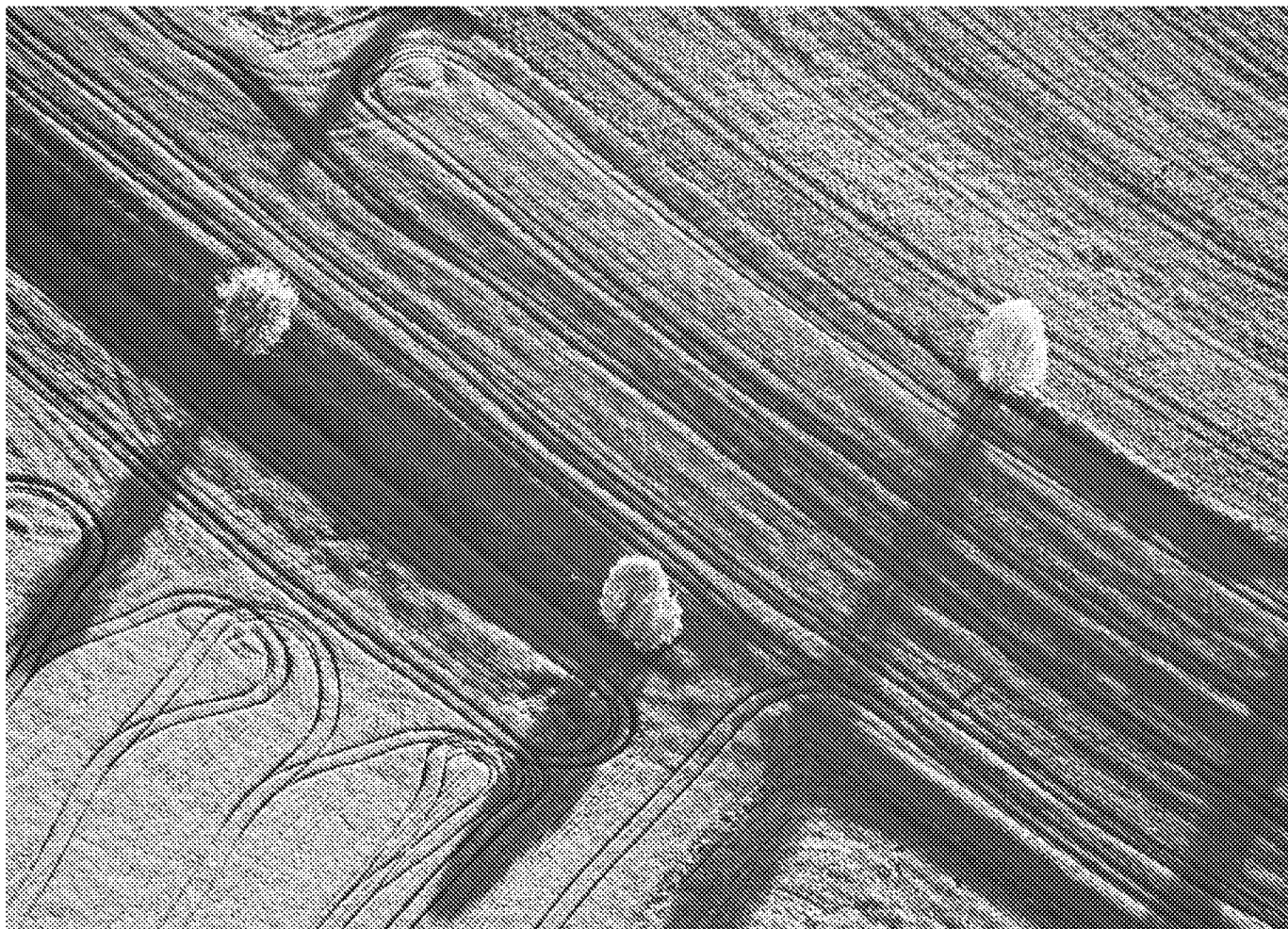


APPENDIX 15.1
GEO-ENVIRONMENTAL SITE ASSESSMENT



Redrow Homes Limited & Wates Developments Limited

Ford Airfield, Arundel, BN18 0YH

Geo-environmental and geotechnical site assessment

Project no. 29228-R01 (01)

NOVEMBER 2018





RSK GENERAL NOTES

Project No.: 29130-R01 (01)

Title: Geo-environmental and geotechnical site assessment of Ford Airfield, Arundel, BN18 0YH.

Client: Redrow Homes Limited and Wates Developments Limited

Date: 6th November 2018

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK Environment Ltd.

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1 INTRODUCTION

RSK Environment Limited (RSK) was commissioned by Redrow Homes Limited and Wates Developments Limited (the 'Clients') to carry out a geo-environmental and geotechnical assessment of the former Ford Airfield, located near Arundel in West Sussex. It is understood the site is being considered for a residential development with community facilities and employment areas.

This report is subject to the RSK service constraints given in **Appendix A**.

1.1 Background/Objective

The site covers approximately 102 hectares of land that formed part of the former Ford Airfield. The former airfield is now predominantly used for agriculture, but commercial properties are present on the site including a waste treatment facility, sports/recreation facilities, and waste recycling centre.

It is understood that the Clients as part of a joint venture intend on acquiring the site for a large scale residential development, and therefore require a geo-environmental and geotechnical assessment to inform on any site constraints that may impact on the proposed development.

