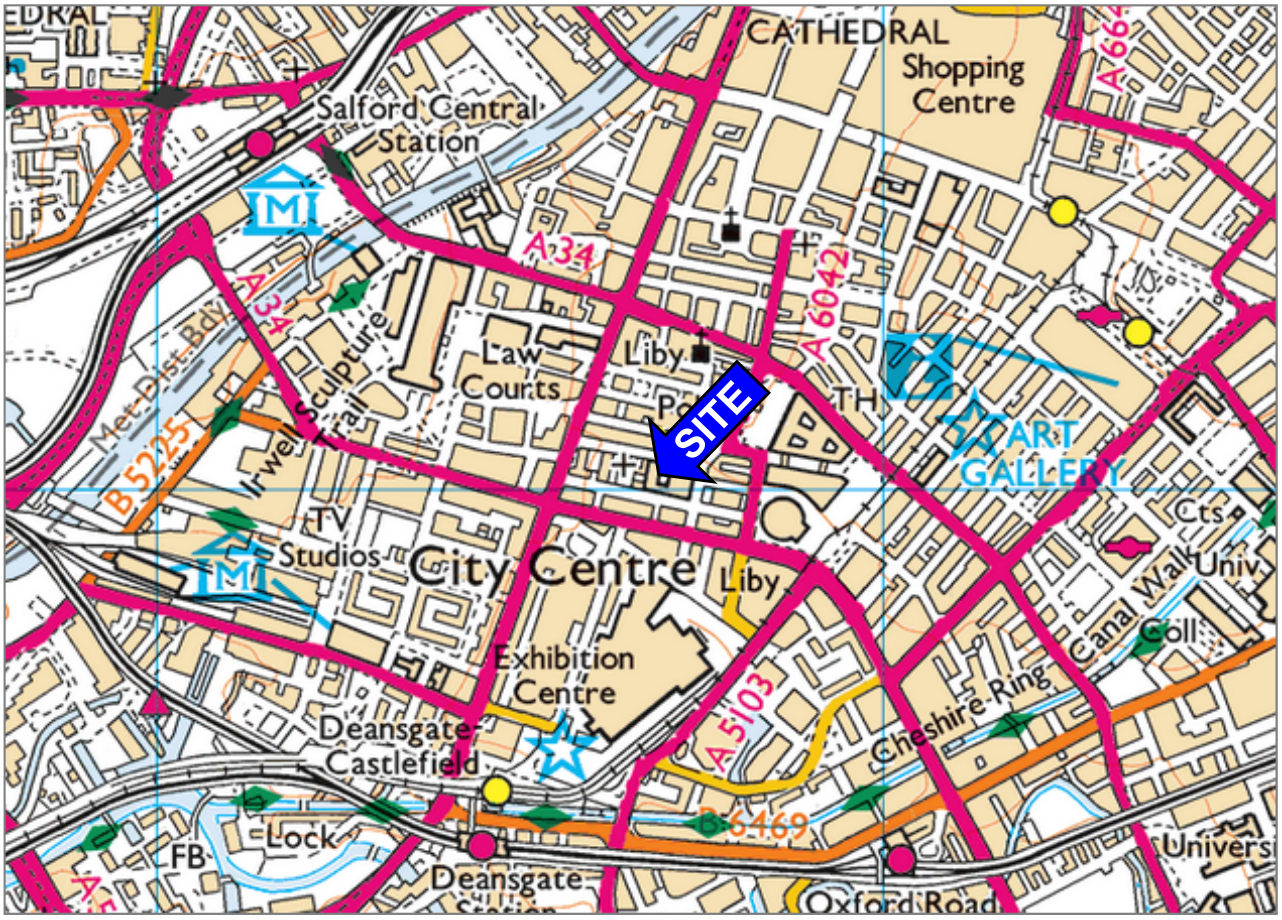
Dynasafe BACTEC Limited 26th October 2015

