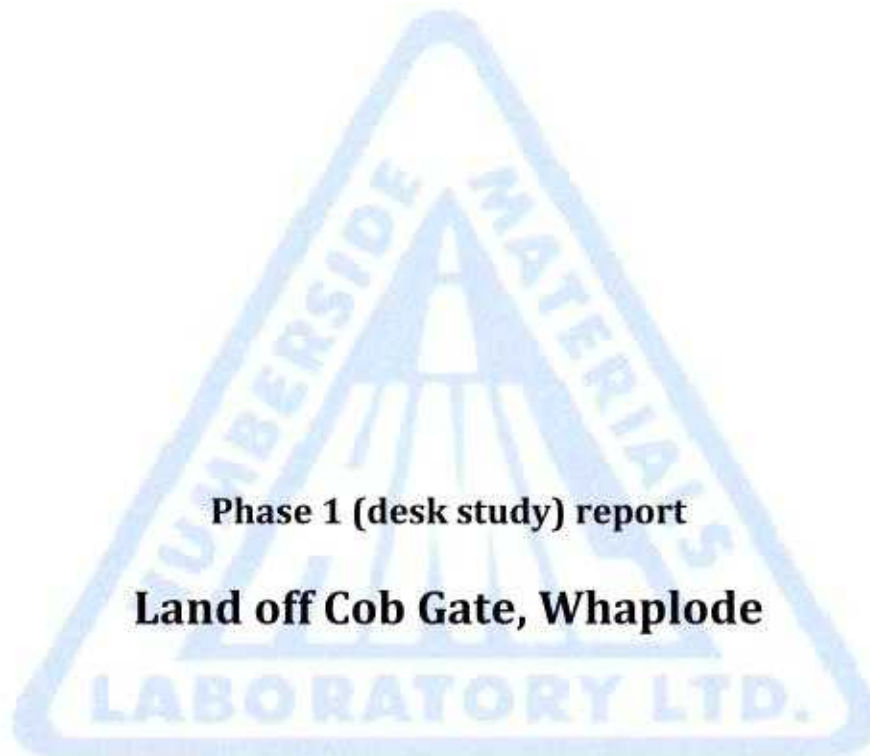


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Phase 1 (desk study) report

Land off Cob Gate, Whaplode

Client: Alan Finch of MLP

Date: May 2018

Report number: 1059/4540/P/P1

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1 Introduction

The client, Alan Finch of Moulton Land and Planning, on behalf of the developer, has engaged Humberside Materials Laboratory Limited (HML) to undertake a Phase 1 geo-environmental (desk study) investigation report for a proposed development on land off Cob Gate, Whaplode, Lincolnshire. The land will be hereinafter described as *the site*.

1.1 Aims

The aim of the investigation is to assess relevant engineering aspects of the site in relation to the proposed development works. This includes an evaluation of encountered ground conditions and geotechnical issues.

1.2 Scope

The scope of the investigation includes:

- Σ Collection of desk-top information (including an Envirocheck report with historical maps)
- Σ A site walkover
- Σ A geo-environmental conceptual site model
- Σ A preliminary contamination risk assessment
- Σ Recommendations for further investigation works, where appropriate

1.3 Conditions and Limitations

This report is produced solely for the above client(s) and should only be copied in full. When transmitted electronically, the definitive copy of the report is held by Humberside Materials Laboratory Ltd.

This report is prepared on the assumption that all facts have been disclosed.

The comments given in this report and the opinions expressed assume that conditions do not vary beyond the range revealed by this study and the information provided in the production of this report is complete and reliable.

2 Sources of Site Information

Various sources of information, as shown below (in Table 1), were reviewed to investigate and compile this desk study investigation.

Table 1: Sources of site information		
<i>Source description</i>	<i>Details</i>	<i>Date</i>
HML site walkover	Photos (in Appendix A) and notes	10 May 2018
Client plans/drawings	Cooper Architectural Design Proposed Residential Development: Block and Location Plan (Drawing no. 1711-01)	Apr 2017
	Ratcliff Land and Engineering Surveys Ltd: Topographical Survey of Land at Cobgate Whaplode. (Drawing no. 5985-01)	Apr 2017
Online maps and photos	www.google.co.uk , www.openstreetmap.org , www.promap.co.uk & www.streetmap.co.uk	Apr 2018
Envirocheck report	Environmental data (in Appendix C), historical maps (Appendix B). Landmark ref. no.: 160380086_1_1	22 Mar 2018
Local geological map	BGS 1:50000 series, Sheet 144 Spalding	1992
Online BGS data	www.bgs.ac.uk (map data & borehole records)	Apr 2018
EA flooding info	https://flood-map-for-planning.service.gov.uk/	Apr 2018
Historic aerial photos	www.britainfromabove.org.uk	Apr 2018
Historical maps	www.oldmapsonline.org ; www.old-maps.co.uk	Apr 2018
Historical information	www.nationalarchives.gov.uk	Apr 2018

3 Site Description and Topography

3.1 Location and size

The site is situated in agricultural fields in the western outskirts of the village of Whaplode, within the South Holland district of Lincolnshire. The site is adjacent to the north side of Cob Gate and is centred around national grid reference (NGR) 531960, 324000.

The site occupies a roughly rectangular parcel of land which is about 100m wide by about 220m long. The total area is about 2.2 hectares.

The site access is via Cob Gate.

A site location plan is included in Appendix A.

3.2 Site features

The site is essentially a farmer's field. It is mostly bare earth. There are some shallow land drains running around most of the north and west boundaries.

A survey of underground services is beyond the scope of this report. However, it is understood that there is a pumped water main running just inside and parallel to the east boundary of the site.

Views of the site and a site features plan are presented in Appendix A.

3.2.2 Evidence of potential contamination

No evidence of potential contamination has been found at the site. No unusual odours have been detected and no oil sheen observed. No irregular vegetation growth was found. No evidence of any existing or former tanks, barrels or other liquid storage containers was seen. The site appears entirely consistent with a field which has been used exclusively for arable farming.

3.3 Site topography

The site is generally very flat and level. The average ground level is estimated to be about 3m above Ordnance Datum.

3.4 Surrounding land use

The site is bound by the following:

- Σ **North:** agricultural fields
- Σ **East:** rear gardens to residential properties
- Σ **South:** rear gardens to residential properties and Cob Gate (road).
- Σ **West:** agricultural fields.

There appears to be an Anglian Water pumping station (and possibly a storm overflow) situated near to the southeast corner of the site. This is evidenced by the large concrete slab with metal grates. The feature also includes an above-ground lifting frame and electrical control units.

3.5 Local topography

The local topography beyond the site is flat. The site is within The Fens, a geographical area which is typically flat and low-lying.

3.7 Proposed development

It is proposed to develop the site by constructing residential properties across most of the site. These will be accessed via a new link road network that extends off Cob Gate.

Much of the site is expected to become soft landscape or private gardens. It is assumed that the residential gardens may be used to cultivate homegrown produce for human consumption.

Plans of the proposed works are presented in Appendix A.

4 Site History

4.1 Historical timeline

The historical documents (i.e. maps and photos) from within the Envirocheck report have been reviewed with respect to the proposed works. Features considered to be potentially relevant are detailed below (in Table 2).

Table 2: Historical map features		
<i>Date</i>	<i>Within site boundary</i>	<i>Outside of site boundary</i>
1887 ^[1]	There are no features within the site. It is part of an agricultural field. Drainage ditches run along the west, north and east boundaries. Occasional trees are noted at or next to the drainage ditches.	Cob Gate road is shown in its existing location immediately to the south of the site. A small pit (about 5m in diameter) is shown about 150m to the east of the site.
1888 ^[2]	No significant changes identified	No significant changes identified
1904 ^[2]	No significant changes identified	The small pit is now shown as a small pond. A well and pump are shown in Cobgate Cottage, about 100m to the east of the site.
1906 ^[1]	No significant changes identified	No significant changes evident
1931 ^[2]	No significant changes identified	No significant changes identified
1938-1952 ^[1]	No significant changes identified	No significant changes identified
1951-1952 ^[1]	No significant changes identified	No significant changes identified
1956-1958 ^[1]	No significant changes evident	No significant changes evident
1968-1970 ^[2]	The drainage ditch for the land drain along the west boundary appears to have widened slightly.	The previous railway about 300m south of the site has been dismantled.
1971-1977 ^[2]	No significant changes identified	Two small works buildings are indicated about 180m north of the site. A medium-sized single works building is indicated about 300m northeast of the site.
1977-1991 ^[2]	The land drain along the west boundary now extends further towards the southwest of the site.	Residential dwellings (accessed from Abbots Gardens) are shown adjacent to the east boundary. The pumping station adjacent to the southeast corner of the site is shown. A medium-sized rectangular suspected works building is shown about 110m to the east of the site. The medium-sized works building (~300m to the northeast) is now a large works building (~200m to the northeast)
1981-1991 ^[2]	No significant changes identified	The large works building is slightly larger (~180m to the northeast of the site).

Table 2: Historical map features

<i>Date</i>	<i>Within site boundary</i>	<i>Outside of site boundary</i>
		A depot is shown about 180m to the southeast.
1992 ^[1]	No significant changes identified	No significant changes identified
1995 ^[2]	No significant changes identified	No significant changes identified
1999 ^[4]	No significant changes identified	No significant changes identified
2000 ^[1]	The land drain along the east boundary appears to have been infilled / culverted	No significant changes identified
2006 ^[1]	No significant changes identified	No significant changes identified
2018 ^[1]	No significant changes identified	No significant changes identified
<i>Note: year in bold indicates a historical document that includes (part of) the site.</i> [1] - 1:10560 or 1:10000 scale map, [2] - 1:2500 scale map, [3] - 1:1250 scale map, [4] - aerial photo.		

