

PHASE 2 SITE INVESTIGATION REPORT

ISSUE 2

BURNTWOOD RD, GRIMETHORPE

**FOR
STRATA HOMES**

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1.0 EXECUTIVE SUMMARY

1. This report presents the findings of a geotechnical and geo-environmental site investigation carried out by Eastwood & Partners (Consulting Engineers) Limited for, and on the instructions of, Strata Homes.
2. The site is located off Burntwood Road in Grimethorpe, approximately 4 miles east of Barnsley. It has an area of approximately 2.2 hectares and is centred on National Grid Reference SE417 086.
3. Historical maps show the site to have been occupied by residential properties between circa 1931 and 2000. No other development has occurred on the site in the past.
4. The geology beneath the site comprises the Dalton Rock of the Middle Coal Measures occupying a wide band running from north east to south west across the site. The Brierley coal seam is inferred to outcrop along its western edge.
5. The Brierly coal is considered unlikely to have been worked due to its thinness and poor quality. The next shallowest seam is the Shafton coal and this is at a sufficient depth so that it will not affect the proposed development.
6. Grass over topsoil was present across the majority of the site underlain by gravelly sand progressing to sandstone. Made ground of predominantly demolition rubble was encountered underlying the topsoil at the positions of former buildings.
7. Strip footings designed with an allowable bearing capacity of 150 kN/m^2 , founded on undisturbed natural ground, at a minimum depth of 600 mm, will be suitable.
8. No radon or landfill gas precautions are required at the site.
9. It is possible that soakaways will be a viable option for surface water drainage however infiltration tests would be required to check this.
10. A Design Sulphate Class of DS-2 and ACEC class of AC-2 has been assigned to the made ground at the site and DS-1 and AC-1 has been assigned to the natural ground. FND2 concrete should therefore be used in the made ground and GEN-1 concrete is suitable for the natural ground.

11. A single elevated concentration of arsenic and two elevated concentrations of TPH were recorded in the made ground at the site. The arsenic is not thought to pose a risk to human health and additional testing is being undertaken on the TPH to assess the risk from this.
12. Due to elevated PAHs in the topsoil in the southern section of the site this topsoil requires delineation and removal. Topsoil across the remainder of the site had slightly elevated PAH concentrations. It may suitable for re-use if further testing and discussions with the regulators are undertaken.
13. The conclusions made in this report are subject to agreement by the approving bodies such as the Local Authority.

2.0 INTRODUCTION

2.1 Terms of Reference

This report presents the findings of a site investigation, undertaken by Eastwood & Partners, for Strata Homes. It is based on a desktop study and intrusive investigation. The desktop study incorporates information from a Landmark Envirocheck report, a Coal Authority Mining report and a previous site investigation undertaken by Carl Bro Group and, the intrusive investigation comprises a trial pit investigation and laboratory results for geotechnical properties and contamination levels.

The recommendations are based on the assumption that the site will be developed with residential properties with associated private gardens. It is also assumed that ground levels will remain similar to those at present. Where assessments of the site areas affected in particular ways are given these are approximate.

All information, comments and opinions given in this report are based on the information gained from the ground conditions encountered during the site work and the results of the laboratory and field tests performed during the investigation. However, there may be conditions at the site, which have not been taken into account such as unpredictable soil strata and water conditions. It should be noted that groundwater levels vary due to seasonal or other affects and may at times differ to those measured during the investigation.

This report was prepared for the sole and exclusive use of Strata Homes in response to particular instructions. Any other parties using the information contained in this report, unless given prior written approval to do so, do so at their own risk, and any duty of care to those parties is excluded.

3.0 THE SITE

3.1 Description

The site is located off Burntwood Road in Grimethorpe, approximately 4 miles east of Barnsley. It has an area of approximately 2.2 hectares and is centred on National Grid Reference SE417 086. It is bordered by residential properties to the south and east, common land to the west and Burntwood Road, beyond which is open fields, to the north.

The site is rough grassland, dissected by a tarmacadam road running north/south along the centre of the site and a spur road running of this to the west. The south west corner of the site was previously occupied by allotment gardens however these are no longer present and the area is now overgrown. The evidence of several bonfires was noted, particularly in the south east area of the site.

The site slopes down to the north at approximately 1 in 18.

The 'Exploratory Hole Location Plan', drawing 32376/001 revision A, in appendix 1 shows the site features described.

3.2 History

Historical Ordnance Survey maps obtained as part of the Landmark Envirocheck report have been studied to assess the previous use of the site. Copies of the maps are presented in Appendix 2.

3.2.1 The Site

The earliest map reviewed, dated 1854, shows the site to comprise open fields. This remains the same until circa 1931 where the majority of the site is occupied by residential properties. The 1962 map shows the site to be much the same, with the addition of allotment gardens in the south west corner. Demolition of the properties began at some point between 1984 and 1986 and was completed between 1993 and 2000. The site then remains unoccupied to the present day.

3.2.2 The Surrounding Area

The first map of 1854 shows the surrounding area to be predominantly agricultural land. Lady Wood is present approximately 30 m south east of the site and the village of

Grimethorpe is located approximately 300 m north west of the site. By 1906 Grimethorpe Colliery is constructed approximately 650 m south west of the site and the village of Grimethorpe is shown to have expanded in size. A gas works is also shown to be located approximately 1.1 km north east of the site. By 1932 the residential properties surrounding the eastern and southern boundaries of the site are constructed and a sports ground is shown to the north west of the site. In addition, the village of Grimethorpe is much expanded and this expansion continues to the present day. At some point between 1989 and 2000 Grimethorpe Colliery is demolished and development of the area with industrial units commences circa 2006.

3.3 Geology

The Geological Map sheet 275 NW (1 inch:1 mile scale) shows the solid geology beneath the majority of the site to be Dalton Rock of the Middle Coal Measures of the Carboniferous period. The geological memoir, 'Geology of the Country around Barnsley' states that the Dalton Rock varies in character and thickness across the area but where fully developed consists of irregular beds of yellow felspathic and micaceous sandstone. The Dalton Rock occupies a wide band running from north east to south west across the site. The Brierley coal seam is inferred along its western edge and may therefore outcrop in the north west corner of the site. Beyond the coal in the north west corner of the site and the Dalton Rock in the south east corner of the site are undifferentiated coal measures likely to comprise mudstones and shales.

No faults or other lines of weakness are shown to cross the site.

3.4 Hydrogeology

3.4.1 Groundwater Vulnerability

The 1:10,000 Groundwater Vulnerability Map for the area, Sheet 12 'Vale of York', indicates the site to lie on a minor aquifer. The overlying soils are classified as being of high leaching potential which is due to its location within an urban area and is therefore based on fewer observations than elsewhere. A worst case classification is therefore assumed.

3.4.2 Groundwater Abstractions

There are no groundwater abstractions within 500 m of the site boundary, however there are two abstractions noted between 500 m and 1 km of the site. The first of these is located at a distance of 594 m north of the site and the license permits Brierley Town Council to abstract surface water from an ornamental fishing lake, however the purpose is unclassified. The license for the second abstraction is held by A Ogden & Sons Ltd who are permitted to abstract water from a borehole at Grimethorpe Colliery for the purposes of mineral washing.

These abstractions are not thought to be affected by any contamination at the site.

3.5 Hydrology

There are no major surface water features within 1 km of the site, however there are many surface water springs and drains in the surrounding area. The nearest of these is located approximately 100 m north of the site.

Information within the Landmark Envirocheck report states that the site does not lie within 1 km of a groundwater Source Protection Zone.

3.6 Mining

Reference to the geological maps indicates the Brierley coal seam generally outcrops immediately below the Dalton Rock. This position occurs in the north west corner of the site. The geological memoir states that although the Brierley Coal reaches a thickness of 4 ft in the vicinity of Brierley, it is an inferior coal. It does however appear to have been worked to some extent in the vicinity of Brierley. Frickley Colliery, located approximately 2.5 miles east of the site, does not record the Brierley coal by name in the shaft sinking although three 'seams of coal' are recorded overlying the Shafton coal which is the next named seam stratigraphically below the Brierley coal. These are generally recorded as two bands of coal separated by spavin and the thickest band of coal is recorded as 14 in. however the Geological Survey map indicates that at the site position the Brierley seam is absent. This could be due to a local washout. The Coal Authority report also does not mention any risk from shallow mining. It is therefore thought that the Brierley coal is too thin and poor quality to have been worked in the vicinity of the site.

As mentioned above, the next seam stratigraphically below the Brierly is the Shafton coal. The geological memoir states that the Shafton coal is an important seam ranging from 4 ft to 5 ft in thickness and has been largely worked at outcrop. At Grimethorpe Colliery, approximately 700 m south west of the site, the thickness is recorded as 5 ft 5 in (1.65 m) at a depth of 76 yd 2 ft 6 in (70.3 m). The seam is expected to be slightly deeper below the site, it is far below the depth at which drilling and grouting would be required

A Coal Authority report has been obtained and is enclosed in appendix 2. This states that the site is within the likely zone of influence on the surface from workings in twelve seams of coal at 150 m to 910 m depth, the last date of working being 1992. Ground movement from these past coal workings should by now have ceased.

The site is not within the likely zone of influence from any present or future underground coal workings, however, reserves of coal exist in the locality which could be worked at some time in the future subject to feasibility, licences and planning consents. There are no recorded mine shafts or entries within 20m of the site boundary.

3.7 Ground Gas

Information contained within the Landmark Envirocheck report indicates that there are several landfill sites within 1 km of the site boundary. These are listed in the table below.

Landfill Name	Distance & Direction from site	License Holder	Wastes Accepted	Operational
Acorn Way	526 m W	Barnsley MBC	Not Supplied	N
Carlton Main Brickworks	720 m SW	Carlton Main Brickworks Ltd	Inert & Industrial (Polythene Wrappings, Waste & Badly Fired Bricks, Waste Products From Brick Making)	Unknown
New Park Spring Tip	813 m S	National Coal Board	Commercial	N
National Coal Board	991 m SW	Coalite and Chemical Products Ltd	Industrial & Liquid Sludge	N

Due to the distance from site and the types of waste accepted, the risk of landfill gas migrating onto the site is negligible.

Information provided within the Landmark Envirocheck report states that no radon precautions will be required for residential development on this site.

3.8 Pollution Incidents

The Landmark Envirocheck report does not list any pollution incidents within 250 m of the site.

3.9 Discharge Consents

The Landmark Envirocheck report does not identify any discharge consents within 500 m of the site.

3.10 Flooding

Information provided in the Landmark Envirocheck report shows that the site does not lie within 250 m of an indicative flood plain.

3.11 Previous Site Investigation

A previous site investigation was undertaken by Carl Bro Group in 1997. This investigation comprised five cable percussion boreholes and nine trial pits. Chemical and geotechnical testing of disturbed soil samples was also undertaken as part of this investigation. A copy of this report is in appendix 3 and a summary is provided below.

3.11.1 Ground Conditions

The exploratory holes in the Carl Bro report identified 0.1 m to 0.3 m of topsoil at the surface across the entire site. Made ground was then identified underlying the topsoil to a maximum depth of 1.7 m. It is not clear whether the made ground was identified in each exploratory hole, but it is mentioned that the depth of made ground increased in the area of the former buildings. The made ground was described as silty sand with varying amounts of gravel comprising concrete, brick, sandstone, mudstone, metal, coal, ash, clinker, coke, wood, slate and glass. Underlying the made ground or topsoil the natural ground comprised sandy gravelly silt or silty gravelly sand. The gravel proportion increased and the sand/silt proportion decreased until weathered sandstone bedrock was encountered. Siltstone bedrock

was however encountered in one exploratory hole. The depth at which bedrock was encountered was unclear.