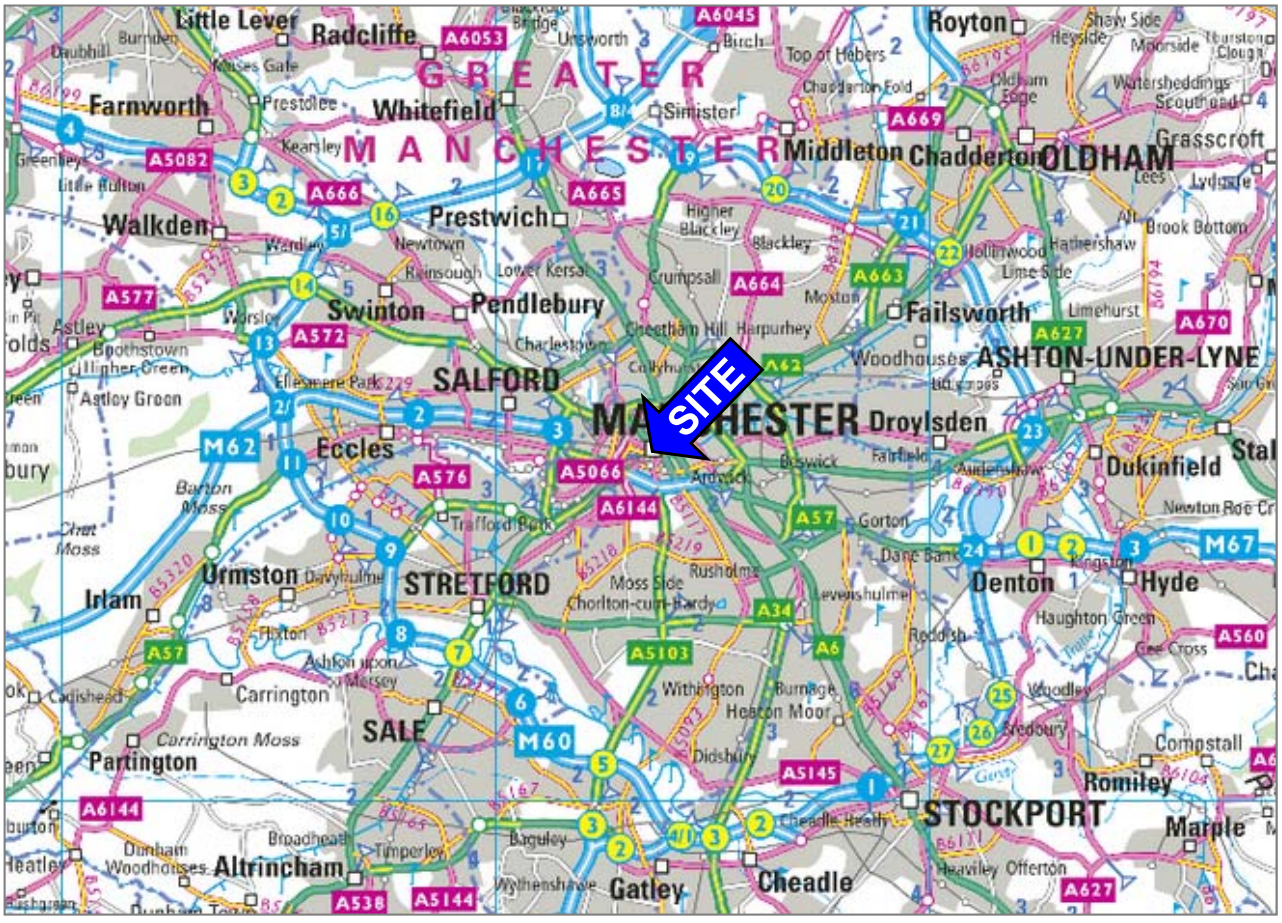
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The key sources consulted during this assessment are listed below:

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North





Report Reference:	Client:	
6239TA	WSP UK Limited	DYNASAFE
	Project: Jacksons Row, Manchester	

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North



Approximate site boundary

Report Reference:	Client:	
6239TA	WSP UK Limited	DYNASAFE
	Project: Jacksons Row, Manchester	