4.2 Historical summary

Evidently, the site has never experienced any significant development. It has been used as an agricultural field since at least as early as 1887. The only site changes have been alterations to the land drains around the edges of the site.

There has only been limited industrial activity near the site. Some large works buildings are shown as close as about 180m to the east of the site.

5 Geology, Hydrogeology and Hydrology

5.1 Geology

5.1.1 Made ground

No made ground is anticipated on site. There is no history of development or evidence of infilling at or near the site that is expected to possibly give rise to made ground.

5.1.3 Geological soil deposits

The whole site is expected to be underlain by a significant thickness of tidal flat deposits. These deposits might have previously been referred to as Fen Beds. Tidal flat deposits typically consist of loosely deposited silts, clays and sands possibly with some bands of peat and (basal) gravel.

Locally, the tidal flat deposits might be about 15m in thickness and comprised predominantly of silty fine sand and sandy silt. BGS historical borehole records nearby the site (located about 1.4km – 2.1km away) suggest that sandy silt or silty sand might be encountered to a depth of about 12m bgl, as shown below (in Tables 3 – 5). Little or no peat or organic / peaty material is recorded.

Glacial deposits are likely beneath the tidal flat deposits, possibly at a depth of about 15m bgl in the form of boulder clay.

Table 3: BGS Historical borehole record (1)

<i>Details</i>	<i>Geological unit</i>	<i>Description</i>	<i>Thickness (m)</i>	<i>Base of stratum (m bgl)</i>
<i>Date: 1902</i> <i>BGS ID: 504111</i> <i>BGS Ref.: TF32SW1</i> <i>NGR: 530520, 324650</i> <i>Ground water: no information</i> <i>Approx. ground level: 3.35m AOD</i>	Fen Beds also known as Channel Sands (TIDAL FLAT DEPOSITS)	Quicksand	12.19	12.19
		Clay	1.83	14.02
		Shell marl	0.15	14.19
		Shingle and shells	0.91	15.09
	Glacial Drift (GLACIAL TILL)	Boulder clay	At least 7.2	Proven to 22.25
Note: borehole location about 1.4km west-northwest of the site				

Table 4: BGS Historical borehole record (2)

<i>Details</i>	<i>Geological unit</i>	<i>Description</i>	<i>Thickness (m)</i>	<i>Base of stratum (m bgl)</i>
<i>Date:</i> 5 Jun 1968	TOPSOIL	(not given)	0.46	0.46
<i>BGS ID:</i> 504116	[TIDAL FLAT DEPOSITS]	Loose fine yellow grey sandy SILT	2.28	2.74
<i>BGS Ref.:</i> TF32SW6		Loose to compact fine grey silty SAND	At least 9.45	Proven to 12.19
<i>NGR:</i> 534070, 324640				
<i>Ground water:</i> 1.8m bgl				
SPT N value (depth in m bgl): 8 (1.5), 5 (3.0), 8 (6.1), 24 (9.1), 58 (12.2)				
<i>Note:</i> Borehole location about 2.0km east of the site				

Table 5: BGS Historical borehole record (3)

<i>Details</i>	<i>Geological unit</i>	<i>Description</i>	<i>Thickness (m)</i>	<i>Base of stratum (m bgl)</i>
<i>Date:</i> 6 Jun 1968	TOPSOIL	(not given)	0.46	0.46
<i>BGS ID:</i> 504115	[TIDAL FLAT DEPOSITS]	Medium density fine brown and yellow sandy SILT	2.13	2.59
<i>BGS Ref.:</i> TF32SW5		Medium density to compact fine grey sandy SILT	At least 10.21	Proven to 12.8
<i>NGR:</i> 534190, 324340				
<i>Ground water:</i> 1.8m bgl				
SPT N value (depth in m bgl): 11 (1.5), 16 (3.0), 22 (6.1), 33 (9.1), 58 (12.2)				
<i>Note:</i> Borehole location about 2.0km east of the site				

In terms of relative density, the tidal flat deposits beneath the site might be loose or medium dense, becoming medium dense or dense with depth. As shown above (in Table 4 and 5), previous SPTs (i.e. standard penetration tests) in the local tidal flat deposits have varied from 5 blows to 16 blows at shallower depths (approximately 1.5m – 3.05m bgl). The blow count increases to between 24 blows and 58 blows at greater depths (approximately 6.1m – 12.2m bgl).

5.1.2 Solid rock (and residual soil) geology

The soil deposits on site are expected to be underlain by the West Walton Formation of mudstone and siltstone. This might be encountered initially (at shallower depths) as silts and clays. The West Walton Formation is likely to be present at significant depth (e.g. >20m bgl).

5.1.4 Mining and quarrying

There are no reported *BGS recorded mineral sites* within 1km of the site.

Mining is not expected to affect the site. According to the Coal Authority, the site is in an area that might not be affected by coal mining. With respect to non-coal mining activity, a designation of no hazard is given.

5.1.5 Geological hazards

Geological hazards are minimal as reported by the British Geological Survey (BGS) as shown below (in Table 6).

Table 6: Geological hazards	
<i>Hazard</i>	<i>Hazard potential</i>
Collapsible ground stability	No hazard
Compressible ground stability	Moderate
Ground dissolution stability	No hazard
Landslide ground stability	Very low
Running sand ground stability	Moderate
Shrinking & swelling clay	Low

5.2 Hydrogeology

The groundwater table beneath the site is anticipated to be about 1.5m to 2.0m bgl. This is based on BGS historical borehole records near the site (~1.5km away) and the observed water level in land drains around the site.

Groundwater flow beneath the site is likely to reflect the local topography as well as the topography of the site itself. Therefore, groundwater is likely to move very slowly beneath the site due to the flat topography.

There are no reported *water abstractions* near the site. There are none within 1km.

In terms of *groundwater vulnerability*, the leaching potential of the soils on site are not classified.

The *bedrock aquifer* designation beneath the site is unproductive strata. This suggests that the groundwater within the bedrock might not be suitable for abstraction.

The *superficial aquifer* classification is unproductive strata. This suggests that the groundwater within the superficial soil deposits might not be suitable for abstraction.

The site is not within 1km of a *source protection zone*. This suggests that the site is not in an area where water is suitable for abstraction.

5.3 Hydrology

There are land drains adjacent to the north, west and east boundaries of the site. The flat topography means the water flow within them is likely to be slow. The drains are reported to be part of the River Nene catchment, the River Nene being about 15km to the southeast of the site.

5.4 Anticipated geology

Based on the reviewed desk top information, the anticipated ground conditions are as shown below (in Table 7).

Table 7: Anticipated geology (subject to site confirmation)			
<i>Strata</i>	<i>Possible description</i>	<i>Possible thickness (m)</i>	<i>Possible depth of base of stratum (m bgl)</i>
Topsoil	Organic soil	0.3 – 0.5	0.3 – 0.5
Tidal flat deposits	(Loose to medium dense becoming dense) silty SAND or sandy SILT.	12	12
	Bands of clay and gravel	3	15
Glacial till	Boulder clay possibly with bands of (water-bearing) sands and gravels	7	22
West Walton Formation	Mudstone and siltstone; possibly initially encountered as silts/clays	~15	37
Notes: anticipated groundwater table: 1.5-2.0m bgl			

6 Environmental Data

6.1 Pollution and pollution control

There are no recorded *contaminated land entries and notices* within at least 1km of the site.

The nearest (wastewater effluent) *discharge consent* is reported to be located about 25m to the southeast of the site. The consent pertains to the Anglian Water pumping station that can discharge sewage to a freshwater stream/river and has been in effect since 1963.

There are no *prosecutions relating to controlled waters* within 1km of the site. Similarly, there are no *enforcement and prohibition notices*.

In relation to (integrated) pollution prevention and control, there are no *IPCs, IPPCs or local authority IPPCs or pollution prevention and controls (or control enforcements)* near to the site. There are none within less than about 373m.

The nearest reported pollution incident to controlled waters occurred about 383m to the east of the site.

There are no reported *prosecutions relating to authorised processes* within at least 1km of the site.

There are no reported *radioactive substances* registered within 1km of the site.

No available *river quality data* has been found for rivers within 1km of the site.

There are no reported *substantiated pollution incidents register entry* near the site. There are none within 1km.

There are no reported *water industry act referrals* noted within 1km of the site.

With respect to hazardous substances, there are no reported *COMAH or NIHHS* sites within 1km of the site.

6.2 Flooding

According to the BGS, there is not reported to be potential at the site for *groundwater flooding* to occur.

The site is identified to be at risk from *flooding or extreme flooding from rivers or seas without defences*.

Some parts of the site may be at risk from *surface water flooding*, as shown in an EA/NRW Suitability Map – Slice A in the Envirocheck report (in Appendix C).

The UK government website *flood map for planning* indicates the site is in Flood Zone 3, which suggests the site has a high probability of flooding.

A flood risk assessment is beyond the scope of this report.

6.3 Waste

There are no reported (*BGS recorded, Historical, Registered or Local authority-recorded*) *landfill sites* near the site. The nearest is about 475m to the east of the site.

There are no reported *licensed waste management facilities* within 1km of the site.

The nearest identified and reported *potentially infilled land* is about 201m to the east of the site. This pertains to an infilled water feature (possibly a land drain) shown in mapping dated 1958.

There are no reported *waste transfer sites or registered waste treatment or disposal sites* within 1km of the site.

6.4 Soil chemistry

Estimated soil chemistry data from the BGS indicates element concentrations for rural soil around the site, as shown below (in Table 8).