3.11.2 Geotechnical Test Results

Disturbed soil samples were obtained for both chemical and geotechnical testing. The geotechnical results indicate CBR results of 6% for near surface sand soils, however it is not stated at what depth the samples were obtained or the type of material tested.

3.11.3 Chemical Test Results

The chemical test results were indicated to be below the assessment criteria of the time in the Carl Bro report, however these have been updated and new assessment criteria are now applicable. Therefore as no specific results were mentioned it cannot be confirmed, without further testing, whether or not remedial precautions will be required.

4.0 OUTLINE CONCEPTUAL MODEL

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

Table 4.0 – Potential Pollutant Linkages

Source	Potential Contaminants	Pathway
Heavy metals and PAHs in any made ground.	Ingestion, inhalation, direct contact	Site workers, future residents
	Migration through ground	Minor aquifer
Naturally elevated levels of heavy metals in the natural ground.	Ingestion, inhalation, direct contact	Site workers, future residents
	Migration through ground	Minor aquifer

5.0 GROUND INVESTIGATION

5.1 Site Works

We visited site on 29 October 2009 and excavated fourteen trial pits, TP1 to TP14 across the site. These reached depths of between 2.0 m and 3.3 m below ground level.

Copies of all trial pit logs are presented in appendix 4, and their locations are plotted on the Exploratory Hole Location Plan, Drawing number 32376/001 revision A in appendix 1.

5.2 Laboratory Testing

Five samples of topsoil, three of made ground and three of natural ground were despatched for chemical testing. Soil samples were taken in 1 kg plastic tubs and 250 ml amber glass jars and analysed at Chemtest Laboratories, Newmarket using MCERTs accredited methodologies where available.

Laboratory testing results are presented in Appendix 5 and discussed further in Section 8.0.

6.0 GROUND CONDITIONS

6.1 Surface Covering

The majority of the site is covered by rough grass overlying topsoil which generally comprised slightly clayey slightly gravelly sand. The gravel portion of the topsoil comprised sandstone, mudstone and occasional brick fragments and thus could also be described as made ground. The topsoil in TP1 was also described as ashy.

The topsoil was encountered to depths of between 0.05 m and 0.35 m bgl.

A tarmac road crosses the site in a north/south orientation and a small spur road off this with a turning circle at the end is also present. No pits were excavated in the road areas due to the presence of services.

6.2 Made Ground

Made ground was identified in four of the trial pits to depths of between 0.5 m and 0.8 m bgl. It generally comprised sandy gravel of brick, concrete and sandstone although additional extraneous material such as glass, metal, wood, clinker and ceramics was also identified. The made ground in TP9 comprised intact, in-situ brickwork in a matrix of natural gravelly sand.

The made ground was only identified in the areas formerly occupied by houses.

6.3 Natural Ground

The natural ground was found to comprise gravelly sand of sandstone. This was occasionally noted as being clayey and in all cases the gravel proportion increased with depth, progressing towards the sandstone bedrock. The sandstone was generally encountered at depths of between 1.6 m and 2.0 m bgl, however in TP13 was encountered at 3.3 m bgl.

6.4 Obstructions

Large blocks of intact brickwork were occasionally encountered within the made ground, however these did not prevent the excavation of any of the trial pits.

6.5 Groundwater

Groundwater was not identified in any of the trial pits.

6.6 Evidence of Contamination

Visual or olfactory evidence of possible contamination was not identified in any of the exploratory holes. In addition no evidence of any organic matter was identified in the exploratory holes.

7.0 GEOTECHNICAL APPRAISAL

7.1 Foundations

Our investigations indicate that beneath the topsoil or made ground are competent natural sand soils. Although these were sometimes recorded as being clayey, they are considered to have a negligible volume change potential.

An allowable bearing pressure of 150 kN/m^2 can be assumed for the foundations within the sand. All foundations must be taken down to bear on undisturbed natural ground. Therefore where made ground is encountered at founding depth the foundations will need to be deepened until natural ground is encountered. Our investigations show that this is expected to be at around 0.5 m to 0.8 m, however the previous investigation identified made ground at a maximum depth of 1.7 m.

As the natural sand is considered to be nonshrinkable, it will be appropriate for strip footings at a minimum depth of 600 mm. Existing or proposed trees will not have an influence, on the depth of the footings unless clay is encountered at founding level.

7.2 Ground Floors

The natural ground on the site would be suitable for the use of insitu reinforced ground slabs. These would normally be suitable when there is less than 600 mm of fill below the slab and this is well compacted granular material. However, where the depth of fill is greater than 600 mm, reinforced suspended floor slabs should be installed.

7.3 Roadworks

We would expect CBR values on the natural gravelly sand soil of around 3 to 5%, but this could be significantly less over areas of made ground. For any roads which are to be adopted you should arrange for in situ CBR testing along the line of the roads just before construction commences so that accurate values can be obtained to satisfy the Local Authority.

7.4 Superstructure Precautions

No additional superstructure precautions will be required due to the ground conditions encountered.

7.5 Excavation Problems

Within the natural ground excavation is expected to be relatively easy and trenches are generally expected to be stable. In areas of made ground however large blocks of intact brickwork are expected and it is possible that relic foundations will be encountered. In addition, trenches within the made ground are not expected to be stable. Support will therefore 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.

7.6 Obstructions

Significant obstructions are not expected across the site, though it is possible that relic foundations will be present in the positions of former buildings.

7.7 Surface Water Drainage

Due to the presence of sandstone at the site it is possible that soakaways will be a viable option for surface water drainage. Infiltration tests would however be required to check this.

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 study was detailed in section 4.0.

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 Conditions

There is no reason to suspect that the materials recorded on site will contain any specific contaminants although may contain elevated concentrations of common contaminants such as arsenic, and sulphates due to the presence of pyrite. Polycyclic Aromatic Hydrocarbons (PAHs), such as benzo(a)pyrene, may also be elevated due to the atmospheric fallout of these derived from the combustion of fossil fuels.

The chemical analysis undertaken for these materials are discussed in section 8.5.

8.3 Gas Precautions

No evidence of any organic matter was identified in the exploratory holes. Therefore, taking into account the location of landfill sites in the vicinity and the confirmation that no radon precautions are required, the site is classified as green according to the NHBC traffic light system.

8.4 Unexpected Contamination

No visual or olfactory observations of unexpected contamination were noted.

8.5 Chemical Testing

Five samples of topsoil, three samples of made ground and three samples of natural ground were sent for testing. Each of the samples was analysed for the suite of contaminants listed overleaf.

Contaminant Type	Actual Contaminants
Metals/Metalloids	Arsenic, cadmium, chromium, lead, mercury, nickel, copper and zinc
pH	pH
PAHs	Speciated PAH

In addition to the above testing the three samples of made ground and natural ground were analysed for water soluble sulphate, acid soluble sulphate and sulphur. The made ground samples were also tested for a TPH screen.

Testing was undertaken by Chemtest, using MCERTs accredited methodologies, where available.

8.6 Assessment Criteria

The proposed development of the site is to be residential with associated gardens. Therefore the assessment criteria relating to a residential end use with plant uptake have been used.

Tables detailing the relevant assessment concentrations used are included in appendix 5.

8.7 Chemical Test Results

Some preliminary risk assessment is undertaken in this section of the report where determinants can be readily discounted.

8.7.1 Metals/Metalloids

8.7.1.1 Topsoil

No metals or metalloids were found to exceed their relevant assessment concentrations within the topsoil.

8.7.1.2 Made Ground

Arsenic

Arsenic was found to exceed its 32 mg/kg assessment concentration in one of the three samples of made ground tested. A value of 33 mg/kg was recorded in the sample from TP7 at 0.5 m, the remaining samples recorded values of 13 mg/kg and 18 mg/kg.

8.7.1.3 Natural Ground

No metals or metalloids were found to exceed their relevant assessment concentrations within the natural ground.

8.7.2 Polycyclic Aromatic Hydrocarbons (PAHs)

8.7.2.1 Topsoil

Benzo(a)pyrene was found to be elevated over the 1 mg/kg assessment concentrations in four of the five samples tested. Values of 47 mg/kg, 2 mg/kg, 1.2 mg/kg and 1.1 mg/kg were recorded in the samples from TP1, TP3, TP11 and TP13. The remaining sample, from TP8, recorded a value of 0.4 mg/kg.

Concentrations of benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were also found to be elevated in the sample from TP1. The concentrations recorded, together with their assessment concentrations are shown in the following table.

PAH compound	Recorded Concentration (mg/kg)	Assessment Concentration (mg/kg)
Benzo(a)anthracene	39	5.9
Chrysene	31	9.3
Benzo(b)fluoranthene	49	7
Benzo(k)fluoranthene	15	10
Dibenzo(ah)anthracene	8.1	0.9
Indeno(1,2,3-cd)pyrene	23	4.2

8.7.2.2 Made Ground

The results indicate that the levels of PAHs were below their respective assessment concentrations in the made ground.

8.7.2.3 Natural Ground

The results indicate that the levels of PAHs were below their respective assessment concentrations in the natural ground.

8.7.3 Total Petroleum Hydrocarbons (TPH)

Only the three samples of made ground were tested for a TPH screen. Of these, the sample from TP2 did not record any levels over the detection limit, the sample from TP6 at 0.5 m recorded a value of 230 mg/kg and the sample from TP7 at 0.5 m recorded a value of 130 mg/kg.

8.7.4 Sulphates

8.7.4.1 Made Ground

In accordance with BRE Special Digest 1, the site comes under the classification of 'brownfield'. Three samples of the made ground were tested for total sulphate and the results indicate the total potential sulphates as between 0.04% and 0.19%. The concentrations of water soluble sulphate were between 40 mg/l and 210 mg/l compared with the upper limit of Design Sulphate Class 1 of 500 mg/l. On the basis of both the potential sulphate and water soluble sulphate results the ground would be assigned a Design Sulphate Class of DS-1 and Aggressive Chemical Environment for Concrete (ACEC) class of AC-1. However, due to the inconsistent nature of made ground, it may be prudent to incorporate DS-2 and AC-2 precautions for concrete in contact with the made ground.

8.7.4.2 Natural Ground

Three samples of the natural ground were tested for total sulphate and sulphur and the results indicate the proportion of oxidisable sulphates as between <0.03% and 0.03%. The threshold above which it is considered that pyrite is probably present is 0.3% and thus pyrite is not expected to be present in the natural ground.

The concentrations of water soluble sulphate were between <10 mg/l and 20 mg/l compared with the upper limit of Design Sulphate Class 1 of 500 mg/l. On the basis of both the potential sulphate and water soluble sulphate results the ground would be assigned a Design Sulphate Class of DS-1 and Aggressive Chemical Environment for Concrete (ACEC) class of AC-1.

