LK CONSULT LIMITED

PART OF THE LK GROUP

LAND OFF
SOUTH NEWINGTON ROAD
BLOXHAM

PHASE 1 PRELIMINARY
RISK ASSESSMENT

Prepared for:

Gladman Developments Ltd

Gladman House

Alexandria Way

Congleton

CW12 1LB

By:

LK Consult Ltd

Eton Business Park

Eton Hill Road

Radcliffe

Manchester

M26 2ZS

Tel: 0161 763 7200

Email:cl@thelkgroup.com

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Prepared By	Punit Patel	**Signature**	[redacted]
Reviewed By	Colin Crompton	**Signature**	

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NON TECHNICAL SUMMARY

LK Consult Ltd (LKC) has undertaken a Preliminary Risk Assessment for Land off South Newington Road, Bloxham. The assessment was required to identify any potential contamination risk should the study area be developed for housing.

The works were undertaken in accordance with UK guidance and included a review of the history of the area from historical mapping dating back to 1881 and a review of geological, hydrogeological, ecological, mining, radon and landfill data.

The study area appears to have been used for agricultural purposes from the first edition of available mapping. The study area currently comprises pastoral farming with a field boundary.

LKC undertook a visit to the study area and hand excavated 5 no. trial holes to identify shallow ground conditions. These identified made ground comprising red silty sand to at least 0.5mbgl in two locations and a brown silty sand to at least 0.2mbgl over natural clay in three locations. Rare brick fragments and rare clinker were encountered in three of the trial holes.

A conceptual model in accordance with UK guidance was derived which considers all potential sources, all potential receptors (such as future residents or groundwater) who may be affected by contamination and the possible pathways of how the potential source may affect the identified potential receptors. Where a source, pathway and a receptor are all present then this comprises a potential pollutant linkage which could warrant further assessment such as by soil sampling and / or remediation.

LKC identified seven potential pollutant linkages, of which one was considered a high risk and the remainder a moderate to very low risk.

A **moderate risk** from radon gas posing a risk to human health was noted across the study area. LKC recommend that full radon protection measures are installed across the study area.

A localised **moderate risk** from hazardous gas posing a risk to human health and buildings (relating to infilled features within 250m of the study area) was noted in the northern part of the study area. LKC recommend that the radon protection measures are upgraded to Characteristic Situation 2 specification in this part of the study area.

A localised **moderate risk** from PAHs, heavy metals and ACMs posing a risk to human health was identified along the northern boundary where overspill from adjacent land uses may have contaminated the study area and within the footprint of the former barn and enclosure, tracks and field boundaries where made ground may be present. A targeted intrusive investigation was recommended to further assess this risk.

A **low to very low risk** has been identified across the remainder of the study area for PAHs and heavy metals. Pesticides, fertilisers and volatile contaminants posing a risk to human health, mobile contaminants posing a risk to controlled waters, soluble sulphate posing a risk to building structures, organic contaminants posing a risk to potable water pipes and for phytotoxic contaminants posing a risk to flora. A study area wide low density investigation is recommended to assess any risk from pesticides and fertilisers.

A watching brief is recommended during the development works for any contamination sources, such as ash and clinker; any unusual ground conditions and any visual and / or olfactory evidence of contamination.

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1 INTRODUCTION

1.1 Background

LK Consult Ltd (LKC) has been commissioned by Gladman Developments Ltd to carry out a Phase 1 Preliminary Risk Assessment (PRA) for Land off South Newington Road, Bloxham. The report was undertaken in support of a future planning application to redevelop the study area for a residential end use.

According to guidance set out in CLR11[1], GPLC1-3[2] and the National Planning Policy Framework (NPPF)[3] a PRA with a study area reconnaissance is required as a minimum to ascertain if there is a potential contamination risk.

In accordance with current guidance, the PRA will include a study area reconnaissance, study area history, geology, hydrogeology, hydrology, mineral search and a landfill search. Information gathered from the desk study and study area reconnaissance will be used to develop a contamination conceptual model for the study area, which will support the identification and assessment of any pollutant linkages.

Based on the findings of this report, an appropriate study area investigation can be derived, if required.

1.2 Study Area Details

A summary of the study area details is presented in Table 1-1. Figures 1 and 2 indicate the study area location and boundary.

Location	Land off South Newington Road, Bloxham, Banbury, OX15 4HZ. Centred at approximate National Grid Reference 442370E 235310N.
Area	5.92Ha.
Topography	Approximately 115 metres above ordnance datum (AOD). Gently rising from east to west across the study area.
Current Land Use	Study area Pastoral farming with barn along the southern boundary. Surrounding Area North: Recreational ground and residential properties. East: South Newington road, fields and residential properties. South: Undeveloped fields. West: Undeveloped fields.
Proposed Development	Residential development including soft landscaping, roads and car parking.

Table 1-1: Summary of study area details.

[1] EA (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11.
[2] EA (2010). "Guiding Principles for Land Contamination." GPLC1-3.
[3] DCL (2019). "National Planning Policy Framework." Department of Communities and Local Government.

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2 STUDY AREA HISTORY

2.1 Historical Map Review

In compiling the study area history, LKC consulted historical mapping and aerial photography provided by the Landmark Information Group Ltd and public domain aerial photography. Copies of relevant historical plans are provided in Appendix A and are summarised Table 2-1. Notable features within 100m of the study area boundary have been presented (distances will be approximate). The exception to this will be features within a 250m buffer that could be infilled historically.

Study Area Features	Location	Map Dates Present	Comments
Field boundary	N	1881 – 1900	No longer present by 1922 mapping.
Watercourse	N	1881 – 1955	No longer present by 1972 mapping.
Track	E	1881 – 1979	No longer present by 1982 mapping.
Track	W	1881 – 1983	No longer present by 1990 mapping.
Building	NE	1881 – 1983	No longer present by 1992 mapping.
Field boundary	N	1881 – 1983	No longer present by 1990 mapping.
Track	S	1881 – Present	
Field boundary	Centre of study area	1881 – Present	
Enclosure	NE	1900 – 1955	No longer present by 1972 mapping.
Path	N	1990 – Present	
Building	S	1990 – Present	
Surrounding Area Features	**Distance/ Location**	**Map Dates Present**	**Comments**
Watercourse	Adj to W of study area	1881 – 1955	No longer present by 1972 mapping.
Railway line	Adj to N of study area	1881 – 1999	No longer present by 2006 mapping. Dismantled from 1955 mapping.
Bloxham Brook	38m N	1881 – Present	Flowing W.
Gasometer	223m NE	1881 – 1966	No longer present by 1972 mapping.
Pond	250m W	1881 – Present	
Marshy area	92m NW	1881 – 1982	No longer present by 1983 mapping.
Timber Yard	95m NE	1900 only	No longer present by 1922 mapping.
Allotments (3)	40m N 52m NE 62m N	1900 – 1955	No longer present by 1972 mapping.
Cuttings/embankments (2)	36m N 40m NE	1900 – 1955	No longer present by 1972 mapping. Associated with the railways and sidings.

Table 2-1: Summary of historical features.

Surrounding Area Features	Distance/ Location	Map Dates Present	Comments
Pump (8)	102m NE 115m NE 129m NE 136m NE 154m NE 156m NE 164m NE 176m NE	1900 only	No longer present by 1922 mapping.
Well (2)	90m NE 162m NE	1900 only	No longer present by 1922 mapping.
Issue	16m NW	1900 – Present	Flowing NE.
Weir	30m N	1900 – 1922	No longer present by 1923 mapping.
Goods shed	20m NW	1900 – 1955	No longer present by 1972 mapping.
Sidings	36m N	1900 – 1955	No longer present by 1972 mapping.
Cuttings/embankments	156m E	1900 – 1999	No longer present by 2006 mapping.
Railway station	156m NE	1900 – 1955	No longer present by 1972 mapping.
Recreation ground	Adj to N of study area	1922 – Present	
Sidings	36m N	1922 – 1951	No longer present by 1955 mapping.
Ironstone Quarry	125m N	1922 – Present	No longer annotated by 1972 mapping, however markings remain. Old quarry markings reduced in length by 1994 mapping.
Pavilion	10m N	1955 – Present	
Sidings	206m N	1955 only	No longer present by 1972 mapping.
Spreads	50m NW	1972 – 1982	No longer present by 1990 mapping.
Sewage pumping station	236m N	1972 – Present	

Table 2-1 (continued): Summary of historical features.

3 ENVIRONMENTAL SETTING

In compiling this Section, LKC consulted environmental information provided by the Envirocheck Report (Appendix B), British Geological Survey (BGS) (Appendix C), Natural England and the Environment Agency. A summary is presented in Table 3-1.

Categories (data sources)			Details
Geology	Artificial[1]		None recorded on study area.
	Superficial[1]		None recorded on study area.
	Bedrock[1,2]		East of study area, Marlstone Rock Formation (Ferruginous Limestone and Ironstone), Toarcian – Pilensbachinan. West of study area, Whitby Mudstone Formation (Mudstone), Toarcian.
	BGS logs[3]		BH Ref: SP43NW54, 135m NE: Marlstone Rock Beds, loose brown rubbly sandstone to 5.75m, Middle Lias – Silts and clays, mudstone, Grey silty CLAY to 9m. Water struck at 6.5m.
Hydro-geology	Aquifer Designation	Superficial[1]	None recorded on study area.
		Bedrock[1]	East of study area – Secondary Aquifer – A. West of study area – Unproductive strata.
	Source Protection Zone (SPZ)		Study area is not within an SPZ.
	Groundwater Abstractions[1]		None within 250m.
Hydrology	Nearest Surface Water[1]		16m NW, Issue, flowing NE. 38m N, Bloxham Brook, flowing W.
	Water Quality Data[1]		Within study area, Bloxham Brook – River Quality B.
	Flooding[1]		Potential for groundwater flooding at the surface to the E of the study area.
	Surface Water Abstractions[1]		None within 250m.
	Discharge Consent[1]		None within 250m. Nearest 444m NE, Bovis Homes Ltd, Bloxham Brook.
	Pollution Incidents[1]		4 within 250m. Nearest 112m NE, 3rd February 1995, Category 3 – Minor Incident, Unknown sewage, affected water not given.
Minerals / Mining	Coal Mining Development High Risk Area[4]		Study area is not within a Coal Authority Development High Risk Area.
	Coal Report		Study area is not within a Coal Authority Reporting Area.
	Surface Extractions[1]		1 within 250m. 228m N, Opencast, Iron Ore – Ironstone, ceased.
	Cheshire Brine Compensation District[5]		Not within study area.
Ground Stability[1] (on-study area)	Collapsible Ground		Very low hazard.
	Compressible Ground		No hazard.
	Landslide		Very low hazard.

Table 3-1: Summary of environmental setting.

Data Sources: **1** - Envirocheck Report (Appendix A and B); **2** - BGS Sheet 218 1:50,000; **3** - BGS GeoIndex http://mapapps2.bgs.ac.uk/geoindex/home.html (Appendix C); **4** - The Coal Authority Web Mapping Services (WMS) and Interactive Map Viewer http://coal.decc.gov.uk/en/coal/cms/publications/data/map/map.aspx.

Categories (data sources)		Details
Ground Stability[1] (on-study area)	Running Sand	No hazard.
	Shrinking / Swelling Clay	No hazard – low hazard.
	Ground Dissolution	No hazard.
Landfill sites	Known/Registered[1]	1 within 250m. 110m E, 'Bloxham Railway Cutting'. Deposited Brick, Concrete, Wood, Subsoil. Operational 1977 - 1993.
	Potential[1]	16 within 250m: - 8 Pumps, 102m – 176m NE, potentially infilled by 1922 mapping. - Watercourse, adjacent W, potentially infilled by 1972 mapping. - 2 Wells, 90m – 162m NE, potentially infilled by 1922 mapping. - Ironstone quarry – 125m N, potentially infilled by 1972 mapping. - 3 cuttings/embankments, 36m – 156m NE and N, potentially infilled by 1972 – 2006. - Quarry markings, 125m N, partially potentially infilled by 1994 mapping.
Radon[1]		2 designations within the study area. - Probability of less than 1% of homes estimated to be at or above the Action Level. - Probability of 10-30% of homes estimated to be above the Action Level. Full radon protective measures are necessary in the construction of new dwellings or extensions. A detailed radon information map is provided in Appendix D. This indicates the extent of the two designations.
Designated Sites[1]		Study area is within a Nitrate Vulnerable Zone.
Contemporary Trade Directory[1]		1 within 250m. 237m NE, Garage Services.
Fuel Station Entries[1]		None within 250m.
Unexploded Ordnance[5]		No readily available records of bombing or other significant military activity on the study area have been found. It is considered that the study area is likely to have a low UXO hazard level.