Table 8: BGS Estimated Soil Chemistry (rural soil)	
<i>Contaminant</i>	<i>Concentration (mm/kg)</i>
Arsenic	<15
Cadmium	<1.8
Chromium	60-90
Lead	<100
Nickel	0-30

6.5 Radon

With respect to *radon potential*, the site is in a lower probability area with less than 1% of homes above the action level. No radon protection measures are therefore necessary for new homes.

6.6 Industrial land use

There is no reported *fuel station entry* near the site. The closest is about 540m to the northeast of the site.

There are no *contemporary trade directory entry* near the site. The nearest is reported to be located 380m to the northwest of the site.

The nearest reported *point of interest-commercial services* is located about 82m to the south of the site. It pertains to distribution and haulage.

No commercial or industrial activity has been identified that is considered to have the potential to have a significant geo-environmental impact on the site. The nearest works buildings are located about 180m to the east of the site in the rural village of Whaplode.

6.7 Sensitive land use

The site is within a nitrate sensitive area. Otherwise, no *sensitive land use* has been identified within 1km of the site.

6.8 Summary of environmental data

No evidence has been found of any significant industry near the site. No mineworkings, quarries or factories have been identified near the site.

The only identified source of pollution near the site is the Anglian Water Pumping Station situated adjacent to the southeast corner of the site, which appears to involve a discharge consent into a stream/river. However, there are no reported pollution incidents associated with this pumping station.

The site is at risk of flooding. However, a complete flood risk assessment is beyond the scope of this report.

7 Initial Contaminated Land Assessment

7.1 Assessment principles

Current legislation and best practice, such as Part IIA of the Environmental Protection Act and CLR 11 (EA/Defra, 2004), recommend that potentially contaminated land is managed using a risk-based approach. Model procedures to assess the risks from contaminated land involve the development of a conceptual site model (CSM) and the identification of relevant contamination linkages.

A contamination linkage comprises a *source* (i.e. a contaminant capable of causing pollution or harm), a *receptor* and a viable *pathway* by which one can be transmitted to the other. If one of these three elements are missing, there is no significant risk.

Any risk from potential contamination can be assessed as a product of the severity of the consequences that might arise from of the contamination hazard and the probability of the hazard occurring, as outlined in CIRIA C552 (Rudland et al., 2001). The definitions used to perform the risk assessment for the subject site are shown below (in Tables 9 and 10).

Table 9: Severity of hazard being realised

Classification	Category/Definition			
	Human	Controlled waters	Property	Eco system
Severe	Short term acute risk	Short term risk	Catastrophic damage	Short term risk
Medium	Chronic damage	Pollution to sensitive water resources		Significant change
Mild	Lasting but not chronic effects	Pollution to non-sensitive water resources	Significant damage	Significant damage
Minor	Non-permanent health effects		Repairable damage	

Table 10: Probability of hazard being realised

Classification	Definition
Highly likely	There is a pollution linkage and an event that appears very likely in the short term and or almost inevitable over a long term, or evidence at the receptor of harm or pollution
Likely	There is a pollution linkage and all elements are present which means that it is probable that an event will occur.
Low likelihood	There is a pollution linkage and circumstances are possible under which an event will occur. However, it is not certain that even over a long period such an event would occur and is less likely in the short term.
Unlikely	There is a pollution linkage, but circumstances are such that it is improbable that an event would occur even in the long term.

A matrix can be used to determine a suitable risk classification, as shown below (in Table 11). The largest risks are where the severity of the contaminant is great and the probability of the contaminant linkage occurring is highly likely. The definitions of the different classifications used in this assessment, based on CIRIA C552 (Rudland *et al.*, 2001), are also shown below (in Table 12).

Table 11: Risk classification matrix					
		Consequence			
		Severe	Medium	Mild	Minor
Probability	Highly likely	Very high	High	Medium	Medium/low
	Likely	High	Medium	Medium/low	Low
	Low likelihood	Medium	Medium/low	Low	Very low
	Unlikely	Medium/low	Low	Very low	Very low

Table 12: Risk classification definition	
Classification	Definition
Very High	There is a high probability that severe harm could arise to a designated receptor from an identified hazard or there is evidence that severe harm to a designated receptor is currently occurring. This risk if realised is likely to result in a substantial liability. Investigation and or remediation is required.
High	Harm is likely to a designated receptor from an identified hazard or there is evidence that severe harm to a designated receptor is currently occurring. This risk if realised is likely to result in a substantial liability. Investigation and or remediation may be necessary in the short term and likely over the long term.
Medium	It is possible that harm could arise to a designated receptor from the identified hazard. However, it is relatively unlikely that such a hazard would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation is normally required to clarify and determine the potential risk. Some remedial works may be required in the long term.
Low	It is possible that harm could arise to a designated receptor from the hazard identified, but is likely that this hazard if realised would at worst normally be mild.
Very low	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe

7.2 Potential contamination linkages

7.2.1 Sources of contamination

There are no identified sources of potential soil contamination. The site has only ever experienced agricultural land use as arable fields. There is no record of any agricultural storage at the site. There are no reported issues with the nearby pumping station.

No potentially significant source of hazardous ground gas has been identified. No source of mineworking- or waste-related ground gas has been identified and no made ground is anticipated. While tidal flat deposits in some geographical areas can contain bands of

peat or peaty material (which can be a source of methane and carbon dioxide), local borehole records indicate the tidal flat deposits in this area are dominated by silty sands and sandy silts with little clay material reported.

7.2.2 Pathways

There are many potential pathways to receptors. For the proposed site, these may include:

- Σ Inhalation (i.e. indoor or outdoor dust or vapour)
- Σ Ingestion (i.e. swallowing soil, dust, homegrown produce consumption or water polluted within service pipes)
- Σ Absorption (i.e. dermal contact with soil)
- Σ Migration (i.e. vertical/lateral movement through soil, rock, groundwater, building materials, voids and along services, including potable water supply pipes)

7.2.3 Receptors

Receptors comprise those material items or living beings that may be impacted by contaminants. For the site, these may include:

- Σ human site users (i.e. future occupants and construction workers),
- Σ controlled waters (i.e. groundwater and surface water features),
- Σ building materials and services (e.g. clean water pipework and buried concrete)
- Σ ecological systems (e.g. local wildlife)
- Σ adjacent site users (e.g. humans, ecological systems).

7.3 Initial conceptual site model (CSM)

Based on the possible sources, pathways and receptors identified, *potential* relevant contamination linkages (RCLs) for the proposed development have been created, as shown below (in Table 13). Potential RCLs are those linkages that might possibly pose more than a *low* or *very low* risk to receptors.

Table 13: Initial Conceptual Site Model

Source, S		Pathway, P		Receptor, R
Source type/area	Contaminant	Route	Sub-route	
		Ingestion	Soils Indoor dust Outdoor dust Root uptake In water supply	Workers, future occupants
		Absorption	Dermal contact	Workers, future occupants
		Inhalation	Indoor dust Outdoor dust Vapours	Workers, future occupants
		Leachate migration	Vertically in unsaturated zone Laterally in saturated zone Along services	Surface water, bedrock aquifer Building materials & services
		Gas migration	Through pores and fissures Along services	Future occupants, building materials
		Aggressive attack	Permeation of material Chemical reaction	Future occupants, building materials,
Not applicable				
Item		Rationale		
-		-		

As can be seen, no plausible sources of contamination have been identified. Therefore, the conceptual site model contains no potentially significant contamination linkages.

7.4 Preliminary risk assessment (PRA)

No identified plausible sources of potential contamination have been identified. Therefore, at this stage there is not considered to be any significant risk from ground contamination.

Nevertheless, any unforeseen contamination encountered during the development of the site should be reported to the local authority. Work should be halted in that area and the contamination investigated/assessed to the satisfaction of the local authority.

RB17, A Pragmatic Approach to Ground Gas Risk Assessment by CL:AIRE (authored by Card et al., 2012) outlines a procedure for evaluating the risks of ground gas. Accordingly, given that only natural soils are anticipated (that do not produce methane and carbon dioxide), no ground gas monitoring is recommended at this stage. Further, it

is anticipated that CS1 conditions could be appropriate for the site, subject to site confirmation of ground conditions.

8 Summary and Conclusions

8.1 Anticipated ground conditions

An assessment of available desk top information indicates the following general sequence of sub-strata at the site (in descending order).

- Σ **TOPSOIL:** organic soil *[to depths of about 0.3m – 0.5m bgl]*
- Σ **TIDAL FLAT DEPOSITS:** Loose to medium dense (becoming dense) silty SAND or sandy SILT *[to depths of about 12m bgl]* with a basal band of clay and gravel *[to depths of about 15m bgl]*
- Σ **GLACIAL TILL:** Boulder clay with bands of (water-bearing) sands and gravels *[to depths of about 22m bgl]*
- Σ **WEST WALTON FORMATION - MUDSTONE / SILTSTONE:** possibly initially encountered as silts / clays *[to potential depths of about 37m bgl]*

These anticipated ground conditions are subject to confirmation on site. This can be achieved through intrusive exploratory holes (e.g. boreholes and trial pits).

8.2 Historical summary

Evidently, the site has never experienced any significant development. It has been used as an agricultural field since (at least as early as) 1887. The only site changes have been alterations to the land drains around the edges of the site.

There has only been limited industrial activity near the site. Some large works buildings are shown as close as about 180m to the east of the site.

8.3 Contamination and gas risk assessment

A conceptual site model of potential relevant contamination linkages has been developed. However, no plausible sources of contamination and, therefore, no potentially significant contamination linkages have been identified. Consequently, the preliminary risk assessment cannot find any significant contamination risk.