Source: Google Earth ™ Mapping Services

North

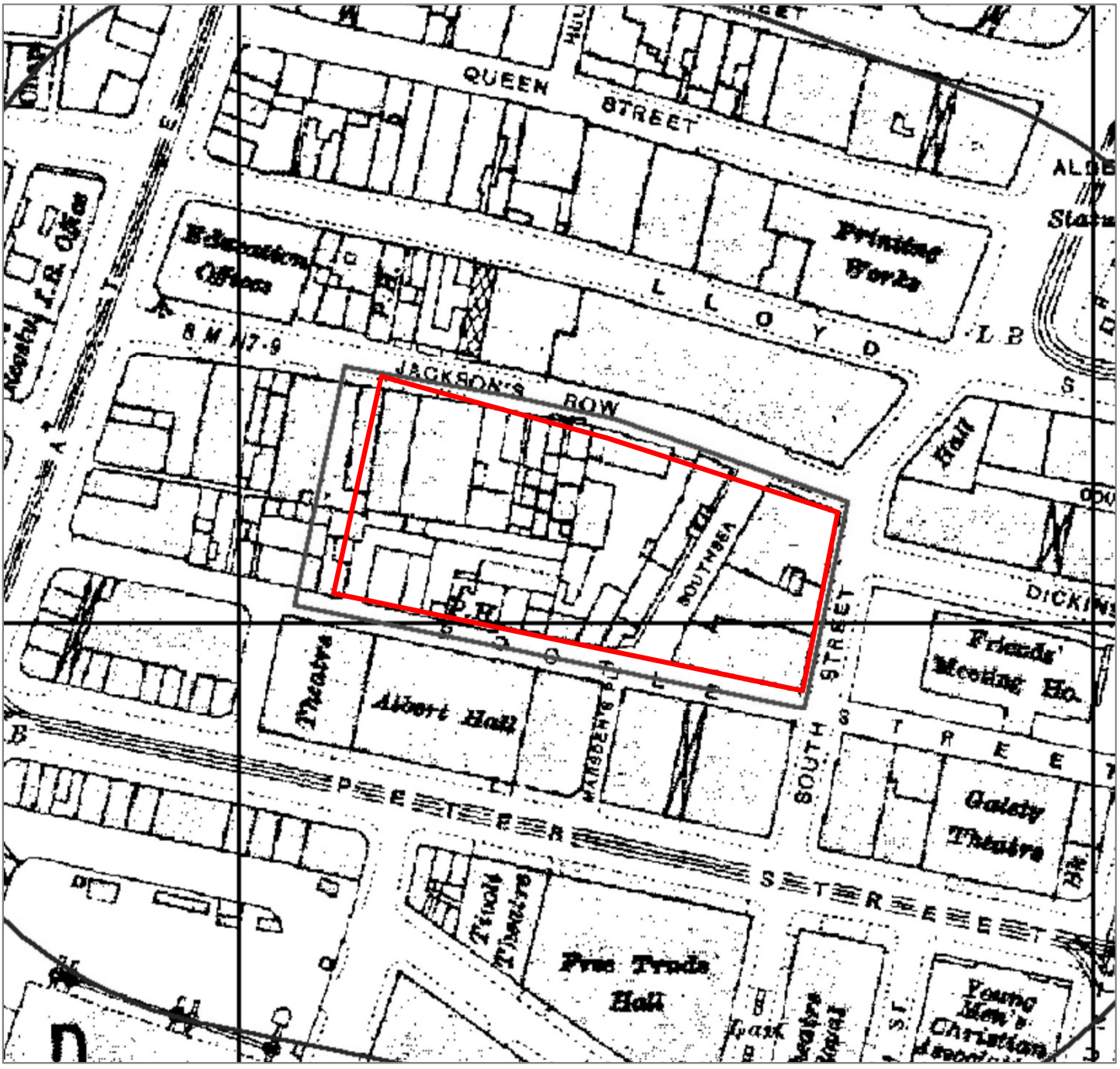


Site boundary

Report Reference:	Client:	
6239TA	WSP UK Limited	DYNASAFE
	Project: Jacksons Row, Manchester	

Source: WSP UK Limited

North



Approximate site boundary

Report Reference:	Client:	
6239TA	WSP UK Limited	DYNASAFE
	Project: Jacksons Row, Manchester	

Source: WSP UK Limited

North



Approximate site boundary

Ruin

Redevelopment

Report Reference:	Client:	
6239TA	WSP UK Limited	DYNASAFE
	Project: Jacksons Row, Manchester	

Source: WSP UK Limited

SC 50

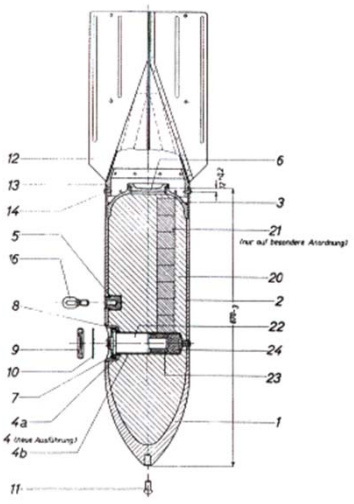
Bomb Weight:	40-54kg (110-119lb)
Explosive Weight:	c25kg (55lb)
Fuze Type:	Impact fuze/electro-mechanical time delay fuze
Bomb Dimensions:	1,090 x 280mm (42.9 x 11.0in)
Body Diameter:	200mm (7.87in)
Use:	Against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to three stories.
Remarks:	The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.



50kg bomb, London Docklands



Minus tail section



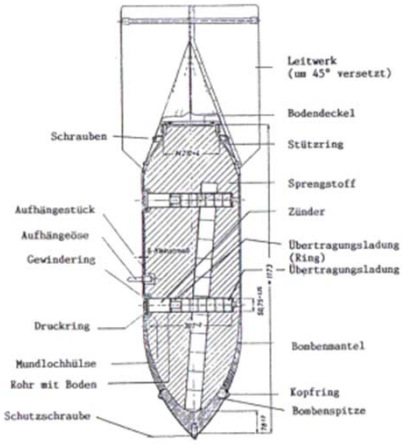
SC-50 JA (Güteklasse 1)

SC 250

Bomb weight:	245-256kg (540-564lb)
Explosive weight:	125-130kg (276-287lb)
Fuze type:	Electrical impact/mechanical time delay fuze.
Bomb dimensions:	1640 x 512mm (64.57 x 20.16in)
Body diameter:	368mm (14.5in)
Use:	Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.