Table 3-1 (continued): Summary of environmental setting.
Data Sources: **1** - Envirocheck Report (Appendix); **5-** Zetica Ltd Summary (Appendix E);

4 STUDY AREA RECONNAISSANCE

A study area reconnaissance was carried out on 7th September 2016. Hand dug trial holes were undertaken in accessible areas to confirm the shallow ground conditions.

An annotated plan with photographs and trial holes is provided in Appendix F.

Relevant features identified on study area are summarised below:

- The study area is pastoral farm land.
- A barn was noted along the southern boundary of the study area.
- The study area is bounded by hedgerows along the southern, western and eastern boundaries. The northern boundary is bounded by a metal wire fencing, residential properties and hedgerows.
- The study area is split with a north – south aligned hedgerow present from the southern boundary to near the northern boundary.
- No above ground fuel tanks were observed within the boundary of the study area.
- A public right of way (PROW) was noted during the study area reconnaissance along the northern, western and eastern boundaries.
- A water main cover was noted along the northern study area boundary, ten metres from the PROW.
- A water trough was noted on the eastern boundary of the study area.
- Five hand dug trial holes were undertaken across the study area which identified brown clayey sand to at least 0.2mbgl over natural clay in three trial holes. In TH1 and TH5, red silty sand was identified to at least 0.5mbgl. Made ground was observed in all the trial holes consisting of rootlets, rare clinker was observed in TH1, TH2 and TH3.
- No access restrictions.

The surrounding area comprises

- North: Recreational ground and residential properties.
- East: South Newington Road, fields and residential properties.
- South: Undeveloped fields.
- West: Undeveloped fields.

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5 PRELIMINARY CONCEPTUAL MODEL

5.1 Introduction

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

The Sections below are therefore divided into potential contaminant, potential pathway and potential receptor as described in CLR11[4]. The final Section provides an assessment of the potential pollutant linkages that may still be present on the study area if redevelopment were to occur.

5.2 Potential Contaminants

Study area

No significant potentially contaminative land use has been identified within the study area.

The study area predominantly comprises pastoral farmland. Pesticides and fertilisers may have been used on the area historically. Contaminants associated with the use of pesticides and fertilisers include heavy metals (Pb/As), organophosphates, organochlorides, chlorophenols as well as specific contaminants such as aldrin, dieldin, atrazine and DDT.

Localised spillages of hydrocarbon fuels (e.g. diesel, oils) and Volatile Organic Compounds (VOCs) may have occurred in the vicinity of the study area. Contaminants associated with these areas could include hydrocarbons, heavy metals and VOCs. These are not likely to be a significant source of contamination across the study area and no visual evidence of hydrocarbon contamination was noted during the reconnaissance.

Rare clinker and brick fragments were noted during the study area reconnaissance. Made ground may be present elsewhere on the study area within former field boundaries and the path. Typical contaminants could include heavy metals (such as arsenic and lead), sulphates and PAHs[5].

Former barn and enclosure in the north east of the study area

The former barn in the north east of the study area may have been built originally with asbestos containing materials (ACMs); therefore there may be localised contamination within the vicinity of the former building.

The former barn may have been used to store hydrocarbon fuels; therefore there may be localised contamination of petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAHs) within the vicinity of the former building.

Ash and clinker may be present within the vicinity of the barn and enclosure as it was used historically as a levelling material. Contamination associated with this could include heavy metals (such as arsenic and lead), sulphates and PAHs[5].

[4] Defra (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11.

Landfills / Potentially infilled ground

Known landfills and potentially infilled ground have been identified within 250m of the study area. These have the potential to generate hazardous gas (principally carbon dioxide and methane).

The potential for migration of hazardous gas can depend upon the age of the feature, volume of material, type of infill material, size of feature, distance from the study area and intervening geology.

The 'Bloxham Railway Cutting' landfill is within 250m of the study area; given the age of the infilling; the size and distance from the study area this feature is not considered to comprise a viable source of gas to the north of the study area.

The ironstone quarry, watercourse and the cuttings/embankments are within 250m of the study area; given the ages of the potential infilling of these features, the size and the distance from the study area these features are considered to comprise a viable source of gas to the north of the study area.

The 8 pumps and 2 wells are within 250m of the study area; however, given the ages of the potential infilling and the size of the features it is not considered that these comprise a viable source of gas to the study area.

Approximately half of the study area is mapped as being underlain by limestone which is a known source of carbon dioxide generation. However it is not considered to be a viable source of ground gas due to the likely low production rates[5].

Radon

The study area is located within a Radon Affected Area.

Industries in Surrounding Area

Railway Land was identified north of the study area (including railway line / sidings and goods yard). Potential contaminants could include fuels, oils, PAHs, ethylene gycol (antifreeze), creosote, solvents, herbicides (including atrazine and simazine), heavy metals, sulphate, phenols and asbestos[6]. Atmospheric fallout of ash may have occurred along the northern boundary.

Allotment Gardens and a Recreation Ground are identified to the north of the study area. Ash and clinker was often used for drainage and paths may have spilt out onto the adjacent study area. Contamination associated with this could include heavy metals (such as arsenic and lead), sulphates and PAHs[5]. In addition, pesticides may have been used on the allotments.

A Timber Yard was identified northeast of the study area. Potential contaminants could include creosote and water-based copper-chromium-arsenic solutions (CCA)[7]. Given the distance to the study area this is not considered to be a viable source of contamination to the study area.

The immediate surrounding areas have been developed for both residential and agricultural usage. Contamination is unlikely to be more significant than the potential contamination sources already identified within the study area.

[5] CL:AIRE (2012). "A Pragmatic Approach to Ground Gas Risk Assessment". RB17.
[6] Department of the Environment Industry Profile – Railway land (1995).
[7] Department of the Environment Industry Profile – Timber treatment works (1995).

5.3 Potential Pathways

The pathways are split into the migration of soil, water and gas.

Soil

This also includes soil-derived dust / fibres, vapours from the soil and the uptake of contaminants from the soil into flora / vegetables.

Principal potential pathways associated with human health from soil contamination are ingestion, dermal and inhalation. The current UK technical report document[8] recognises ten such pathways comprising four ingestion, two dermal and four inhalation. These are listed as follows:

- Ingestion of soil
- Ingestion of soil-derived indoor dust
- Ingestion of contaminated vegetables
- Ingestion of soil attached to vegetables
- Dermal contact with soil
- Dermal contact with soil-derived indoor dust
- Inhalation of soil-derived outdoor dust
- Inhalation of soil-derived indoor dust
- Inhalation of vapours outside
- Inhalation of vapours inside

The proposed end-use follows a standard conceptual model of residential end use. For this land use scenario all ten of the pathways will have to be considered.

Soils may be within direct contact with receptors (e.g. building foundations, services).

Soils can also generate dust / fibres which could migrate via windblow to adjacent receptors.

Water

Surface water and groundwater are principal mechanisms for the migration of contaminants. The following pathways are considered in the assessment:

- Surface run-off over impermeable surface.
- Infiltration into the ground, through potentially contaminated material (contamination possibly going into solution).
- Migration through potentially permeable strata and preferential pathways, such as drains, sewers, culverts, faults and mine workings.

The anticipated limestone and ironstone bedrock on the eastern part of the study area is likely to be relatively permeable and could act as a pathway to the migration of potential contaminated waters.

The anticipated mudstone bedrock on the western part of the study area is likely to be relatively impermeable and reduce the migration of potential contaminated waters.

Gas

Gas can migrate via the following potential pathways:

- Migration through potentially permeable strata and preferential pathways, such as drains, sewers, culverts, faults and mine workings.
- Migration into buildings (e.g. via services) and accumulation of gases in confined spaces (potentially causing explosion if methane is present).

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

As discussed above, the geology and preferential pathways may acts as pathways or barriers for gas migration.

5.4 Potential Receptors

Potential receptors include:

- Human Health: future users, adjacent land users.
- Controlled Waters: Bloxham Brook 38m N and Secondary Aquifer in the E of the study area.
- Buildings and structures.
- Potable water pipes.
- Flora within future gardens/landscaping.

5.5 Preliminary Contamination Conceptual Model

The preliminary contamination conceptual model for Land off South Newington Road, Bloxham, is illustrated in Table 5-1 below and has identified seven generic potential pollutant linkages.

Each linkage is described along with an assessment of the risk based upon guidance on probabilities and consequences outlined in CIRIA C552[9].

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

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

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

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

It should be noted that there may be risk from short term exposure from contaminated soil to study area workers. The Preliminary Contamination Conceptual Model deals with long term exposure to key receptors. Acute risks can be easily mitigated by good environmental management of the study area during study area works. Standard health and safety precautions (as per HSE guidance[10]) should be adopted by all workers involved with study area enabling and construction works. Therefore, this receptor is not considered in the contamination conceptual model.

[9] CIRIA (2001). "Contaminated land risk assessment: A guide to good practice". C552.
[10] HSE (1991). "Protection of Workers and the General Public During Development of Contaminated Land" London HMSO.

Pollutant Linkage	Pathway	Receptor	Contaminant (source)	Probability	Consequence	Risk	Assessment
PL1	Dermal contact. Inhalation of soil, fibres and dust. Ingestion of soils, dust, vegetables, soil attached to vegetables. Windblown dust.	Future users. Adjacent receptors.	ACM (footprint of barn and made ground)	Low (localised)	Severe	**Moderate**	Low (localised) probability of ACMs in the made ground in the vicinity of the former barn. **Recommendation:** Targeted intrusive investigation required.
				Unlikely (remainder)	Severe	Moderate/ **Low**	Unlikely probability as no source of ACMs is identified across the remainder of the study area. Low risk assumed as no historic use has been identified on the study area, **Recommendation**: A watching brief is recommended.
			Heavy metals and PAHs (made ground, footprint of barn and enclosure, field boundaries, and tracks, atmospheric fallout).	Likely (Localised)	Medium	**Moderate**	Likely (localised) probability of heavy metals and PAHs along the northern boundary of the study area and the vicinity of the barn and walls. **Recommendation**: Targeted intrusive investigation required.
				Low (remainder)	Medium	Moderate/ **Low**	Low probability across the reminder of the study area as rare clinker and or brick inclusions were identified in the made ground during the reconnaissance. Low risk assumed as no historic use has been identified on the study area. **Recommendation:** Low density confirmatory intrusive investigation.
			Heavy end hydrocarbons (footprint of barn and enclosure, pastoral farm land, tracks).	Low (localised)	Medium	Moderate/ **Low**	Low (localised) probability of hydrocarbons in the vicinity of the barn. Low risk assumed as no historic use has been identified on the study area. **Recommendation**: Targeted low density confirmatory intrusive investigation.
				Unlikely (remainder)	Medium	**Low**	Unlikely probability of hydrocarbons as minimal spills / leakages expected from farm vehicles. Contamination could come into contact with receptors in soft landscaping / gardens. **Recommendation:** No intrusive work required unless evidence of contaminants identified on the ground. A watching brief is recommended.
			Pesticides and fertilisers: (pastoral farm land)	Low	Medium	Moderate/ **Low**	Low probability of pesticides and fertilisers as the study area is pastoral farming Low risk assumed as long term farming activities will likely disperse any contaminants in the soil. **Recommendation:** No testing.
PL2	Inhalation of vapours. Migration through permeable strata and preferential pathways.	Future users.	Volatile Contaminants: Agricultural use	Unlikely	Medium	**Low**	Unlikely probability as no significant historical source identified. **Recommendation:** No testing required unless evidence of volatile contaminants identified in the ground. A watching brief is recommended.