8.8 Significant Pollutant Linkages

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

Table 8.8 – Significant Pollutant Linkages

Source	Pathway	Receptor
Single elevated concentration of arsenic in the made ground.	Ingestion, inhalation, direct contact	Future residents
Elevated concentrations of PAHs in the topsoil.	Ingestion, inhalation, direct contact	Future residents
Elevated concentrations of TPH in the made ground	Ingestion, inhalation, direct contact Direct contact	Future residents Plastic service pipes
Sulphates in the made ground	Direct contact	Below ground concrete

8.9 Risk Assessment – Human Health

8.9.1 Arsenic

Arsenic was found to exceed its assessment concentration of 32 mg/kg in one sample of the made ground with a value of 33 mg/kg. The remaining samples recorded values of 13 mg/kg and 18 mg/kg. A modified mean has been calculated and is shown to be 38.9 mg/kg, the average is however only 21.3 mg/kg. It is therefore considered that, as the value only marginally exceeds its assessment concentration, the made ground will be covered with a layer of topsoil and the mean value is significantly below the assessment concentration, the values recorded will not pose a significant risk to human health.

8.9.2 Benzo(a)pyrene

Benzo(a)pyrene was found to exceed its assessment concentration of 1 mg/kg in four of the five samples of topsoil tested with values of 47 mg/kg (TP1), 2 mg/kg (TP3), 1.2 mg/kg (TP11) and 1.1 mg/kg (TP13). A modified mean has been calculated which shows the value of 47 mg/kg to be an outlier. This was therefore re-calculated excluding the outlier and a value of 1.95 mg/kg was calculated. Copies of the calculation sheets are in appendix 6. The topsoil in TP1 was described as ashy and there was evidence of bonfires in the immediate vicinity. It is considered that the topsoil in this location is unsuitable and should be delineated and removed from site. The topsoil across the remainder of the site was not described as ashy. It is possible that, with further testing and discussions with the relevant authorities, the topsoil

may be suitable for re-use on the site. However without this the topsoil is considered unsuitable for re-use.

8.9.3 Other Polycyclic Aromatic Hydrocarbons

The remaining polycyclic aromatic hydrocarbons (PAHs) which were recorded exceeding their assessment concentrations were within the sample from TP1 which also recorded the significantly elevated benzo(a)pyrene concentration. The topsoil in this area is to be removed from site and hence any risk to human health will be mitigated.

8.9.4 Total Petroleum Hydrocarbons

TPH was detected in two of the samples of made ground with values of 230 mg/kg and 130 mg/kg. Only total TPH was determined and it is therefore not possible to carry out further risk assessment without undertaking further testing. Both samples were therefore sent for additional testing of TPH with Texas banding and aromatic/aliphatic split. The results are within test report 79560, a copy of which is in appendix 5. These show total TPH concentrations of 63 mg/kg and <10 mg/kg. It is not unusual for the total TPH concentration to reduce when full fractionation is undertaken as the total TPH test can mistake organic matter in the soil for TPH whereas the test for TPH with Texas banding and aromatic/aliphatic split does not include any organic matter.

A hazard index has been calculated for both sets of results, using the assessment criteria from Nathanail, C. P., McCaffrey, C., Ashmore, M. H., Cheng, Y. Y., Gillett, A., Ogden, R. & Scott, D., 2009 *'The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment 2nd Edition'*, Land Quality Press, Nottingham. These are based on a sandy loam soil and 1% soil organic matter. Hazard indices of 0.2 and 0.04 were calculated and copies of the worksheets are enclosed. As both hazard indices are below unity there is no significant risk to human health.

As there were no significantly elevated contaminants recorded in the made ground, it does not pose a significant risk to human health. No remedial measures will therefore be required, however it is not considered that the made ground is physically suitable to remain at the surface and in addition, it would not perform well as a growing medium. We would therefore recommend placing topsoil over any made ground in garden or landscaped areas.

8.10 Risk Assessment – Construction Materials

8.10.1 Total Petroleum Hydrocarbons

Slightly elevated concentrations of TPH were recorded in the made ground and these can permeate plastic water pipes. It is not thought that the concentrations recorded are high enough to significantly affect plastic service pipes on the site, however it is recommended that the results are forwarded to the water company. They will then confirm what type of pipes need to be installed at the site.

8.10.2 Sulphates

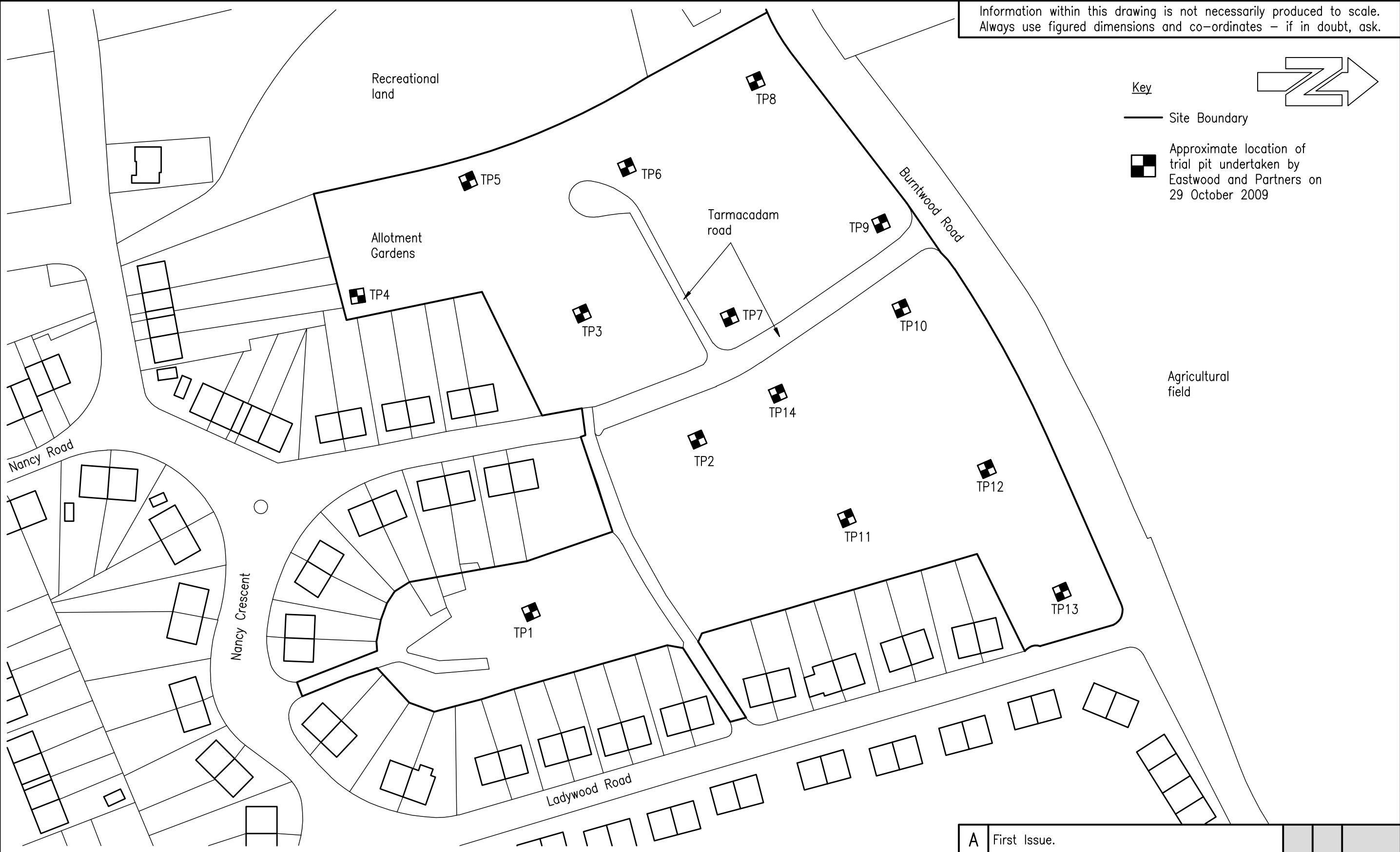
As discussed in section 8.6.4 it is recommended that sulphate precautions comprising DS-2 and AC-2 are incorporated in any concrete in contact with the made ground. This will result in the use of FND2 type concrete. Concrete not in contact with the made ground will be suitable for DS-1 and AC-1 precautions, resulting in the use of GEN-1 concrete.

9.0 CONTAMINATION - RECOMMENDATIONS AND APPROVALS

1. A single elevated concentration of arsenic and two elevated concentrations of TPH were recorded in the made ground at the site. The arsenic is not thought to pose a risk to human health and additional testing is being undertaken on the TPH to assess the risk from this.
2. Several PAHs were found to be significantly elevated in one sample of ashy topsoil from the southern section of the site. This topsoil requires delineation and removal from site.
3. Slightly elevated concentrations of benzo(a)pyrene were recorded in the topsoil across the rest of the site. It is possible that, with further testing and discussions with the relevant authorities, the topsoil can be shown to be suitable for re-use. Without this however the topsoil is unsuitable for re-use.
4. A Design Sulphate Class of DS-2 and ACEC class of AC-2 has been assigned to the made ground at the site and DS-1 and AC-1 has been assigned to the natural ground. FND2 concrete should therefore be used in the made ground and GEN-1 concrete is suitable for the natural ground.
5. No radon or landfill gas precautions are required at the site.
6. There should be no significant contamination risks to construction workers from the ground on the site but normal good hygiene precautions such as washing hands before eating should be adopted.
7. The conclusions made in this report in relation to contamination are subject to agreement by the approving bodies such as the Local Authority and the NHBC.

APPENDIX 1

'Exploratory Hole Location Plan', Drawing 32376/001 revision A



Information within this drawing is not necessarily produced to scale.
Always use figured dimensions and co-ordinates – if in doubt, ask.

Key

— Site Boundary

 Approximate location of trial pit undertaken by Eastwood and Partners on 29 October 2009

Eastwood & Partners
CONSULTING ENGINEERS

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www.eastwoodandpartners.com

STRATA HOMES
BURNTWOOD ROAD, GRIMETHORPE
EXPLORATORY HOLE LOCATION PLAN

A	First Issue.					
REV	DESCRIPTION			SIG	CHK	DATE
SCALE WHEN PLOTTED AT A3			DRAWING STATUS			
1:1000			PRELIMINARY			
DRAWN	CHECKED	DATE	DRAWING NUMBER		REV	
CS	RAN	13.11.09	32376/001		A	

APPENDIX 2

Landmark Envirocheck Report
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		
	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
	Bracken		Heath
	Marsh		Reeds
	Building		Glasshouse
	Sloping Masonry		Pylon
	Cutting		Embankment
	Road Under		Road Over
	Level Crossing		Foot Bridge
	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
	Civil Parish		
	Boundary Post or Stone		Police Station
	Church		Post Office
	Club House		Public Convenience
	Fire Engine Station		Public House
	Foot Bridge		Signal Box
	Fountain		Spring
	Guide Post		Telephone Call Box
	Mile Post		Telephone Call Post
	Mile Stone		Well

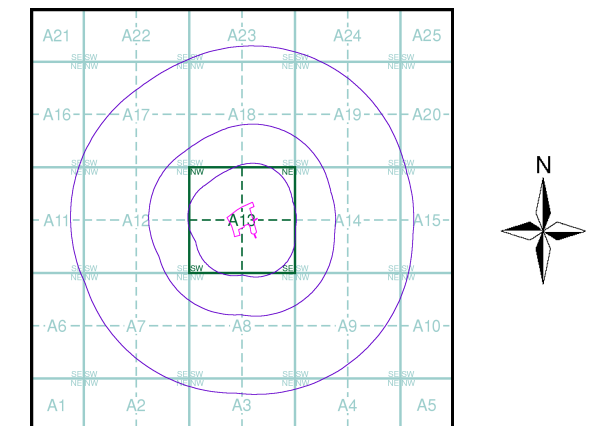
1:10,000 Raster Mapping

	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
	Mean high water (springs)		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