250kg bomb, Hawkinge



SC-250 JA (Güteklasse I)

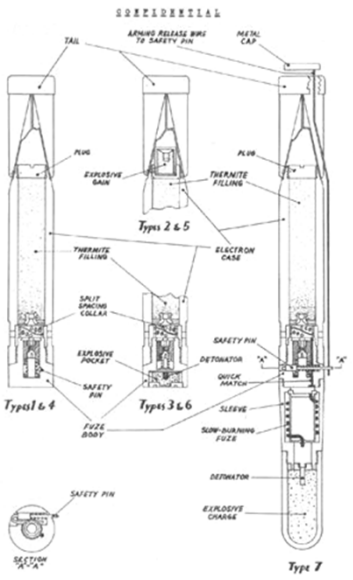
1kg Incendiary Bomb

Bomb weight:	1.0 and 1.3kg (2.2 and 2.87lb)
Filling:	680gm (1.3lb) Thermite
Fuze type:	Impact fuze
Bomb dimensions:	350 x 50mm (13.8 x 1.97in)
Body diameter:	50mm (1.97in)
Use:	As incendiary – dropped in clusters against towns and industrial complexes
Remarks:	Jettisoned from air-dropped containers. Magnesium alloy case. Sometimes fitted with high explosive charge





1. Scaffold pipe
2. Incendiary 1kg bomb
3. Incendiary bomb recently found on site in UK



GERMAN 1 Kg. INCENDIARY & MODIFICATIONS (INCLUDING 1.3 and 2.2 Kg.)

Report Reference:	Client:	
6239TA	WSP UK Limited	DYNASAFE
	Project: Jacksons Row, Manchester	

Source: Dynasafe BACTEC Limited and various historical sources

The Telegraph 11:50AM GMT 24 Mar 2015

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Giant WWII bomb dug up by builders in London

A massive evacuation procedure is carried out in Bermondsey, south London, after the 1,000lb explosive measuring 5ft long was uncovered



Mother-of-two digs up unexploded WWII bomb in garden and casually flings it on the rubbish thinking it was an old exhaust pipe

- Carole Fisher-White, 56, unearthed a mortar shell in her back garden
- It was only when sons said it looked like a bomb that the penny dropped
- Royal Navy bomb disposal team called to defuse the device
- The 29mm Spigot Mortar was was an infantry anti-tank weapon
- Also known as the Blacker Bombard it was used by the Home Guard



Unexploded Second World War grenade discovered by a curious dog

2008, 27 March 2013 | By Charlotte Cox

Police and Army bomb disposal experts were called to the address in Peakdale Avenue, Heald Green.

A dog called Snoop has sniffed out a suspected Second World War grenade in a Stockport garden.

Police and Army bomb disposal experts were called to the address in Peakdale Avenue, Heald Green.

The took the grenade to nearby parkland and destroyed in a controlled explosion.



Page last updated at 14:23 GMT, Thursday, 5 June 2008 15:23 UK BBC

E-mail this to a friend Printable version

Unexploded bomb 'started to tick'

An unexploded World War II bomb started to tick and ooze liquid as experts tried to defuse it, police have said.

The large bomb was found in a river at Sugar House Lane, near Bromley-by-Bow Tube station in east London, on Monday.

Rush-hour travel was disrupted as overnight work to make the bomb safe continued into Thursday morning.



"It measures approximately the size and length of a man, and weighs around 1,000kg (2,200lb).

Express & Echo

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Road closed after German bomb found in Axminster garden

By Exeter Express and Echo | Posted: June 03, 2014



A major road in Axminster has been closed after an air-dropped German bomb was found in a garden.

Page last updated at 14:45 GMT, Friday, 22 May 2009 15:45 UK

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Building site WWII bomb exploded



00:20 / 00:28 SHARE

Building site WWII bomb exploded

A controlled explosion has been carried out on a World War II bomb found on a building site in East Sussex.

The 110lb (50kg) SC50 bomb, thought to have been dropped from a German aircraft in 1940 or 1941, was found at the Hollenden House

Royal Navy clearance divers dispose of 70-year old German bomb

Posted on August 8, 2013



The team of four from the Southern Diving Unit 1 at HM Naval Base Devonport, Plymouth, blew up the air-dropped bomb in-situ in a controlled explosion where it was found by contractors for SW Water laying a mains in a field at St Eval Kart Circuit near Wadebridge, north Cornwall yesterday.