Table 5-1: Preliminary Contamination Conceptual Model.

Pollutant Linkage	Pathway	Receptor	Contaminant (source)	Probability	Consequence	Risk	Assessment
PL3	Inhalation of gas. Migration through permeable strata and preferential pathways. Explosion in confined spaces.	Future users. Buildings. Adjacent receptors.	Methane, carbon dioxide. (Potentially infilled features 250m of the study area).	Low (localised)	Severe	**Moderate**	Low (localised) probability in N part of the study area due to viable source of gas identified and sensitive nature of development (residential). **Recommendation:** Upgrade radon protection measures to Characteristic Situation 2 in the N part of study area.
				Unlikely (remainder)	Severe	Moderate/ **Low**	Unlikely (remainder) probability due to no viable source of gas identified. **Recommendation**: No intrusive work required.
			Radon	Likely	Medium	**Moderate**	Likely probability as almost all of study area located within a radon affected area. **Recommendation**: Full radon protection measures required.
PL4	Surface Run-off. Migration through permeable strata and preferential pathways Perched waters migration.	Groundwater (Secondary Aquifer-A). Surface water (Bloxham Brook).	Mobile contaminants (made ground, pastoral farm land)	Unlikely	Medium	**Low**	Unlikely probability as significant source of mobile contamination is not expected. **Recommendation:** No testing required unless evidence of significant contamination is identified in the soil. A watching brief is recommended.
PL5	Sulphate attack on concrete.	Building structure.	Sulphate (made ground).	Low	Mild	**Low**	Low probability as only rare clinker identified in made ground. **Recommendation:** Low density precautionary sampling required as part of PL1. A watching brief is recommended.
PL6	Ingestion of tainted water supply.	Future users.	Organic Contaminants (made ground, pastoral farm land).	Unlikely	Medium	**Low**	Unlikely probability as a significant source of organic contamination is not expected at pipeline depth. **Recommendation:** No intrusive investigation required unless evidence of contamination is identified in the ground at pipeline depth.
PL7	Direct Contact (plant uptake).	Flora.	Phytotoxic Contaminants (made ground).	Unlikely	Minor	**Very Low**	Unlikely as no evidence of vegetation distress noted across the study area. **Recommendation:** No intrusive work required.

Table 5-1 (Continued): Preliminary Contamination Conceptual Model.

6 SUMMARY CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary Conclusions

The study area has been used for agricultural purposes since 1881 mapping and has remained relatively unchanged, with the exception of the demolition of the barn in the north eastern corner of the study area and the construction of the new cow shed along the southern boundary.

The study area is currently used for pastoral farming. The study area soil comprised made ground to 0.2 – 0.5mbgl (with rare clinker and/or brick fragments) over natural sandy clay.

Potential contamination sources affecting the study area were identified as heavy metals, PAHs, sulphate, asbestos, pesticides, fertilisers, hydrocarbons and gas (carbon dioxide, radon and methane).

These contaminants may pose a risk to study area users (via ingestion/dermal contact/inhalation pathways and explosion), controlled waters (via migration through permeable strata / preferential pathways), buildings and structures (direct contact and explosion), water pipes (direct contact) and flora (root uptake).

A contamination conceptual model has been produced by LKC. This has identified the following risks summarised in Table 6-1. Where a Moderate / very low risk was identified, the assumed risk at this stage has been shown.

Pollutant Linkage		Risk	Further Action Required
1	Contaminants posing a risk to study area users via dermal contact, ingestion and inhalation (of soil, dust, fibres and vegetables).	**Moderate** (Localised)	Targeted investigation work required for ACMs, PAHs and heavy metals. A low density study area investigation for pesticides, fertilisers, PAHs, heavy metals and heavy end hydrocarbons.
		Low (Remainder)	
2	Volatile contaminants posing a risk to study area users via the inhalation of vapours.	**Low**	No investigation work required unless evidence of volatile contaminants identified in the soil.
3	Gas posing a risk to buildings and study area users via the migration of gas into building causing explosion and asphyxiation.	**Moderate** (localised)	Upgrade radon protection measures to Characteristic Situation 2 in the N part of study area.
		Low (remainder)	No investigation work required.
		Moderate (Radon)	Full radon protection measures required.
4	Mobile contamination posing a risk to controlled waters via the migration through permeable strata.	**Low**	No intrusive investigation required unless evidence of significant mobile contamination is identified in the soil.
5	Sulphate posing a risk to building via direct contact (sulphate attack).	**Low**	Investigation work required as part of PL1.
6	Organic contaminants posing a risk to water pipes.	**Low**	No intrusive investigation required unless evidence of contamination is identified in the ground at pipeline depth.
7	Phytotoxic Metals posing a risk to flora via root uptake.	**Very Low**	No intrusive work required.

Table 6-1: Risk table.

Based on the above work LKC considers further work will be required, which is briefly detailed in the following Section.

6.2 Recommendations

6.2.1 General

In accordance with the NPPF, LKC consider that sufficient information on the potential contaminative status of the study area is available in this Preliminary Risk Assessment report to allow the validation of any future planning application by the Local Planning Authority and for conditional planning approval to be granted. Such conditional approval will likely include standard prescriptive conditions requiring a study area investigation, risk assessment and, if appropriate, a remedial strategy are completed to the satisfaction of the Local Planning Authority prior to the commencement of any development.

LKC would recommend that once conditional planning approval is granted, a Phase 2 intrusive survey should be carried out across the study area to investigate the identified potential pollutant linkages further. The scope of this Phase 2 survey should be prior agreed with the Local Authority and should include the following.

6.2.2 Phase 2 Investigation

In order to assess potential pollutant linkages 1 and 5, an intrusive investigation is recommended. The investigation should be carried in accordance with relevant guidance documents (including BS10175[11] and BS5930[12]).

A targeted investigation is recommended to address Pollutant Linkage 1 for the presence of PAHs and heavy metals. Targeted sampling locations may include the footprint of the former barn and enclosure, tracks, field boundaries and the northern boundary of the study area. This investigation may also address Pollutant Linkage 5. A low density investigation is recommended to assess the risk from pesticides and fertilisers.

Soil samples should be collected from the trial pits / boreholes and tested for contaminants of concern based on the preliminary conceptual model and field observations.

6.2.3 Remediation and validation

In order to address potential Pollutant Linkage 3, full radon measures are recommended across the study area. The BRE document (BR211[13]) has examples of 'full' protection designs and include:

- Suspended concrete floor with void, cavity tray and radon gas membrane; or
- Suspended beam and block with vented void using a periscopic vent and radon gas membrane; or
- Cast in-situ concrete floor with cavity tray and radon gas membrane.

[11] British Standard (2011). "Investigation of Potentially Contaminated Study areas – Code of Practice." BS10175:2011.
[12] British Standard (2015). "Code of Practice for Ground Investigations. " BS5930:2015.
[13] BRE (2015). "RADON: Guidance on protective measures for new buildings." Document BR211.

In order to address the hazardous gas risk in the northern part of the study area LKC recommend that the radon protection measures are upgraded to a specification commensurate with Characteristic Situation 2[14,15].

LKC advise that final foundation details should be provided to the Local Authority for review.

6.2.4 Watching Brief

Notwithstanding the above, a watching brief should be maintained by the study area manager during the clearance of the study area and developments works, for any likely contaminated made ground, such as ash and clinker; any unusual ground conditions and any visual / or olfactory evidence of contamination.

If such evidence of made ground and / or visual and olfactory evidence of contaminants are identified, then sampling will likely be required to characterise the material and recommendations for appropriate remediation undertaken, if required. Samples should be collected in sufficient quantity and analysed for a suitable suite of determinands to demonstrably characterise the study area. Should any significant thickness of made ground be encountered during works within the study area, LKC would recommend that this information is reported to the Local Authority and to LKC for further assessment.

[14] CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665
[15] BSI (2015). "Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for new buildings." BS8485:2015.

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FIGURES

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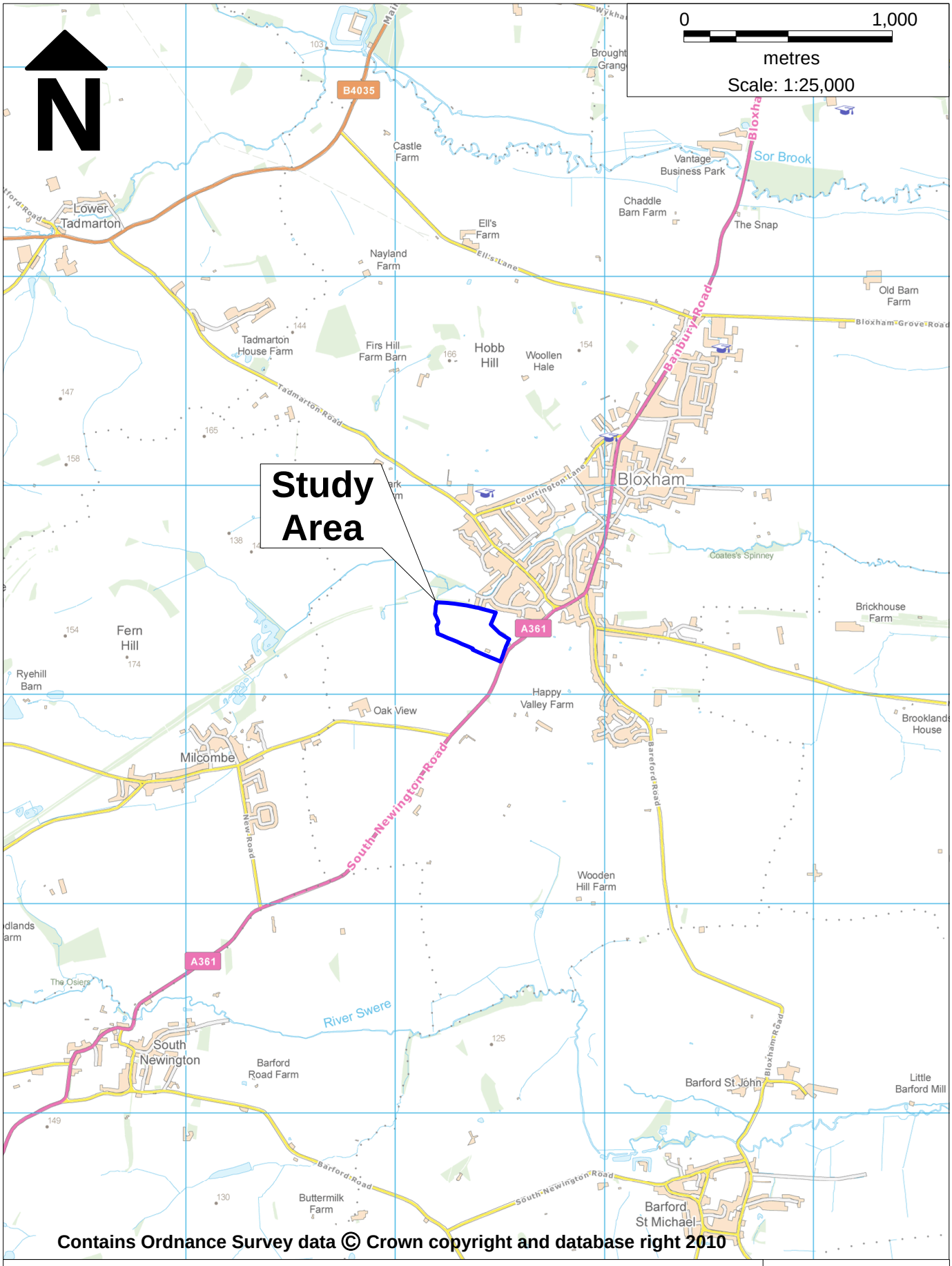

