

**GEOTECHNICAL AND GEO-ENVIRONMENTAL
SITE INVESTIGATION**

HOLLINS ROAD, DARWEN

FOR

GLEESON DEVELOPMENTS LTD

ISSUE 2



40361-002

27 JULY 2017

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Job No. : 40361
Report Status : Issue 2
Document Date : 27 July 2017

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1.0 EXECUTIVE SUMMARY

1. The approximately 6.2 hectare site is located off Hollins Road, and west of Hollins Grove Street and Lower Eccleshill Road, in Darwen.
2. The site comprises part of Hollins Mill, a former paper mill. The main Mill buildings were located west of the site to be developed. The north eastern part of the site was predominantly occupied by a power and steam generation plant and housed three gas fired boilers, which until 1984 were powered by heavy fuel oil stored in three large tanks south of the power station. The south eastern part of the site is a former lorry park, situated over two infilled reservoirs and a spoil heap. A bunded diesel tank and interceptor were present in the south east corner of the lorry park. In addition, the historical maps indicate several locations where tanks used to be present elsewhere on site. The southern corner of the site is separated from the rest of the site with a stream and trees and appears to have been used as allotments. It was not possible to access this area during our visit.
3. Most buildings have been demolished with the slabs, and therefore foundations, still present. The tanks have been removed with only a number of concrete bases still on site. Old services are also still present beneath the site, with several private pipes and underground channels in the north eastern part of the site.
4. The former lorry park area lies at around 152.5 m AOD, falling at around 1 in 40 to around 150 m in the north west. Ground levels then drop at around 1 in 3 to around 144 m before gently sloping to the west to around 143 m along the western boundary. In the north of the site, the ground level around the former buildings and tanks is around 153 to 155 m, dropping down to 145 m further west at around 1 in 7 before reaching a 3 m high embankment in the centre of this part of the site. West of the embankment, ground levels are fairly level at around 141 m. The proposed development plan appears to take these central embankments into account.
5. The geology beneath the site is shown to comprise Till (boulder clay). The solid geology below comprises Lower Coal Measures (mudstone) strata, except for the north western third which is shown to be underlain by Lawrence Rock (sandstone).
6. Precautions against the effects of shallow coal mining are not considered to be required.
7. In the south eastern part of the site, made ground was recorded to between 3.2 and 6.5 m. The historical investigations recorded a maximum depth of about 8 m. In the western and south western part of the site, the made ground extended to depths of around 0.9 to 2.6 m. Below the former power station in the north east, made ground was generally found to

between 2 and 3 m depth. Natural firm clay was generally encountered below, although in a number of locations it was found to be soft. In the north western corner of the site, natural gravelly sand over sandstone was recorded at a depth of about 1 m.

8. In a number of trial pits, fast ingresses of perched groundwater were encountered at depths of about 0.5 m. This was noted to the north and west of the former reservoirs and in one trial pit located below the former power station.
9. Penetrometer readings equivalent to safe bearing capacities of 75 to 125 kN/m² were recorded in the firm clays. The lower readings could be attributed to the proportion of sand and gravel. A safe bearing capacity of 125 kN/m² is considered can be assumed for foundation design.
10. Although it is likely that levels will be regraded, due to the depth of made ground, presence of perched groundwater and the variation in the competency of the natural ground beneath, it is considered that the majority of the plots will need to be piled.
11. Piles should be assumed will need to be steel driven tubes, since obstructions are expected, and pre-digging at pile positions should be allowed for.
12. Trench fill foundations could be used for a number of plots towards the northern end of the site where shallow sandstone was found, and along the western site boundary where less than 2 m of made ground was found. Spread foundations should be taken through any made or soft ground to natural ground at a minimum depth of 750 mm.
13. Spread foundations would need to be deepened in accordance with the NHBC Standards where in clay soils and within influence of trees. Heave precautions would not be required within the spread foundations, however would still be required for piled plots within influence of trees.
14. Once finished ground levels are known, and ideally during site clearance works, plot specific trial pits are recommended to confirm the most appropriate foundations in some areas.
15. Precast concrete floors with an underlying void are considered to be required for all plots. The void height should be a minimum of 150 mm, increasing to 200 mm where heave precautions are required for piled plots, and where spread foundations are deepened over 1500 mm due to past or present tree influence.
16. To reduce the effects of the potential settlement of external areas in relation to the piled plots within made ground, extra facings, flexible service connections and generous falls on drain runs should be allowed for.

17. The slopes on site should be assessed and taken into account within the proposed development. If ground levels are to be regraded, retaining walls, tanking and underbuild should be allowed for. Consideration of the offsite slopes may also be required.
18. Soakaways are not considered to be viable, due to the depth of the made ground, presence of shallow perched groundwater and cohesive natural ground.
19. Elevated concentrations of arsenic, lead and polycyclic aromatic hydrocarbons were recorded within the made ground. Asbestos has also been recorded. A minimum 600 mm thick capping layer will be required in gardens and soft landscaping over made ground.
20. Any visible fragments of asbestos containing material should be hand-picked and removed from site by a specialist contractor.
21. Very little topsoil exists on site. Clean, inert topsoil will therefore need to be imported.
22. Unrecorded underground tanks or hydrocarbon impacted perched water (e.g. with an oily sheen) may be encountered. Any underground fuel tanks should be removed by a specialist contractor, and any impacted material around removed or remediated.
23. DS-4 AC-4 sulphate precautions should be allowed for in below ground concrete in contact with made ground. DS-2 AC-2 precautions would be appropriate for concrete in contact only with natural ground.
24. Elevated hydrocarbon concentrations were recorded. The chemical test results should be sent to the water supplier to confirm the type of supply pipe required for the development.
25. The overall risk to controlled waters is considered to be low.
26. No radon measures are required. Elevated concentrations of carbon dioxide and methane were recorded in historical gas monitoring, equivalent to a Red gassing regime. However, the concentrations recorded in this investigation are much lower. Based on the results of this gas monitoring programme, Amber 1 gas precautions are recommended for the majority of the site, increasing to Amber 2 for plots above the landfill (around 40% of the plots).
27. Further investigation is recommended in the south eastern corner.
28. A contingency should be allowed for removing hotspots of impacted material and significant obstructions.
29. The conclusions made in this report in relation to contamination are subject to agreement by the approving bodies such as the Local Authority and your warranty provider.

2.0 INTRODUCTION

2.1 Terms of Reference

This report presents the findings of a geotechnical and geo-environmental site investigation carried out by Eastwood & Partners (Consulting Engineers) Ltd for, and on the behalf of, Gleeson Developments Ltd. Any other parties using the information in this report do so at their own risk and any duty of care is excluded.

2.2 Context

The following reports have been reviewed:

- Phase 2 Site Investigation, prepared by Aspinwall, dated March 1997;
- Phase 1 Desk Study, prepared by Aspinwall, dated January 2001;
- Phase 2 report, prepared by Hyder, dated October 2001;
- Biological Water Quality Assessment, prepared by Cresswell Associates, dated September 2010;
- Permit Surrender – Ground Investigation, prepared by Environmental Resources Management, dated March 2013; and
- Site Closure Report, prepared by Environmental Resources Management, dated March 2013.

The 1997 investigation covered the former pulp tipping area and infilled reservoirs which now comprise part of the lorry park. This report was further summarised in the January 2001 Phase 1 report.

An IPC Permit was first issued in March 2002. A Site Investigation from 1997, a Phase 1 Desk Study from January 2001 and a Phase 2 from October 2001 were reviewed to provide baseline data for the Permit.

2.3 Aims and Objectives

The aims and objectives of this investigation were as follows:

- Assimilate Phase 1 data to derive an outline conceptual model identifying potential contaminants, pathways and receptors, as well as possible linkages between these;

- Detail the ground conditions and their geotechnical properties enabling outline foundation proposals to be made.
- Obtain information enabling refinement and subsequent testing of the conceptual model;
- Carry out tiered risk assessment to establish the likely risks to future receptors, involving the use of generic assessment criteria and where unacceptable risks are identified, site specific assessment criteria within a detailed quantitative risk assessment;
- Identify feasible remediation options if unacceptable risks are highlighted; and
- Develop an appropriate remediation strategy where remediation is required.

2.4 Scope of Investigation

This document is split into two sections. These constitute the findings of the Phase 1 and Phase 2 investigations, consecutively.

2.4.1 Phase 1

The Phase 1 investigation involved a review of information extracted from published documentation, review of previous reports, as well as that obtained from a site reconnaissance. Information regarding the current and former land uses both on and surrounding the site, as well as the environmental sensitivity of the site location as determined by factors including geology, hydrogeology and hydrology have been examined.

Information analysed in this section of the report has been obtained from a variety of sources and included the following:

- A Landmark Envirocheck. This includes historical Ordnance Survey maps, as well as information regarding environmental issues such as abstraction licenses, pollution incidences and waste facilities;
- British Geological Survey maps and memoirs; and
- A Coal Authority mining report

The results of the Phase 1 investigation were used to derive an outline conceptual model from which a preliminary risk assessment was made.

2.4.2 Phase 2

This part of the investigation consisted of intrusive works and laboratory analysis. The findings were used to test the conceptual model and produce a final risk assessment. The intrusive works comprised trial pits, cable percussive boreholes and window sample holes to enable:

- Examination of the upper few metres of ground within the trial pits and deeper ground within the cable percussive holes, and obtain a strength profile for the ground;
- In-situ description of soils, enabling any localised lateral and vertical changes in soil conditions to be identified;
- Assessment of any contamination identified using visual and olfactory methods;
- Collection of samples for chemical and geotechnical testing; and
- Installation of gas and groundwater monitoring wells.

2.5 Limitations of Investigation

This report is based on the assumption that the site will be developed for residential use, with houses up to three storeys in height, which will be of conventional construction. If this is not the case, then the advice given in this report may not be appropriate. It is considered that the current ground levels and slopes will be taken into account into the proposed development and that ground levels may require regrading.

Where assessments of site areas affected in particular ways are given, these are approximate. All information, comments and opinions given in this report are based on the ground conditions encountered during the site work, on the results of laboratory testing carried out as part of the investigation and information gained from a historical, geological and environmental desk study. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata and water conditions between or below investigation points. It should be noted that groundwater and gas levels vary due to seasonal or other effects, and may at times differ from those measured during the investigation.

This report considers the ground and groundwater and does not cover any buildings or hardstanding. Generally, testing has only been carried out for contaminants identified as potentially present with no assessment made of biological contamination. Risks to ecological receptors, such as bats, have not been considered.

3.0 THE SITE

3.1 Description

The approximately 6.2 hectare site is located off Hollins Road, west of Hollins Grove Street and Lower Eccleshill Road, in Darwen. It is centred around approximate grid reference 368930, 423680.

The site comprises part of Hollins Mill, a former paper mill. The main Mill buildings were located west of the site to be developed. The north eastern part of the site was predominantly occupied by a power and steam generation plant and housed three gas fired boilers, which until the early 1980s were powered by heavy fuel oil stored in three large tanks south of the power station. The south eastern part of the site is a former lorry park, situated over two infilled reservoirs and a spoil heap. A bunded diesel tank and interceptor were once present in the south east corner of the lorry park. In addition, there are several locations where tanks used to be present elsewhere on site. The tanks have been removed with only a number of concrete bases still on site, in some locations.

The majority of the buildings have been demolished with the ground slabs and therefore foundations still present. There is one small abandoned building still present in the central part of the site, adjacent to Hollins Road, as well as a tall chimney in the north east.

Old services are also still present beneath the site, with several private pipes and underground channels in the north eastern part of the site. The southern corner of the site is separated from the rest of the site by a stream and trees and appears to have been used as allotments. It was not possible to access this area during our visit.

A topographical survey covering the majority of the site has been reviewed. The former lorry park area lies at around 152.5 m AOD, falling at around 1 in 40 to around 150 m in the north west. Ground levels then drop at around 1 in 3 to around 144 m before gently sloping to the west to around 143 m along the western boundary. In the north of the site, the ground level around the former buildings and tanks is around 153 to 155 m, dropping down to 145 m further west at around 1 in 7 before reaching a 3 m high embankment in the centre of this part of the site. West of the embankment, ground levels are fairly level at around 141 m.

The Exploratory Hole Location Plan in Appendix 1 shows the features formerly and currently present on site.

3.2 History

Historical maps, obtained as part of the Envirocheck, have been reviewed to assess the previous use of the site and surrounding area. Copies of the maps are presented in Appendix 2.

3.2.1 The Site

The earliest map reviewed, dated 1849, shows the majority of the site to comprise fields. A rectangular reservoir is present in the centre of the site. A stream is also shown in the southern quarter of the site in its current day position. A cluster of small mill buildings is shown along the western site boundary in the northern half of the site.

The 1894-1895 map shows two large reservoirs in the southern half of the site, with steep embankments along the northern and western edges indicating a drop in ground level towards the west and north. Two wells are shown north and east of the reservoirs. The mill buildings in the north west are labelled as Baron Mill Farm. Hollins Road is shown crossing the central part of the site oriented approximately west / south east.

The wells are no longer shown on the 1911 map.

By 1930, a small spoil heap is shown in the eastern part of the site. Tanks are also shown in the central part of the site north of the reservoirs. The southern corner of the site has been developed as allotments.

By 1955, the spoil heap has expanded towards the south, along the eastern boundary of the site. An additional tank is indicated in the central part north of the reservoirs. Small circular features are shown east of Baron Mill Farm which could also represent tanks.

By the early 1960's, an electricity works (power station) has been constructed in the north eastern part of the site. A cooling tank, pipe line and three large circular tanks are shown south of the works. Three large circular tanks are also shown near the central part of the western boundary of the site. By 1969, the layout of the Baron Mill Farm facilities has slightly changed, with some of the buildings having been demolished. The circular features here are no longer shown, and one of tanks north of the reservoir is no longer labelled although the structure remains.

By 1989 the reservoirs appear to have been backfilled although the embankments remain. A large circular tank is now shown along the western boundary next to the former farm, and a smaller rectangular tank is shown north of the farm buildings. Three small rectangular buildings are also indicated east of this tank. A rectangular building has been constructed in the central part of the site, immediately west of the reservoirs.

In subsequent years, the majority of the area of the backfilled reservoirs is known to have been used as a lorry park. We understand the mill ceased manufacturing in 2012. Aerial photos indicate the site was cleared of buildings except for a tall chimney by 2013.

3.2.2 The Surrounding Area

The earliest historical map from 1849 shows the land south east of the site to comprise fields. Lower Eccleshill Lane and railway lines are present immediately east of the north eastern part of the site. The River Darwen and Hollins Print Works are shown west of the site, with a number of reservoirs beyond. Two sandstone quarries are also located about 60 m and 150 m north west of the site, surrounded by fields. Fields are also shown south of the site, with a sandstone quarry shown around 240 m to the south east.

By 1894, Hollins Mills has expanded and a reservoir is shown north of the mill. A section of the River Darwen has been culverted beneath the mill. A sewage works is shown about 90 m south west of the site, with a raised plateau shown to the west of the works. Housing is shown around 100 m south of the site. A brickworks is shown immediately north east of the site as is a clay pit, located 100 m east beyond the railway line. The sandstone quarries in the north are no longer shown.

By 1911, additional mill buildings have been constructed to the west. The sewage works is no longer shown. East of the site, Hollins Grove Street is shown along the eastern site boundary, and the railway lines have expanded to the west. The clay pit east of the site has also expanded and a fireclay works is shown around 150 m east of the site. To the north east, additional brickworks buildings have been constructed, and a spoil heap is shown to the west of these buildings. Filter tanks are shown around 90 m north of the site wither side of the River Darwen.

By 1930, some of the reservoirs west of the site have been backfilled and industrial buildings have been constructed on these locations. By 1966, the brick works immediately north east of the site is shown as disused and by 1969, extensive spoil heaps are now within the clay pit. By 1990, the spoil heaps are no longer shown.

The immediate surrounding area has remained industrial / commercial in use to the present day.