Nevertheless, any unforeseen contamination encountered during the development of the site should be reported to the local authority. Work should be halted in that area and the contamination investigated/assessed to the satisfaction of the local authority.

RB17, A Pragmatic Approach to Ground Gas Risk Assessment by CL:AIRE (authored by Card et al., 2012) outlines a procedure for evaluating the risks of ground gas. As only natural soils are anticipated (that do not produce methane and carbon dioxide), no

ground gas monitoring is recommended at this stage. Further, it is anticipated that CS1 conditions could be appropriate for the site, subject to site confirmation of ground conditions.

8.4 Further investigation works

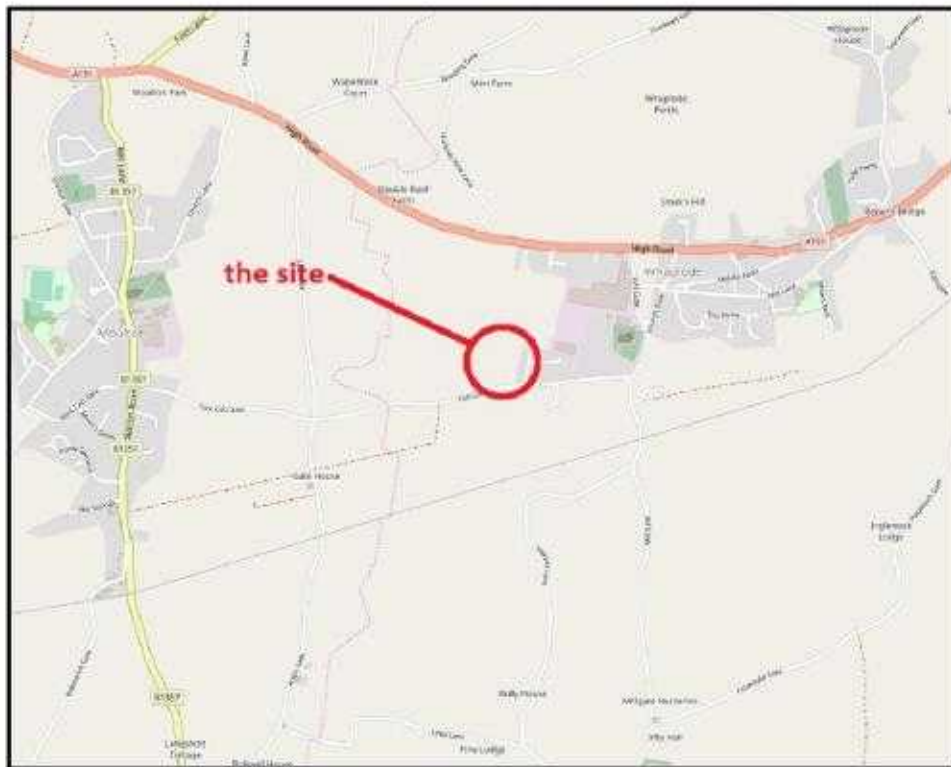
Site investigation works would be useful to:

1. Confirm the anticipated ground conditions (and location of groundwater)
2. Facilitate the foundation design of proposed structures
3. Investigate the feasibility of potential soakaways for the drainage of the site's proposed development
4. Assess the aggressivity of the in-situ ground to buried concrete
5. Facilitate the design of proposed road pavements
6. Identify any unforeseen potential sources of soil contamination or ground gas

8 References

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- BS 8485:2007 *Code of practice for the characterisation and remediation from ground gas in affected developments*, British Standards Institute
- Card G, Wilson S, Mortimer S. (2012) *A Pragmatic Approach to Ground Gas Risk Assessment*. CL:AIRE Research Bulletin RB17. CL:AIRE, London, UK.
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- Powell, W.D., Potter, J.F., Mayhew, H.C., and Nunn, M.E. (1984) *The structural design of bituminous roads*. TRRL Report LR 1132, 62 pages.
- Rudland, D. J., Lancefield, R. M., Mayell, P. N. (2001) *CIRIA C552 Contaminated Land Risk Assessment: A guide to good practice*, London: CIRIA.
- Stroud, M. A. (1974) "The standard penetration test in insensitive clays and soft rock," *Proceedings of the 1st European Symposium on Penetration Testing*, Sweden: Stockholm, vol. 2(2), 367-375.
- Wilson, S; Oliver, S; Mallett, H; Hutchings, H; Card, G (2007) *CIRIA C665: Assessing risks posed by hazardous ground gases to buildings*. London: CIRIA.

Appendix A



Site location



Aerial view of site (north is up page)



East side of the site (view towards north)



Centre of site (view towards northwest)



South part of site (view towards west)

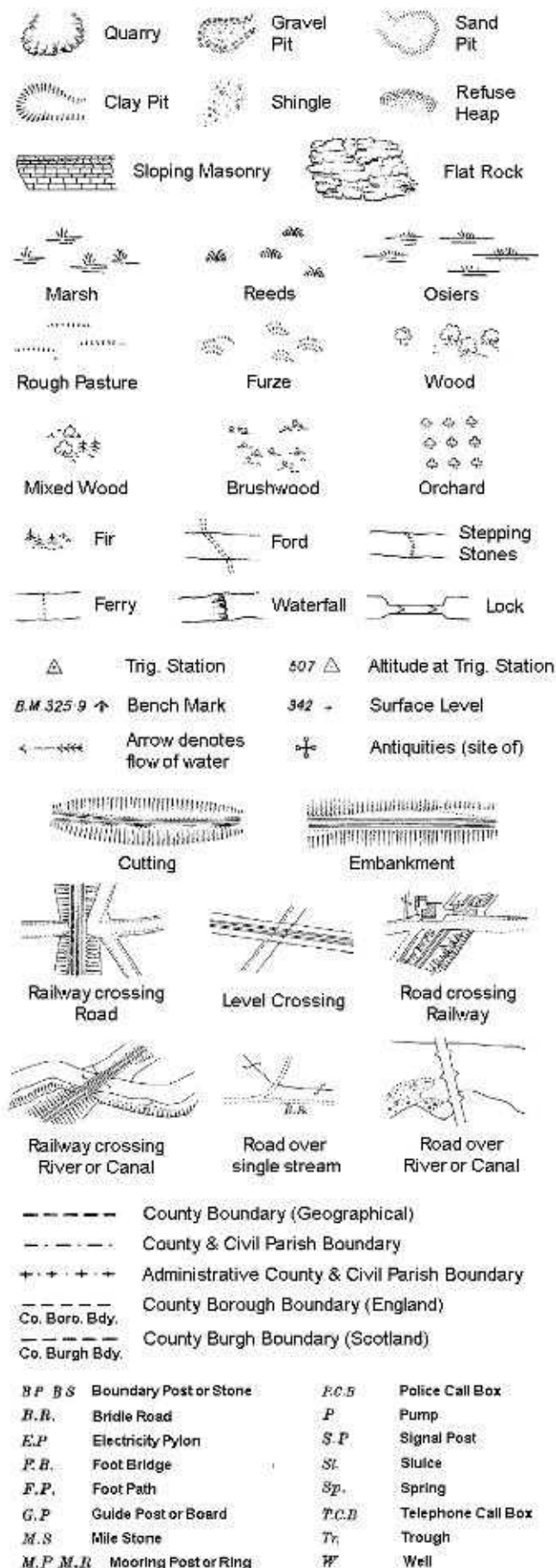


Pumping station near to southeast corner of site (view towards east)