Figure 1: Study Area Location Plan, Land off South Newington Road, Bloxham

Drawn: February 2017 Scale: 1:25,000 @ A4 (see scale bar)

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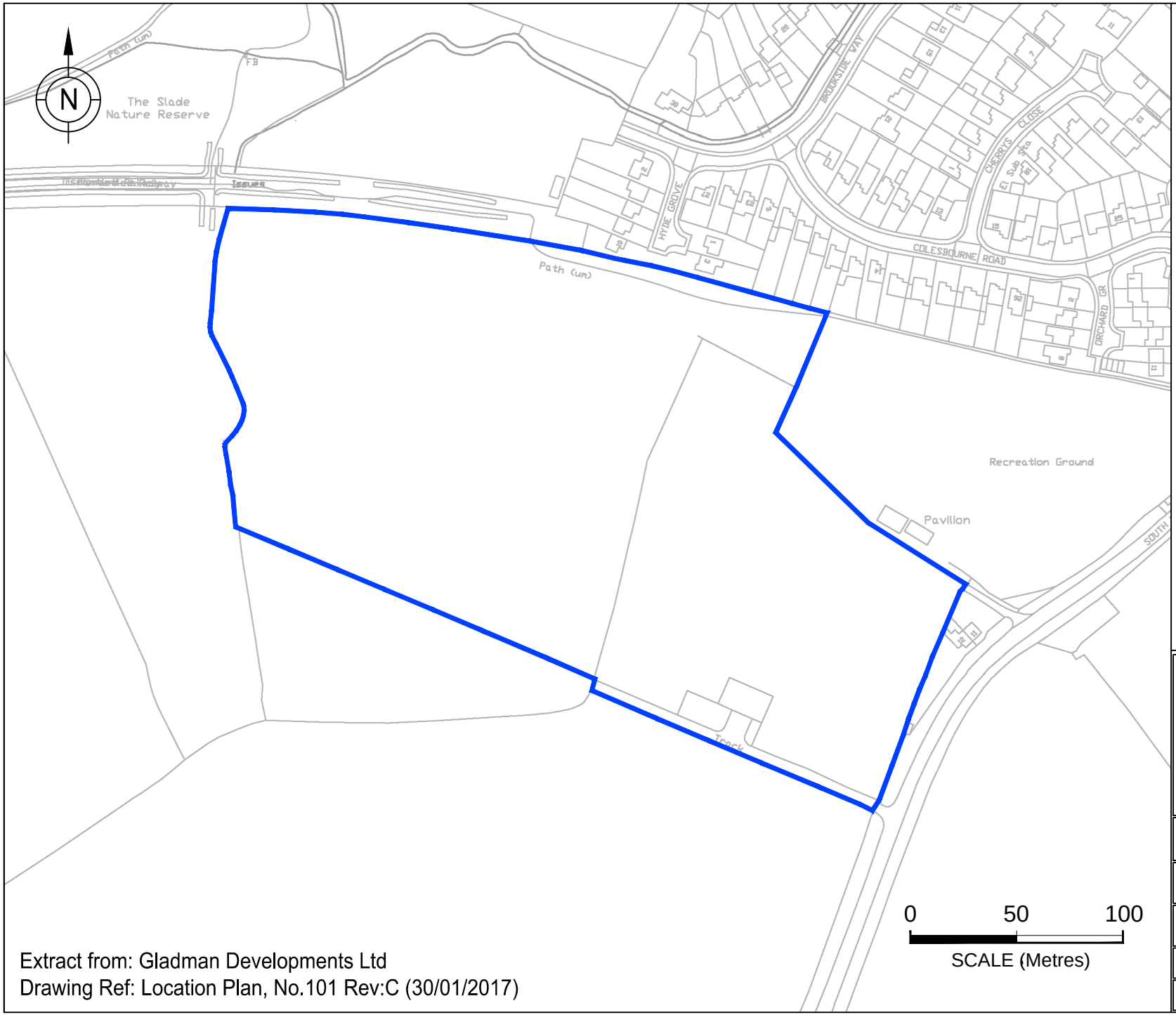

KEY

Study Area Boundary

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

LK CONSULT LIMITED

Client: Gladman Developments Ltd

Site: Land off South Newington Road, Bloxham

Title: Study Area Boundary Plan

Job No.:	Scale (See Scale Bar):	Figure:	Revision:
LKC 16 1314	1:2500 @ A4	2	

Drawn By:	Checked By:	Drawn:
AC	PP	Feb 2017

Extract from: Gladman Developments Ltd
Drawing Ref: Location Plan, No.101 Rev:C (30/01/2017)

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APPENDIX A

HISTORICAL MAPS

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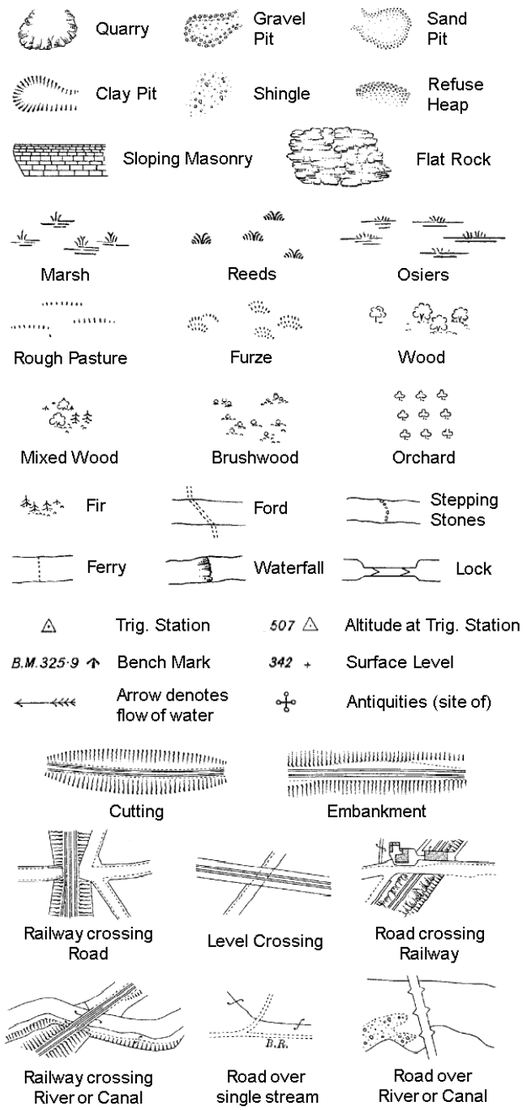
Historical Mapping Legends

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



County Boundary (Geographical)

County & Civil Parish Boundary

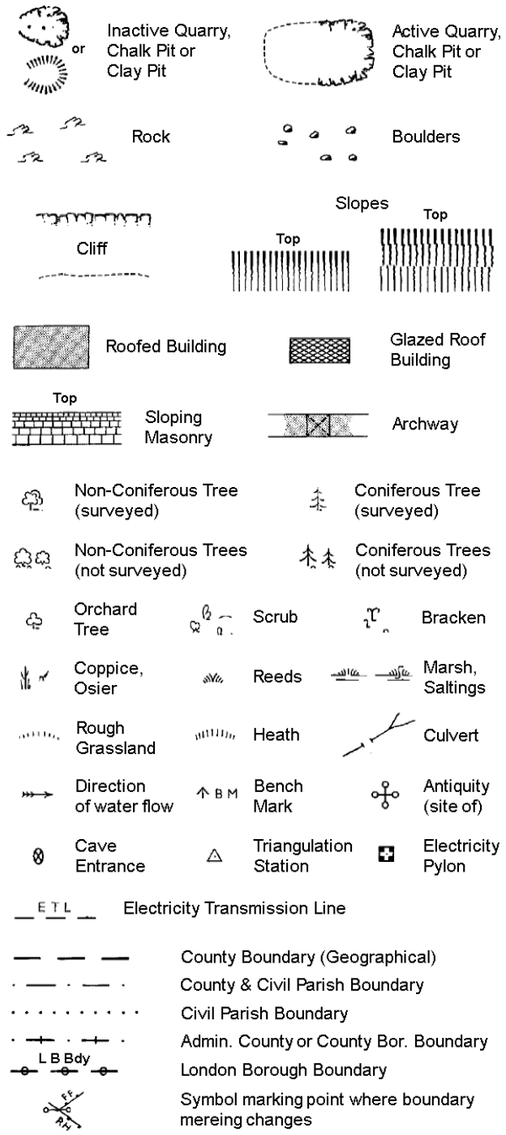
Administrative County & Civil Parish Boundary

Co. Boro. Bdy. County Borough Boundary (England)

Co. Burgh Bdy. County Burgh Boundary (Scotland)

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

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



County Boundary (Geographical)

County & Civil Parish Boundary

Civil Parish Boundary

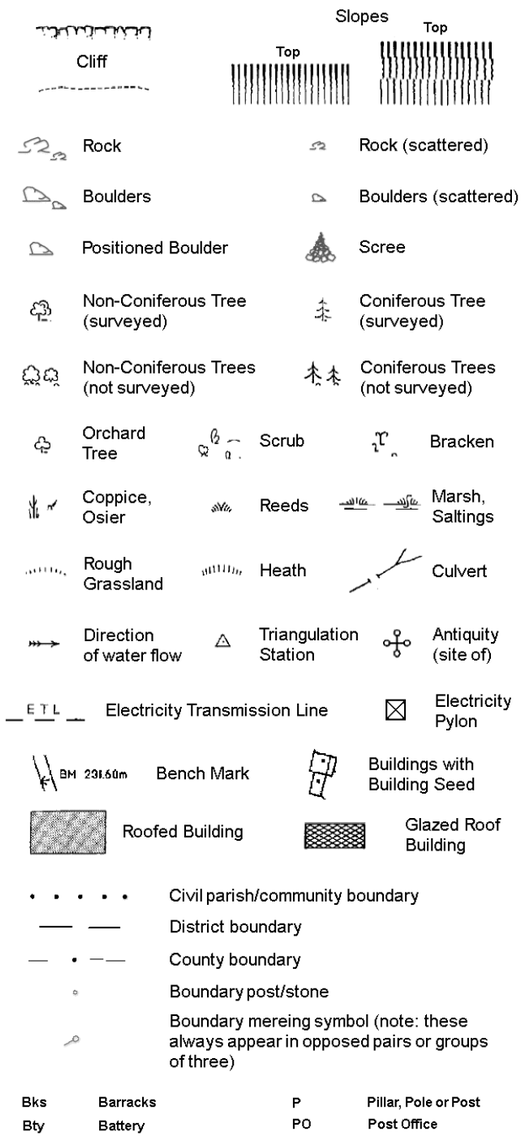
Admin. County or County Bor. Boundary

L B Bdy London Borough Boundary

Symbol marking point where boundary mereing changes

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

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



Civil parish/community boundary

District boundary

County boundary

Boundary post/stone

Boundary mereing symbol (note: these always appear in opposed pairs or groups of three)

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

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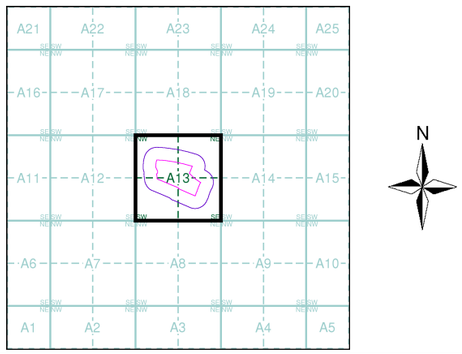
Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Oxfordshire	1:2,500	1881	2
Oxfordshire	1:2,500	1900	3
Oxfordshire	1:2,500	1922	4
Ordnance Survey Plan	1:2,500	1972 - 1973	5
Additional SIMs	1:2,500	1978	6
Ordnance Survey Plan	1:2,500	1979	7
Additional SIMs	1:2,500	1982	8
Additional SIMs	1:2,500	1990	9
Large-Scale National Grid Data	1:2,500	1993 - 1994	10
Large-Scale National Grid Data	1:2,500	1994	11
Large-Scale National Grid Data	1:2,500	1995	12
Historical Aerial Photography	1:2,500	1999	13