1994



RESCUE workers search for survivors after a Second World War bomb exploded at a building site in Berlin, killing three people and injuring at least eight others.

A fire brigade spokesman said he feared the final death toll could be higher. One worker was still missing, believed to be trapped under a machine. "We've found human remains 100 metres away but we can't tell if they belong to the dead already found," the spokesman said.

The blast, set off by drilling work on Frankfurter Allee, one of east Berlin's busiest avenues, trapped workers under building machinery and sent huge chunks of concrete tumbling through the air.

A large office block was being built on the site of the explosion which sent shoppers scrambling for shelter and paralysed dense afternoon traffic. One eyewitness said: "There was a bang, then silence, and then it started raining stones and dirt."

Dozens of cars within a 250-metre radius were wrecked and the top two floors of a nearby apartment block caved in.

Radio reports claimed that the total number of injured stood at 14.

Blown up by history

2008





2006

World War II bomb kills three in Germany

Three people have been killed and six injured trying to defuse a World War II bomb in central Germany.

Workers building a sports stadium had earlier unearthed the bomb in the town of Goettingen.

It was not immediately clear why the bomb, reportedly weighing 500kg (1,100lb), had detonated.



Unexploded WWII bombs dropped by Allied planes are frequently found in Germany, though it is unusual for them to explode unexpectedly.

2010

2006





The bomb went off as the machine lifted up earth and debris

A World War Two bomb has exploded at a construction site near a west German town, killing a man and injuring eight others, police say.

Related

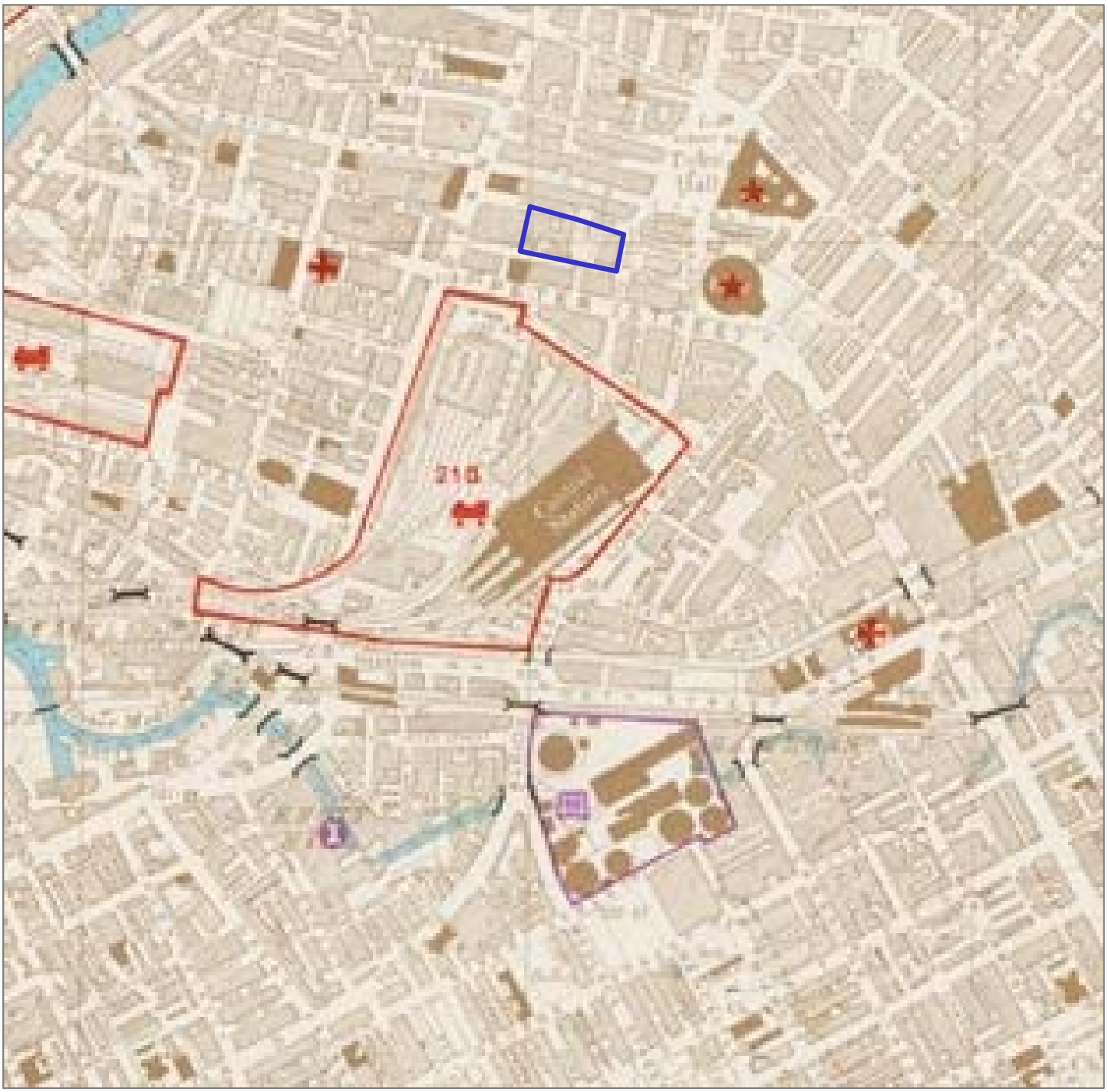
The explosion occurred after a digger accidentally struck the device during excavation work in Euskirchen in the state of North Rhine-Westphalia.