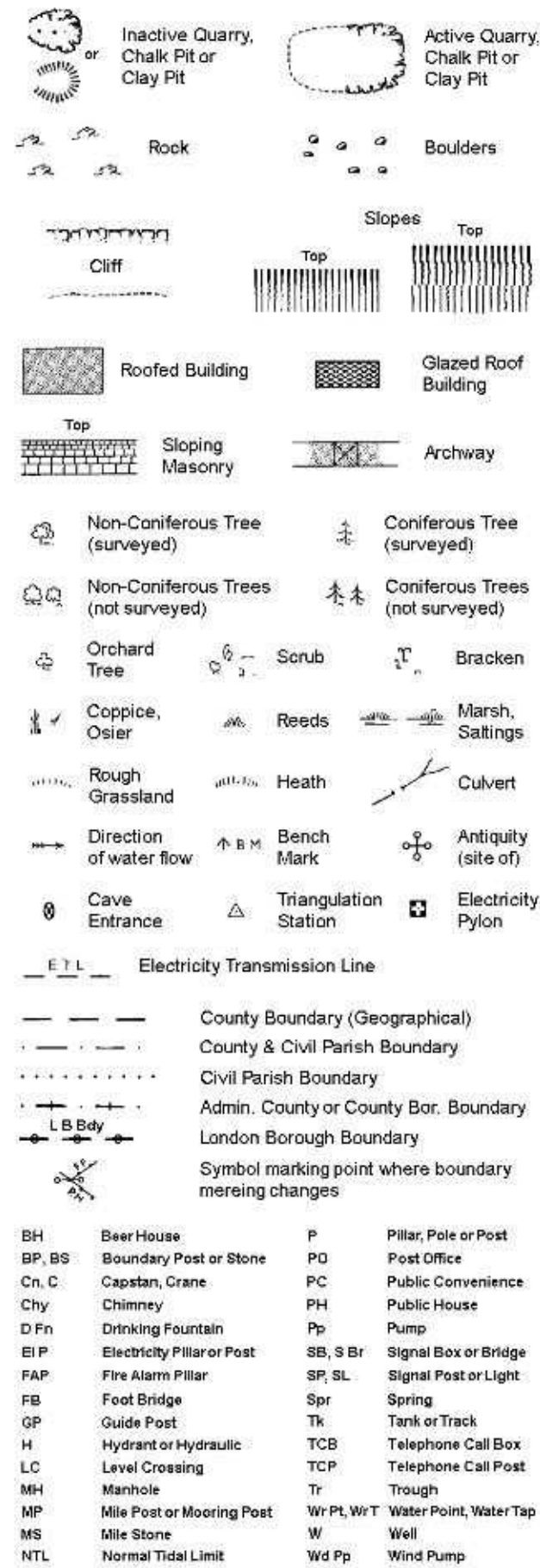
Appendix B

Historical Mapping Legends

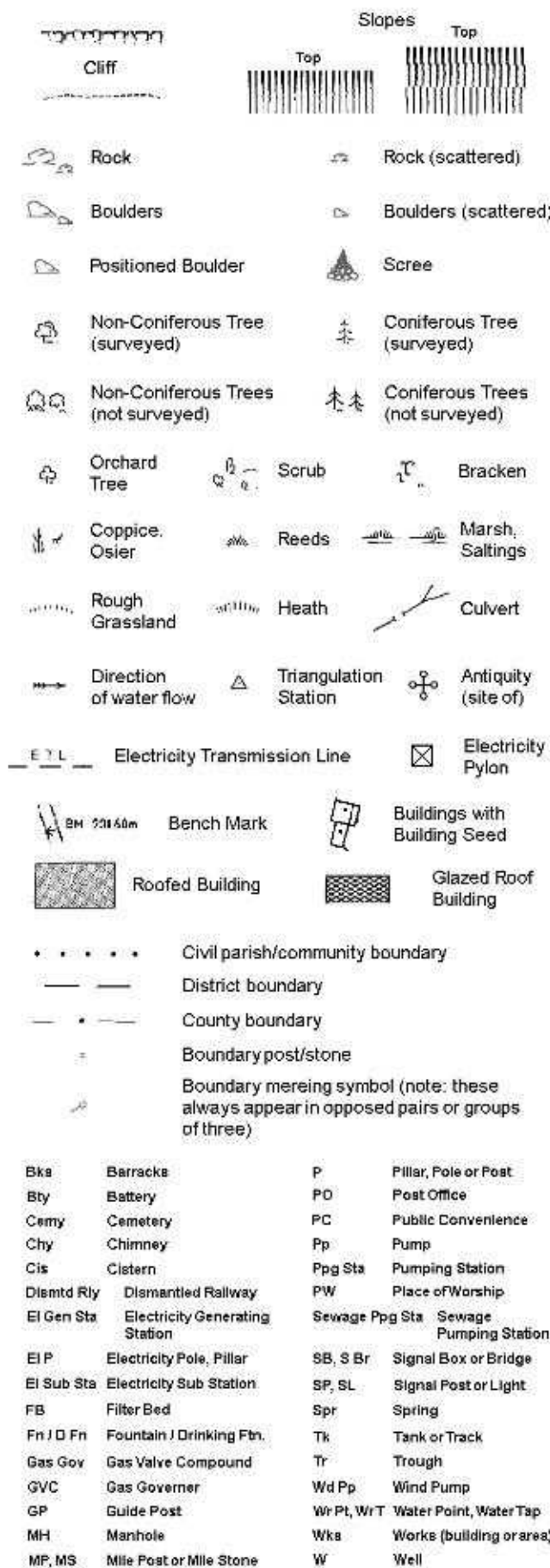
Ordnance Survey County Series and Ordnance Survey Plan 1:2,500



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



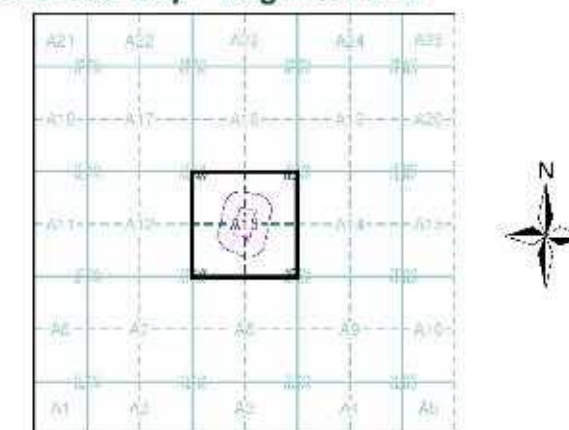
Large-Scale National Grid Data 1:2,500 and 1:1,250



Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Lincolnshire	1:2,500	1888	2
Lincolnshire	1:2,500	1904	3
Lincolnshire	1:2,500	1931	4
Ordnance Survey Plan	1:2,500	1968 - 1970	5
Additional SIMs	1:2,500	1977 - 1991	6
Additional SIMs	1:2,500	1981 - 1991	7
Ordnance Survey Plan	1:2,500	1988	8
Additional SIMs	1:2,500	1991	9
Additional SIMs	1:2,500	1993	10
Large-Scale National Grid Data	1:2,500	1995	11
Large-Scale National Grid Data	1:2,500	1996	12
Historical Aerial Photography	1:2,500	1999	13

Historical Map - Segment A13



Order Details

Order Number: 160380086_1_1
 Customer Ref: MG2203
 National Grid Reference: 531960, 324000
 Slice: A
 Site Area (Ha): 1.91
 Search Buffer (m): 100

Site Details

, 7, Abbots Gardens, Whaplode, Spalding, PE12 6SZ

Landmark
 INFORMATION GROUP

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



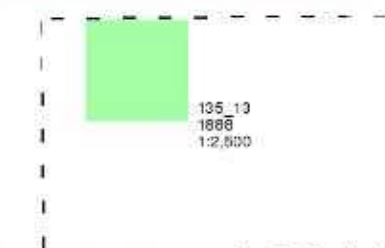
Lincolnshire

Published 1888

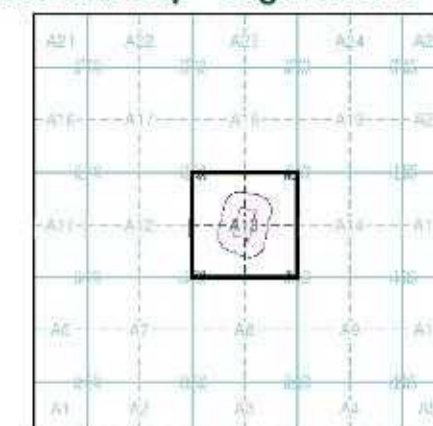
Source map scale - 1:2,500

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

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

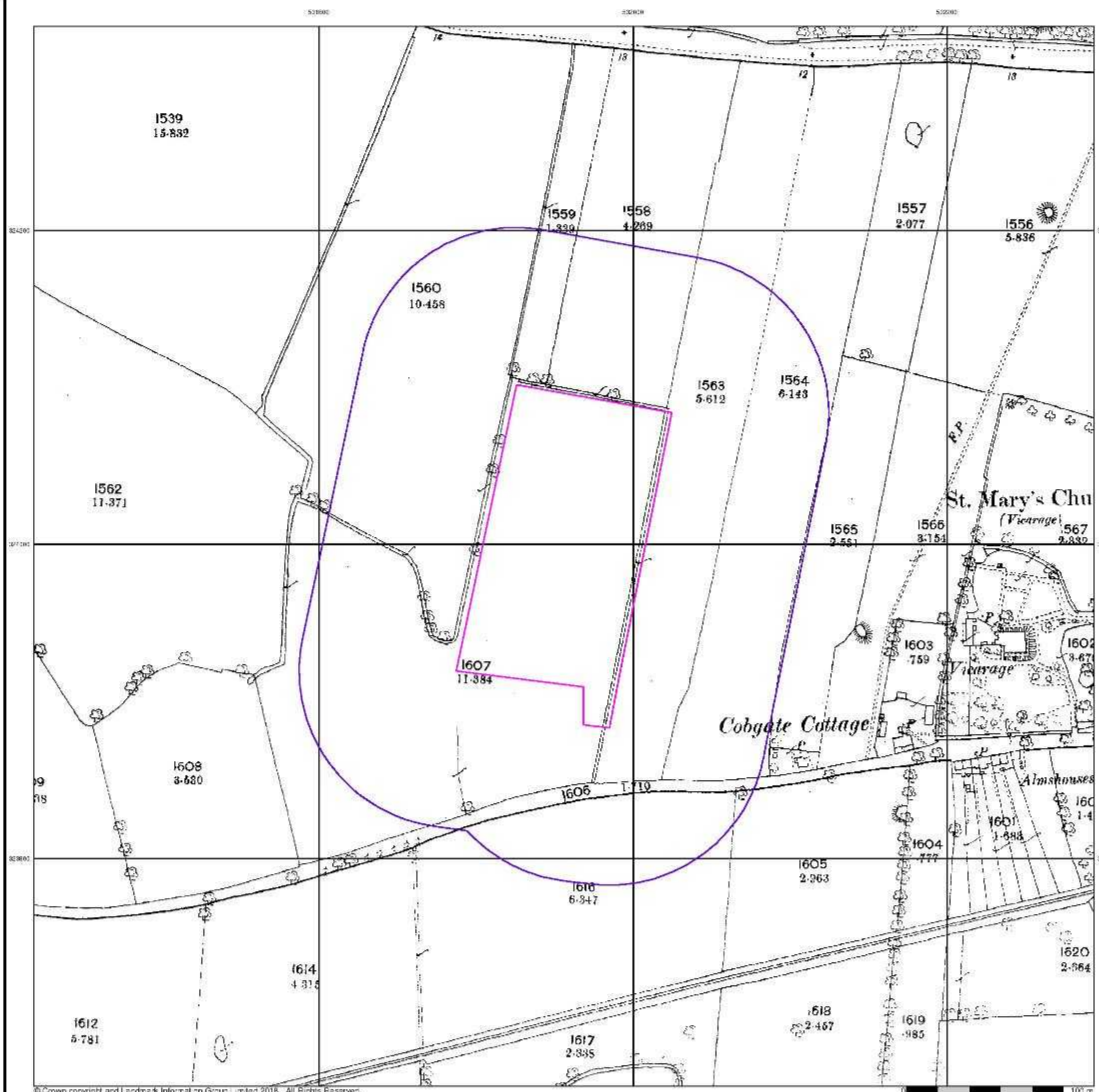
Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 100