Historical Map - Segment A13



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Slice:	A
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Search Buffer (m):	100

Site Details

Site at 442387,235301

Landmark INFORMATION GROUP

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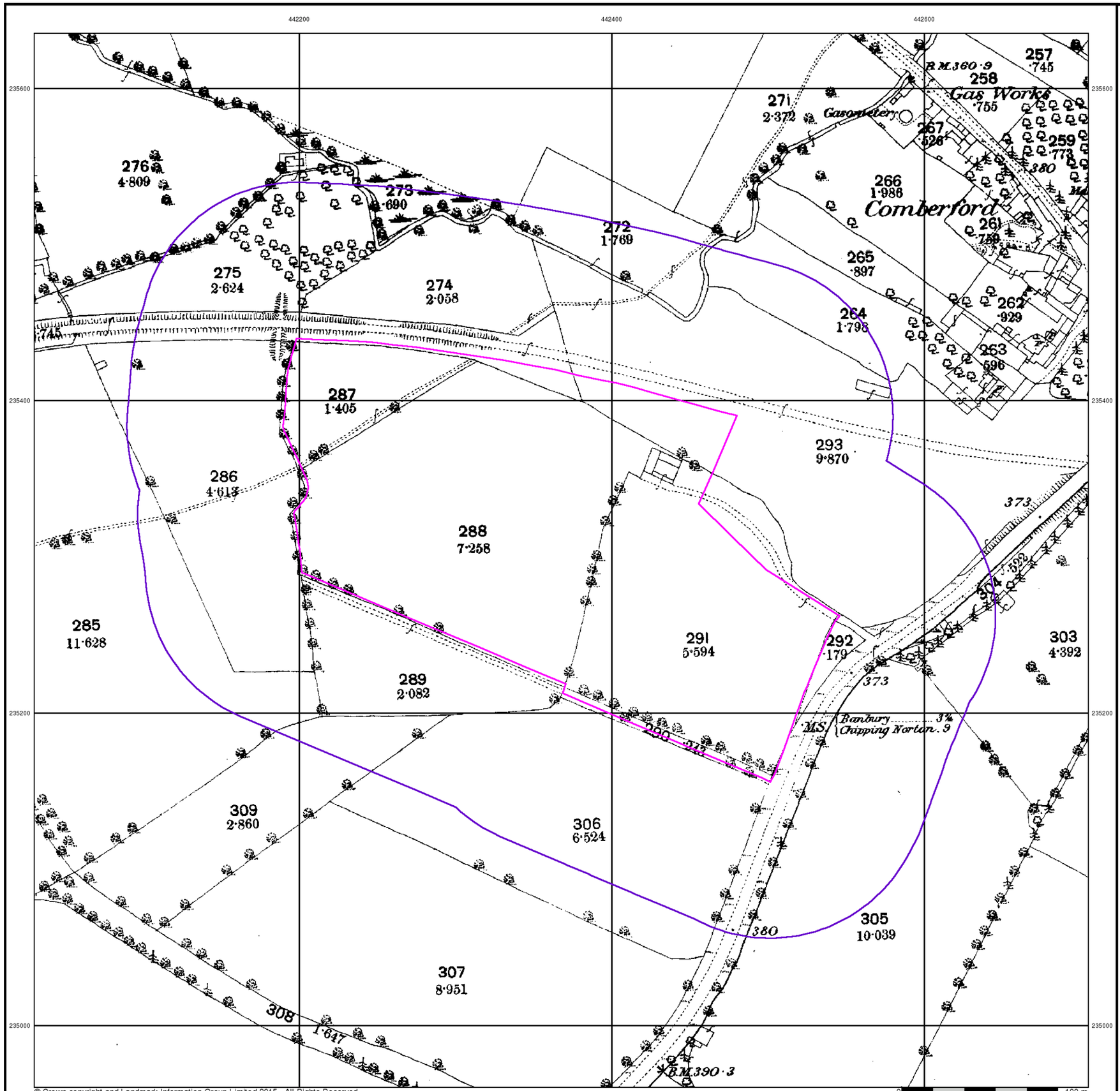
Web: www.envirocheck.co.uk



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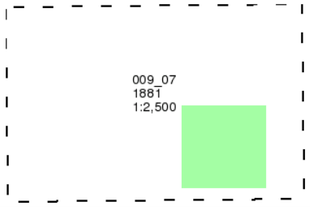
Oxfordshire

Published 1881

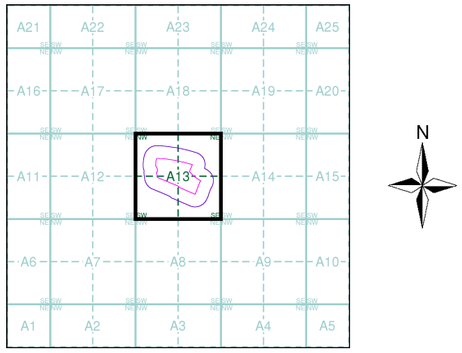
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



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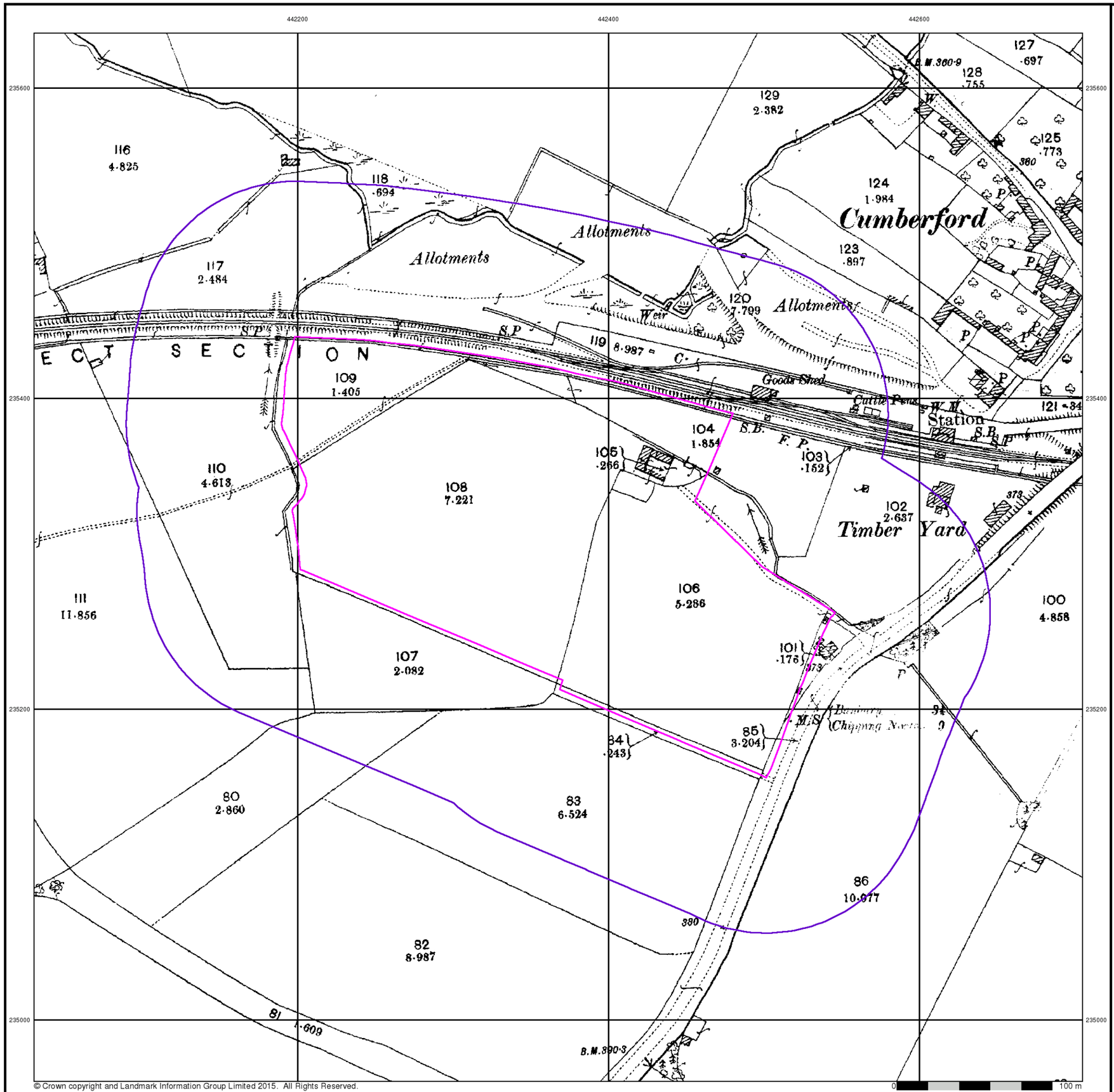

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Oxfordshire

Published 1900

Source map scale - 1:2,500

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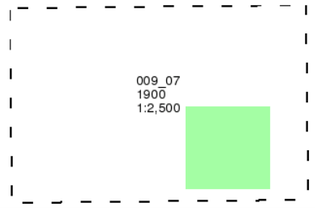

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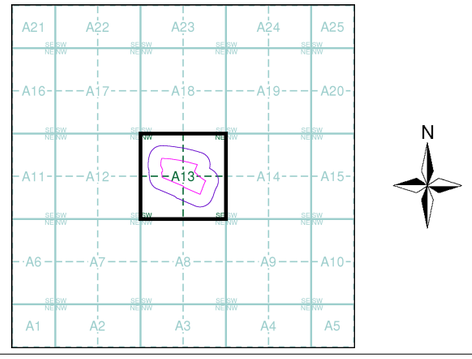

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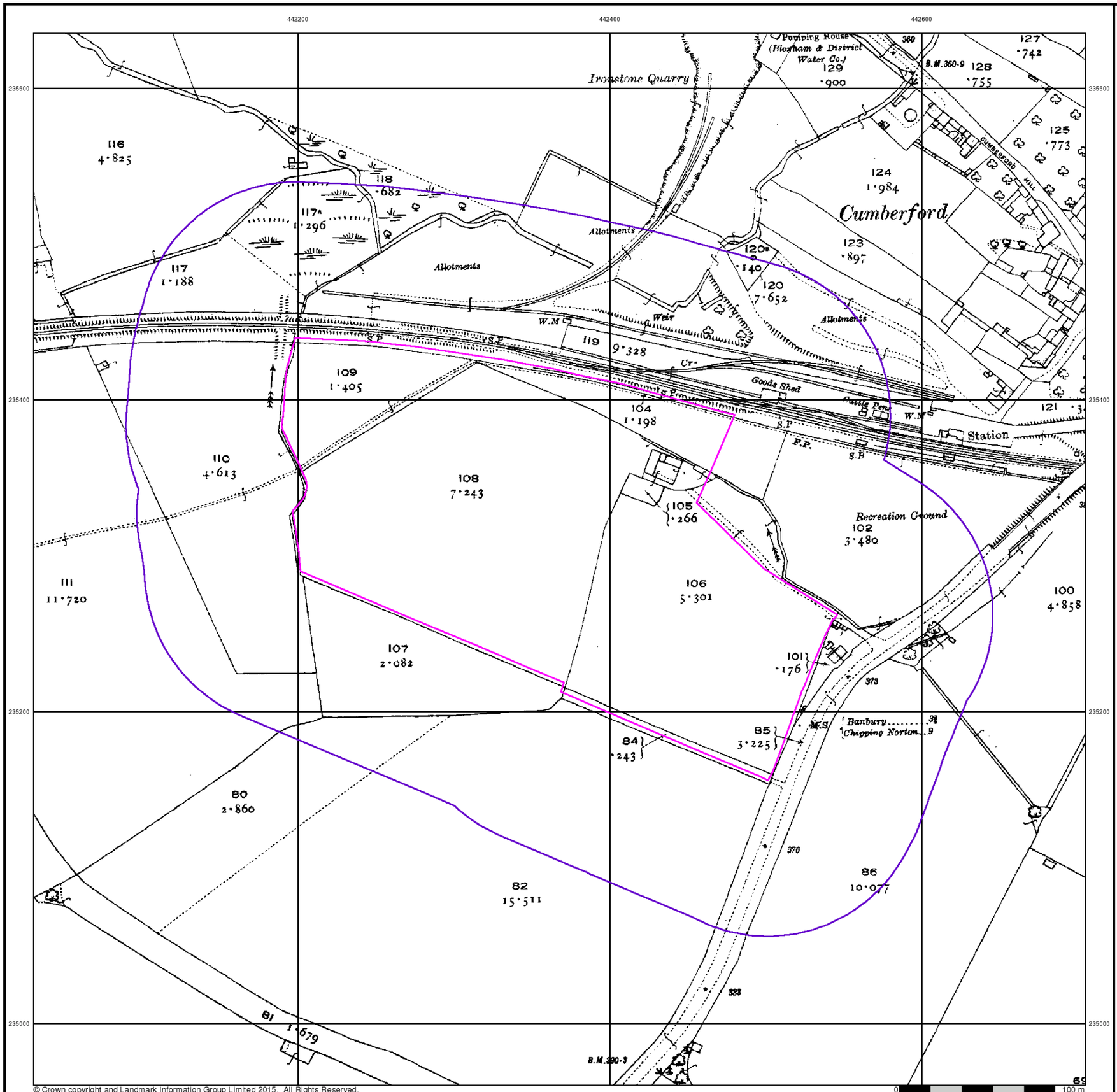