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Yorkshire	1:10,560	1854	2
Yorkshire	1:10,560	1894	3
Yorkshire	1:10,560	1906 - 1907	4
Yorkshire	1:10,560	1930	5
Yorkshire	1:10,560	1932 - 1933	6
Yorkshire	1:10,560	1938 - 1948	7
Yorkshire	1:10,560	1938 - 1948	8
Yorkshire	1:10,560	1948	9
Ordnance Survey Plan	1:10,000	1955 - 1956	10
Ordnance Survey Plan	1:10,000	1967	11
Ordnance Survey Plan	1:10,000	1983 - 1984	12
Ordnance Survey Plan	1:10,000	1989	13
10K Raster Mapping	1:10,000	2000	14
10K Raster Mapping	1:10,000	2006	15
10K Raster Mapping	1:10,000	2009	16

Historical Map - Slice A



Order Details

Order Number: 29191210_1_1
 Customer Ref: 32376/JMW/RAN
 National Grid Reference: 441720, 408850
 Slice: A
 Site Area (Ha): 2.17
 Search Buffer (m): 1000

Site Details

Site at 441500, 408500

Yorkshire

Published 1854

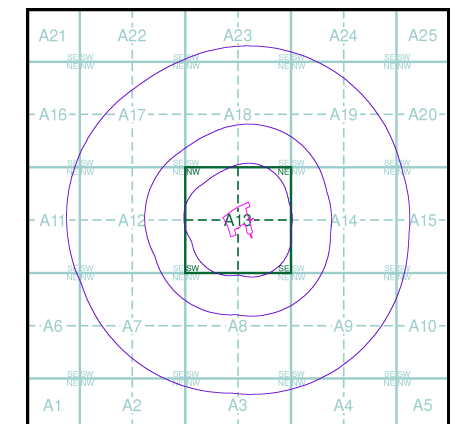
Source map scale - 1:10,560

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)

26300	1854	1:10,560
27500	1854	1:10,560

Historical Map - Slice A

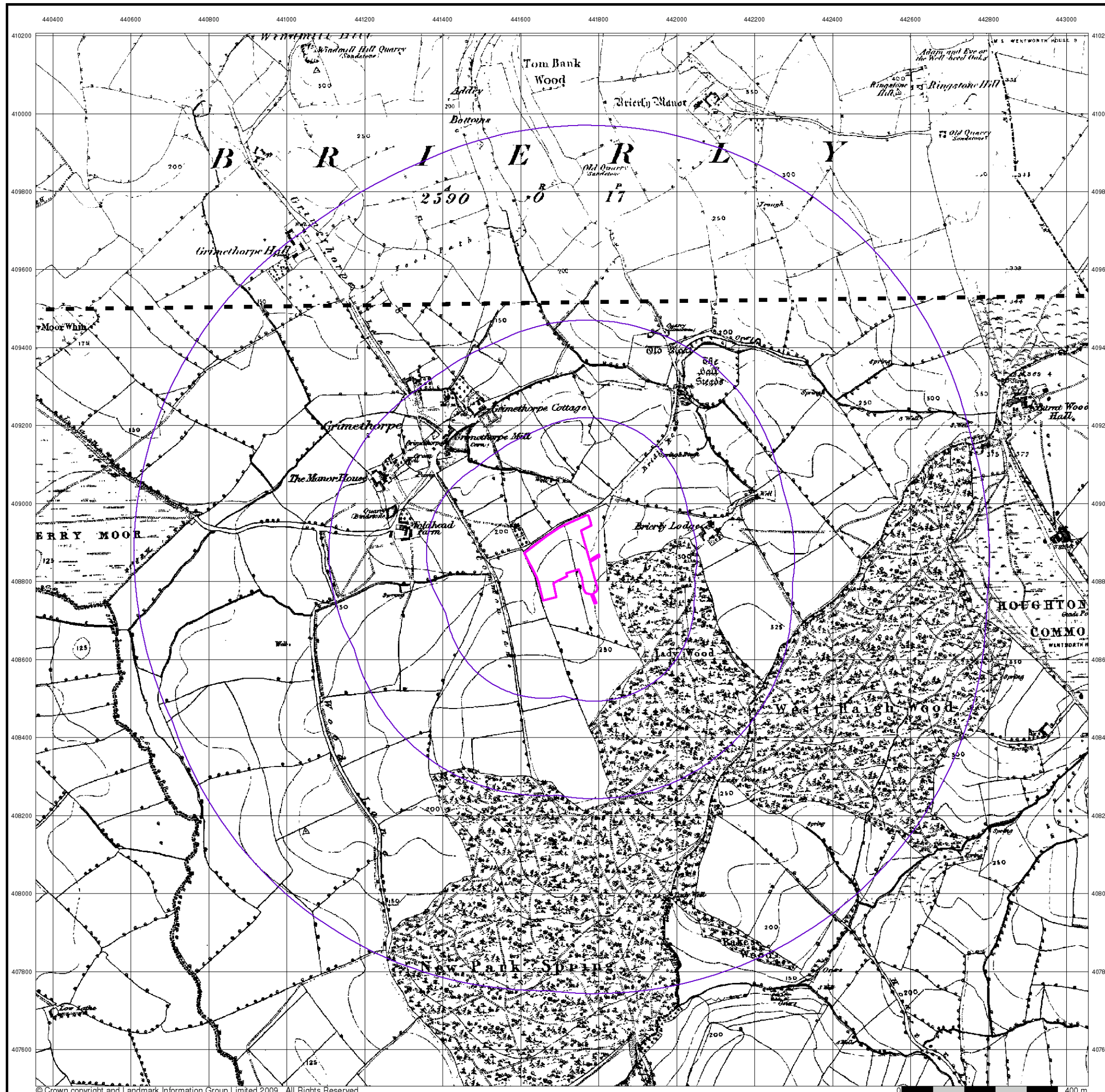


Order Details

Order Number: 29191210_1_1
 Customer Ref: 32376/JMW/RAN
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 Slice: A
 Site Area (Ha): 2.17
 Search Buffer (m): 1000

Site Details

Site at 441500, 408500



Yorkshire

Published 1894

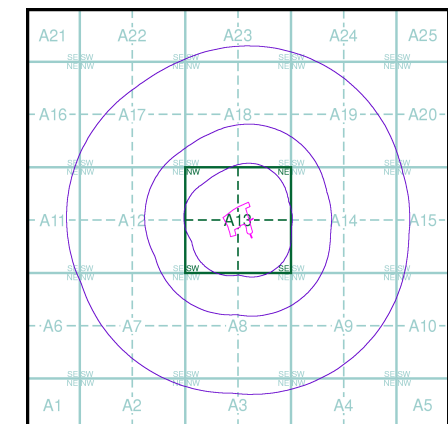
Source map scale - 1:10,560

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)

263SW 1894 1:10,560	263SE 1894 1:10,560
275NW 1894 1:10,560	

Historical Map - Slice A

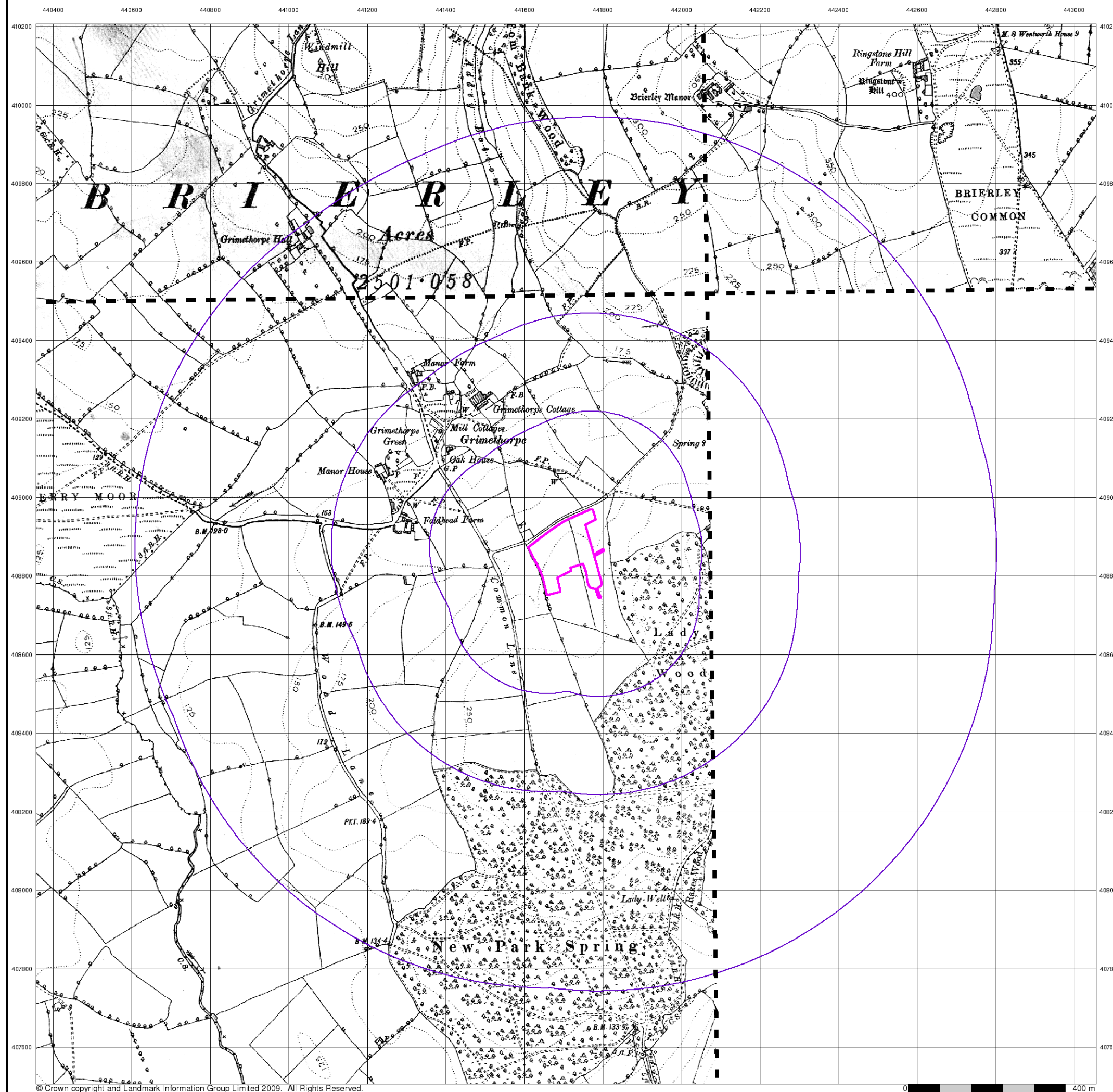


Order Details

Order Number: 29191210_1_1
Customer Ref: 32376/JMW/RAN
National Grid Reference: 441720, 408850
Slice: A
Site Area (Ha): 2.17
Search Buffer (m): 1000

Site Details

Site at 441500, 408500



Yorkshire

Published 1906 - 1907

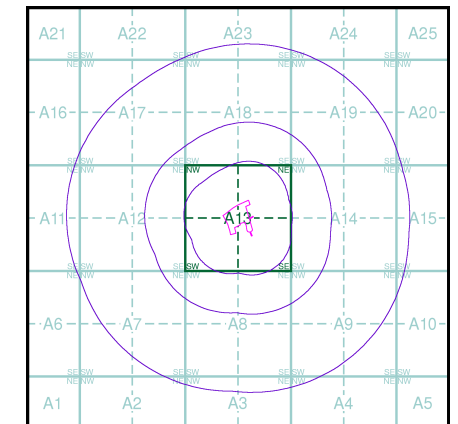
Source map scale - 1:10,560

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)