Site Details

7, Abbotts Gardens, Whaplode, Spalding, PE12 6SZ

Landmark
INFORMATION GROUP

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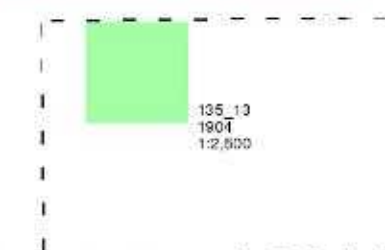
Lincolnshire

Published 1904

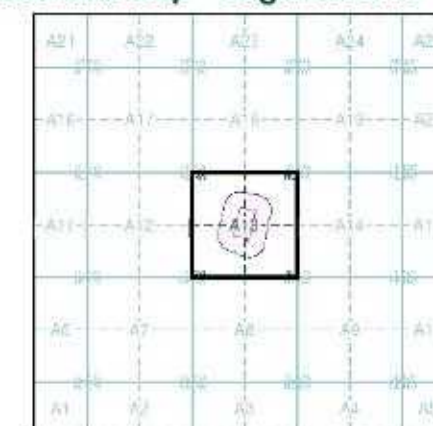
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The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered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

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

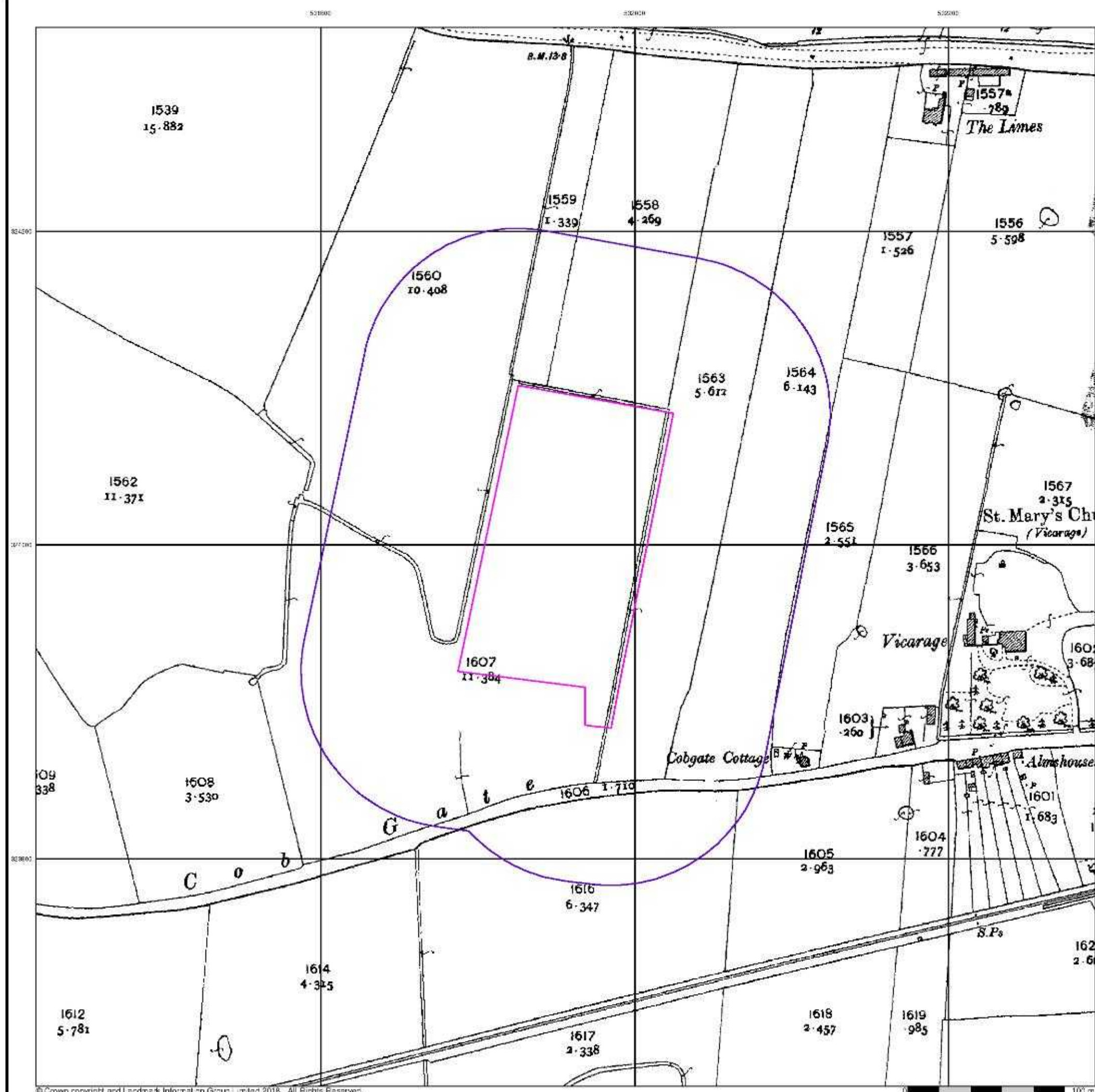
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National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 100

Site Details

, 7, Abbotts Gardens, Whaplode, Spalding, PE12 6SZ

Landmark
INFORMATION GROUP

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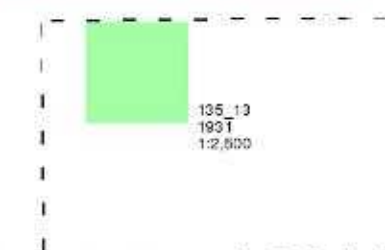
Lincolnshire

Published 1931

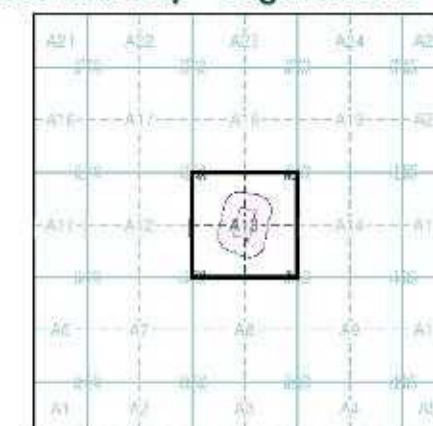
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The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered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

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

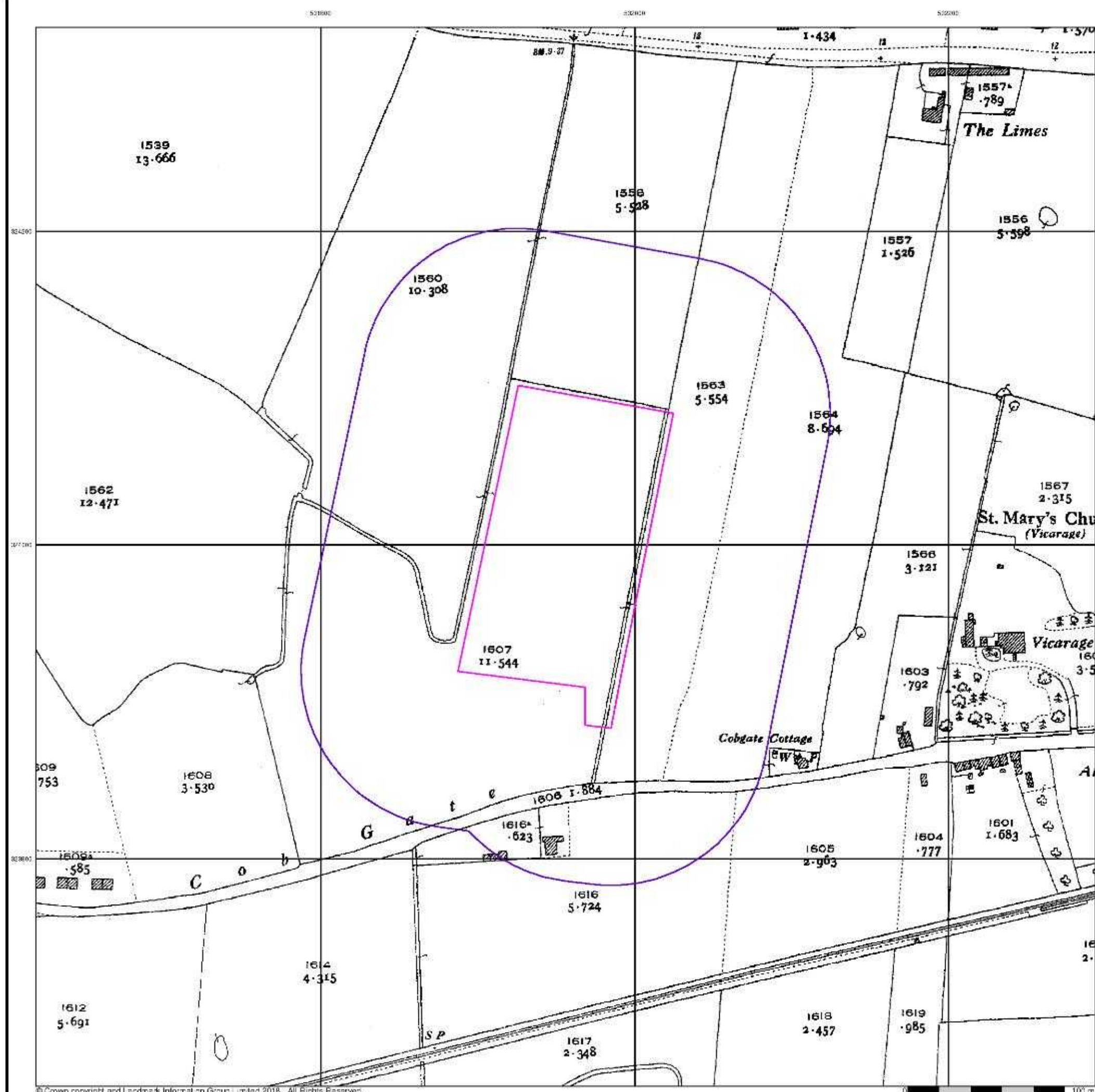
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Site Area (Ha): 1.91
Search Buffer (m): 100