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Oxfordshire

Published 1922

Source map scale - 1:2,500

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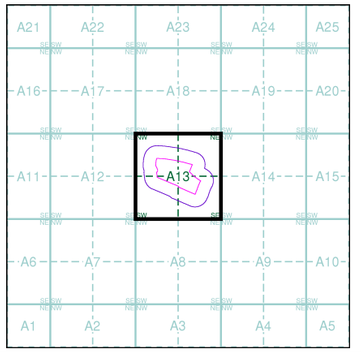
Map Name(s) and Date(s)

Historical Map - Segment A13



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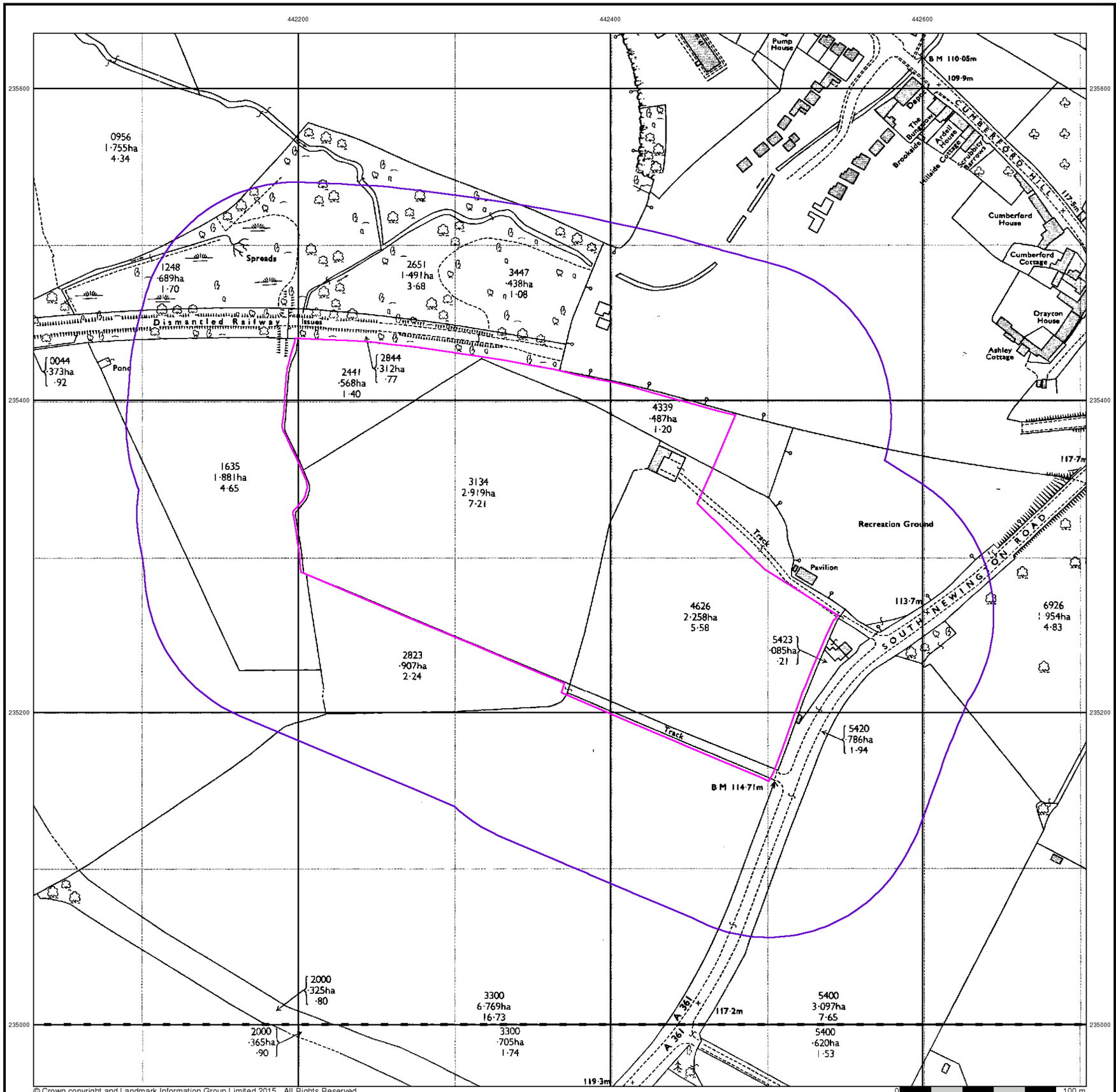

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Ordnance Survey Plan

Published 1972 - 1973

Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

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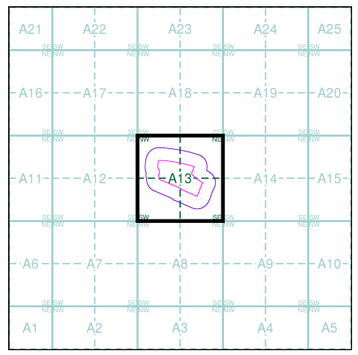
SP4235
1972
1:2,500

SP4234
1973
1:2,500

Historical Map - Segment A13



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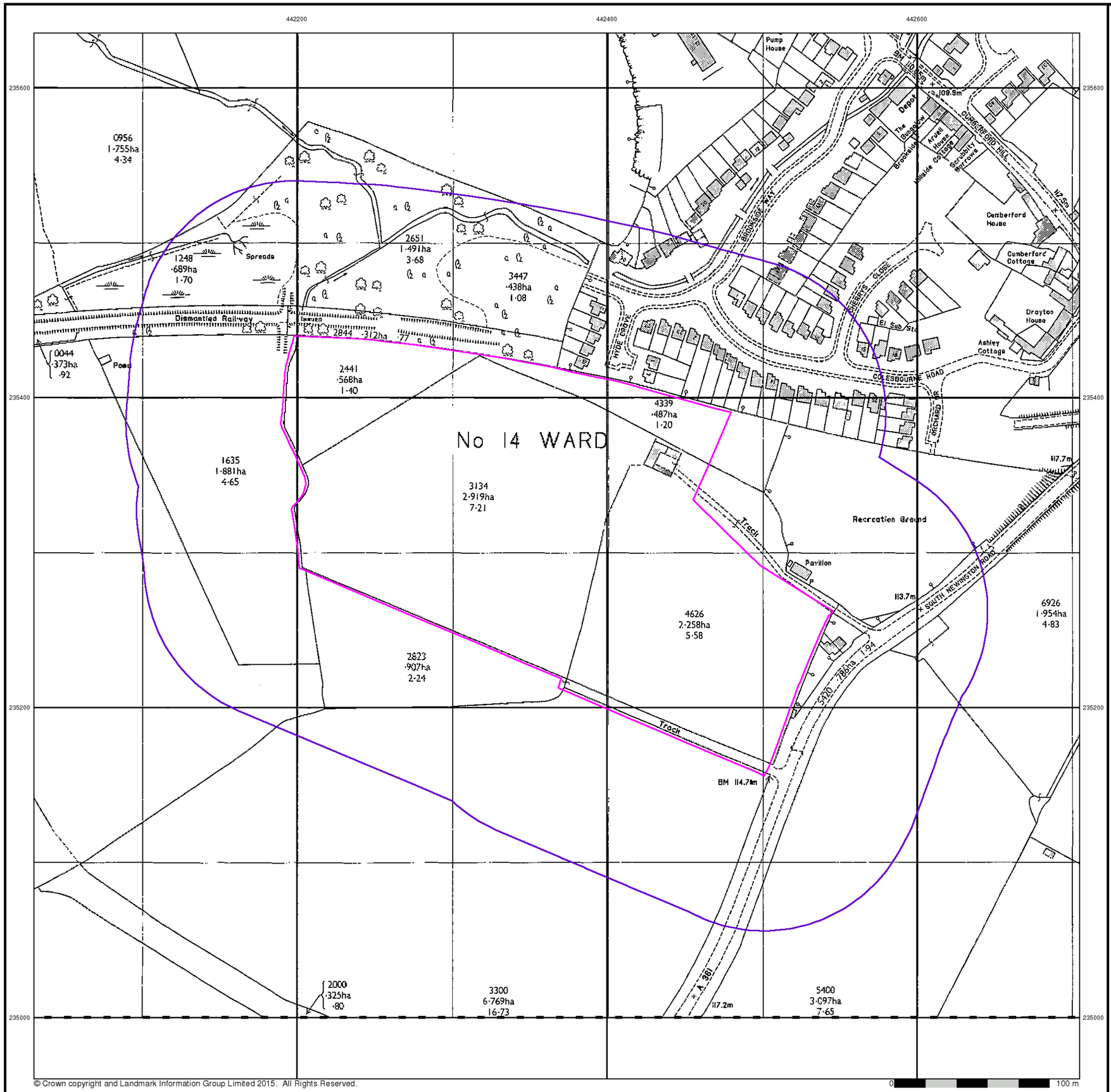

0 100 m

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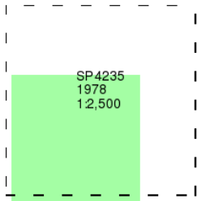
Additional SIMs

Published 1978

Source map scale - 1:2,500

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

Map Name(s) and Date(s)



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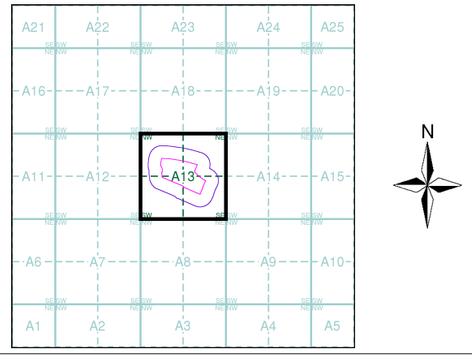