The machine's operator died on the spot. Two of those hurt were critically wounded, the dpa news agency reports.

2014

Top Left: WWII bomb killed 3 and injured 8 in Berlin – 1994.
Middle Left: WWII bomb killed 3 in Goettingen, Germany – 2010.
Bottom Left: Excavator operator killed by WWII bomb in Euskirchen, Germany – 2014.
Top Right: WWII bomb injures 17 at construction site in Hattingen, Germany - 2008.
Middle Right: A highway construction worker in Germany accidentally struck a WWII bomb, killing himself and wrecking several passing cars - 2006.
Bottom Right: Destroyed piling rig and dump truck after detonation of WWII UXB in Austria - 2006.

North



Approximate site boundary

Luftwaffe bombing targets

Report Reference:	Client:	
6239TA	WSP UK Limited	DYNASAFE
	Project: Jacksons Row, Manchester	

Source: Greater Manchester County Record Office

North

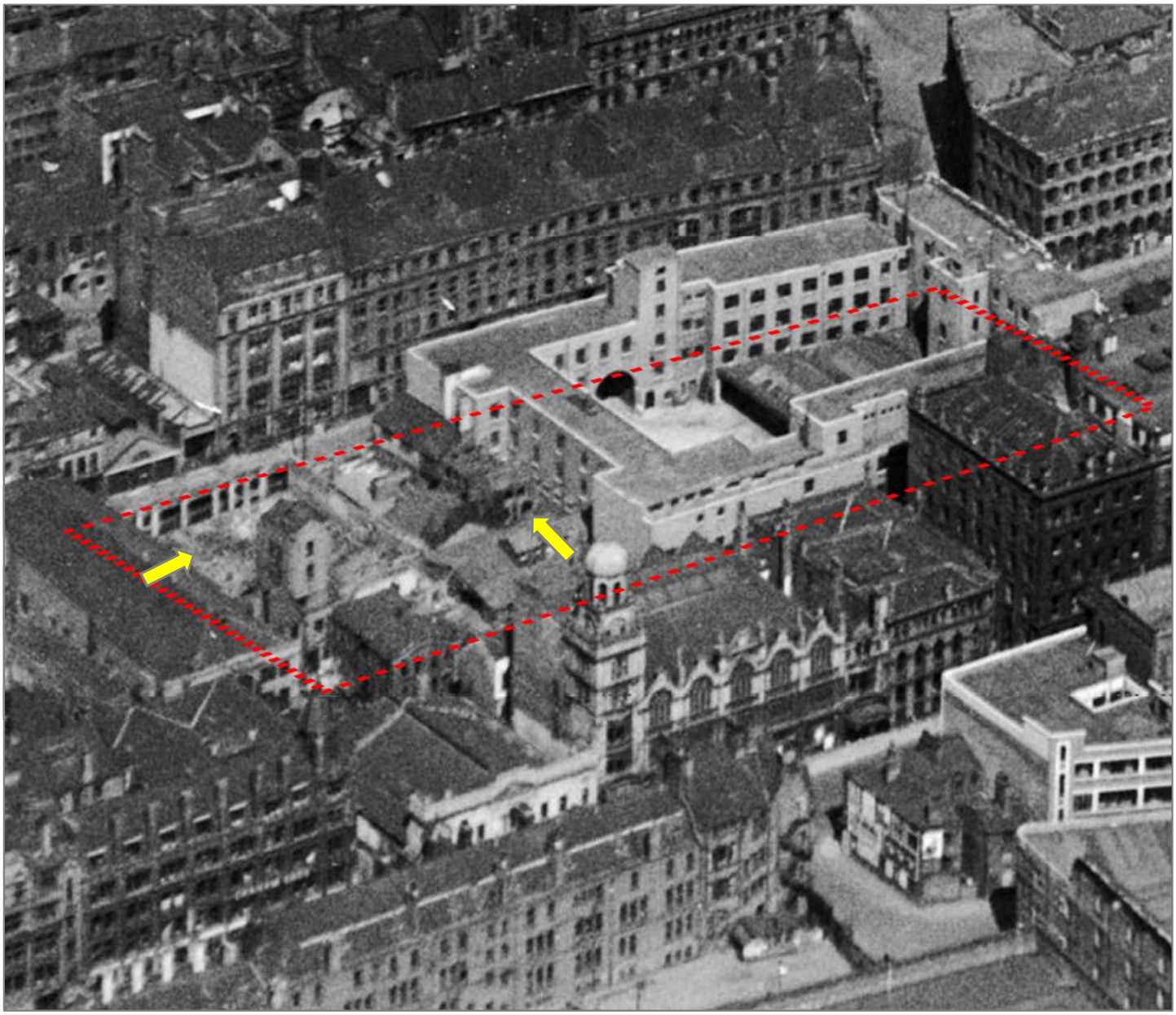


- Approximate site boundary
- Serious damage / clearance
- Minor to moderate damage
- Incendiary bomb strike
- HE bomb strike

Report Reference:	Client:	
6239TA	WSP UK Limited	DYNASAFE
	Project: Jacksons Row, Manchester	

Source: University of Manchester Library

North



Approximate site boundary

Bomb damage

Report Reference:	Client:	
6239TA	WSP UK Limited	DYNASAFE
	Project: Jacksons Row, Manchester	

Source: Britain From Above

North



Approximate site boundary

Report Reference:	Client:	
6239TA	WSP UK Limited	DYNASAFE