263SW 1907 1:10,560	263SE 1907 1:10,560
275NW 1906 1:10,560	275NE 1907 1:10,560

Historical Map - Slice A

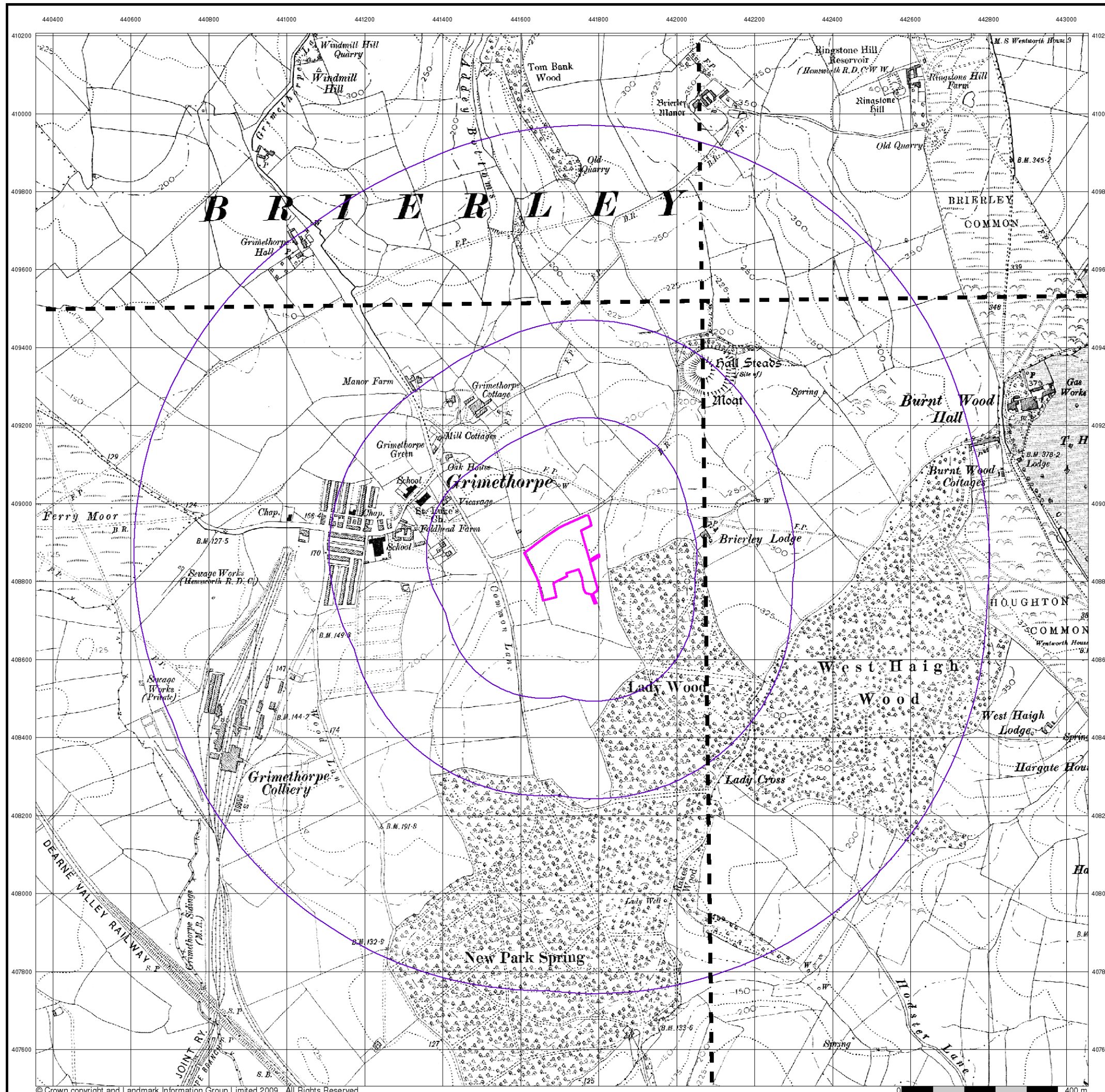


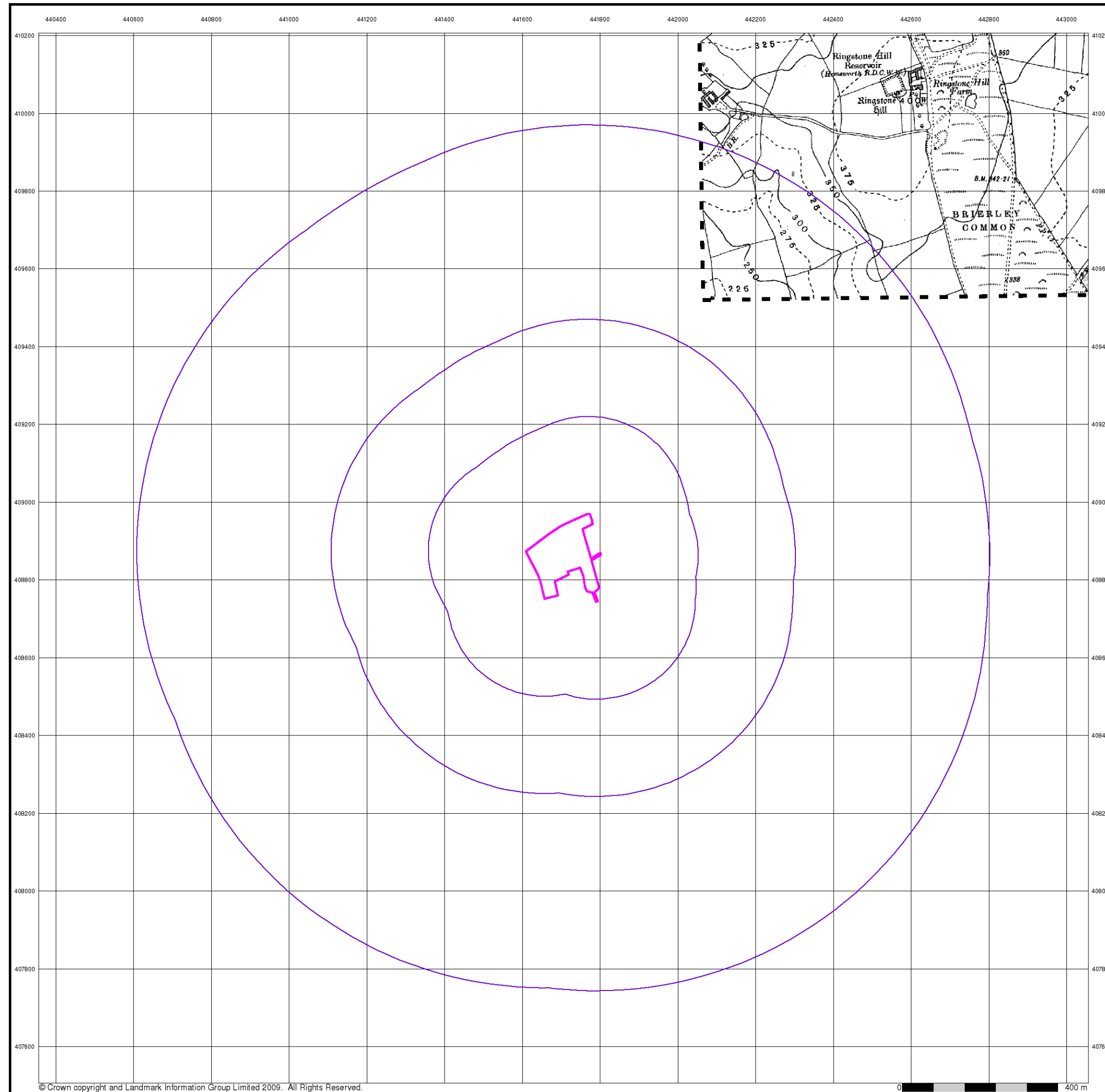
Order Details

Order Number: 29191210_1_1
Customer Ref: 32376/JMW/RAN
National Grid Reference: 441720, 408850
Slice: A
Site Area (Ha): 2.17
Search Buffer (m): 1000

Site Details

Site at 441500, 408500





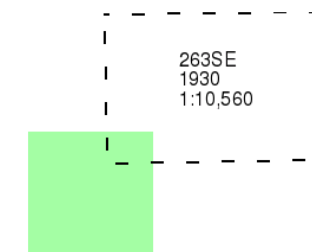
Yorkshire

Published 1930

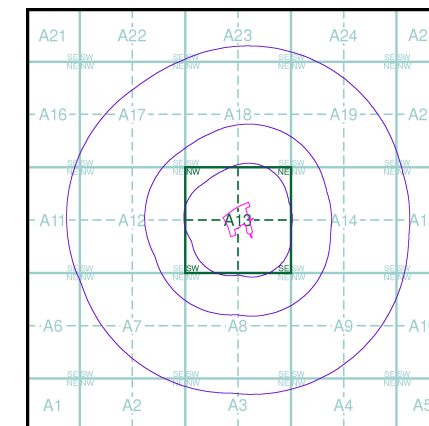
Source map scale - 1:10,560

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



Order Details

Order Number: 29191210_1_1
Customer Ref: 32376/JMW/RAN
National Grid Reference: 441720, 408850
Slice: A
Site Area (Ha): 2.17
Search Buffer (m): 1000

Site Details

Site at 441500, 408500



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

Yorkshire

Published 1932 - 1933

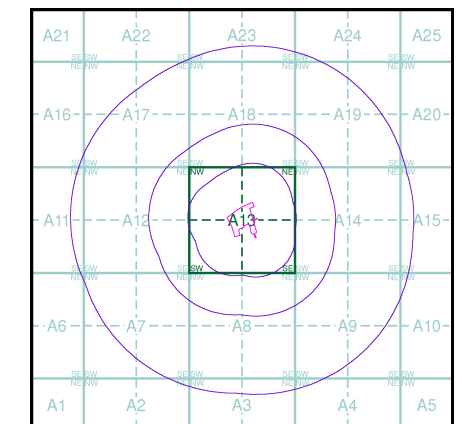
Source map scale - 1:10,560

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)