3.3 Geology

According to the British Geological Survey (BGS) Online Viewer and geological map Sheet 76, superficial Boulder Clay covers the site.

The solid geology below comprises Lower Coal Measures (mudstone) strata, except for the north western third which is shown to be underlain by Lawrence Rock (sandstone).

Two faults are inferred to cross the north eastern half of the site, trending north west to south east.

No dip of strata is shown on the map, but the strata are shown to young towards the south east.

3.4 Hydrogeology

The superficial deposits are classified as 'Secondary Undifferentiated', which is applied where it is not possible to attribute either category A or B to a rock type. The bedrock is shown as a Secondary A aquifer, which is described as permeable layers capable of supporting water supplies at a local rather than strategic scale.

The site does not lie within a Groundwater Source Protection Zone.

The Envirocheck report records 21 water abstractions within 250 m of the site's boundary, the nearest located around 20 m west of the site. The others are also located west and north west of the site with the majority relating to abstraction of surface and groundwater for industrial use associated with Hollins Mills.

3.5 Hydrology

The closest surface water feature is a stream which runs through the southern quarter of the site, flowing into the River Darwen around 70 m west of the site.

3.6 Coal Mining

The online BGS viewer shows a coal seam inferred to outcrop along the eastern boundary of the site. The seam, if present, is expected to dip towards the south east and away from the site. The seam is not shown on the geological map, or in the map's stratigraphic section.

The memoir does note that there is a 'thin but constant coal' which occurs at the top of the Old Lawrence sandstone. This is expected to be the seam presented on the BGS viewer. However, its absence on the older geological map indicates that it was not found, and therefore can be considered to not have been worked. The site is underlain by boulder clay and the seam may also have been eroded.

A Coal Authority mining report has been obtained and is included within Appendix 2. The report states that the site is not within an area that could be affected by past underground mining. However, it states that the site is in an area where the Coal Authority believe there is coal at or close to the surface. It is considered that this statement refers to the coal seam shown on the online BGS viewer.

There are no coal mine entries on or within 20 m of the site and the site is not within the boundary of an opencast site from which coal has been removed by opencast methods.

It is therefore considered that the site is not at risk from shallow coal mining.

3.7 Ground Gas

The Envirocheck report states that no radon precautions are required for new dwellings.

Deep made ground is present beneath the southern half of the site within the areas of the infilled reservoirs and spoil heap. This part of the site is classified as a historic landfill, dating from 1947 to 1991, accepting inert and industrial waste. One other historical landfill site is identified by the Envirocheck to lie within 250 m of the site. This landfill is located around 83 m north west, and the deposited waste is unknown.

The area of the clay pit and spoil heap east of the site is classified as a registered landfill site, estimated to lie around 57 m from the site. Deposited waste included asbestos, commercial and industrial waste, foundry sand, fuel oil, treatment sludge, paint waste, paper waste, resins, waste ink, PVC plastic, synthetic rubbers, textiles and wood waste. It is dated from 1981. Two other landfills are present within 250 m of the site, both located 222 m east of the site, within the landfill discussed above.

Potentially infilled ground is indicated immediately north east of the site, in the area of the former brick works. Eighteen other areas of infilled ground are present within 250 m of the site. Historical maps indicate these features are former sandstone quarries, streams, reservoirs and spoil heaps.

In conclusion, a ground gas monitoring programme is required in order to determine the gassing regime of the site.

3.8 Pollution Incidents to Controlled Waters

The Envirocheck report records 25 pollution incidents to controlled waters within 250 m of the site. The closest one occurred about 20 m north of the site and was classed as a Category 2 – Significant Incident, involving pollution from chemicals with the receptor probably comprising the River Darwen. The incident is dated 1995.

Two further incidents classed as Category 2 – Significant, occurred about 30 and 40 m south west of the site, in 1993. These relate to pollution involving rubble / litter and industrial effluent, into an unknown receiver.

The rest of the pollution incidents occurred at distances greater than 100 m from the site's boundary, with ten incidents classed as significant. These relate to pollution involving miscellaneous pollutants, including chemicals, inert suspended solids, organic trade effluent, urban/agricultural runoff. All of the incidents date during the 1990s.

The stream in the south of the site was tested as part of a 1997 investigation and gave no indication that the tipping area in the south was contaminating the watercourse.

3.9 Discharge Consents

The Envirocheck Report indicates 15 discharge consents within 250 m of the site. The closest three are located approximately 65 and 95 m north of the site and were issued for trade discharges and sewage / storm overflow into the River Darwen.

The rest are located around 100 to 180 m south west and north or north west and relate to storm sewage overflows and trade discharges into the River Darwen.

3.10 Flooding

According to the Envirocheck report, the site does not lie within a flood zone, but there is a risk of surface water flooding locally in small areas of the site in the centre, east and south west.

The Envirocheck report also records the majority of the site to lie within an area at risk of groundwater flooding at surface.

3.11 Soil Geochemistry

The soil geochemistry maps included in the Envirocheck report estimate the following concentrations of arsenic, cadmium, chromium, nickel and lead to be present in the natural soil at the site:

Contaminant	Estimated Concentration (mg/kg)	Assessment Value (mg/kg)
Arsenic	<15	37
Cadmium	<1.8	11
Chromium	60 to 90	910
Lead	<100	200
Nickel	15 to 30	180

The above contaminants are therefore not expected to exceed the residential assessment value within the natural ground.

3.12 Summary of Previous Reports

Ground Conditions

The 1997 investigation is understood to have recorded made ground in the south of the site to be between 3.3 and 7.7 m deep, comprising silty clay with ash, brick, stone and timber, as well as asbestos cement tiles. One borehole recorded 'pulp' at the base of the made ground. Natural clay or sand and gravel was found below. Sandstone bedrock was found south of the reservoirs from around 7 m below ground level (bgl).

Across the former power station made ground up to around 1.5 m was recorded over boulder clay. Sandstone was found from around 3 m depth north of this area.

The 2013 investigation summarises the following ground conditions:

- Topsoil found to 0.25 m bgl in 7 out of the 29 2012 exploratory holes;
- Surface concrete slab up to 0.2 m found in 16 holes;
- Made ground found between 0.4 to 4.8 m thick, generally comprising gravelly clay with brick, concrete, clinker, ash, plastic and wood;
- Buried obstructions such as slabs or sandstone boulders;
- Natural ground comprising clay – logged as soft, firm or stiff; and
- Groundwater strikes were often recorded between 2 and 4 m depth. Resting groundwater levels were recorded to be between surface (expected to be perched) and 1.6 m in the northern half of the site, and between 2 and 3.7 m in the southern half of the site.

No exploratory holes were undertaken within the far southern corner of the site.

Evidence of Contamination

The Phase 1 report records a 'soil gas survey' (assumed to be spike testing) within the investigation of the infilled reservoirs. The spike tests recorded up to 3% methane and 9% carbon dioxide. Monitoring wells were also installed and monitored three times. Carbon dioxide was found up to 18% and methane was found up to 36%. The highest concentrations of methane were recorded along the west of the area where the waste paper was deposited.

In the 2012 ERM investigation, the following evidence of contamination was found:

- SBH1 found an oily sheen on water and soil arisings from 0.4 to 0.55 m bgl.
- SB8 found an 'iridescent sheen' and odour between 1.7 and 1.9 m bgl.
- TP1 recorded a grey/black silty clay pocket at 1.6 m bgl.
- TP3 found a slight hydrocarbon odour at 1.3 m.
- Strong hydrocarbon odour in purged water from monitoring well BH4, located near the tank in the south of the site.

Asbestos fibres were recorded in the made ground in the 1997 investigation in 7 out of 10 samples screened.

4.0 OUTLINE CONCEPTUAL MODEL

The site is being considered for residential development with associated areas of hardstanding, private gardens and soft landscaping.

4.1 Potential Sources of Contamination

Northern Half of Site

The north eastern quarter of the site was predominantly occupied by a power and steam generation plant and housed three gas fired boilers, which until 1984 were powered by heavy fuel oil stored in three large tanks south of the power station. The northern tank once ruptured, spilling oil, although the previous reports note that the oil did not spill over the bund. The report also states that the tanks sat on ash rather than a concrete base. The spillage was dealt with by a specialist contractor who removed the oil and the contaminated ash.

The previous reports note that there were 13 transformers on the site. Polychlorinated biphenyls (PCBs) may be present in underlying soils.

An above ground diesel filling tank was located in the north of the central area of the site (assumed location is off the north west corner of the power station building), removed prior to 1997.

A 'boiler house' is referred to in the report as part of the power station but the boiler house is not clearly shown on the plans contained within the previous reports. On the south side of this house, bunded tanks were present which stored hydrochloric acid and caustic soda. Oil drums were also stored within the boiler house.

Washing down of equipment took place west of the main building.

The historical baseline investigation recorded elevated concentrations of arsenic, copper, lead, nickel, zinc, total petroleum hydrocarbons (TPH) and sulphates. From the Surrender investigation, the report states that only pH was greater than the levels recorded in the baseline investigation.

Semi volatile organic compounds (SVOCs) and polycyclic aromatic hydrocarbons (PAHs) were also recorded to be above detection limit in the Surrender investigation, but were not tested for within the baseline investigation.

The groundwater samples from this investigation recorded slightly elevated TPH, surfactants and pH than the baseline investigation.

Southern Half of Site

The lorry park is situated over two infilled reservoirs.

A bunded diesel tank and interceptor were present in the south east corner of the lorry park. The report also mentions two bunded above ground gas oil storage tanks south of the diesel tanks.

Within the 'lorry park' area, elevated concentrations of arsenic, copper, lead, mercury, nickel and zinc were found in the Surrender investigation, and a number of SVOCs were also recorded above the detection limit. Sulphates, PAH and TPH were also elevated.

The TPH was generally recorded around the tank in the south in this area. However, the previous report indicates that the type of TPH contamination recorded is more likely due to the former waste tip material than the diesel tank. Surface staining was however, noted around the tank, which the report states was removed prior to 1997.

Groundwater samples from this area recorded elevated heavy metals (zinc in particular) and also TPH in BH3. Samples obtained from wells BH8 to 11, installed further south, did not record hydrocarbon concentrations above the detection limit.

Asbestos containing material was noted on site, and asbestos fibres were recorded in the made ground in the former tip area.

Ground Gas

Deep made ground is present beneath the southern half of the site within the areas of the infilled reservoirs and spoil heap. This part of the site is classified as a historic landfill, dating from 1947 to 1991, accepting inert and industrial waste. At least two other landfills are shown to present within 250 m of the site. Elevated concentrations of carbon dioxide and methane were recorded from these areas, equivalent a Red gassing regime. The area surrounding the site also has a history of sandstone quarries, clay pits and spoil heaps.

4.2 Potential Pollutant Linkages

The following table details the possible sources and associated contaminants of concern, pathways and receptors, highlighted by the Phase 1 as potentially present.

Source	Pathways	Receptor
Made ground with possibly elevated concentrations of heavy metals/metalloids, PAH, TPH, SVOC, VOC, PCB	Ingestion, inhalation, direct contact Migration through ground	Future residents and visitors to the site Site construction workers Plants Secondary A aquifer and watercourse
Asbestos in made ground	Inhalation	Future residents and visitors to the site Site construction workers
Sulphates	Direct contact	Below ground concrete
PAH, TPH, SVOC, VOC, PCB	Direct contact	Water supply pipes
Ground gas	Inhalation Migration	Future residents Site construction workers Buildings

5.0 GROUND INVESTIGATION

5.1 Site Works

We visited site between 16 November and 5 December 2016 and carried out the following works:

- Twenty seven trial pits, TP1 to TP27, using a JCB 3CX type mechanical backhoe excavator to determine the underlying ground conditions. These reached depths of between 0.8 and 3.6 m below ground level (bgl);
- Five cable percussive boreholes, CP1 to CP5. These holes were taken to depths of between 4.45 and 11.45 m bgl. CP1 to CP3 were undertaken within the former reservoirs to determine the depth of made ground; CP4 was positioned in the west of the site near where a trial pit recorded soft natural ground and CP5 was located in the north of the site to obtain a strength profile of the ground. Five gas and groundwater monitoring wells were installed;
- Six window sample holes, WS1 to WS6, were undertaken to install a further six monitoring wells to depths of between 1.4 and 3 m bgl. Dynamic probes were carried out in WS1 and WS2, whilst SPTs were carried out in WS3 to WS6.

Copies of the exploratory hole logs are presented in Appendix 3, and their positions are plotted on the Exploratory Hole Location Plan, Drawing number 40361/001, in Appendix 1.

Six rounds of gas monitoring have been completed. The results are included in Appendix 6.

5.2 Laboratory Testing

Eight samples of natural clay were sent to Professional Soils Laboratory for plasticity testing. The geotechnical test results are presented in Appendix 4 and discussed further in Section 7.

Twenty one samples of made ground and six samples of natural ground were sent for chemical testing. The samples were taken in 500 g plastic tubs and 250 ml amber glass jars. All samples were analysed at Chemtest Limited, using MCERTs accredited methodologies where available. The chemical test results are presented in Appendix 5 and discussed further in Sections 8 and 9.

6.0 GROUND CONDITIONS

6.1 Surface Covering

The area of the former power plant is covered with reinforced concrete, with a general thickness of 0.35 m and locally thicker (to 0.4 and 0.5 m). The western part of the site is also covered with concrete, with a general thickness of 0.35 m. The south eastern part of the site is covered with compacted gravel. A small area of dense vegetation, with trees, covered with topsoil is present in the northern section of the site.

6.2 Made Ground

In the south eastern part of the site (lorry park area) made ground generally comprised a brown and dark brown sandy gravelly clay or sandy gravel of bricks, sandstone, mudstone, with metal and wood fragments. Cobbles and boulders of concrete were frequently encountered. The cable percussive boreholes found the made ground to between 3.6 and 6.5 m bgl. The historical boreholes recorded a maximum depth of made ground of 7.7 m. Standard Penetration Tests (SPTs) carried out within this material recorded N values of between 2 and 36.

Dynamic probes were also carried out in WS1 and WS2 within the made ground in the south eastern part of the site. WS1 refused at 3.6 m, finding soft to stiff ground above. Within WS2, interbedded soft, firm and stiff bands were found to around 5 m bgl, below which firm to stiff ground was found to around 10.9 m bgl where the probe refused. The base of the soft strata (3.5 m in WS1 and 5 m in WS2) is considered to be the base of the made ground.

Below the former power plant in the north east, made ground to depths of between 2 and 3 m was recorded. This made ground predominantly comprises firm to stiff gravelly clay with mudstone, brick, concrete and metal fragments.

Made ground comprising ashy gravelly sand with pockets of dark grey clay was recorded below the former diesel tanks south of the plant. This extended to a depth of 1.7 m with dark grey clay made ground below to around 2.5 to 3 m depth.

SPTs carried out within the north eastern quarter of the site recorded N values of between 15 and 17 within the made ground.

In the north western and south western parts of the site, made ground to depths of around 0.9 to 2.6 m bgl was found.

6.3 Natural Ground

In the south eastern part of the site (lorry park area) natural ground was recorded within the cable percussive boreholes below the made ground to depths of at least 10.45 and 11.45 m. This material was described as brown gravelly boulder clay with gravel and cobbles of sandstone. SPTs carried out within this material recorded N values of between 8 and 43, equivalent to firm to very stiff ground.

In the eastern and north eastern parts of the site, the natural ground was recorded at depths of between 2 and 3 m bgl and generally comprised firm gravelly clay.

In the western and south western parts of the site, natural firm clay was generally encountered below the made ground, although in some locations it was found to be soft. A cable percussive borehole in the area recorded an N value of 9 at 3 m bgl, equivalent to firm ground, increasing with depth to at least 50 at 7.8 m bgl.

In the north western end of the site, gravelly sand over red brown sandstone was recorded at a depth of about 1 m bgl.

6.4 Obstructions

Large parts of the site are covered with reinforced concrete. The buildings have been demolished with slabs and foundations still present. The tanks have been removed with concrete bases still in place in some locations. Old services are still present beneath the site, with several private pipes and underground channels expected in the north eastern part of the site.