	Project: Jacksons Row, Manchester	

Source: Historic England



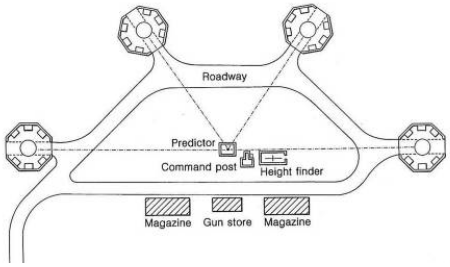
December 1940 – Free Trade Hall, Peter Street approximately 50m to the south of the site

3.7 inch Anti-Aircraft Projectile

Weight:	12.7kg (28lb)
Dimensions:	94 x 360mm (3.7 x 14.7in)
Carriage:	Mobile and Static Versions
Rate of Fire:	10-20 rounds per minute
Ceiling:	9-18,000m (29-59,000ft)
Muzzle Velocity:	792m/s (2,598ft/s)
Remarks:	4.5 inch projectiles were also commonly utilised



This AA shell was uncovered on a construction site in North London in February 2009.



Layout plan for a typical HAA battery site.



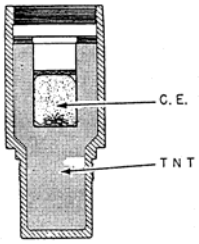
Hyde Park 1939 3.7 Inch QF gun on mobile mounting



3.7 inch AA Projectile Minus Fuze

Rockets / Unrotated Projectiles

Weight:	Overall: 24.5kg (54lb) Warhead: 1.94kg (4.28lb)
Dimensions:	1930mm x 82.6mm (76 x 3.25in)
Carriage:	Mobile – transported on trailers
Ceiling:	6770m (22,200ft)
Maximum Velocity:	457mps (1,500 fps)



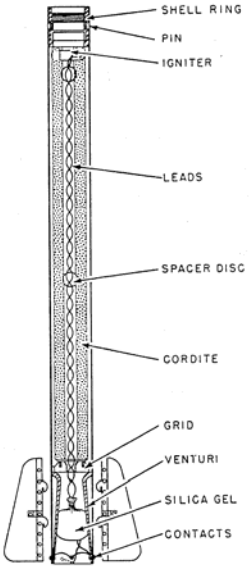
MK II HE Shell (3.5kg)



Rocket Battery in action



Home Guard soldiers load an anti-aircraft rocket at a 'Z' Battery



2" U.P AA Rocket

40mm Bofors Gun Projectile

Weight:	0.86kg (1.96lb)
Dimensions:	40mm x 310mm (1.6in x 12.2in)
Rate of Fire:	120 rounds per minute
Ceiling:	23,000ft (7000m)
Muzzle Velocity:	2,890 ft/s (881m/s)
Remarks:	Mobile batteries – normally few records of where these guns were located