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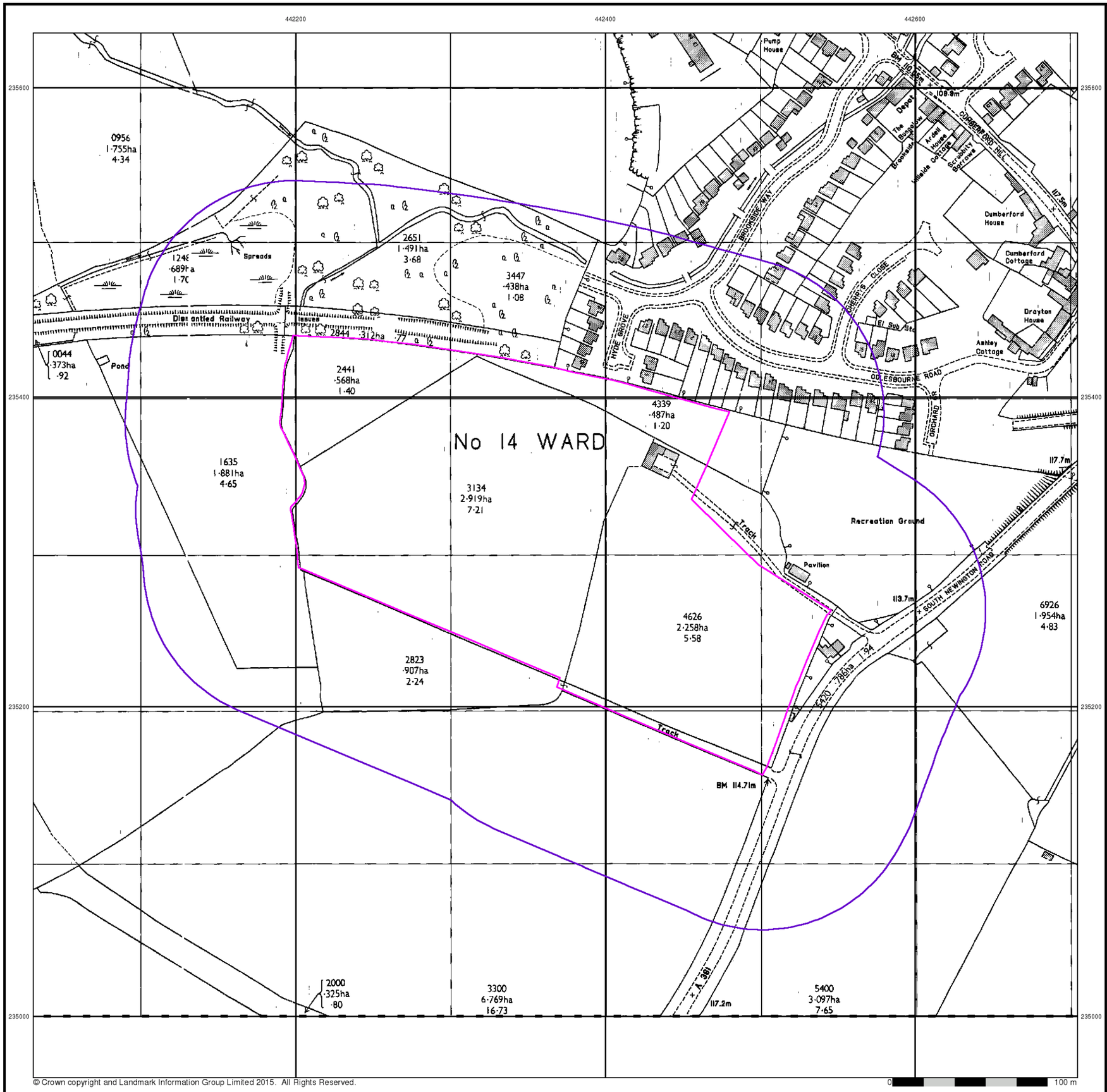

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Ordnance Survey Plan

Published 1979

Source map scale - 1:2,500

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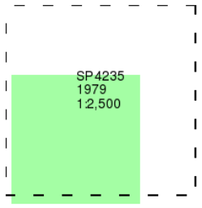
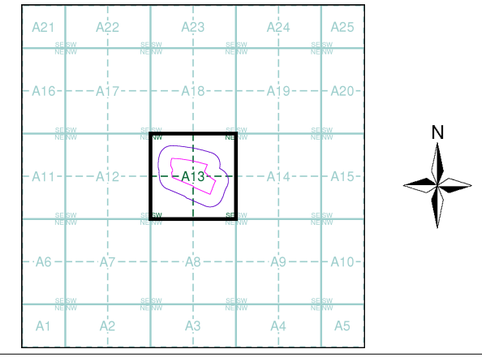


Historical Map - Segment A13



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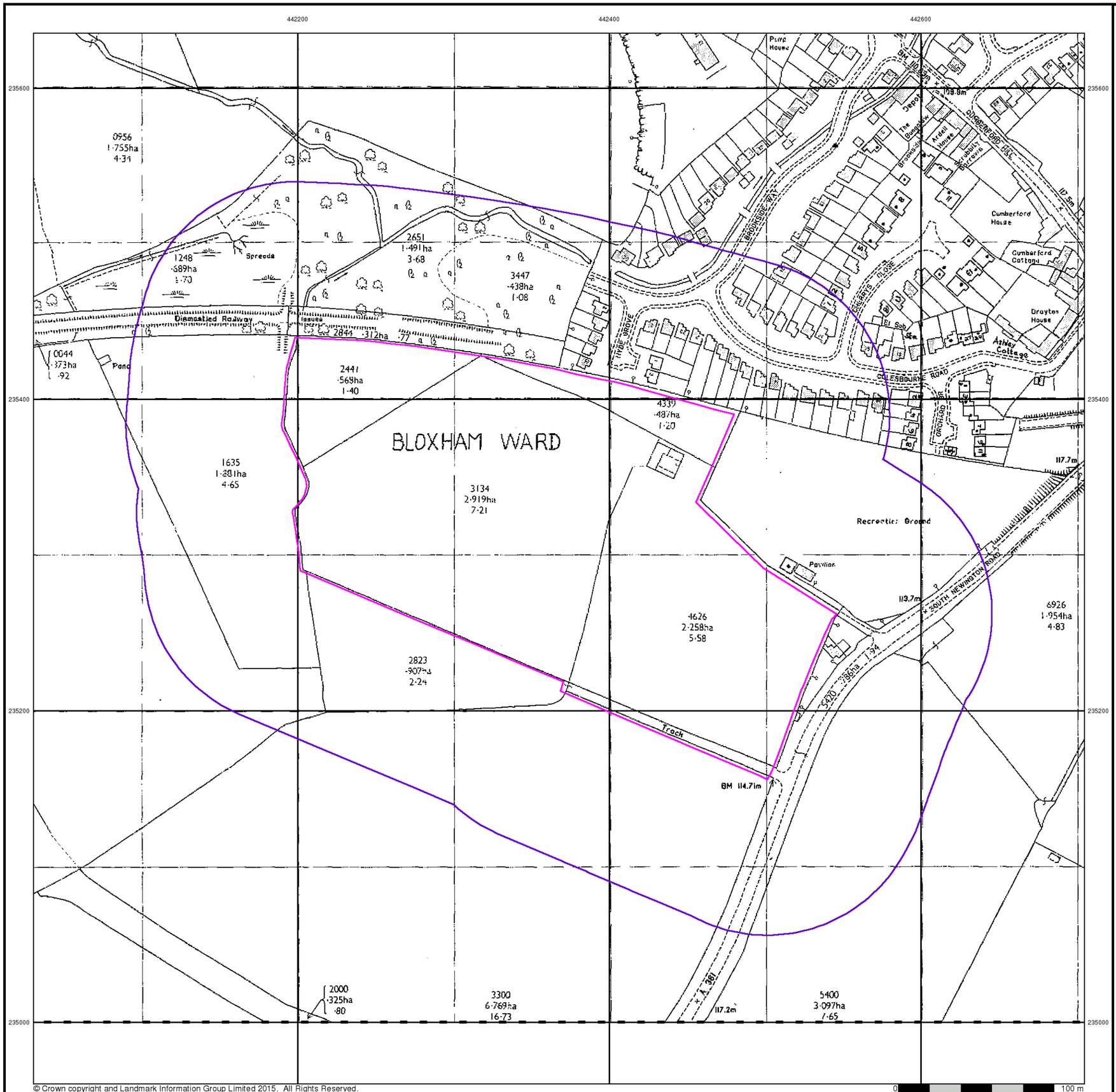

0 100 m

LK CONSULT LIMITED

Additional SIMs

Published 1982

Source map scale - 1:2,500

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

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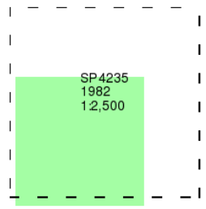
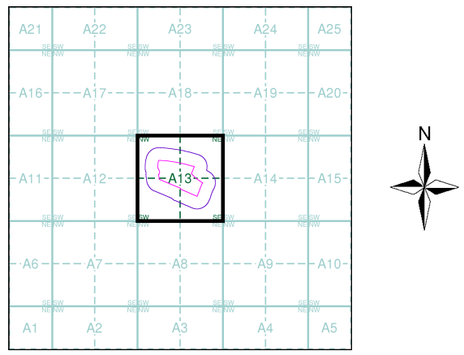


Historical Map - Segment A13



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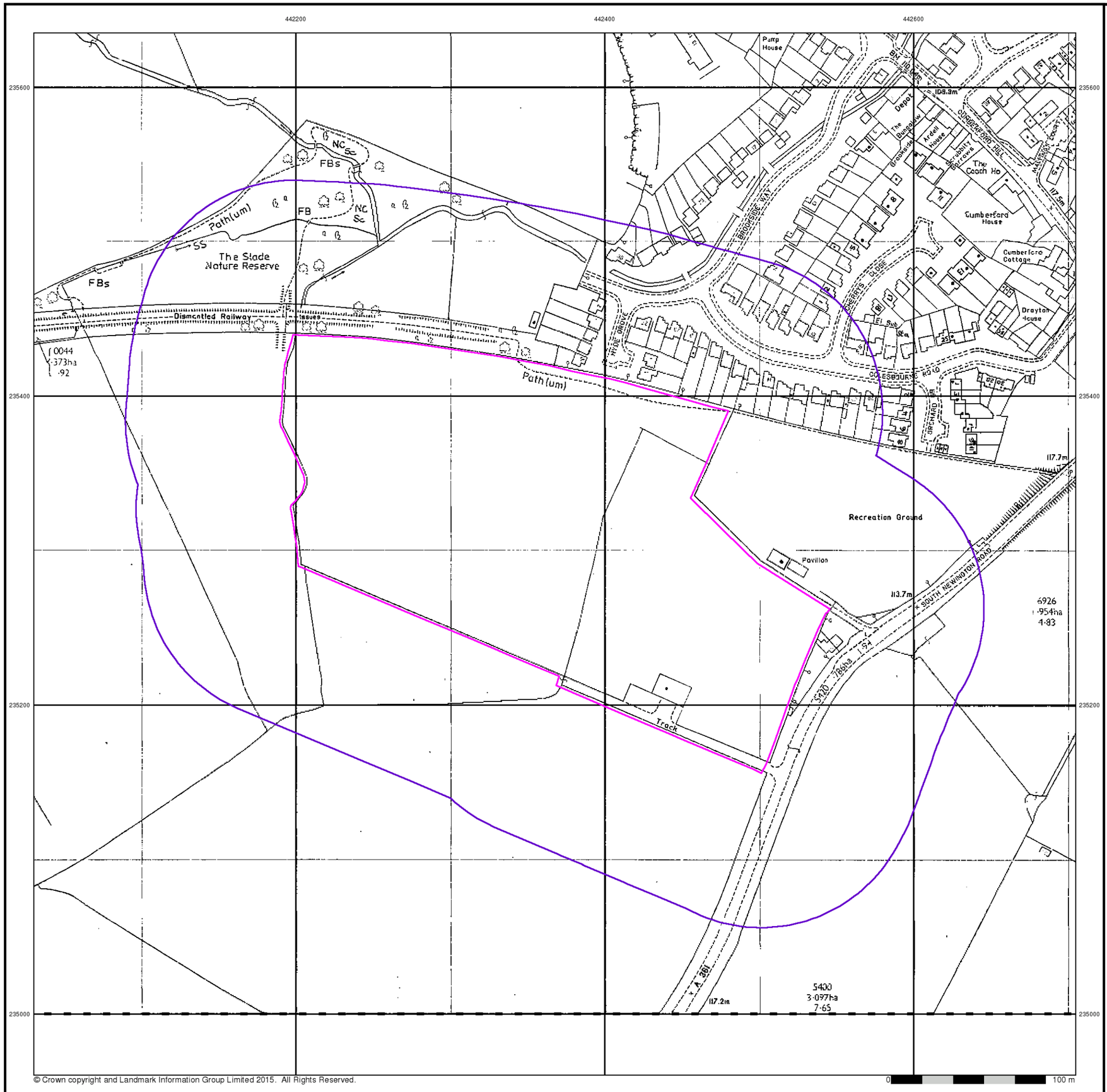
Site Details