Boulders of concrete / sandstone were recorded within the made ground in the south eastern part of the site. In addition within the central, south and north eastern parts of the site, concrete obstructions were encountered in some locations.

6.5 Groundwater

In a number of trial pits, a fast ingress of perched groundwater was encountered at depths of about 0.5 m bgl. These pits were mainly located in the central-western part of the site, west and north west of the former reservoirs. The same situation was encountered in TP18 excavated within the former power plant in the north east.

Shallow groundwater, from around 0.5 to 0.8 m, was recorded in wells WS6 and CP4 located in the mid-west of the site. Most of the other wells recorded groundwater from between 0.9 and 2.85 m bgl, with CP1's well (3.05 m deep) found to be consistently dry. A reading of 0.33 m was also recorded within one round of monitoring in WS5 but is thought to represent perched groundwater since the remaining rounds were recorded a dry well.

7.0 GEOTECHNICAL APPRAISAL

7.1 General

In the south eastern part of the site, made ground was recorded to be between 3.2 and 6.5 m. The historical investigations recorded a maximum depth of about 8 m. In the western and south western part of the site, the made ground extended to depths of around 0.9 to 2.6 m. Below the former power station in the north east, made ground was generally found to be between 2 and 3 m depth. Natural firm clay was generally encountered below, although in a number of locations it was found to be soft. In the north western corner of the site, natural gravelly sand over sandstone was recorded at a depth of about 1 m.

In a number of trial pits, fast ingresses of perched groundwater were encountered at depths of about 0.5 m. This was noted to the north and west of the reservoirs and in one trial pit located below the former power station.

Penetrometer readings equivalent to safe bearing capacities of 75 to 125 kN/m² were recorded in the firm clays. The lower readings could be attributed to the proportion of sand and gravel in the natural ground. A safe bearing capacity of 125 kN/m² is considered can be assumed for foundation design.

Eight samples of natural clay were tested. Modified plasticity indices ranged between 11.2 and 15.3%, equating to low volume change potential in accordance with the NHBC Standards.

7.2 Foundations

Although it is likely that levels will be regraded, due to the depth of made ground, presence of perched groundwater and the variation in the competency of the natural ground beneath, it is considered that the majority of the plots will need to be piled.

Trench fill foundations could be used for a number of plots towards the northern end of the site where shallow sandstone was found, and along the western site boundary where less than 2 m of made ground was found. Spread foundations should be taken through any made or soft ground into natural ground at a minimum depth of 750 mm, below the lowest of the existing or finished ground level.

In the north eastern quarter of the site, 2 to 3 m of made ground was encountered. If ground levels are to be lifted, piling may be more economic here too. Also a heavily reinforced slab was found at surface within part of this area, and other obstructions may be present at depth due to its former use as a 'power station'/engineering works. In the western area, ground conditions comprise around 2 m

of made ground but perched water was found to be very shallow at around 0.5 m. To prevent significant side collapse and pumping of excavations, piling may be more economic.

Once finished ground levels are known, and ideally during site clearance works, plot specific trial pits are recommended to confirm the most appropriate foundations in some areas.

Piles should be assumed to will need to be steel driven tubes, since obstructions are expected, and pre-digging at pile positions should be allowed for.

Spread foundations would need to be deepened in accordance with NHBC Standards Chapter 4.2 where in clay soils and within influence of trees. Heave precautions would not be required within the spread foundations since the clay is classified as low volume change potential, however, heave precautions would still be required for piled plots within influence of past or present trees.

Although two faults are inferred to underlie the northern half of the site, future movement is not expected. Additional measures are therefore not deemed necessary in the foundations.

7.3 Ground Floors

Precast concrete floors with an underlying void are considered to be required for all plots on site. The void height should be minimum 150 mm, increasing to 200 mm where heave precautions are required for piled plots, and where spread foundations are deepened over 1500 mm due to past or present tree influence.

7.4 Superstructure Precautions

Additional superstructure precautions due to the ground conditions are not considered to be required.

7.5 Settlement

To reduce the effects of the potential settlement of external areas in relation to the piled plots within made ground, extra facings, flexible service connections and generous falls on drain runs should be allowed for.

7.6 Excavation Problems and Obstructions

The western and north eastern parts of the site are covered with concrete, which is reinforced and 300 to 500 mm thick below the footprint of the former power plant. The concrete bases of a number of former tanks are still present on site. Significant breaking out will be required.

Boulders and cobbles of concrete or sandstone are expected within the made ground in the 'lorry park' area. Concrete obstructions were also encountered in a number of pits in the north eastern and southern parts of the site.

Services and drainage channels are present on site.

In a number of trial pits, mainly towards the central - western part of the site, fast ingresses of perched groundwater were encountered at depths of about 0.5 m.

If the historical wells are encountered these will need backfilling and capping.

The stability of any trenches is likely to be variable due to the presence of made ground and locally groundwater. Support will be required in accordance with current Health & Safety Regulations wherever access is required to trenches deeper than 1.2 m or less where there is risk of collapse.

7.7 Roads

A minimum CBR value of 2% is considered can be taken for road design, but the value will depend on whether the road is formed on natural material, made ground or subsequent engineered fill. The existing natural and made ground should be assumed to be frost susceptible requiring a minimum construction thickness of 450 mm.

It is recommended that CBR tests are undertaken at the actual formation level as work proceeds prior to construction so that more accurate CBR values can be obtained.

7.8 Slopes

The slopes on site should be assessed and taken into account within the proposed development. If ground levels are to be regraded, retaining walls, tanking and underbuild should be allowed for. Consideration of the offsite slopes may also be required, in particular along the south western boundary of the site.

7.9 Surface Water Drainage

Soakaways are not considered viable, due to the depth of the made ground, presence of shallow perched groundwater and cohesive natural ground.

8.0 REFINEMENT OF OUTLINE CONCEPTUAL MODEL

8.1 Source Characterisation

An outline conceptual model, detailing the possible sources and associated contaminants of concern, potential pathways and receptors identified in the Phase 1 is set out in Section 4.

This section of the report documents the works undertaken to obtain information to test and refine this model enabling a risk assessment to be produced and, where significant risks are expected, remediation recommendations.

8.2 Ground Gas

Eleven gas monitoring wells have been installed across the site. Six rounds of monitoring have been completed. The following results have been recorded:

- Maximum 15.1% methane, recorded in CP2 in the fourth round of monitoring. The other five rounds of monitoring recorded methane readings of between 6 and 12.4% in CP2. WS1 and WS2 also recorded slightly elevated methane concentrations in the 1st round initially of 1.6 and 2.3% respectively, dropping to zero in 13 and 8 seconds. All other readings in these wells on other rounds and in other wells were zero;
- Maximum 7.1% carbon dioxide within WS4 on the 6th round of monitoring. The other five concentrations recorded ranged between 2.5 and 4.9%. A second concentration was recorded over 5%. This was 5.4%, recorded in CP3 in the 4th round. Other concentrations from this well were recorded between 1 and 4%. Other wells recorded concentrations less than 5%;
- Oxygen concentrations generally ranging between 7 and 20%, with two wells, CP2 and CP5, recording lower concentrations of 1.1 and 3%;
- Maximum 0.7 l/hr flow in CP4 in the 1st round. All other flows were zero; and
- Shallow groundwater readings of between 0.5 and 0.85 in wells WS6 and CP4. Most of the other wells recorded groundwater from between 0.9 and 2.85 m bgl, with CP1's well (3.05 m deep) found to be dry. A reading of 0.33 m was also recorded within one round of monitoring in WS5 with the remaining rounds recording the well as dry at 1.58 m.

8.3 Evidence of Contamination

In the 2012 ERM investigation, the following evidence of potential contamination was found:

- SBH1 found an oily sheen on water and soil arising from 0.4 to 0.55 m bgl;

In this investigation, TP7 was excavated adjacent to SBH1's position. A hydrocarbon odour was noted between 0.4 and 0.8 m.

- SB8 found an 'iridescent sheen' and odour between 1.7 and 1.9 m bgl;

In this investigation, TP21 was excavated next to SB8. No visible or olfactory evidence of impacted ground was noted.

- TP1 recorded a grey/black silty clay pocket at 1.6 m bgl.

In this investigation, TP7, 8 and 12 were excavated within the vicinity of the 2012 TP1. Lenses of dark grey black clay were found between 0.8 and 2.4 m in TP12, but no visible or olfactory evidence of impacted soils was noted.

- TP3 found a slight hydrocarbon odour at 1.3 m.

In this investigation, TP1 was excavated next to TP3. No visible or olfactory evidence of impacted soils was noted.

- Strong hydrocarbon odour in purged water from monitoring well BH4 (1997), located near the tank in the south of the site.

In this investigation, CP1 was drilled next to BH4. No visible or olfactory evidence of impacted soils was noted.

- Asbestos fibres were recorded in the made ground in the 1997 investigation in 7 out of 10 samples screened.

Within the exploratory holes in this investigation, the upper 1.7 m of made ground in TP4, excavated below the former diesel tanks in the north eastern part of the site was found to be ashy.

8.4 Chemical Testing

Twenty samples of made ground, one sample of topsoil and six samples of natural ground were sent for chemical testing.

Each of the samples was analysed for the suite of contaminants listed in the table below:

Contaminant Type	Actual Contaminants
Metals/Metalloids	Arsenic, cadmium, chromium (III and VI), lead, mercury, nickel, selenium, copper and zinc
pH	pH
PAHs	Speciated Polycyclic Aromatic Hydrocarbons
Sulphates	Water soluble sulphate, acid soluble sulphate and sulphur

The topsoil and made ground samples were also tested for an asbestos screen.

Thirteen samples of made ground collected in the vicinity of the former tanks, in locations where TPH was found to be elevated locally and where a hydrocarbon odour was noted were tested for fully fractionated petroleum hydrocarbons with an aliphatic and aromatic split (TPH CWG). Seven of these samples were also tested for BTEX.

Two samples of made ground (TP6 0.3 m, located near western site boundary, and TP19 0.7 m, located in the north eastern quarter of the site) were tested for SVOCs and VOCs.

One sample of made ground collected from the former power plant area was also tested for PCBs.

Six samples of made ground and two samples of natural ground were tested for Total Organic Carbon.

Four samples of made ground were tested for heavy metals and PAH leachability and one sample of made ground collected from below the former diesel tanks in the north east was tested for TPH leachability.

8.5 Assessment Criteria

The proposed development of the site is for residential properties with private gardens. Therefore the assessment criteria relating to a residential with home-grown produce end use have been used. Tables detailing the relevant assessment concentrations used are included in Appendix 5.

The eluate results have been compared against EQS Freshwater Standards, where available. The laboratory detection limit will be used elsewhere.

8.6 Chemical Test Results

8.6.1 Topsoil

One sample of topsoil, S1, collected from the northern site boundary did not record any elevated concentrations above the assessment criteria, or any asbestos fibres.

8.6.2 Made Ground

Six samples of made ground were tested for Total Organic Carbon and recorded values between 0.77 and 26%, with an average of 6.7%. This equates to 11.6% soil organic matter (SOM). Assessment criteria derived using 6% SOM have therefore been used.

The following table depicts the concentrations of contaminants that were found to be elevated within the samples of made ground tested:

Contaminant	Assessment Value – Human mg/kg	Elevated Concentrations mg/kg
Arsenic	37	40
Lead	200	2500, 370, 210, 5400, 2200
Benzo(a)anthracene	13	41
Chrysene	27	45
Benzo(b)fluoranthene	3.7	4, 48, 7.5
Benzo(a)pyrene	3.0	3.6, 44, 6.1
Dibenz(a,h)anthracene	0.3	7, 0.33

Contaminant	Assessment Value – Plant mg/kg	Elevated Concentrations mg/kg
Lead	300	2500, 370, 5400, 2200
Copper	200 pH>7.0	750, 750
Nickel	110 pH>7.0	130
Mercury	1	1.1
Zinc	300 pH>7.0	1700, 360, 1700, 310

One sample of made ground, collected in the area of the former diesel tanks in the north eastern part of the site recorded an elevated aromatic hydrocarbon fraction C21 to 35 of 9500 mg/kg compared with the assessment value of 1700 mg/kg.

None of the SVOCs, VOCs or PCBs were recorded above the detection limit.

Chrysotile or amosite asbestos fibres were found in four samples of made ground collected from TP7, TP8, TP12 (all located below the former power station) and TP25 (located south west of the lorry park). Quantification tests recorded between <0.001% and 0.25%.

8.6.3 Natural Ground

One sample of natural clay collected from TP4, excavated below the former diesel tanks in the north eastern part of the site, recorded an elevated concentration of lead of 500 mg/kg compared with the generic assessment value of 200 mg/kg for human health and 300 mg/kg for plants.

8.6.4 Sulphates

The site has been taken as a brownfield location in relation to the Aggressive Chemical Environment for Concrete classifications and groundwater is assumed to be mobile.

Made Ground

The total potential sulphate concentrations were found to be between 0.03% and 1.89%. A characteristic value of 1.28% can be calculated.

Water soluble sulphates ranged between <0.01 g/l and 0.95 g/l. A characteristic value of 0.5 g/l can be calculated.

pH values ranged between 7.2 and 10.7.

Natural Ground

The natural ground recorded total potential sulphates of between 0.03% and 0.48%. A characteristic value of 0.29% can be calculated.

All water soluble sulphate concentrations were below 0.01 g/l.

pH values ranged between 6.3 and 8.7. A characteristic value of 7.1 can be calculated.

8.6.5 Eluates

Most of the samples recorded copper, lead and zinc concentrations exceeding the lower end of assessment range, as shown in the table below:

Contaminant	Assessment Value µg/l	Concentrations µg/l
Copper	1 to 28	12, 14, 7.8, 9.1
Lead	4 to 250	2.1, 4.6, 5.7, 47, 13
Zinc	8 to 500	26, 390, 21, 12

The concentrations of TPH and PAHs were found to be below the detection limit.

8.7 Significant Pollutant Linkages

The significant pollutant linkages consequently identified are documented in the table below.

Source	Pathways	Receptor
Made ground with heavy metals/metalloids, PAH TPH in the area of former tanks in the north eastern part of the site	Ingestion, inhalation, direct contact Migration through ground	Future residents and visitors to the site Site construction workers Plants Secondary A aquifer and watercourse
Sulphates	Direct contact	Below ground concrete
Asbestos in made ground	Inhalation	Future residents and visitors to the site Site construction workers
PAH in made ground, TPH in the location of the former diesel tanks	Direct contact	Water supply pipes
Ground gas	Inhalation Migration	Future residents Site construction workers Buildings

9.0 RISK ASSESSMENT

9.1 Human Health – Construction Workers

Ground workers employed during the construction phase of the development are most at risk of harm due to them having direct contact with the affected soils. However, the contact is generally of short duration, and all competent ground workers will be aware of the potential risks associated with made ground. Therefore, the overall risk to the health of construction workers is considered to be low.

Normal site procedures such as the wearing of gloves when handling soils, and the washing of hands prior to eating should be implemented.

Any unusual, brightly coloured, ashy or odorous material or material suspected of containing asbestos encountered during construction should be brought to the attention of the site staff and investigated.

9.2 Human Health – Future Residents and Visitors

Made Ground

Elevated concentrations of arsenic, lead and PAHs were recorded within the made ground. In particular, lead was found to be significantly elevated in shallow soils below former locations of tanks in the north eastern and south eastern parts of the site.

Asbestos fibres, comprising chrysotile or amosite, were identified in four samples of made ground collected from the south eastern part of the site and the power plant area in the north east. Asbestos was also recorded within the made ground during the previous investigation in 1997. The topographical survey also notes 'asbestos' in the south eastern part of the site. No asbestos was identified visually during this site investigation.

Any visible fragments of asbestos containing material should be hand-picked and removed from site by a specialist contractor.

It is considered that a 600 mm capping layer should be placed in all gardens and areas of soft landscaping over made ground, mitigate risks to human health post construction.