263SW 1933 1:10,560		275NE 1932 1:10,560
	275NW 1932 1:10,560	

Historical Map - Slice A

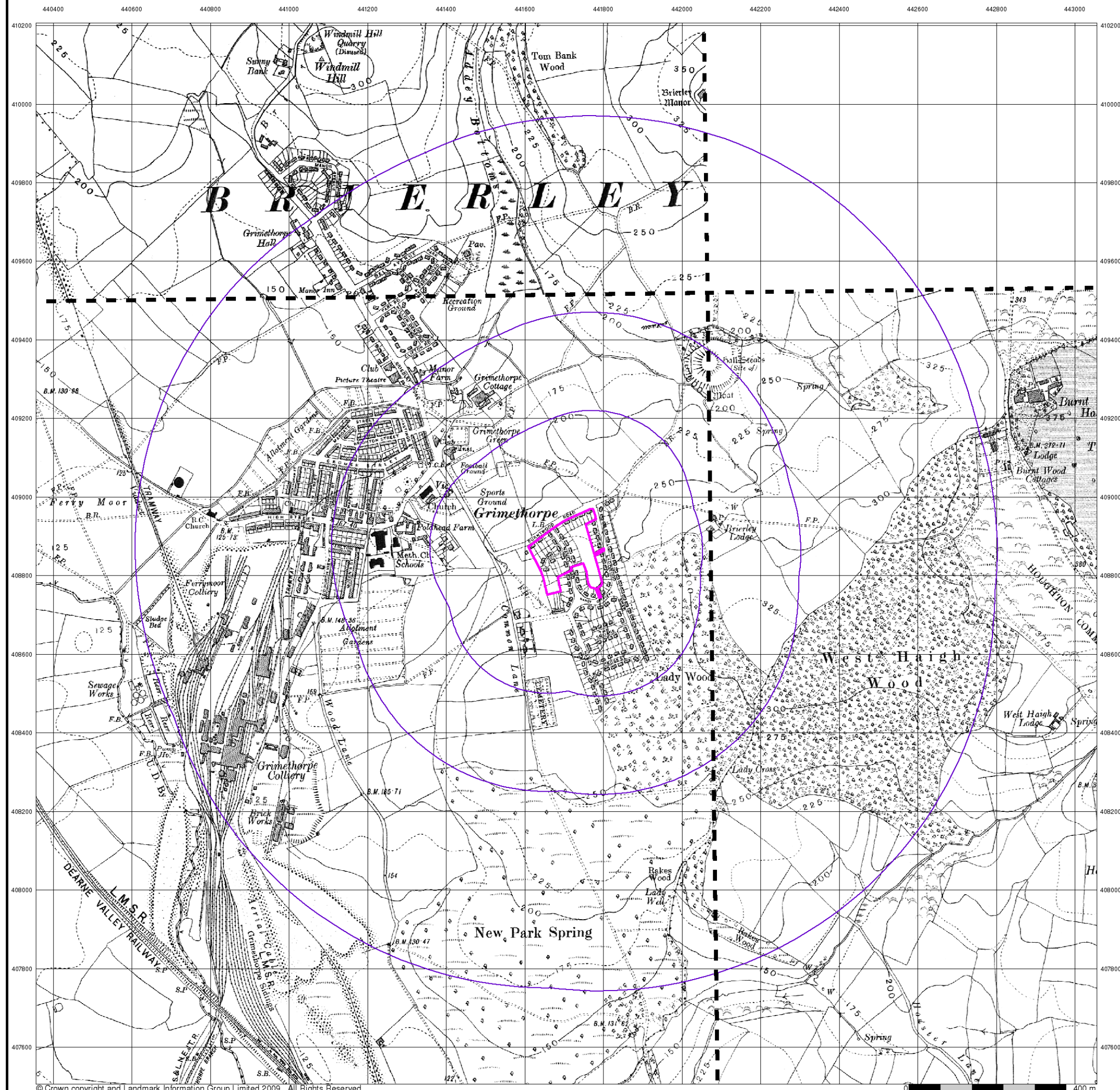


Order Details

Order Number: 29191210_1_1
Customer Ref: 32376/JMW/RAN
National Grid Reference: 441720, 408850
Slice: A
Site Area (Ha): 2.17
Search Buffer (m): 1000

Site Details

Site at 441500, 408500



Yorkshire

Published 1938 - 1948

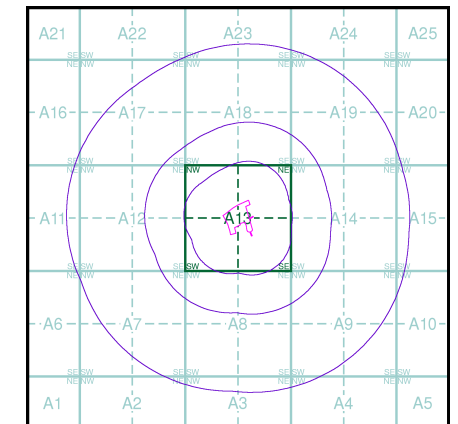
Source map scale - 1:10,560

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)

263SW 1938 1:10,560	263SE 1938 1:10,560
275NW 1938 1:10,560	275NE 1948 1:10,560

Historical Map - Slice A

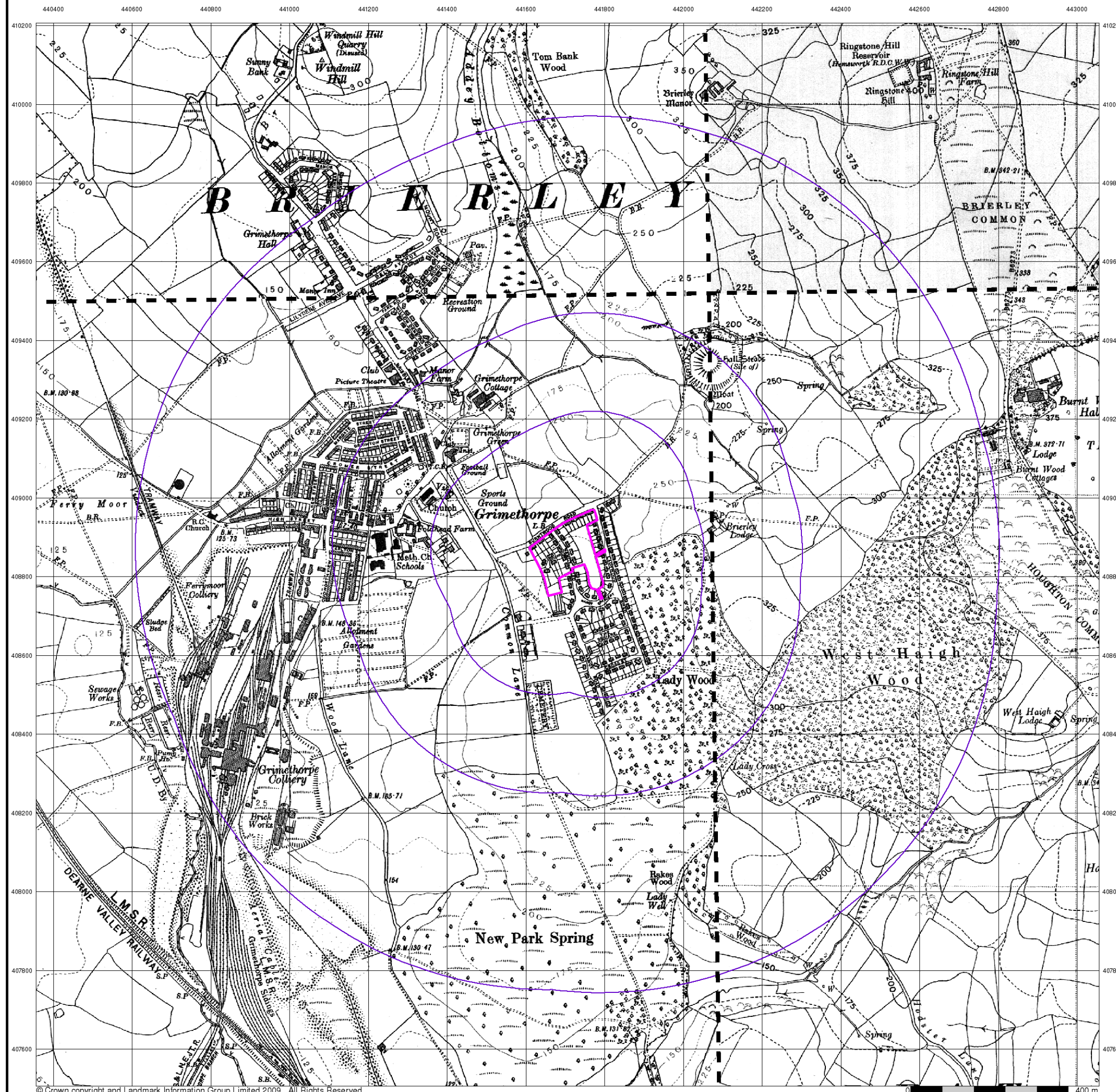


Order Details

Order Number: 29191210_1_1
 Customer Ref: 32376/JMW/RAN
 National Grid Reference: 441720, 408850
 Slice: A
 Site Area (Ha): 2.17
 Search Buffer (m): 1000

Site Details

Site at 441500, 408500



Yorkshire

Published 1938 - 1948

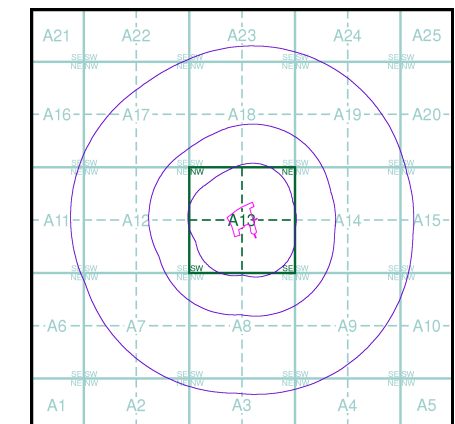
Source map scale - 1:10,560

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)