Site at 442387,235301

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



LK CONSULT LIMITED

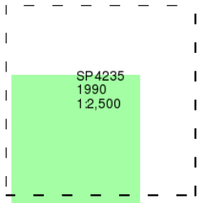
Additional SIMs

Published 1990

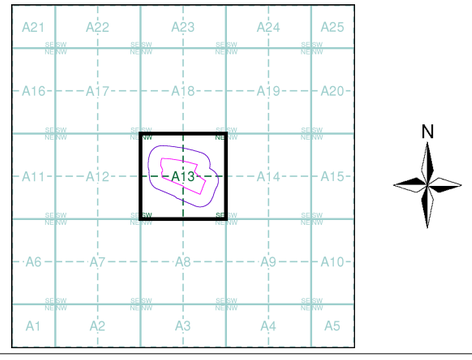
Source map scale - 1:2,500

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

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number:	112367251_1_1
Customer Ref:	LKC 16 1314
National Grid Reference:	442370, 235310
Slice:	A
Site Area (Ha):	5.92
Search Buffer (m):	100

Site Details

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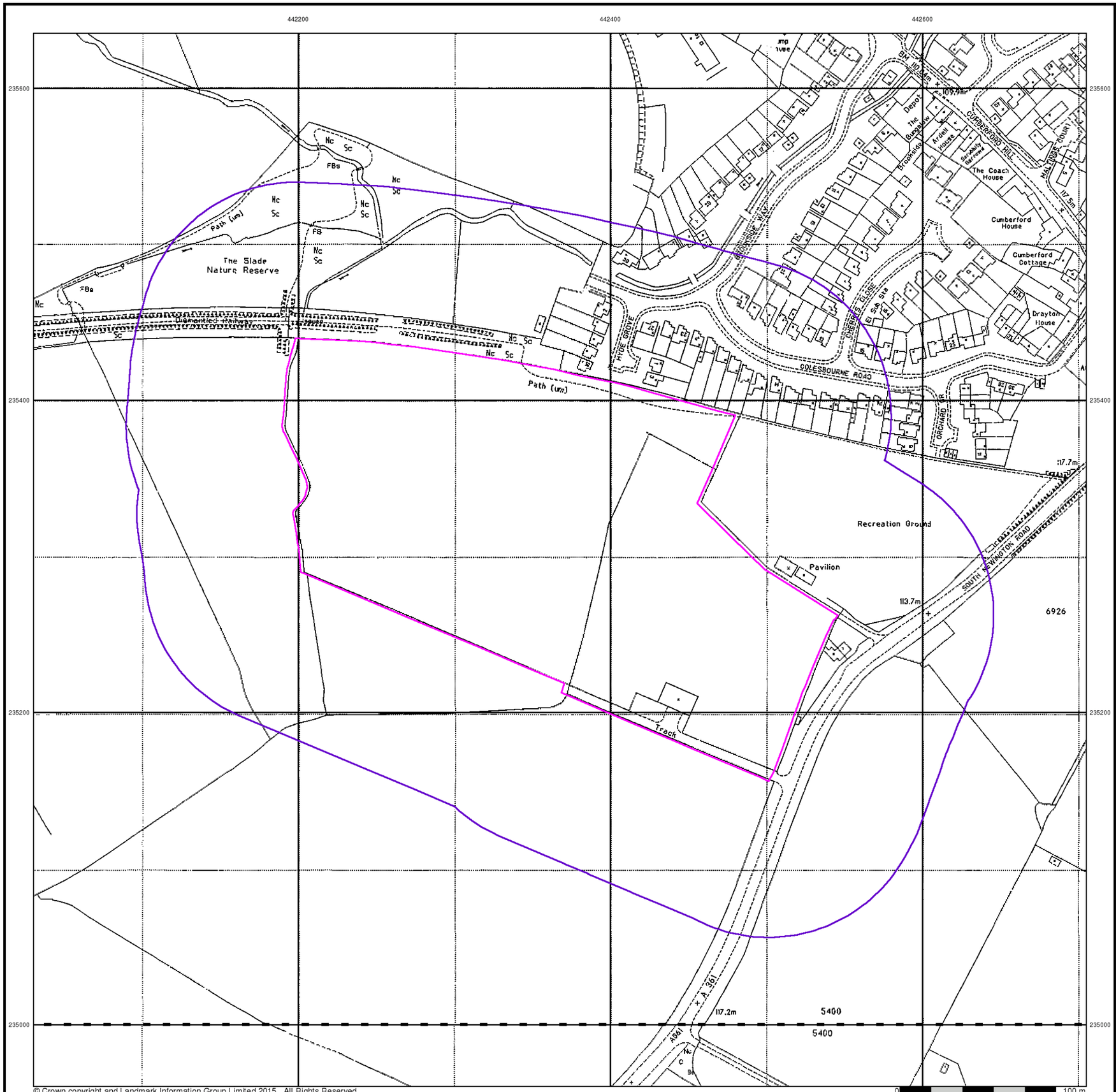


LK CONSULT LIMITED

Large-Scale National Grid Data

Published 1993 - 1994

Source map scale - 1:2,500

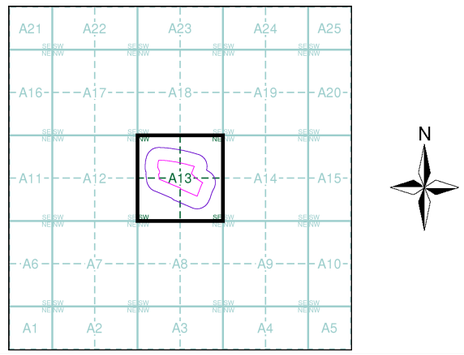
'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic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

Map Name(s) and Date(s)

SP4235
1993
1:2,500

SP4234
1994
1:2,500

Historical Map - Segment A13



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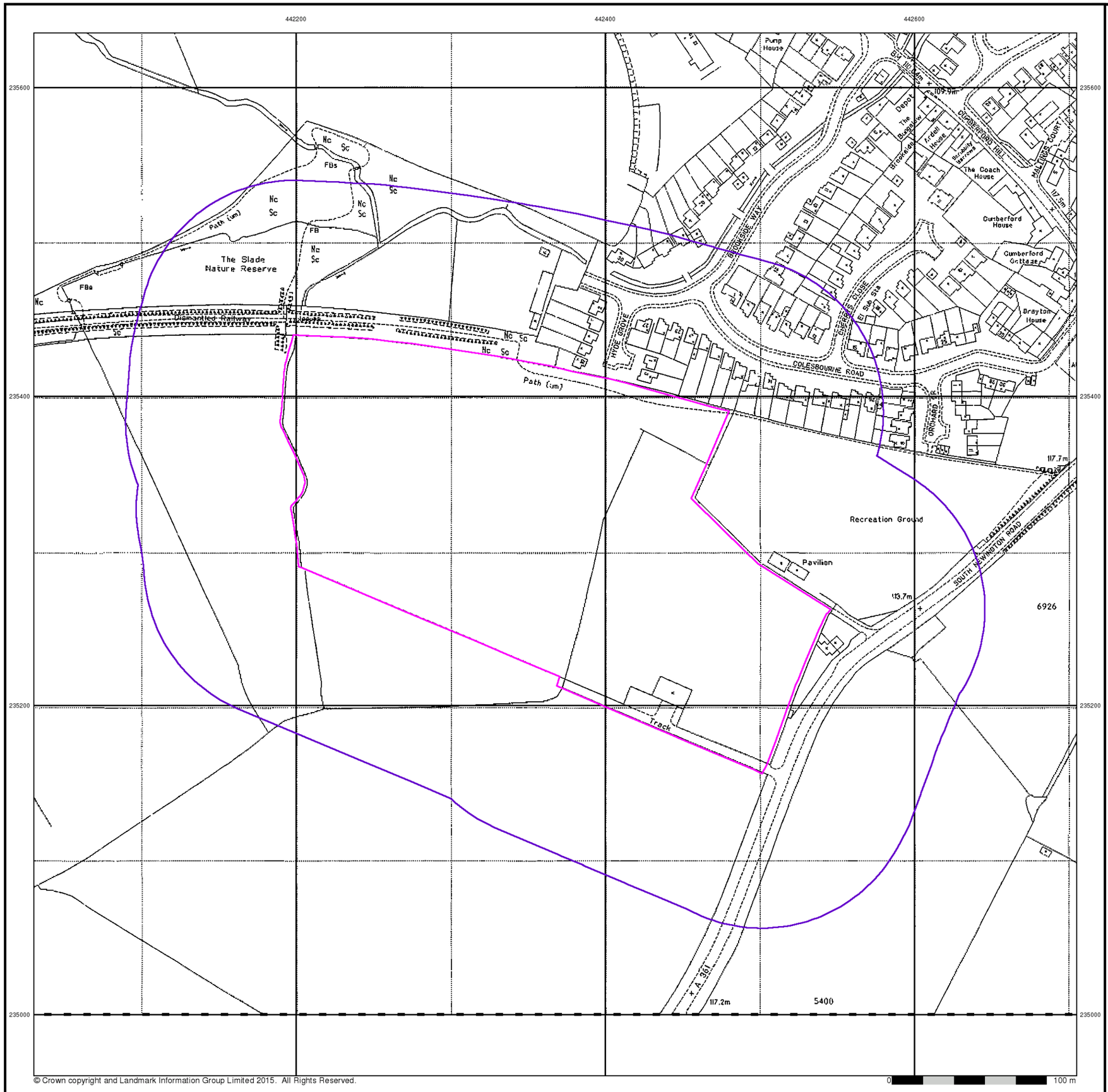


LK CONSULT LIMITED

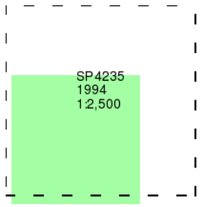
Large-Scale National Grid Data

Published 1994

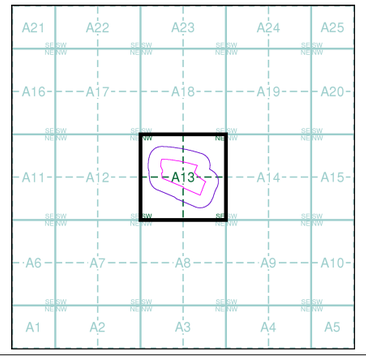
Source map scale - 1:2,500

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

Map Name(s) and Date(s)



Historical Map - Segment A13



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Large-Scale National Grid Data

Published 1995

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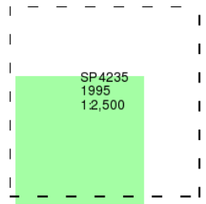
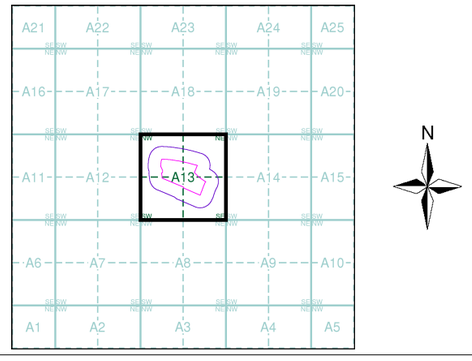
Map Name(s) and Date(s)



Historical Map - Segment A13



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