Unexploded 40mm Bofors projectile recovered from a marine environment



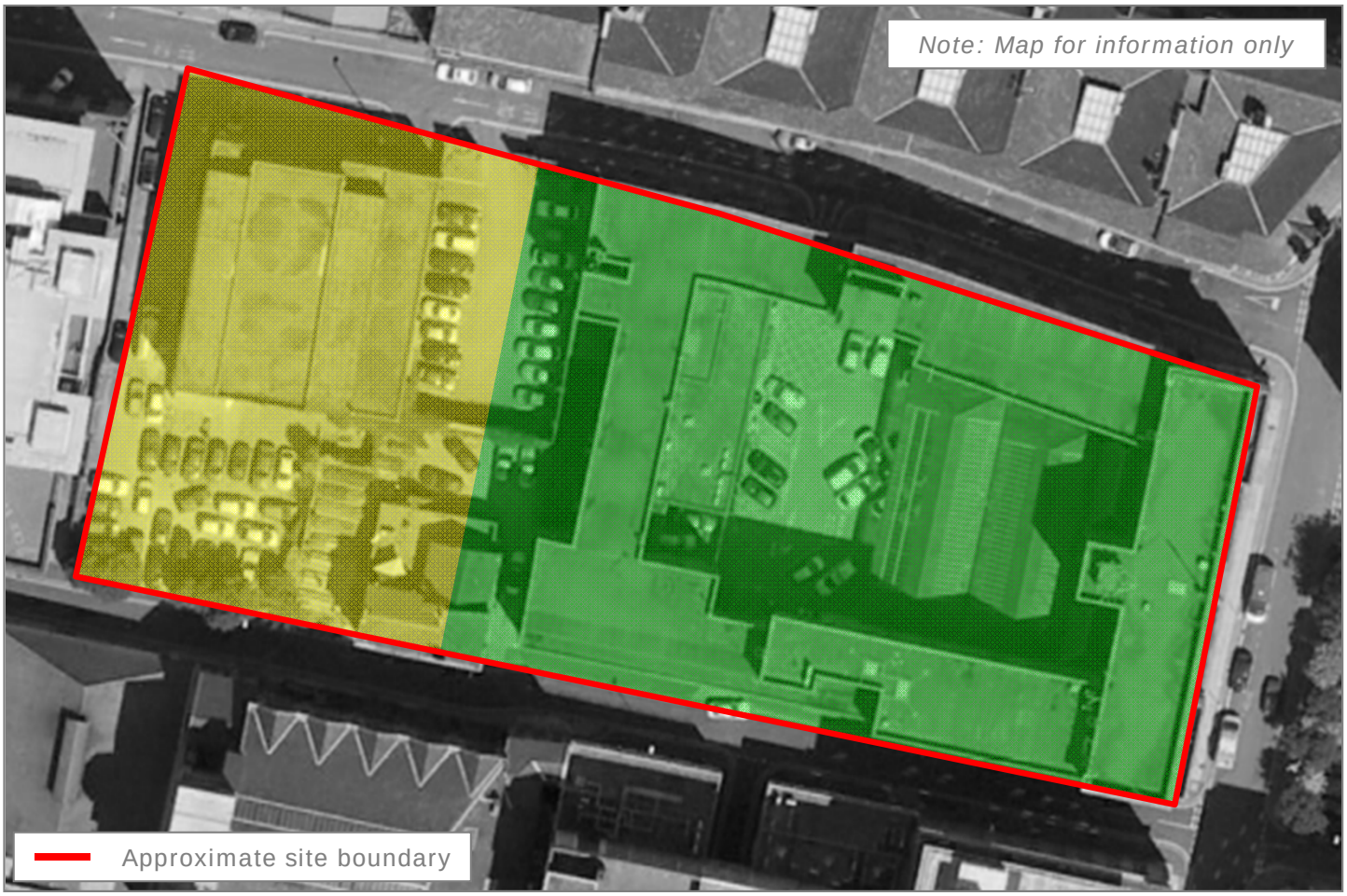
40mm Bofors gun and crew at Stanmore in Middlesex, 28 June 1940.



Report Reference: 6239TA	Client: WSP UK Limited	DYNASAFE
	Project: Jacksons Row, Manchester	

Source: Dynasafe BACTEC International Limited and various historical sources

North



Low Risk Zone

Relatively undamaged buildings and hard-standing during WWII.

Medium Risk Zone

a) Buildings which sustained serious bomb damage during WWII

b) Buffer area to account for the J-Curve Effect

Recommended Mitigation Measures

Both Risk Zones

- Explosive Ordnance Safety and Awareness Briefings to all personnel conducting intrusive works
- The Provision of Unexploded Ordnance Site Safety Instructions

Medium Risk Zone only

- Explosive Ordnance Disposal (EOD) Engineer presence on site to support any open excavations
- Intrusive Magnetometer Survey of any pile / boreholes locations down to the maximum bomb penetration depth