263SW 1938 1:10,560	263SE 1948 1:10,560
275NW 1938 1:10,560	

Historical Map - Slice A

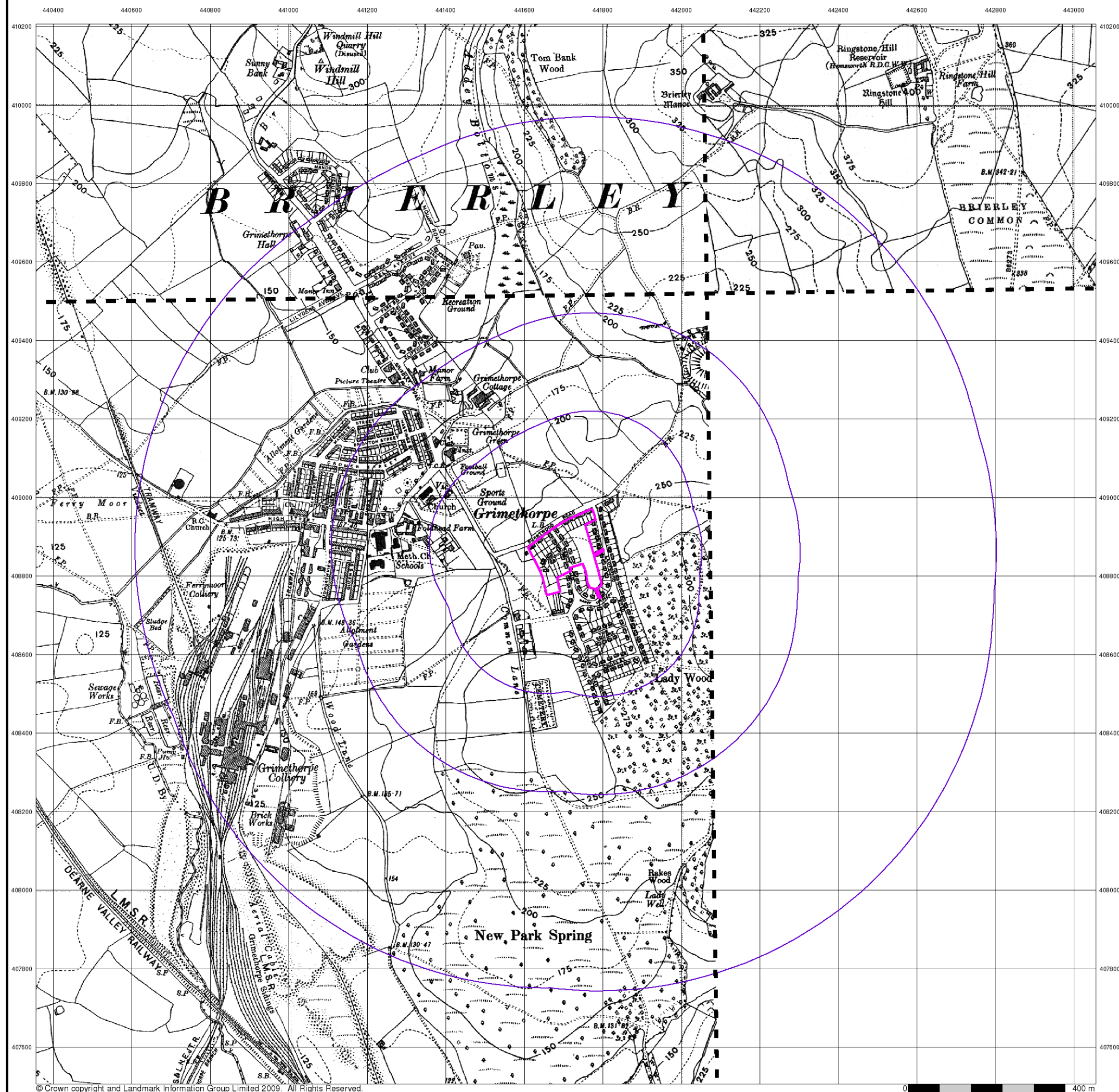


Order Details

Order Number: 29191210_1_1
 Customer Ref: 32376/JMW/RAN
 National Grid Reference: 441720, 408850
 Slice: A
 Site Area (Ha): 2.17
 Search Buffer (m): 1000

Site Details

Site at 441500, 408500



Yorkshire

Published 1948

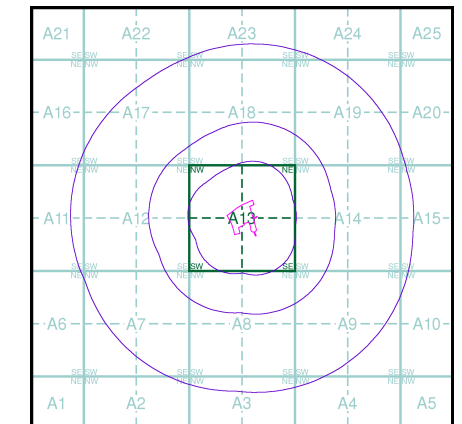
Source map scale - 1:10,560

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)

263SW	1948	1:10,560
275NW	1948	1:10,560

Historical Map - Slice A

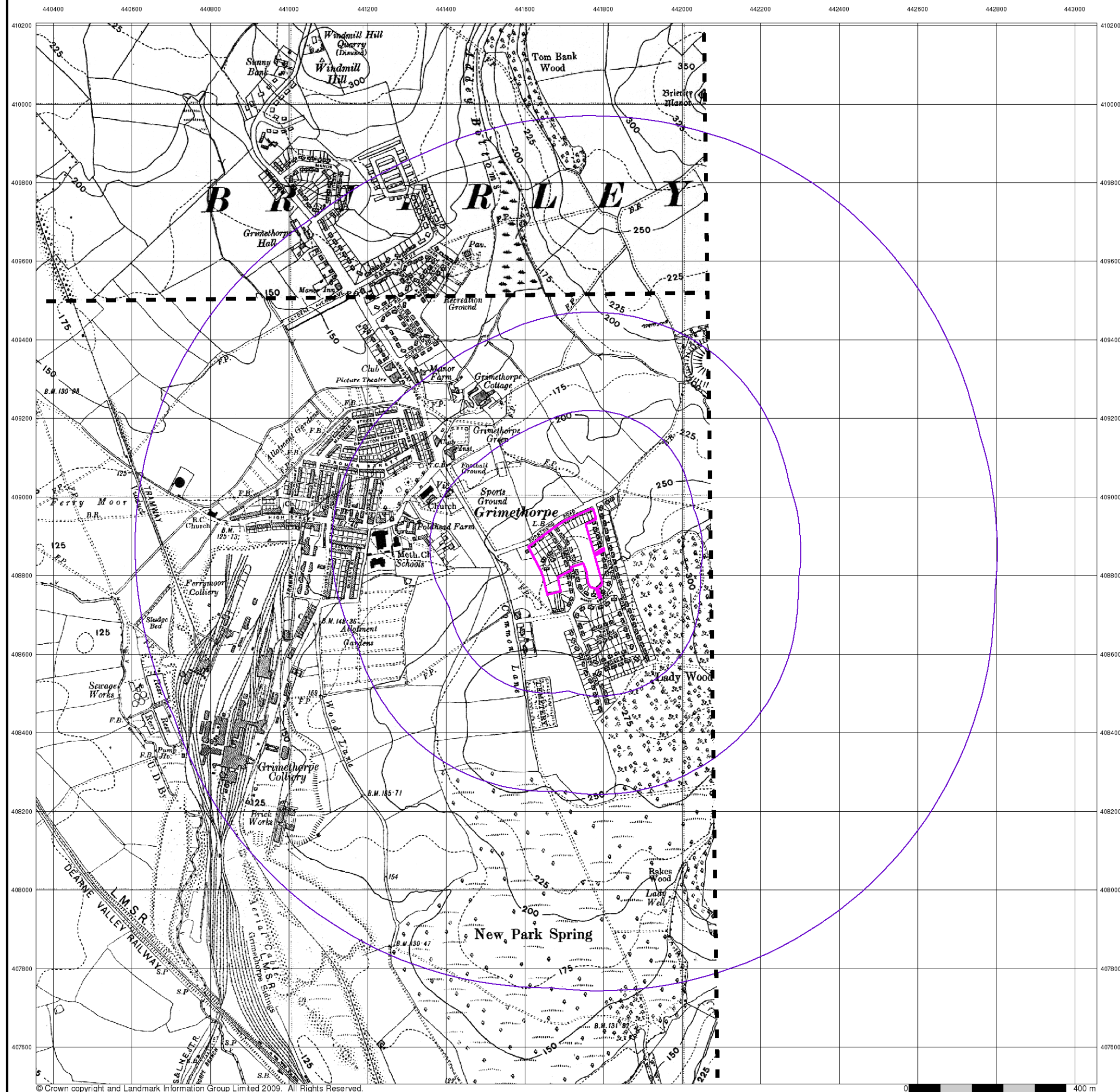


Order Details

Order Number: 29191210_1_1
 Customer Ref: 32376/JMW/RAN
 National Grid Reference: 441720, 408850
 Slice: A
 Site Area (Ha): 2.17
 Search Buffer (m): 1000

Site Details

Site at 441500, 408500



Ordnance Survey Plan

Published 1955 - 1956

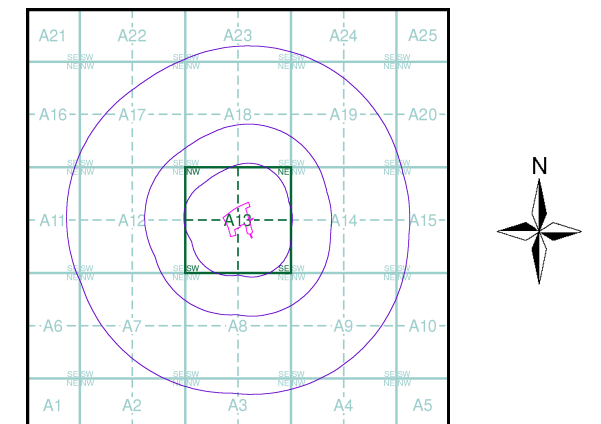
Source map scale - 1:10,000

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Map Name(s) and Date(s)

SE41SW	1956	1:10,560
SE40NW	1955	1:10,560

Historical Map - Slice A

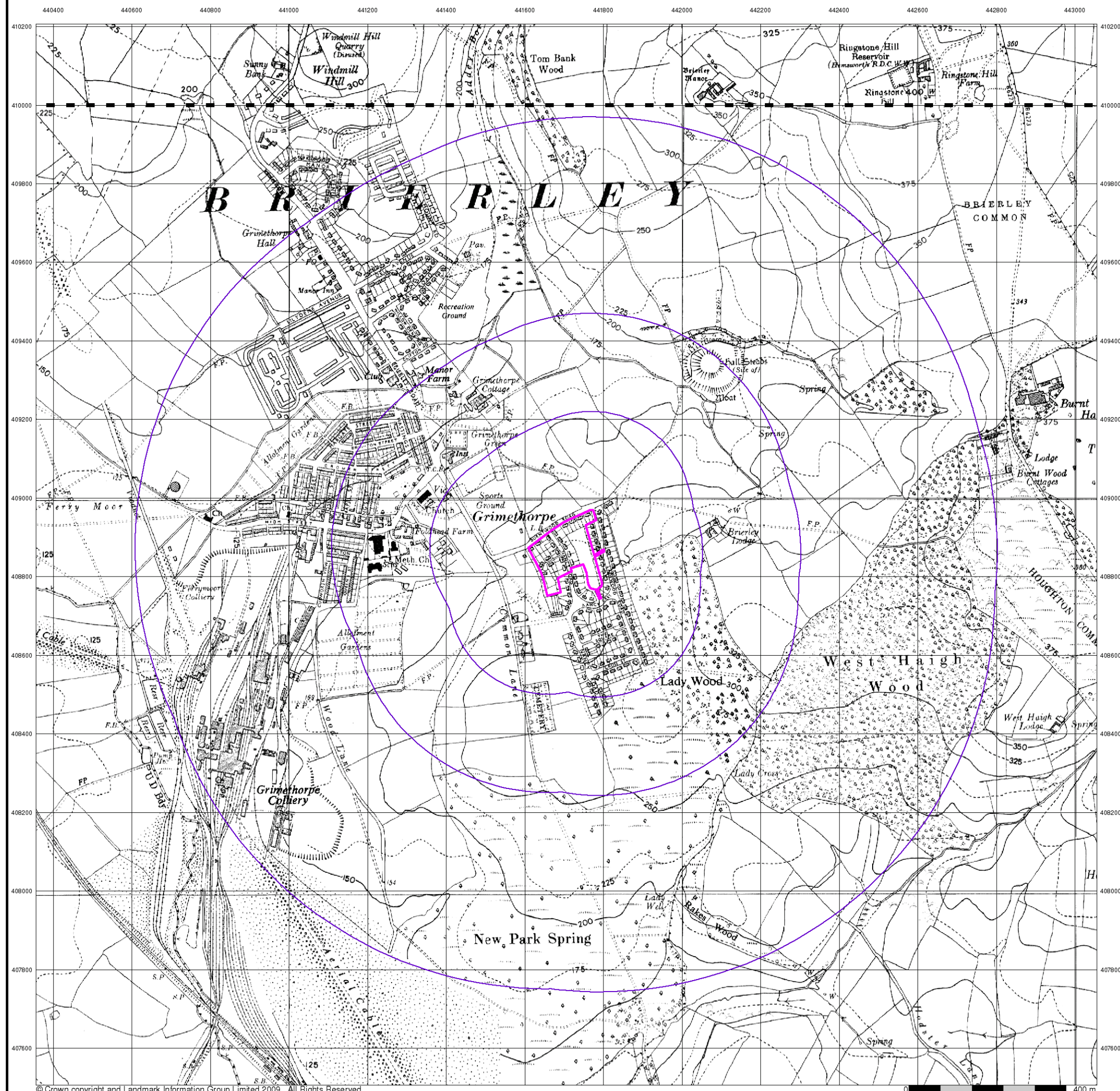


Order Details

Order Number: 29191210_1_1
 Customer Ref: 32376/JMW/RAN
 National Grid Reference: 441720, 408850
 Slice: A
 Site Area (Ha): 2.17
 Search Buffer (m): 1000