Site Details

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Ordnance Survey Plan

Published 1968 - 1970

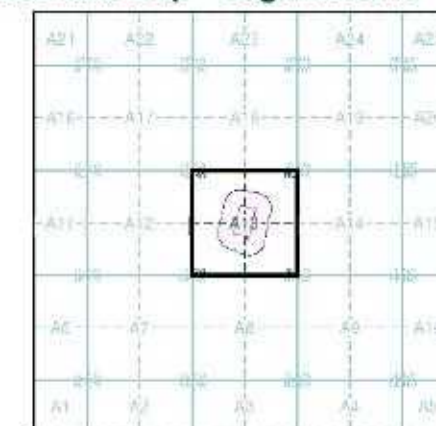
Source map scale - 1:2,500

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

Map Name(s) and Date(s)

TF3124 1968 1:2,500	TF3224 1970 1:2,500
TF3123 1968 1:2,500	TF3223 1970 1:2,500

Historical Map - Segment A13



Order Details

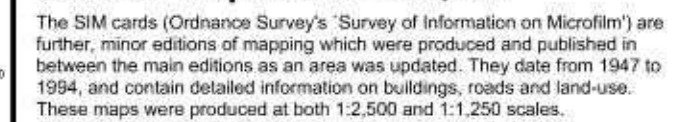
Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 100

Site Details

7, Abbotts Gardens, Whaplode, Spalding, PE12 6SZ

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TF3124	TF3224
1985	1977
12,500	12,500
TF3123	TF3223
1991	1977
12,500	12,500



Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 100

, 7, Abbots Gardens, Whaplode, Spalding, PE12 6SZ



Additional SIMs

Published 1981 - 1991

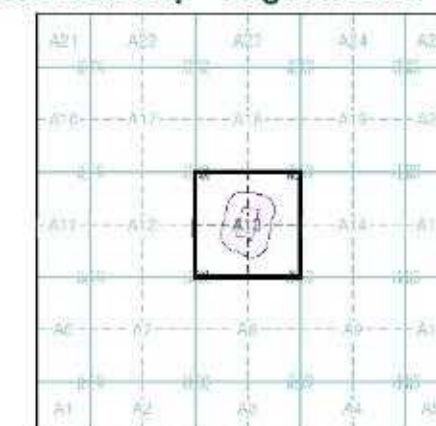
Source map scale - 1:2,500

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)

TF3224	1981	1:2,500
TF3223	1981	1:2,500

Historical Map - Segment A13



Order Details

Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 100

Site Details

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Ordnance Survey Plan

Published 1988

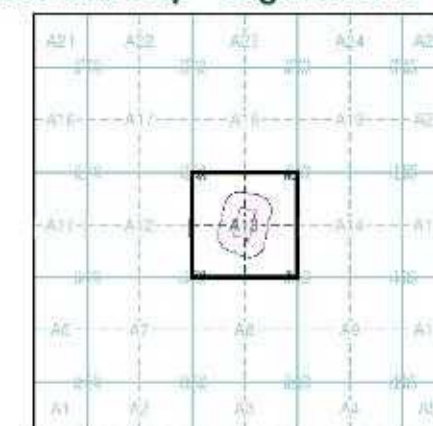
Source map scale - 1:2,500

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)

TF3124
1988
1:2,500

Historical Map - Segment A13



Order Details

Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 100

Site Details

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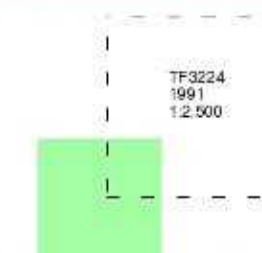
Additional SIMs

Published 1991

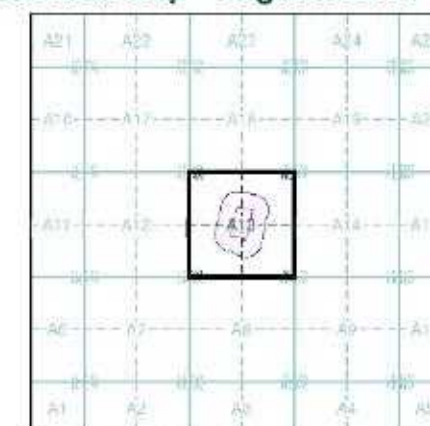
Source map scale - 1:2,500

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: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 100

Site Details

, 7, Abbots Gardens, Whaplode, Spalding, PE12 6SZ

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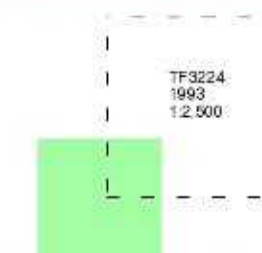
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Published 1993

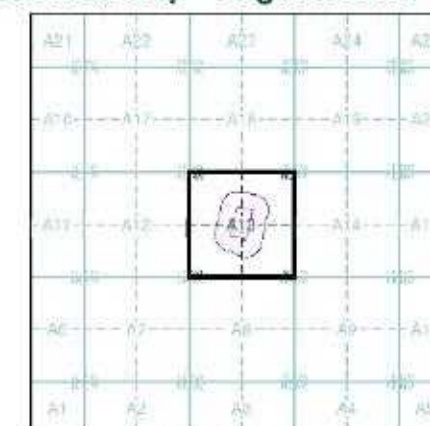
Source map scale - 1:2,500

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: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 100

Site Details

, 7, Abbots Gardens, Whaplode, Spalding, PE12 6SZ

Landmark
INFORMATION GROUP

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



Large-Scale National Grid Data

Published 1995

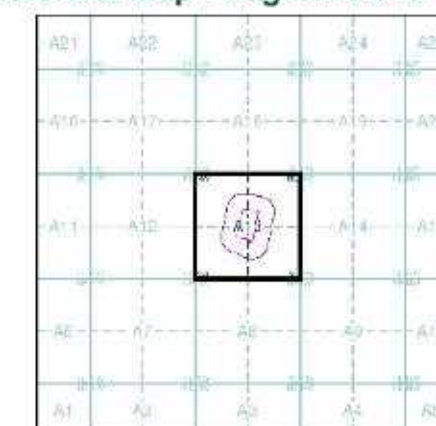
Source map scale - 1:2,500

'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)

TF3124	TF3224
1995	1995
1:2,500	1:2,500
TF3123	TF3223
1995	1995
1:2,500	1:2,500

Historical Map - Segment A13



Order Details

Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 100

Site Details

, 7, Abbotts Gardens, Whaplode, Spalding, PE12 6SZ

Landmark
INFORMATION GROUP

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



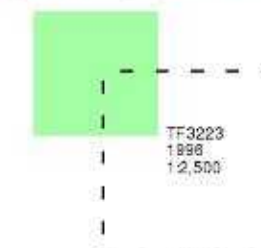
Large-Scale National Grid Data

Published 1996

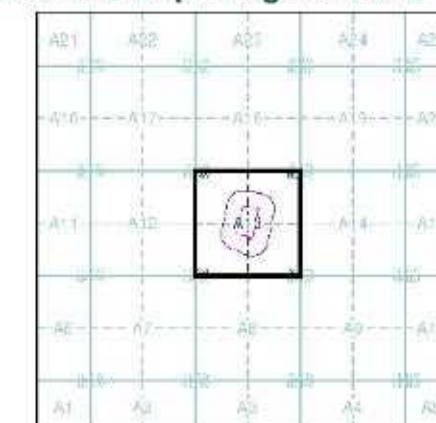
Source map scale - 1:2,500

'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



Order Details

Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 100

Site Details

, 7, Abbotts Gardens, Whaplode, Spalding, PE12 6SZ

Landmark
INFORMATION GROUP

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

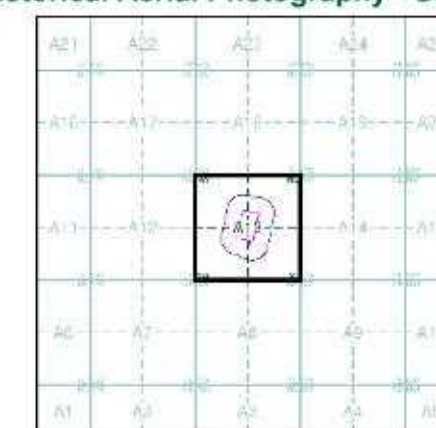


Historical Aerial Photography

Published 1999

This aerial photography was produced by Getmapping, these vertical aerial photographs provide a seamless, full colour survey of the whole of Great Britain

Historical Aerial Photography - Segment A13



Order Details

Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 100

Site Details

, 7, Abbots Gardens, Whaplode, Spalding, PE12 6SZ

Landmark
INFORMATION GROUP

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

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		Bench Mark
	Site of Antiquities		Well, Spring, Boundary Post		
	Pump, Guide Post, Signal 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
	Electricity Transmission Line		Pole
	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