Very little topsoil exists on site. Clean, inert topsoil will therefore need to be imported for use in the capping layer.

Natural Ground

An elevated lead concentration of 500 mg/kg was also identified within a sample of natural clay in the location of the former diesel tanks in the north east. Any gardens and landscaped areas overlying this part of the site will already be capped with 600 mm of clean cover due to the level of contamination recorded in the made ground. No further remedial measures are therefore considered to be necessary.

Former Tank Positions

One sample of made ground, collected in the area of the former diesel tanks in the north eastern part of the site recorded an elevated aromatic hydrocarbon fraction C21 to 35 with 9500 mg/kg compared with the assessment value of 1700 mg/kg. Elevated lead was also found below a number of former tank positions.

The 600 mm of clean cover recommended in gardens and landscaped areas is considered to be sufficient for the hydrocarbon contamination encountered. The elevated aromatic carbon fraction C21-35 is not considered to be volatile, consequently there is no significant inhalation risk and further remedial measures are not considered to be required.

However, unrecorded underground tanks or hydrocarbon impacted perched water (e.g. with an oily sheen) may be encountered in areas of the site. Any underground fuel tanks should be removed by a specialist contractor, and any impacted material around removed or remediated. Remediation of the water may also be required, for example with hydrophobic pillows.

9.3 Plants

Several heavy metals were found to be above the assessment values of phytotoxicity for plants. It is considered that the 600 mm capping layer proposed will mitigate any significant risks posed to plants.

9.4 Construction Materials

The chemical test results indicate that DS-4 AC-4 sulphate precautions should be provided in concrete in contact with the made ground. This correlates with the findings of the previous investigation.

For concrete in contact only with the natural ground, DS-2 AC-2 precautions are considered to be applicable.

Elevated PAH and TPH concentrations were recorded. The chemical test results should be sent to the water supplier to confirm the type of supply pipe required for the development.

9.5 Controlled Waters

Elevated hydrocarbon concentrations were recorded around the tank in the south eastern part of the site in one of the historical investigations. However, this was not found to be extensive and the 2013 report concluded that the tank did not have a significant impact on local groundwater quality. In addition, the historical Phase 1 report notes that the stream in the south of the site was tested as part of the 1997 investigation and gave no indication that the tipping area was contaminating the watercourse.

Leachability testing for PAHs and TPH was undertaken on three samples of made ground and PAH testing only on one sample of made ground, collected from TP1, TP4, TP5 and TP25, located below or adjacent to former tank positions. None of the concentrations exceeded the laboratory's detection limit.

Heavy metal leachability testing was also undertaken and concentrations of copper, lead and zinc were generally found to be elevated above the lower assessment threshold.

The elevated heavy metals recorded in the made ground are not particularly mobile, as indicated by the lack of elevated metals in the underlying natural ground, except in one location – TP4, where lead was found to be elevated in a sample of natural ground. The lead eluate from this sample was recorded to be 5.7 µg/l, which very slightly exceeds the lower EQS Freshwater threshold of 4 µg/l. The sample of natural ground was taken from just below the base of the made ground. The underlying boulder clay is expected to hinder any deeper migration of contamination.

The overall risk to controlled waters is therefore considered to be low.

9.6 Ground Gas

No radon measures are required.

Within the 1997 investigation 'soil probing results' were obtained from TP1 to TP17 from depths of between 0.8 and 1.5 m. These were completed within the landfill in the south of the site. The following results were recorded:

- TP1, 2, 10 and 11 recorded methane above the 0.1% detection limit with concentrations of 2.5, 3, 1.1 and 1.8%;
- Carbon dioxide concentrations ranged between 0.1 and 9%.

Also within the 1997 investigation five boreholes, BH1 to BH5, were monitored. These wells were also installed within the landfill. The following results were recorded across three monitoring rounds:

- Maximum 36.3% methane, recorded in BH2. This well recorded concentrations of 33.3 and 31.4% on the other two rounds. Other wells recorded concentrations of between <0.1 and 12.2%;
- Maximum 18.2% carbon dioxide, recorded in BH2. This well recorded concentrations of 17.1 and 17.5% on the other two rounds. Other wells recorded concentrations of between 2.1 and 15.6%; and
- Groundwater was found in BH1 and BH3 at around 4 to 4.6 m bgl.

The maximum methane concentration of 36.3% is equivalent to 'Red' in accordance with the Traffic Light System as detailed in C665. The lower threshold of Red is 20%. The maximum carbon dioxide concentration recorded in 1997 is equivalent to Amber 2.

Monitoring wells were installed within the landfill area in CP1 to CP3, WS1 and WS2 and were monitored on six occasions over a period of seven months. A maximum methane concentration of 15.1% and carbon dioxide of 4.9% was recorded within these wells, which are both significantly lower than those concentrations recorded in 1997. No flows were recorded in these wells during the six visits undertaken.

Gas screening values (GSVs) can be calculated using a flow of 0.1 l/hr, the minimum flow detected by the gas monitor. Using the maximum concentrations, GSVs of 0.015 and 0.005 l/hr are calculated for methane and carbon dioxide respectively. These GSVs equate to Green or Characteristic Situation 1 in accordance with C665.

However, the maximum concentration of methane (15.1%) recorded equates to Amber 2 classification, whilst the maximum concentration for carbon dioxide (4.9%) equates to Green. It is considered that it would be prudent to allow for Amber 2 gas precautions for plots overlying the landfill (around 40% of the site).

Amber 2 gas precautions would include a fully lapped and sealed proprietary gas membrane that is resistant to methane and carbon dioxide, and the provision of a minimum 150 mm high ventilated void below the ground floor slab. The installation would require independent certification/integrity testing.

Monitoring wells installed across the rest of the site in CP4 and CP5, WS3 to WS6 were also monitored on six occasions. No steady methane concentrations were detected alongside a maximum carbon dioxide concentration of 7.1% and a maximum flow rate of 0.7 l/hr. A carbon dioxide GSV of 0.05 l/hr can be calculated which equates to Green (and Characteristic Situation 1) in accordance with C665, however the maximum concentration of 7.1% recorded equates to Amber 1.

Amber 1 gas precautions should be allowed for the rest of the plots, which includes a fully lapped and sealed proprietary gas membrane that is resistant to methane and carbon dioxide, and the provision of a minimum 150 mm high ventilated void below the ground floor slab.

The Site Investigation carried out in 2012 by ERM, detected SVOC's within the made ground, in a number of location in the north eastern and south eastern parts of the site.

Within the 1997 investigation, a number of made ground samples in the landfill recorded naphthalene concentrations: 4.1 mg/kg (TP11 1.9 m), 3.2 mg/kg (TP14 1.5-2 m), 11.2 mg/kg (BH1 5.1-5.6 m) and 5.65 mg/kg (BH2 4.1-4.6 m).

Within the 2012 investigation, made ground samples from TP2, TP3 and SB3 recorded a number of concentrations exceeding the detection limit for compounds such as carbazole, dibenzofuran, 2-methylphenol, 4-methylphenol, 2,4-dimethylphenol and phenol. These holes are located near to former tank positions. One sample of natural ground from SB3, taken from just below the made ground interface, and one sample taken from the made ground/natural ground interface in SB8 (located along the north western site boundary) also both recorded elevated concentrations of carbazole and dibenzofuran.

Carbazole and dibenzofuran are associated with fuel. The samples where these SVOCs were recorded above the detection limit were taken from below or near to former tank positions. In this investigation, the samples tested for TPH and CWG and speciated PAH from the same locations did not record elevated concentrations of volatile carbon fractions or naphthalene.

The assessment value (derived using 1% soil organic matter) for phenol is 280 mg/kg. The concentrations recorded in 2012 are significantly below this, ranging between 0.05 to 0.18 mg/kg.

Based on the results recorded in the most recent site investigations, the gas membrane is not considered to be required to be suitably resistant to volatile hydrocarbons, unless areas of unexpected hydrocarbon soils are found.

9.7 Disposal of Material

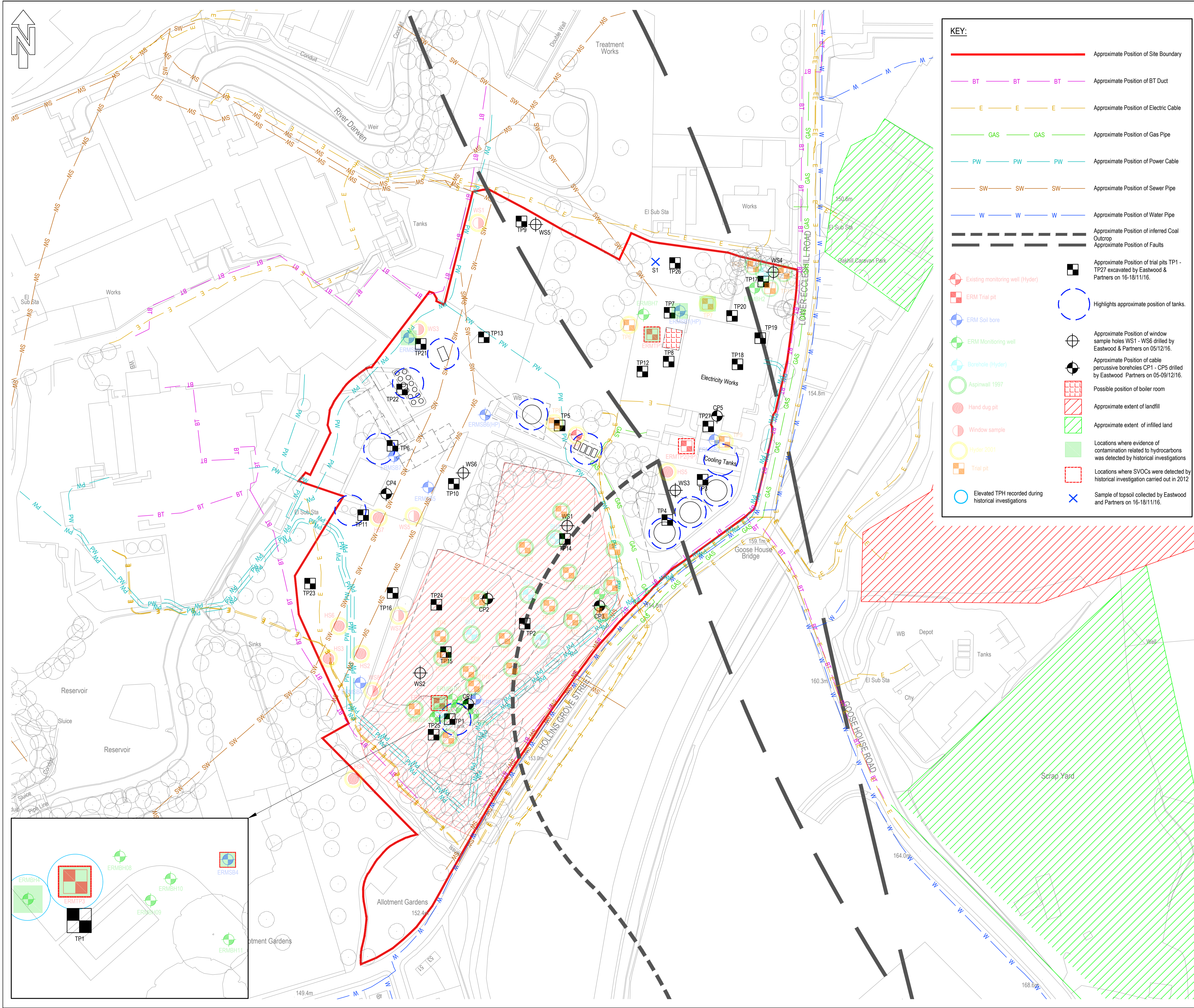
If material needs to be removed, it should to be taken to a suitably licensed landfill or waste treatment facility. The costs of disposal and landfill tax can be substantial. The disposal of material should therefore be seen as a last resort with options such as treatment and reuse either on-site or off-site considered where possible.

The category of landfill which can accept the waste (inert, non-hazardous or hazardous) would need to be determined and will also have a significant effect on the costs. Additional testing may be required by the landfill operator and the acceptance of material is generally at their discretion.

Appendix 1

Exploratory Holes Location Plan, Drawing Number 40631/001A

NOTES



KEY:

- Approximate Position of Site Boundary
- BT — BT — BT Approximate Position of BT Duct
- E — E — E Approximate Position of Electric Cable
- GAS — GAS — GAS Approximate Position of Gas Pipe
- PW — PW — PW Approximate Position of Power Cable
- SW — SW — SW Approximate Position of Sewer Pipe
- W — W — W Approximate Position of Water Pipe
- - - - - Approximate Position of inferred Coal Outcrop
- - - - - Approximate Position of Faults
- Existing monitoring well (Hydr) ■ Approximate Position of trial pits TP1 - TP27 excavated by Eastwood & Partners on 16-18/11/16.
- ERM Trial pit ○ Highlights approximate position of tanks.
- ERM Soil bore ⊕ Approximate Position of window sample holes WS1 - WS6 drilled by Eastwood & Partners on 05/12/16.
- ERM Monitoring well ⊙ Approximate Position of cable percussive boreholes CP1 - CP5 drilled by Eastwood & Partners on 05-09/12/16.
- Borehole (Hydr) ■ Possible position of boiler room
- Aspinwall 1997 ■ Approximate extent of landfill
- Hand dug pit ■ Approximate extent of infilled land
- Window sample ■ Locations where evidence of contamination related to hydrocarbons was detected by historical investigations
- Hydr. 2001 ■ Locations where SVOCs were detected by historical investigation carried out in 2012
- Trial pit x Sample of topsoil collected by Eastwood and Partners on 16-18/11/16.
- Elevated TPH recorded during historical investigations

A	First Issue.			
REV	DESCRIPTION	SIG	CHK	DATE

GLEESON DEVELOPMENTS

HOLLINS ROAD, DARWEN

EXPLORATORY HOLE LOCATION PLAN

Eastwood & Partners
CONSULTING ENGINEERS

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23 Kingfield Road
Sheffield
S11 9AS
Tel 0114 255 4554
Fax 0114 255 4330

mail@eastwoodandpartners.com
www.eastwoodandpartners.com

SCALE WHEN PLOTTED AT A1		DRAWING STATUS	
1:1000		INFORMATION	
DRAWN	CHECKED	DATE	DRAWING NUMBER
JRB/JL	MM	14.12.16	40361/001
REV			A

Appendix 2

Envirocheck Coal Authority Mining Report

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		Minor Roads		
	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				
	County Borough Boundary (England)				
	County Burgh Boundary (Scotland)				
	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		Glasshouse
	Sloping Masonry		Pylon
	Electricity Transmission Line		Pole
	Cutting		Embankment
	Standard Gauge Multiple Track		
	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
	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)
	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

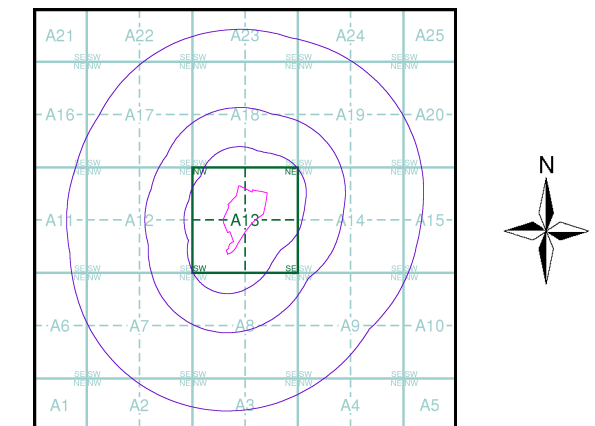
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Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Lancashire And Furness	1:10,560	1849	3
Lancashire And Furness	1:10,560	1894 - 1895	4
Lancashire And Furness	1:10,560	1912 - 1913	5
Lancashire And Furness	1:10,560	1931 - 1932	6
Lancashire And Furness	1:10,560	1931	7
Lancashire And Furness	1:10,560	1938	8
Ordnance Survey Plan	1:10,000	1955 - 1956	9
Ordnance Survey Plan	1:10,000	1965 - 1967	10
Ordnance Survey Plan	1:10,000	1972 - 1977	11
Ordnance Survey Plan	1:10,000	1972	12
Blackburn	1:10,000	1974	13
Ordnance Survey Plan	1:10,000	1982 - 1988	14
Ordnance Survey Plan	1:10,000	1993	15
10K Raster Mapping	1:10,000	2001	16
10K Raster Mapping	1:10,000	2006	17
VectorMap Local	1:10,000	2016	18