Site Details

Site at 441500, 408500



Ordnance Survey Plan

Published 1967

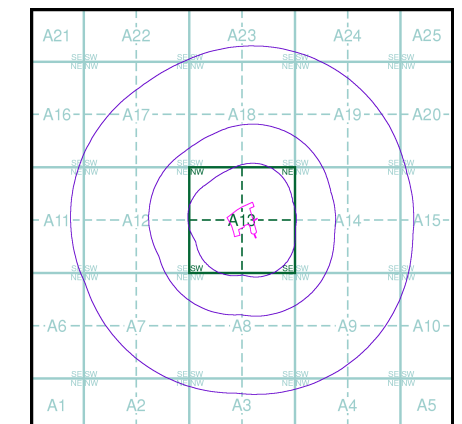
Source map scale - 1:10,000

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)

SE41SW
1967
1:10,560
SE40NW
1967
1:10,560

Historical Map - Slice A

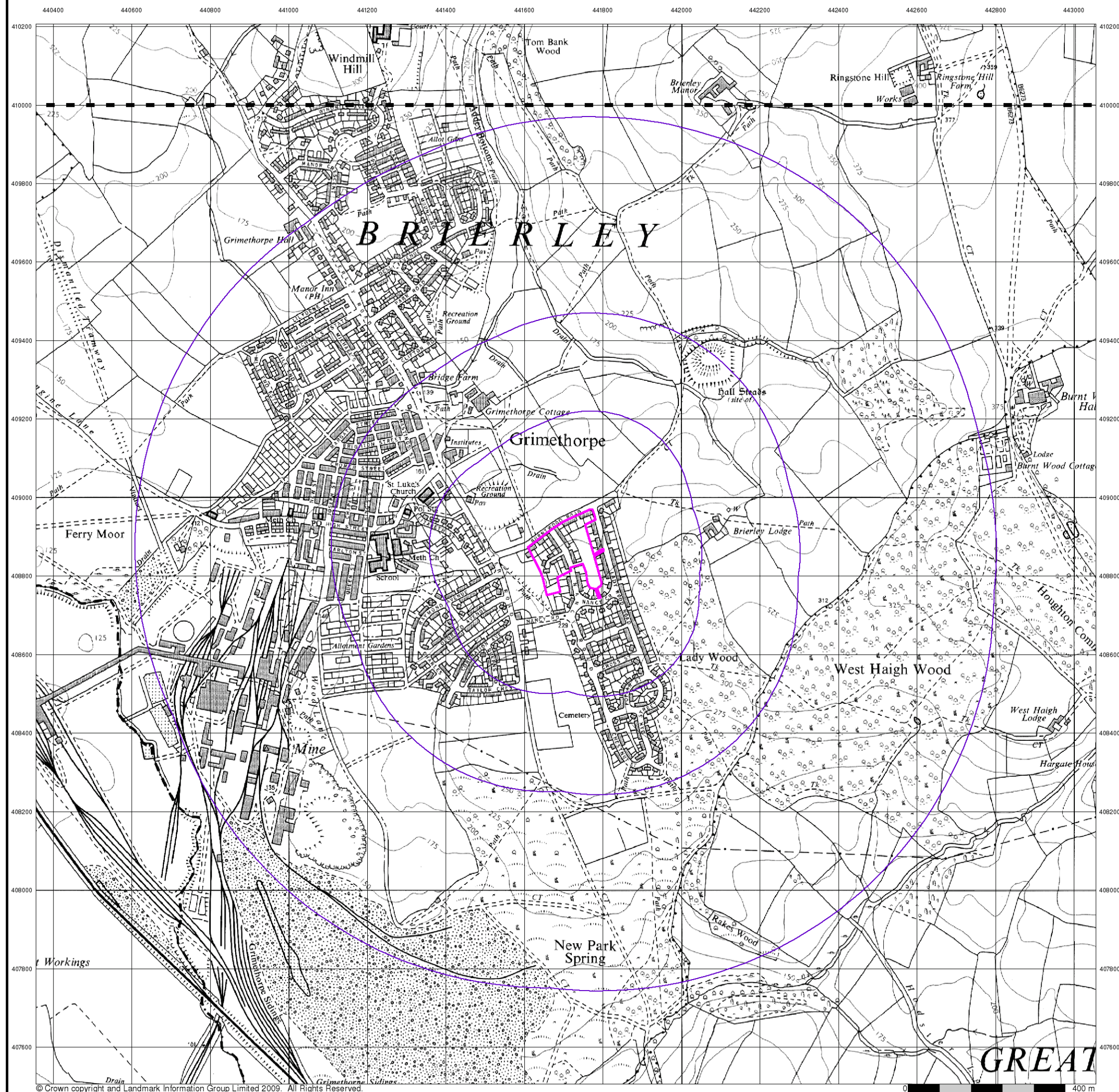


Order Details

Order Number: 29191210_1_1
Customer Ref: 32376/JMW/RAN
National Grid Reference: 441720, 408850
Slice: A
Site Area (Ha): 2.17
Search Buffer (m): 1000

Site Details

Site at 441500, 408500



Ordnance Survey Plan

Published 1983 - 1984

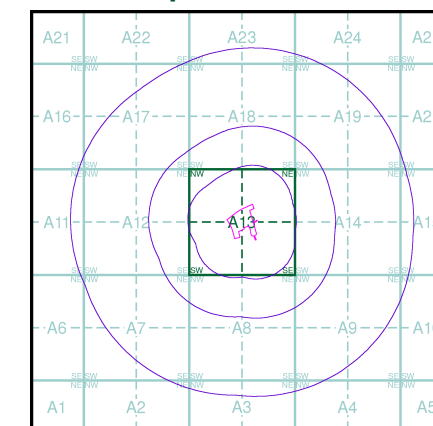
Source map scale - 1:10,000

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)

SE41SW	1984	1:10,000
SE40NW	1983	1:10,000

Historical Map - Slice A

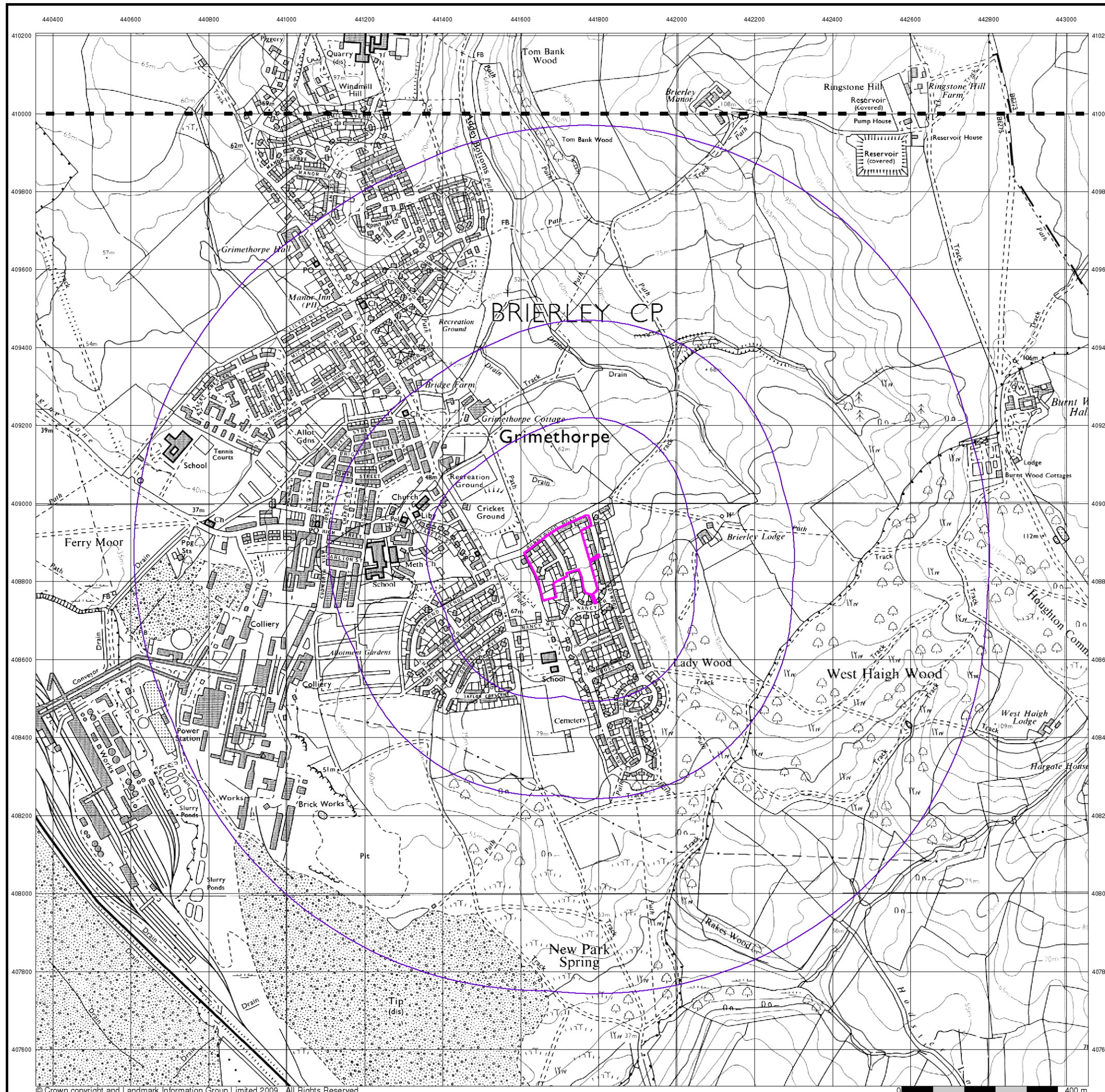


Order Details

Order Number: 29191210_1_1
 Customer Ref: 32376/JMW/RAN
 National Grid Reference: 441720, 408850
 Slice: A
 Site Area (Ha): 2.17
 Search Buffer (m): 1000

Site Details

Site at 441500, 408500



Ordnance Survey Plan

Published 1989

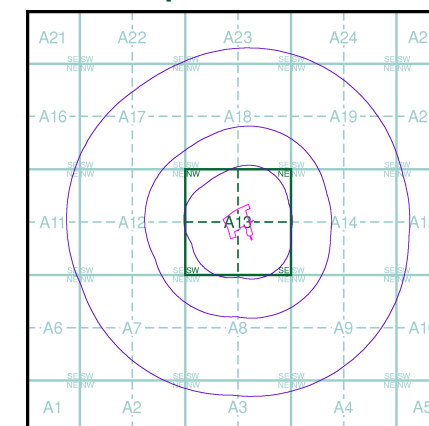
Source map scale - 1:10,000

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)

SE41SW	1989	1:10,000
SE40NW	1989	1:10,000

Historical Map - Slice A



Order Details

Order Number: 29191210_1_1
 Customer Ref: 32376/JMW/RAN
 National Grid Reference: 441720, 408850
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