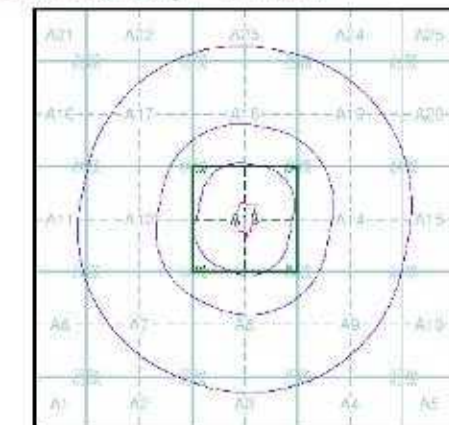
	Gravel Pit		Refuse tip or slag heap
	Rock		Rock (scattered)
	Boulders		Boulders (scattered)
	Shingle		Mud
	Sand		Sand Pit
	Slopes		Top of cliff
	General detail		Underground detail
	Overhead detail		Narrow gauge railway
	Multi-track railway		Single track railway
	County boundary (England only)		Civil, 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
Lincolnshire	1:10,560	1887	2
Lincolnshire	1:10,560	1906	3
Lincolnshire	1:10,560	1906	4
Lincolnshire	1:10,560	1932	5
Lincolnshire	1:10,560	1932	6
Lincolnshire	1:10,560	1932	7
Lincolnshire	1:10,560	1938 - 1952	8
Lincolnshire	1:10,560	1951 - 1952	9
Ordnance Survey Plan	1:10,000	1956 - 1958	10
Ordnance Survey Plan	1:10,000	1971 - 1977	11
Ordnance Survey Plan	1:10,000	1992	12
10K Raster Mapping	1:10,000	2000	13
10K Raster Mapping	1:10,000	2006	14
VectorMap Local	1:10,000	2018	15

Historical Map - Slice A



Order Details

Order Number: 160380086_1_1
 Customer Ref: MG2203
 National Grid Reference: 531960, 324000
 Slice: A
 Site Area (Ha): 1.91
 Search Buffer (m): 1000

Site Details

, 7, Abbots Gardens, Whaplode, Spalding, PE12 6SZ

Landmark
 INFORMATION GROUP

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



Lincolnshire

Published 1887

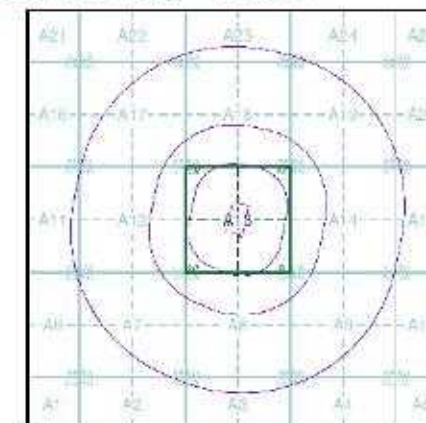
Source map scale - 1:10,560

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)

134SE 1887 1:10,560	135SW 1887 1:10,560
142NE 1887 1:10,560	143NW 1887 1:10,560

Historical Map - Slice A



Order Details

Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 1000

Site Details

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INFORMATION GROUP

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Lincolnshire

Published 1906

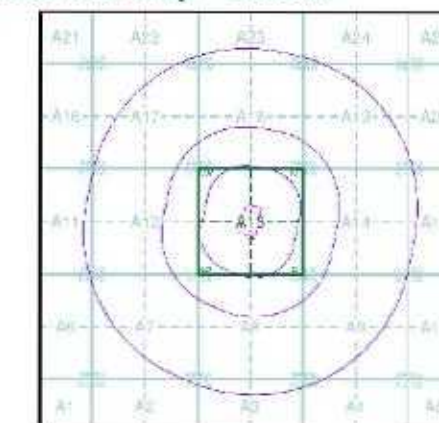
Source map scale - 1:10,560

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)

134SE 1906 1:10,560	135SW 1906 1:10,560
142NE 1906 1:10,560	143NW 1906 1:10,560

Historical Map - Slice A



Order Details

Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 1000

Site Details

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Lincolnshire

Published 1906

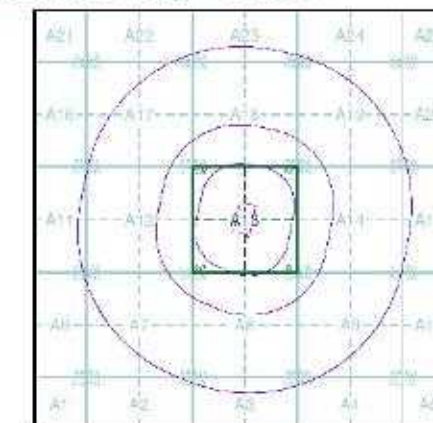
Source map scale - 1:10,560

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Map Name(s) and Date(s)

135SW 1906 1:10,560	143NW 1906 1:10,560
142NE 1906 1:10,560	

Historical Map - Slice A



Order Details

Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
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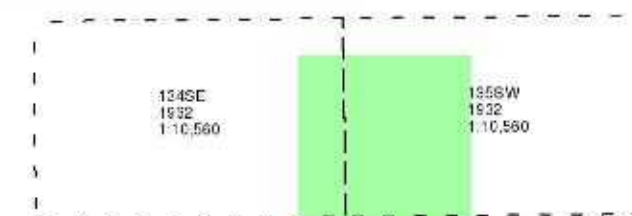
Lincolnshire

Published 1932

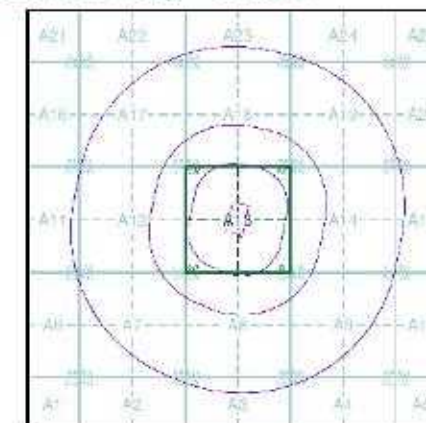
Source map scale - 1:10,560

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Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
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Site Details

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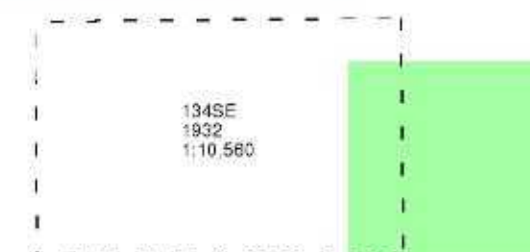
Lincolnshire

Published 1932

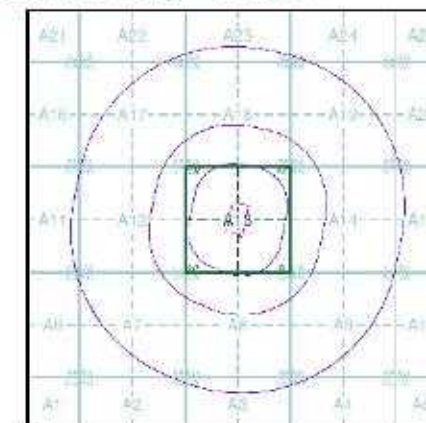
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Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
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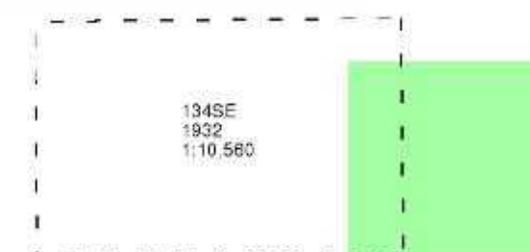
Lincolnshire

Published 1932

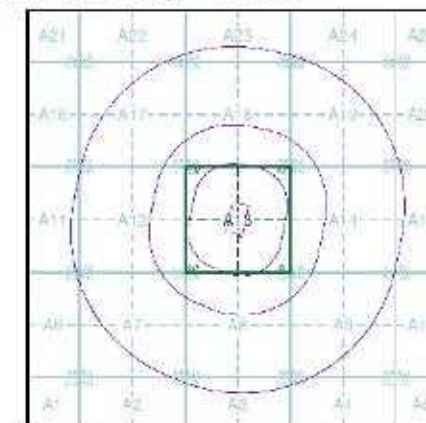
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Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
Search Buffer (m): 1000

Site Details

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Landmark
INFORMATION GROUP

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Lincolnshire

Published 1938 - 1952

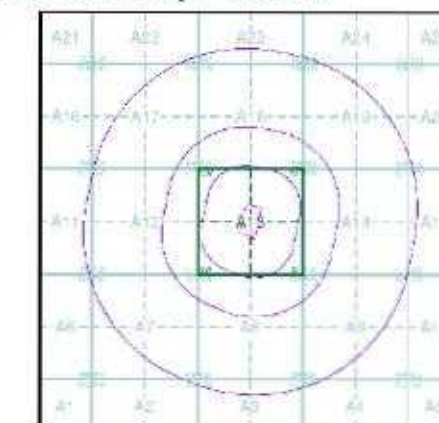
Source map scale - 1:10,560

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Map Name(s) and Date(s)

134SE 1938 1:10,560	135SW 1938 1:10,560
142NE 1938 1:10,560	143NW 1952 1:10,560

Historical Map - Slice A



Order Details

Order Number: 160380086_1_1
Customer Ref: MG2203
National Grid Reference: 531960, 324000
Slice: A
Site Area (Ha): 1.91
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