Historical Map - Slice A



Order Details

Order Number: 106427401_1_1
 Customer Ref: 40361
 National Grid Reference: 368930, 423680
 Slice: A
 Site Area (Ha): 6.17
 Search Buffer (m): 1000

Site Details

12 Hollins Grove Street, DARWEN, Lancashire, BB3 1HG

Landmark
 INFORMATION GROUP

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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		Natural Gas Tank
	Tailings Pile		Fuel Storage Tanks
	Bench Mark		Drill Hole
	Burial Mound		Triangulation Point on Burial Mound
	Single-track Railroad		Double-track Railroad
	Small Bridge		Tunnel
	Pipe (Culvert)		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
180/12 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
	Cut		Fill
	Km Post		Plantings
	Telegraph/Telephone Lines		Main Highway
	Highway under Construction		Improved Dirt Road (former truck road)
	Small Bridge		Pipe (Culvert)
	Tunnel		Dismantled Railroad
	Double-track Railroad with First Class Station		Railroad Under Construction
	Shore Embankment		River or Ditch with Embankment
	Water Reservoir or Rain Water Pit		Spring
	Well		Isobath with value
	Heavy (Index) Contour Line		Half Contour Line
	Contour Line and Value		Spot Elevation Value
	Coniferous		Deciduous
	Mixed		Scrub

Key to Numbers on Mapping

SD62SE_Blackburn

No.	Description
25	Foundry (Cast Iron)
48	Factory (Paper)
55	Factories (Use Unknown)

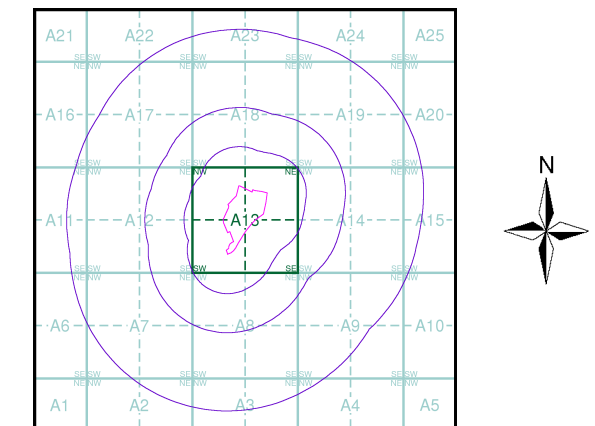
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Historical Mapping & Photography included:

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Lancashire And Furness	1:10,560	1894 - 1895	4
Lancashire And Furness	1:10,560	1912 - 1913	5
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Lancashire And Furness	1:10,560	1931	7
Lancashire And Furness	1:10,560	1938	8
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10K Raster Mapping	1:10,000	2001	16
10K Raster Mapping	1:10,000	2006	17
VectorMap Local	1:10,000	2016	18

Russian Map - Slice A



Order Details

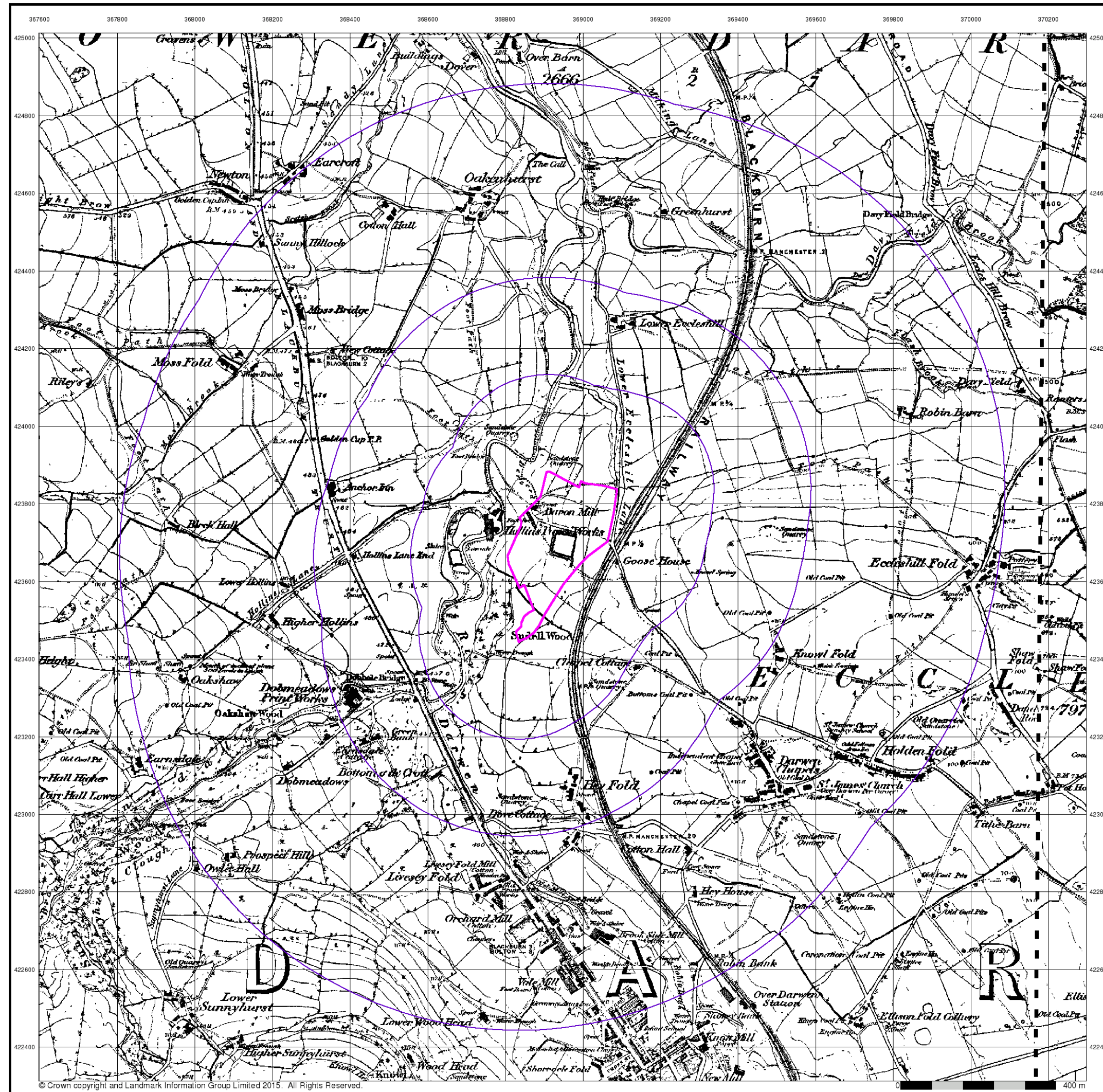
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 Search Buffer (m): 1000

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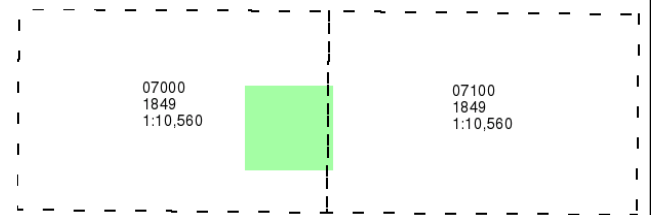
Lancashire And Furness

Published 1849

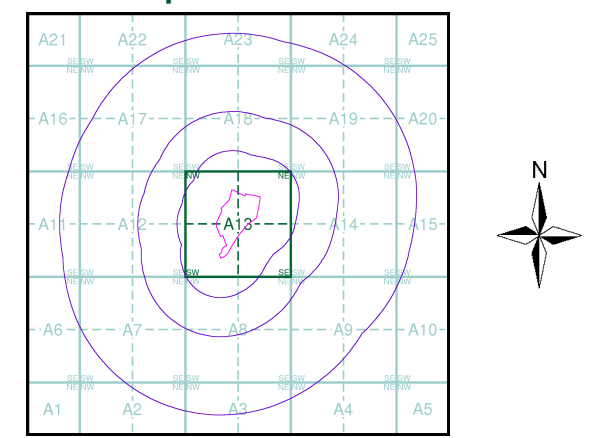
Source map scale - 1:10,560

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

Map Name(s) and Date(s)



Historical Map - Slice A



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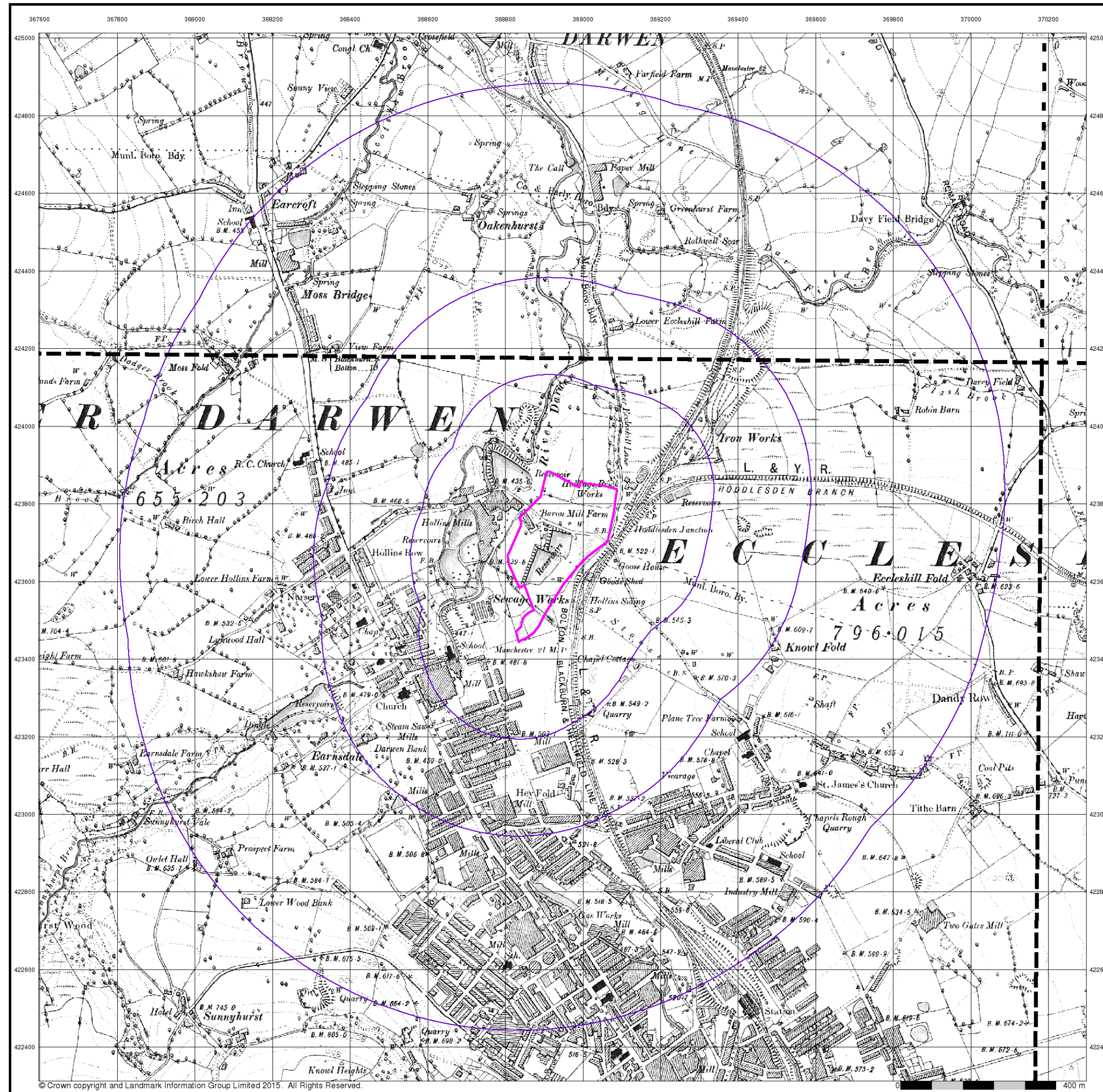
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Lancashire And Furness

Published 1894 - 1895

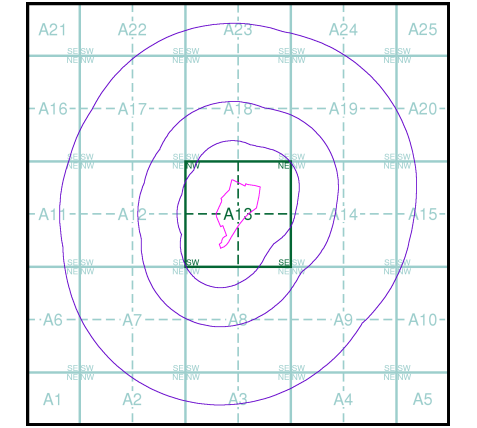
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Map Name(s) and Date(s)

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070SE 1894 1:10,560	071SW 1894 1:10,560

Historical Map - Slice A



Order Details

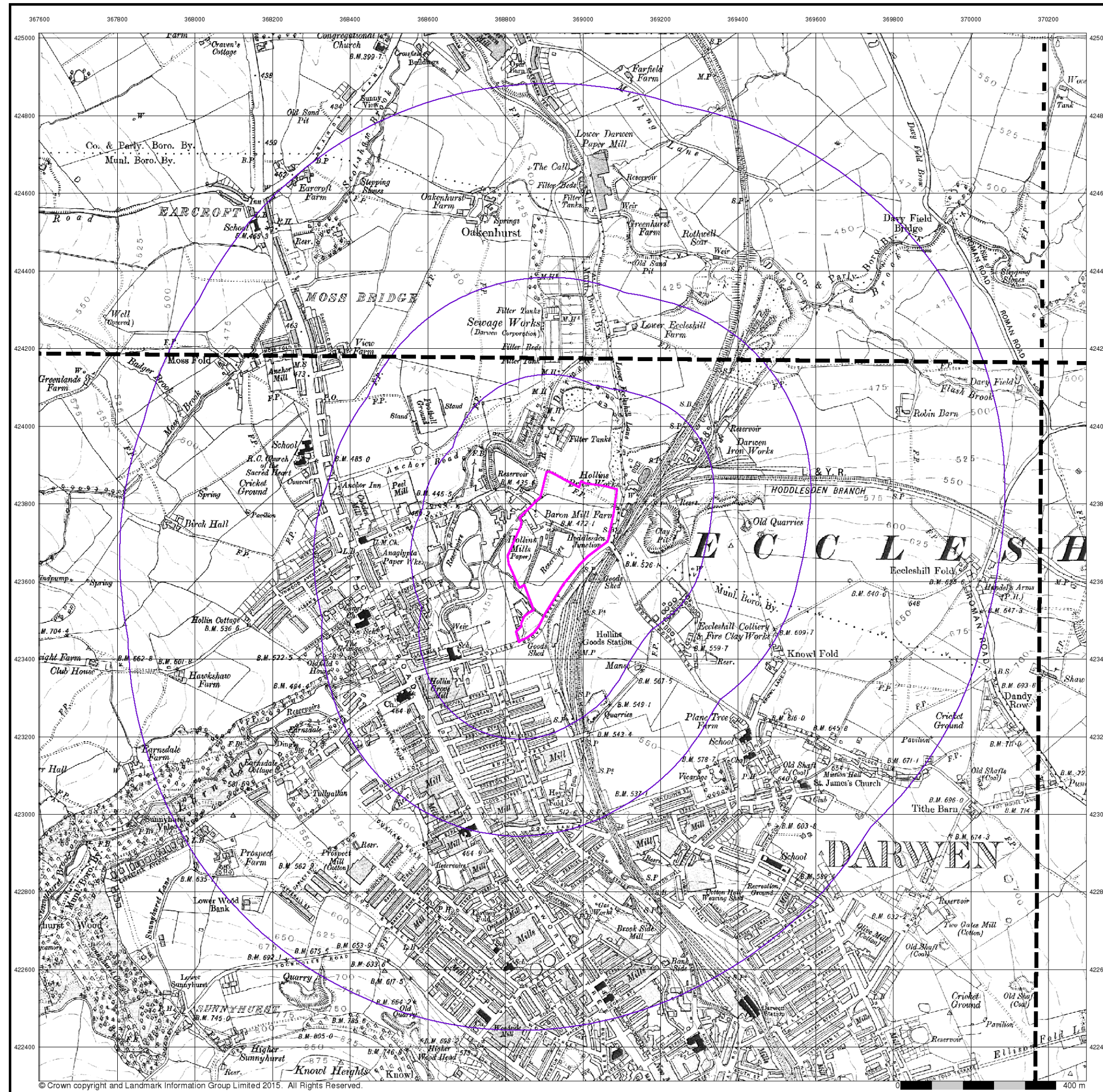
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 Search Buffer (m): 1000

Site Details

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Lancashire And Furness

Published 1912 - 1913

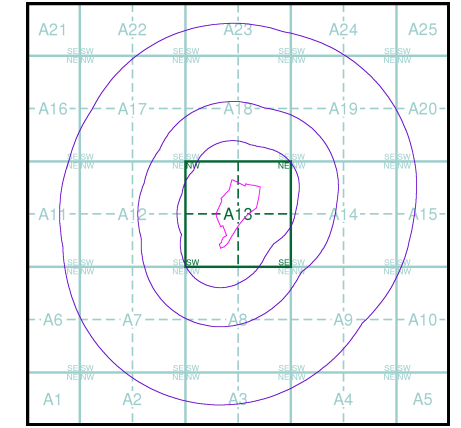
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Map Name(s) and Date(s)

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070SE 1913 1:10,560	071SW 1912 1:10,560

Historical Map - Slice A



Order Details

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 National Grid Reference: 368930, 423680
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 Site Area (Ha): 6.17
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Site Details

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Lancashire And Furness

Published 1931 - 1932

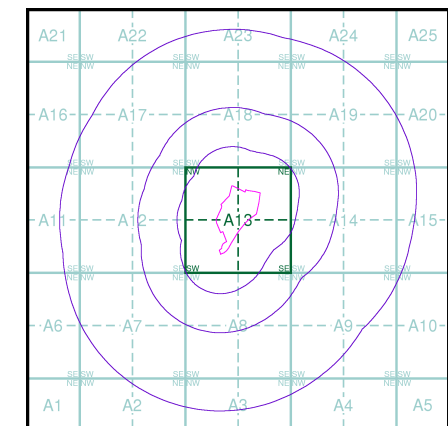
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Map Name(s) and Date(s)

070NE 1932 1:10,560	071NW 1931 1:10,560
070SE 1931 1:10,560	071SW 1931 1:10,560

Historical Map - Slice A

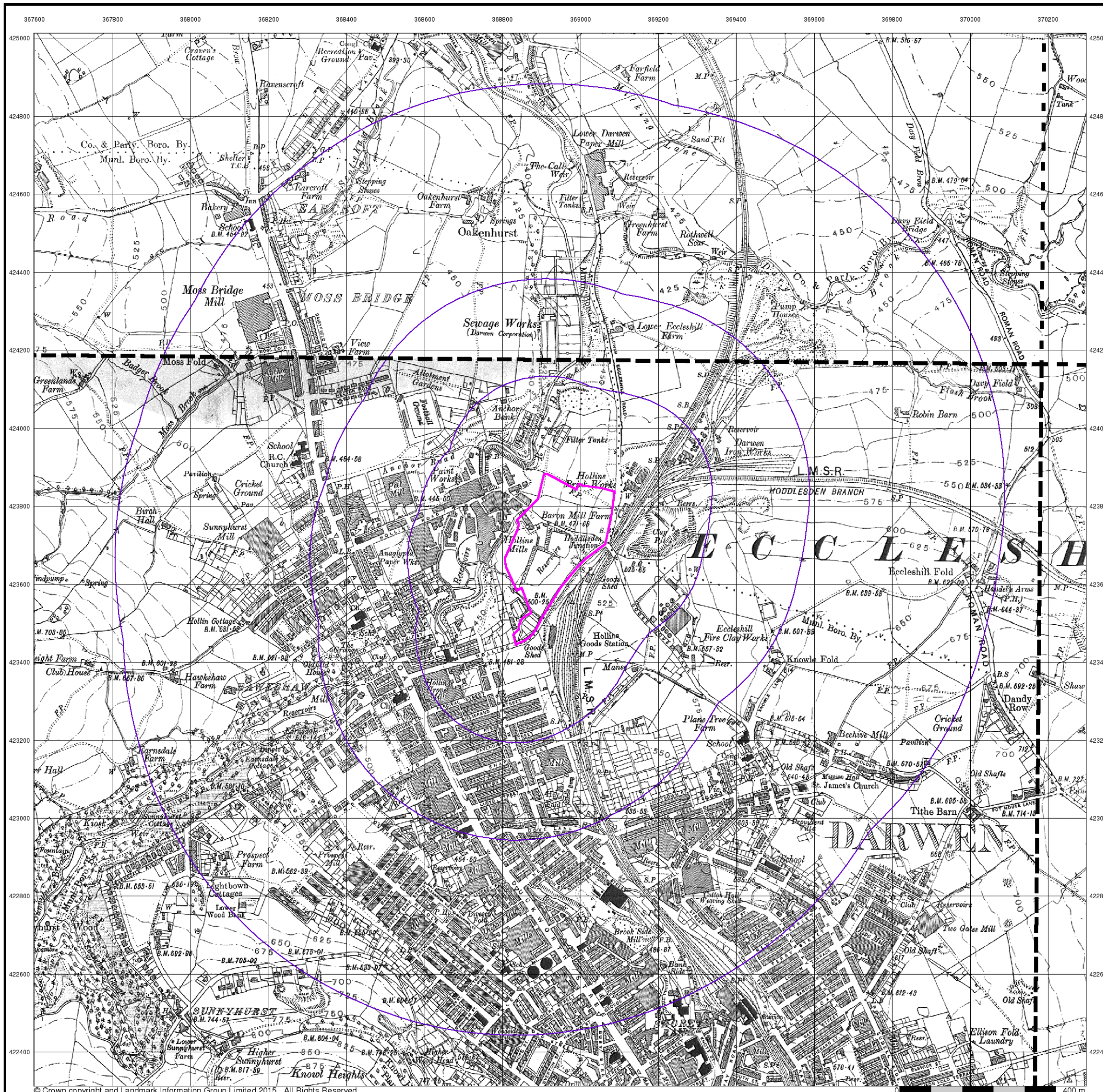


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Site Details

12 Hollins Grove Street, DARWEN, Lancashire, BB3 1HG



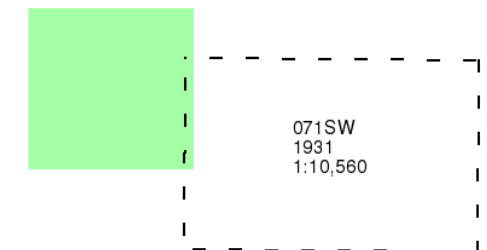
Lancashire And Furness

Published 1931

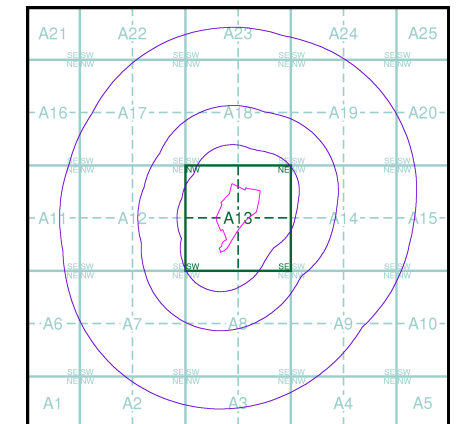
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Map Name(s) and Date(s)



Historical Map - Slice A

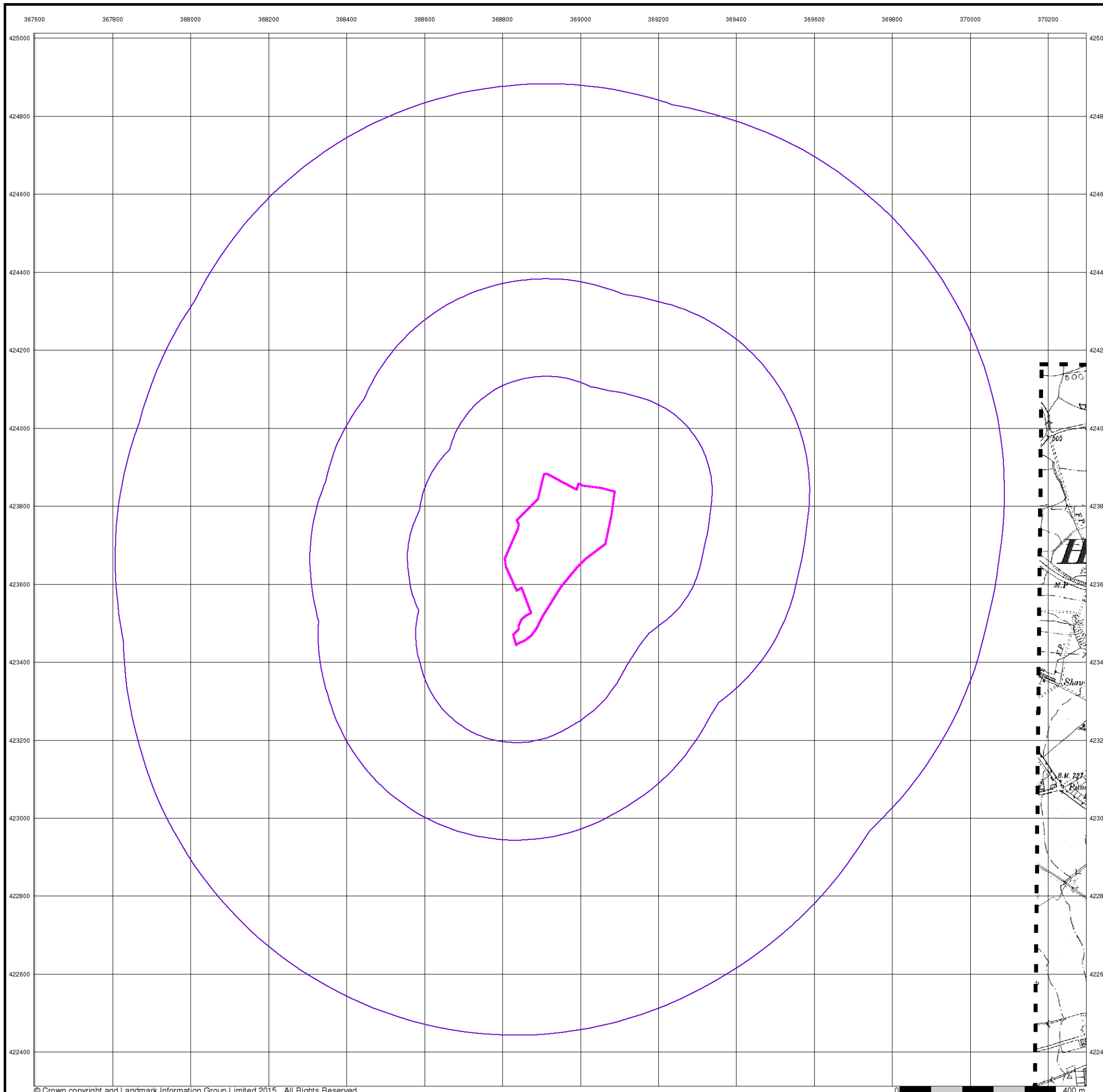


Order Details

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Customer Ref: 40361
National Grid Reference: 368930, 423680
Slice: A
Site Area (Ha): 6.17
Search Buffer (m): 1000

Site Details

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Lancashire And Furness

Published 1938

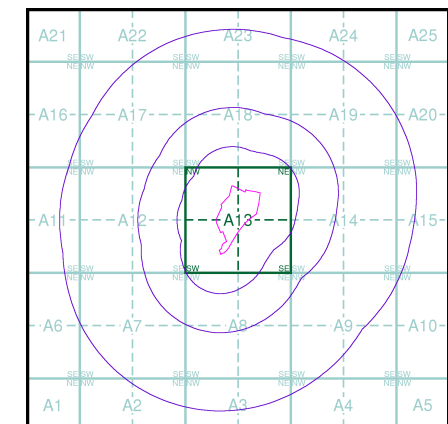
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Map Name(s) and Date(s)

070NE 1938 1:10,560	071NW 1938 1:10,560
070SE 1938 1:10,560	071SW 1938 1:10,560

Historical Map - Slice A



Order Details

Order Number: 106427401_1_1
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 Search Buffer (m): 1000

Site Details

12 Hollins Grove Street, DARWEN, Lancashire, BB3 1HG



Ordnance Survey Plan

Published 1955 - 1956

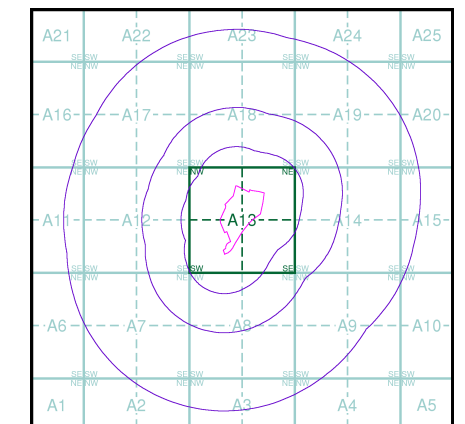
Source map scale - 1:10,000

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

Map Name(s) and Date(s)

SD62NE	SD72NW
1956	1956
1:10,560	1:10,560
SD62SE	SD72SW
1956	1955
1:10,560	1:10,560

Historical Map - Slice A

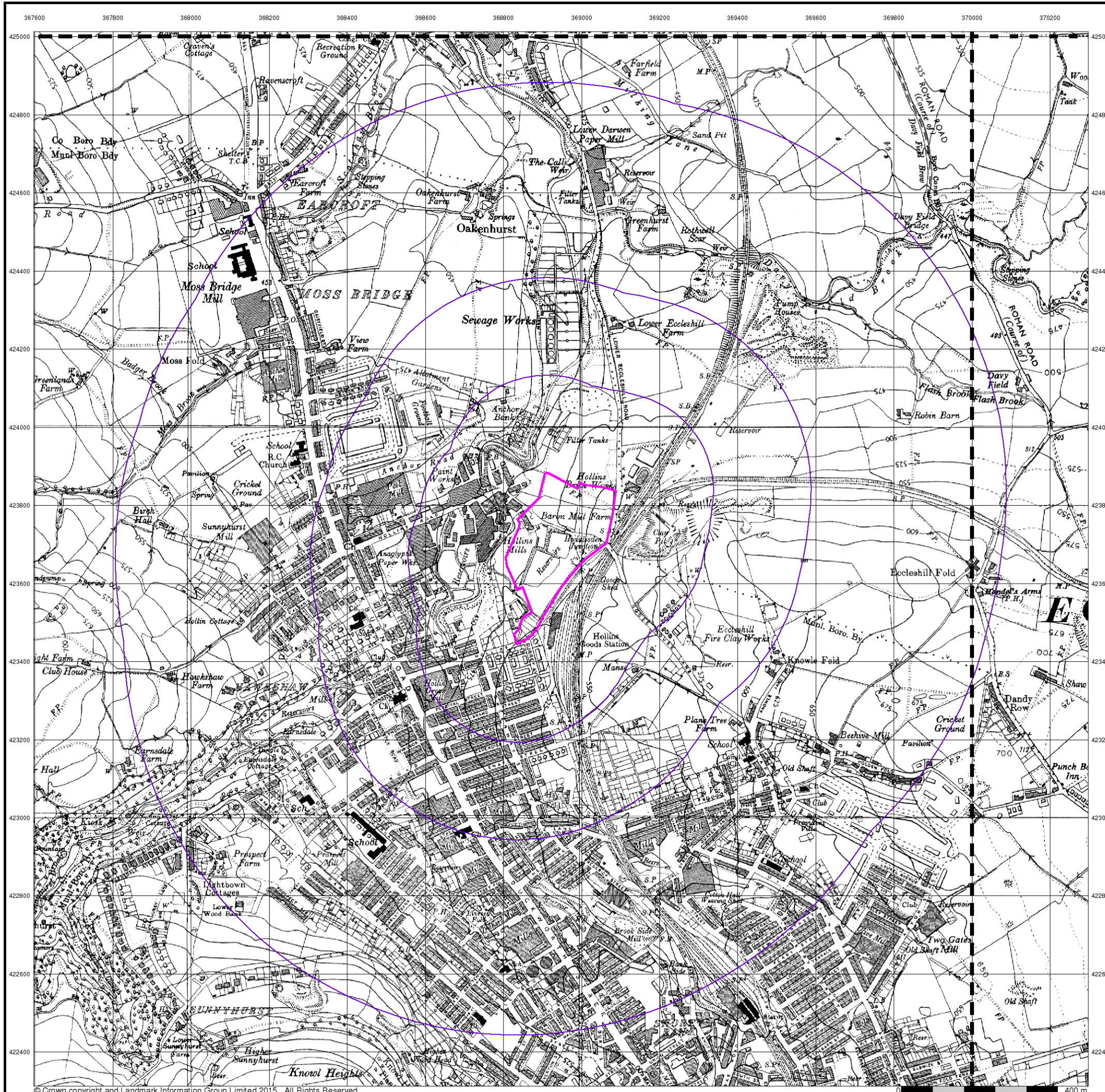


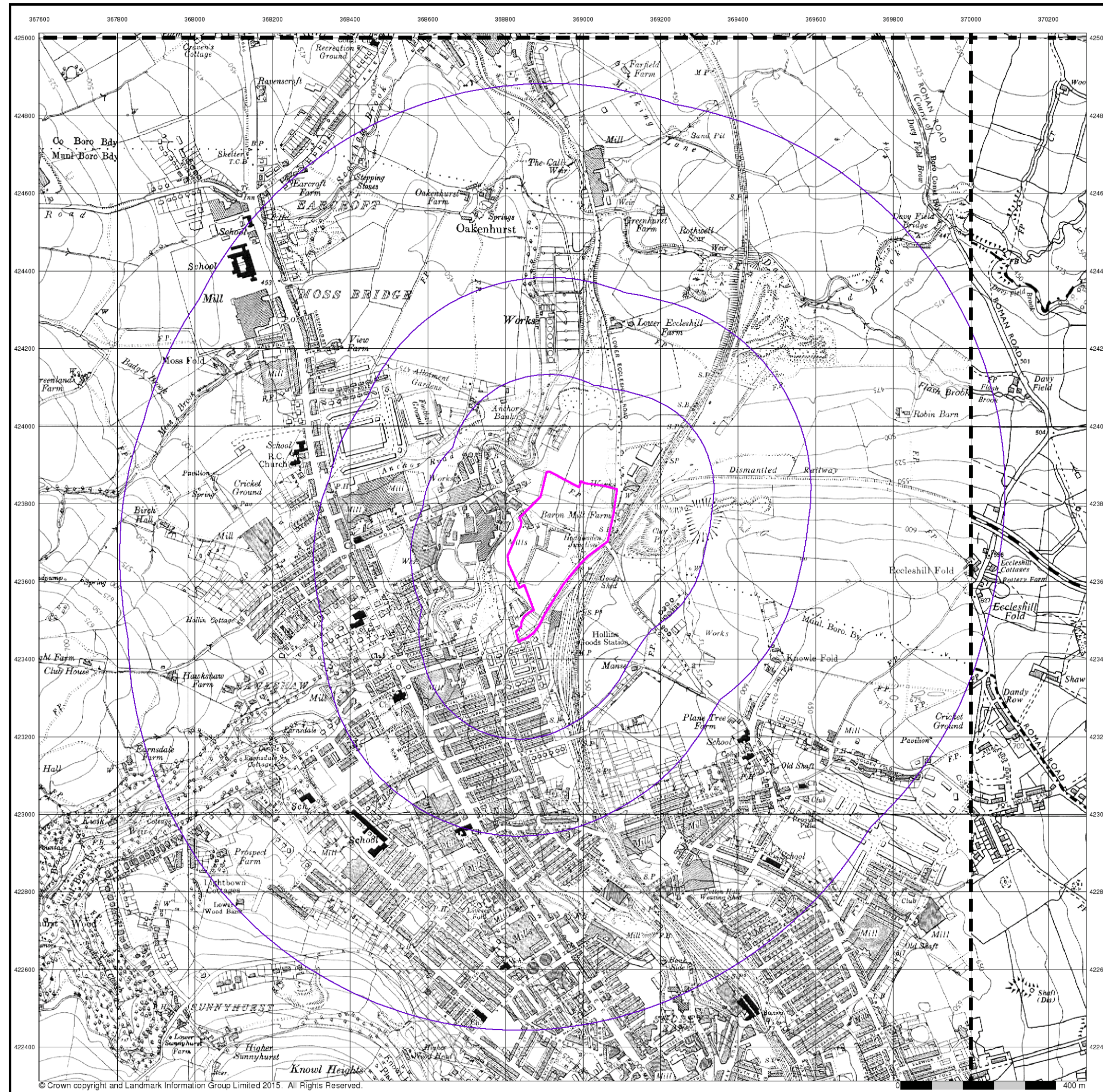
Order Details

Order Number: 106427401_1_1
 Customer Ref: 40361
 National Grid Reference: 368930, 423680
 Slice: A
 Site Area (Ha): 6.17
 Search Buffer (m): 1000

Site Details

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Ordnance Survey Plan

Published 1965 - 1967

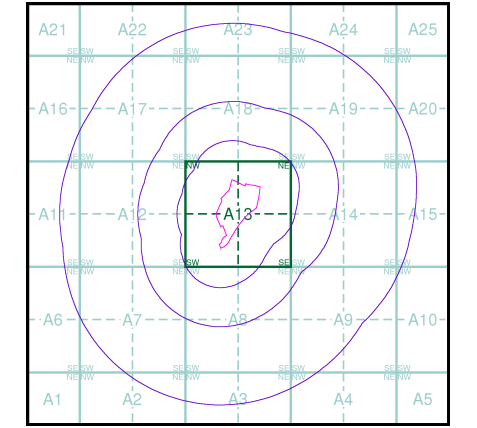
Source map scale - 1:10,000

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

Map Name(s) and Date(s)

SD62NE	SD72NW
1967	1965
1:10,560	1:10,560
SD62SE	SD72SW
1966	1965
1:10,560	1:10,560

Historical Map - Slice A



Order Details

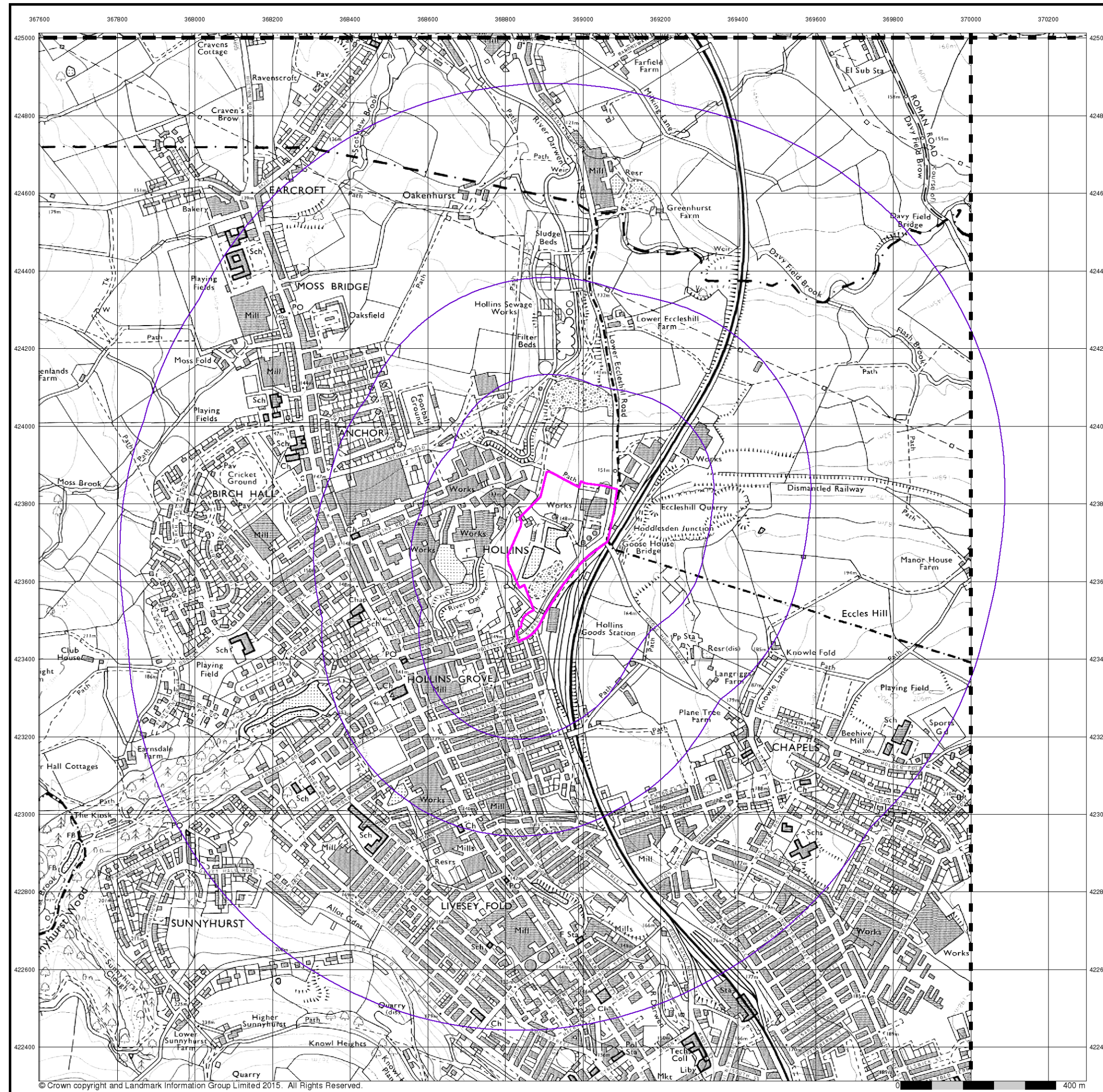
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 National Grid Reference: 368930, 423680
 Slice: A
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 Search Buffer (m): 1000

Site Details

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Ordnance Survey Plan

Published 1972 - 1977

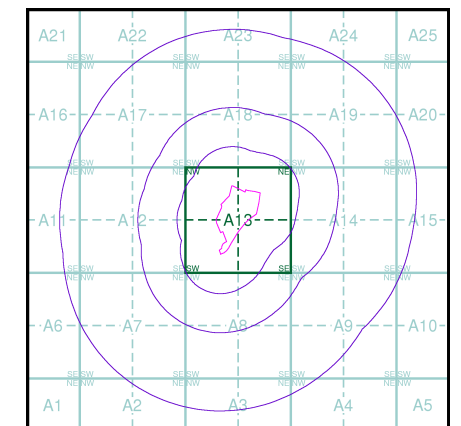
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The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps.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

Map Name(s) and Date(s)

SD62NE	SD72NW
1976	1977
1:10,000	1:10,000
SD62SE	
1972	
1:10,000	

Historical Map - Slice A

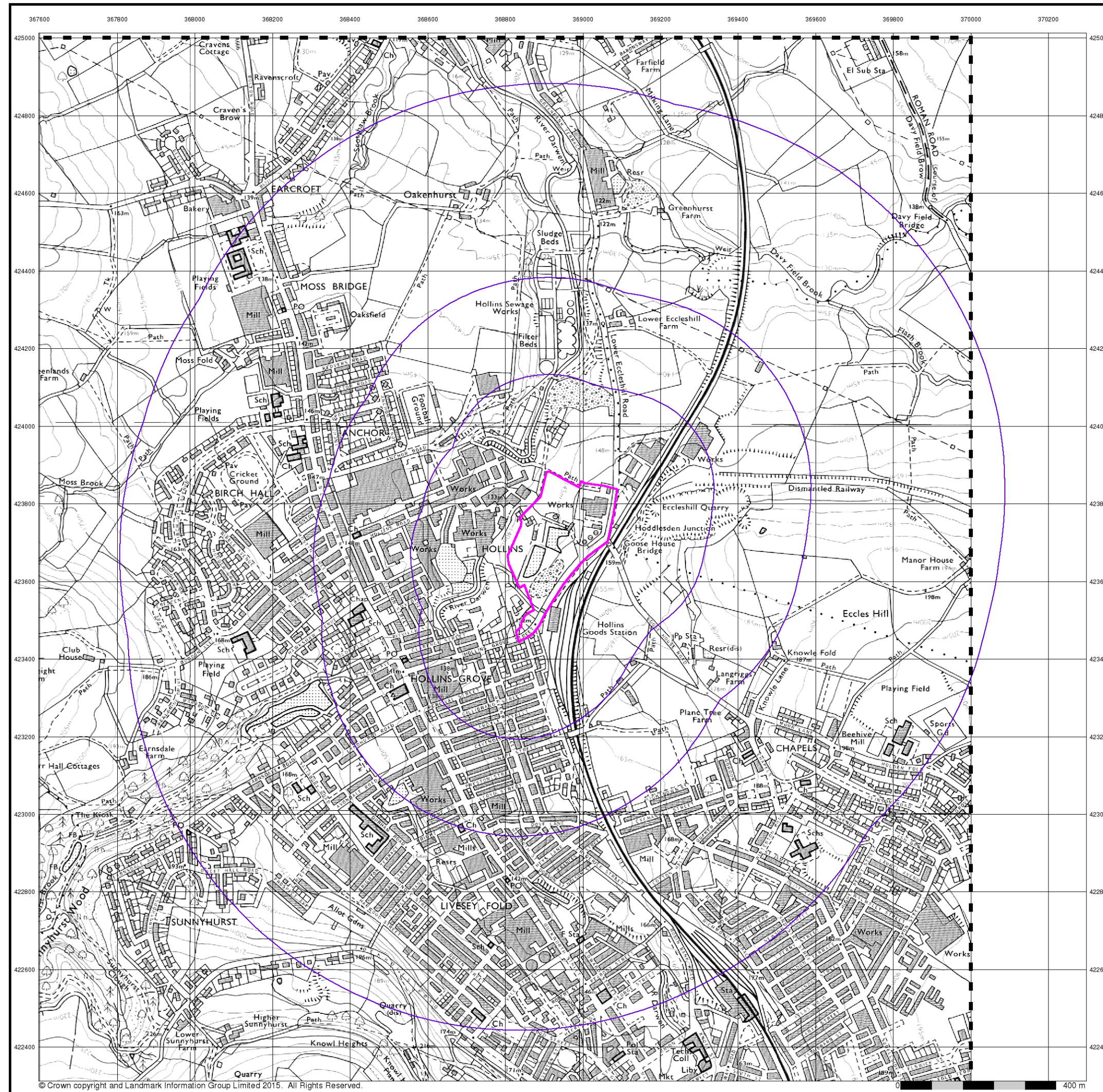


Order Details

Order Number: 106427401_1_1
 Customer Ref: 40361
 National Grid Reference: 368930, 423680
 Slice: A
 Site Area (Ha): 6.17
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Site Details

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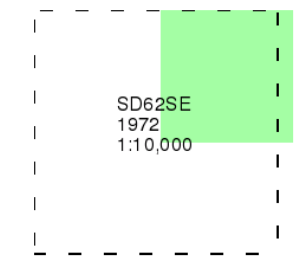
Ordnance Survey Plan

Published 1972

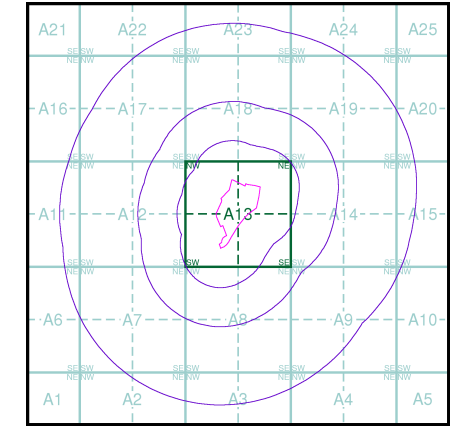
Source map scale - 1:10,000

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

Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

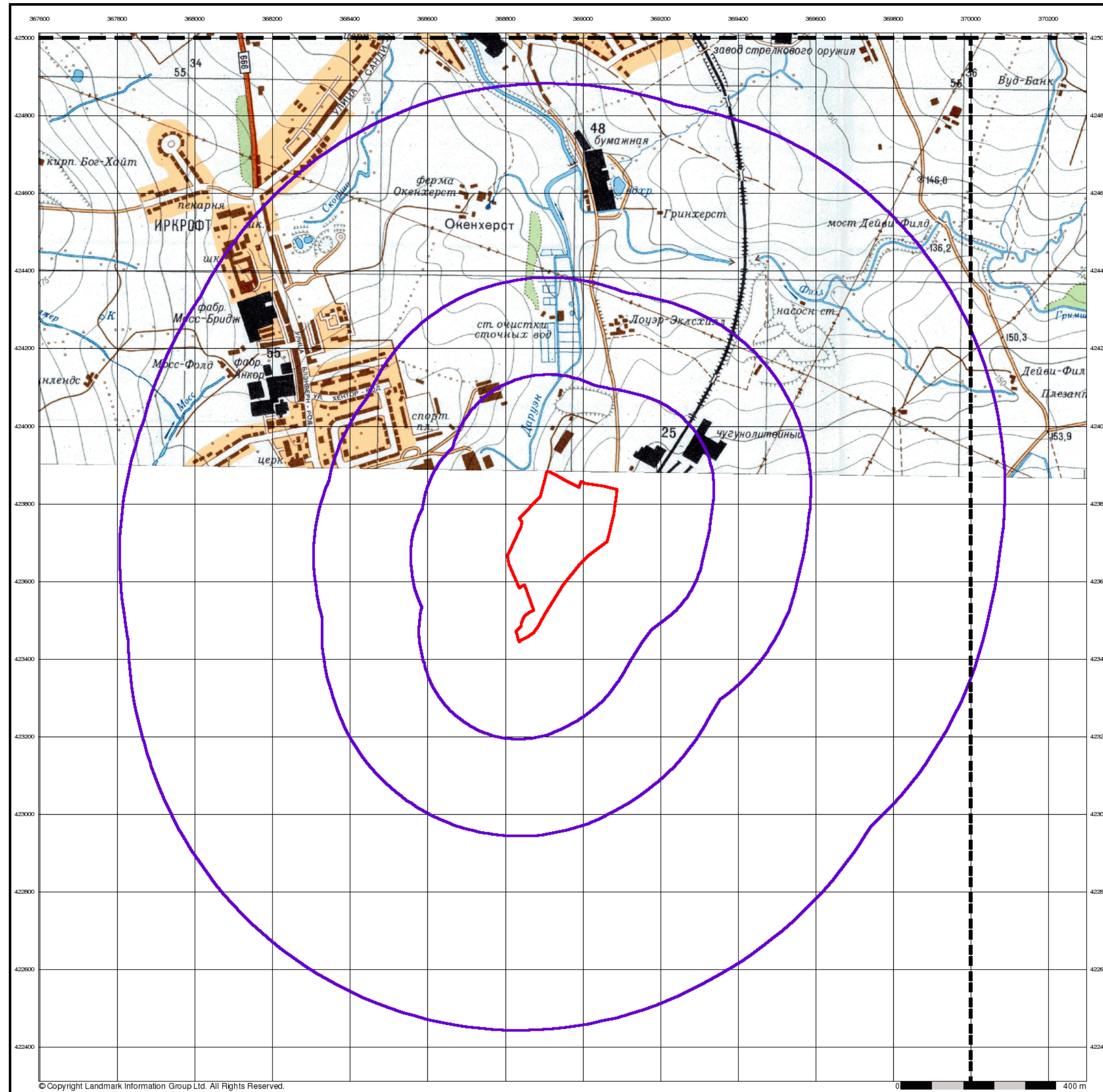
Order Number: 106427401_1_1
 Customer Ref: 40361
 National Grid Reference: 368930, 423680
 Slice: A
 Site Area (Ha): 6.17
 Search Buffer (m): 1000

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Blackburn

Published 1974

Source map scale - 1:10,000

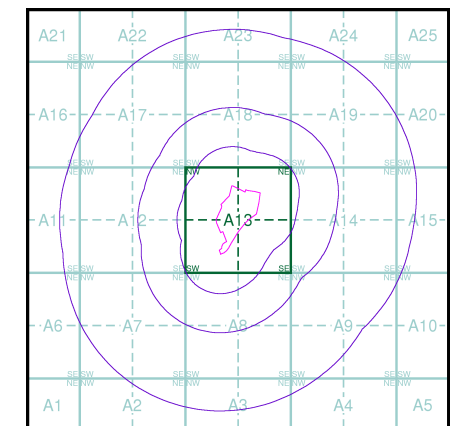
These maps were produced by the Russian military during the Cold War between 1950 and 1997, and cover 103 towns and cities throughout the U.K. The maps are produced at 1:25,000, 1:10,000 and 1:5,000 scale, and show detailed land use, with colour-coded areas for development, green areas, and non-developed 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)

SD62NE 1974 1:10,000	SD72NW 1974 1:10,000
SD62SE 1974 1:10,000	SD72SW 1974 1:10,000

Russian Map - Slice A



Order Details

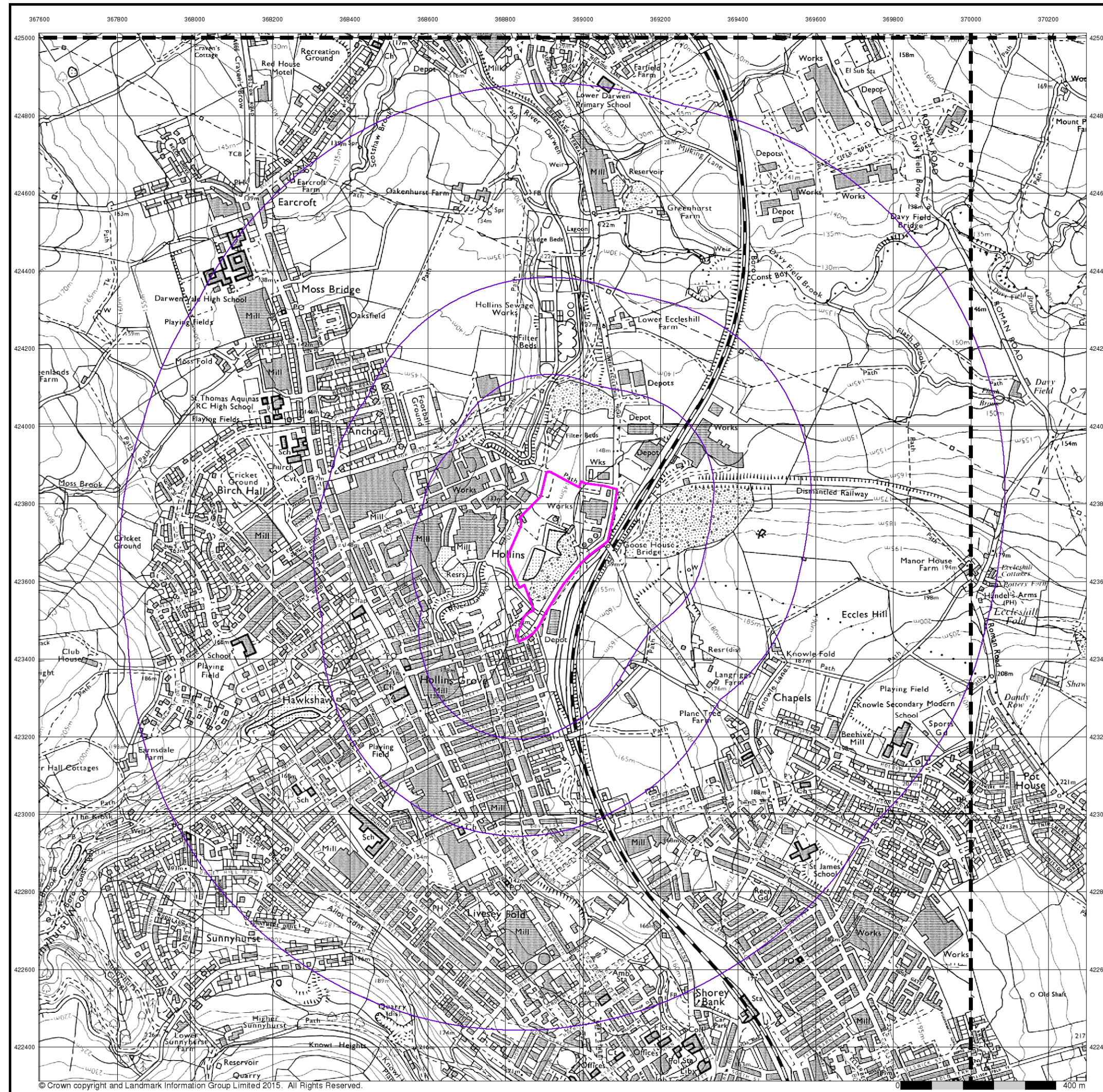
Order Number: 106427401_1_1
 Customer Ref: 40361
 National Grid Reference: 368930, 423680
 Slice: A
 Site Area (Ha): 6.17
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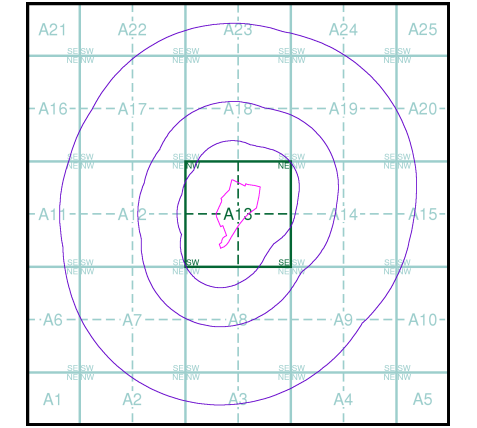
Source map scale - 1:10,000

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

Map Name(s) and Date(s)

SD62NE 1982 1:10,000	SD72NW 1988 1:10,000
SD62SE 1985 1:10,000	SD72SW 1985 1:10,000

Historical Map - Slice A



Order Details

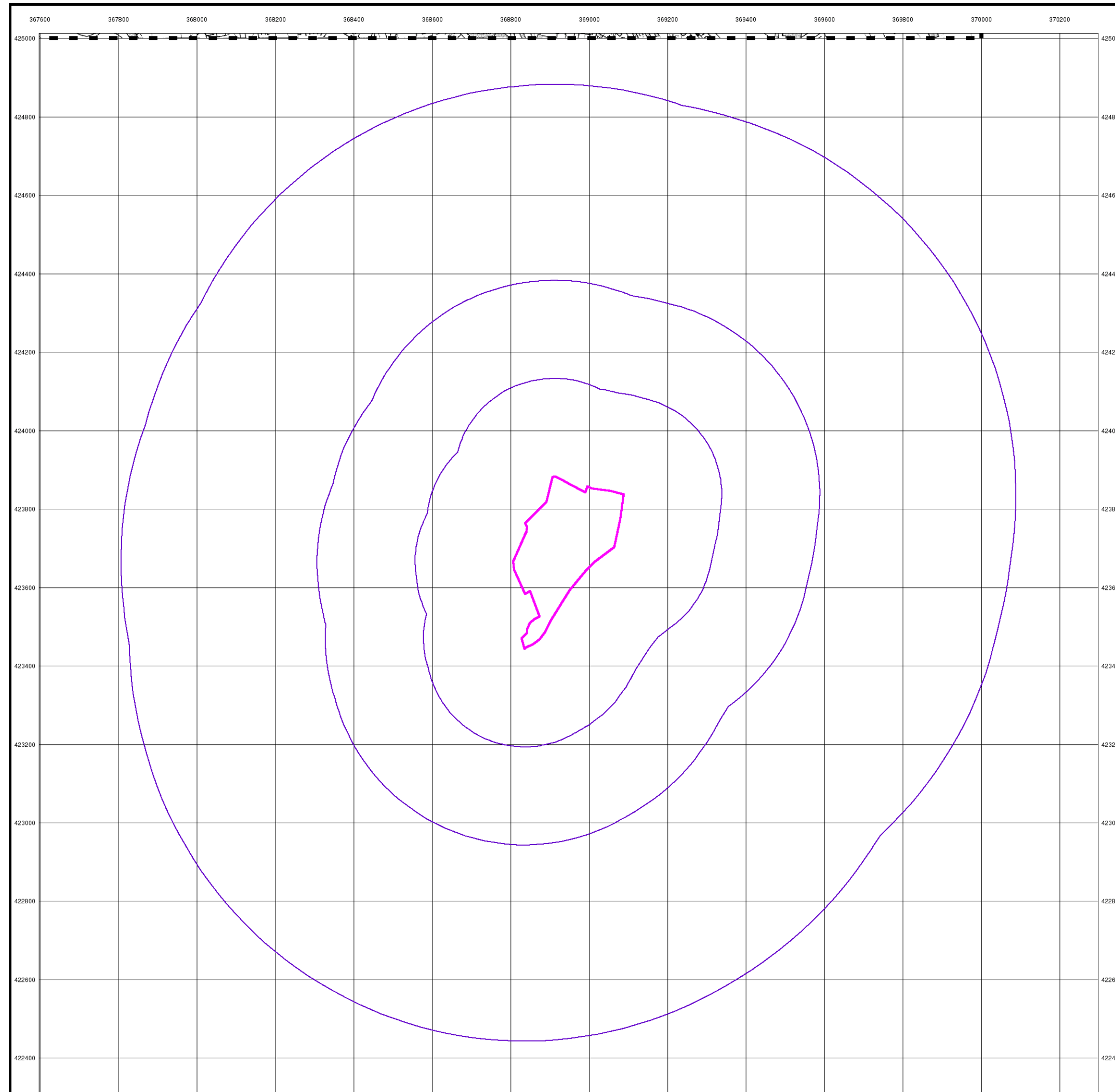
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 Slice: A
 Site Area (Ha): 6.17
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Ordnance Survey Plan

Published 1993

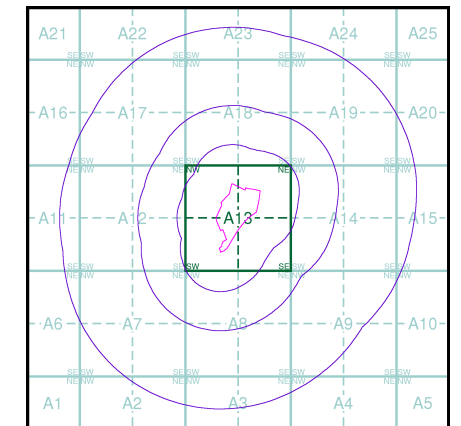
Source map scale - 1:10,000

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

Map Name(s) and Date(s)

SD62NE
1993
1:10,000

Historical Map - Slice A



Order Details

Order Number: 106427401_1_1
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