1.2 Scope

The scope of the investigation and layout of this report has been designed with consideration of CLR11 (Environment Agency, 2014) and BS 10175: 2011 (BSI, 2011) and guidance on land contamination reports issued by the Environment Agency (EA) (2010a).

The project was carried out to an agreed brief as set out in RSK's proposal (ref. 29228-T01 (Rev 1), dated 18th June 2018). The scope of works for the assessment included:

- a preliminary risk assessment (PRA) to include a review of existing reports, geological, hydrogeological and hydrological information, a commercially available environmental database, and historical plans; correspondence with regulatory authorities; and a site walkover – this information is used to develop an initial conceptual site model to consider any potentially complete pollutant linkages;
- a review of published geological data to assess ground stability including a solution features search;
- an intrusive investigation consisting of six deep boreholes and ten shallow boreholes, fifty six trial pits, concrete coring across the former runway, and infiltration tests with laboratory analysis of soils samples;
- three return visits to carry out groundwater and gas monitoring, with laboratory analysis of groundwater samples;

- development of a refined conceptual site model followed by generic quantitative risk assessment (GQRA) to assess complete pollutant linkages that may require the implementation of mitigation measures to facilitate redevelopment;
- identification of outline mitigation measures for complete pollutant linkages or recommendations for further work;
- interpretation of ground conditions and geotechnical data to provide recommendations with respect to foundations and infrastructure design;
- a factual and interpretative report with recommendations for further works; and
- an assessment of the potential waste classification implications of soil arisings.

1.3 Existing reports

The following reports detailing previous works carried out on the former airfield were made available for review:

- Geotechnical and Contamination Review Ford, West Sussex, produced by JE Jacobs, Report No: B0545500\D2, dated April 2007.

These have been summarised in **Section 3**.

1.4 Limitations

The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels and ground gas concentrations and flows may vary from those reported due to seasonal, or other, effects.

2 THE SITE

2.1 Site location and description

The site is located approximately 5km northwest of Littlehampton at National Grid reference 99280, 103060, as shown on **Figure 1**.

The site is approximately 102 hectares in size and comprises part of the former Ford Airfield, situated in between the villages of Ford and Yapton in West Sussex. The land is now predominantly used for agriculture (arable) purposes, but a number of commercial premises are also located on the site. The central/western portions of the site are occupied by a waste recycling facility and a water treatment plant, but these are not included within the redline boundary for the development.

Parts of the former runway still remain across the central and in the northern portions of the site. The runway in the centre of the site is currently used for car boot sales, and two warehouse type units are also situated in this area which are used as an indoor children's play area and sports facilities. These units are also not included within the redline boundary. The northern portion of the runway is occupied by a Highways Agency compound and a warehouse unit.

A combination of fencing, mature hedgerows and trees are situated along the boundaries of the fields, and have been used to screen a number of the commercial properties.

The ground is relatively level across the site at 5 m AOD.

The area around the site is of mixed use as detailed in **Table 1**.

Table 1: Site setting

To the north:	The site is bound to the north by Ford Lane. Ford Lane Industrial Estate and agricultural land is located beyond the road. The village of Ford is located to the northeast of the site.
To the east:	The site is bound to the east by Ford Road and agricultural land. The River Arundel is situated approximately 450 m to the east of the site boundary.
To the south:	Viridor waste treatment facility, HMP Ford, and Rudford Industrial Estate are all situated to the southeast of the site. The village of Horsemere Green and a plant nursery are located directly to the south.
To the west:	The site is bound by agricultural land to the northwest. Ford Industrial Estate and a residential estate (part of Yapton) is located across to the west of the site. Yapton Road bounds the site to the southwest beyond which lies parts of the former runway and agricultural land.

2.2 Proposed development

The proposed development plan comprises the provision of at least 1,500 residential properties along with new community health care, education and recreational facilities, along with employment zones new road infrastructure. The master plan for the proposed development is presented as **Figure 2**.

3 PRELIMINARY RISK ASSESSMENT (PRA)

3.1 Site walkover

The site was visited on 25th July 2018 to undertake a site walkover. Potentially significant environmental and geotechnical issues arising from the survey are summarised below. A site walkover plan is presented as **Figure 3**, and a photographic record is provided in **Appendix B**.

Features	Description
1) Present land uses (on-site)	The majority of the site is currently used for agriculture, other site uses include, a) The former runways in the centre of the site are used for car boots sales. b) Two steel clad warehouse type structures are located on the central portion of the former runway, one is used an indoor children's play area, and is called the Flying Fortress (plan ref 1). The second contains indoor sports pitches (Arena Sports, plan ref 2). A number of football pitches are located to the east of these units (plan ref 3), and a car park is located on hard standing to the north. c) A sewage works is located in the centre of the former airfield and is operated by Southern Water (plan ref 4). The sewage is works not included within the redline boundary for the development. The works are fenced off and screened by vegetation and so could not be viewed during the walkover survey. d) A waste treatment facility operated by Grundon is located in the central / northern portion of the airfield (plan ref 5), and is also not located within the redline boundary of the development. The facility is gated and fenced off, but it was noted that the site encompasses a number of the former airfield hangers. It is understood from the landowner that Grundon have recently carried out an environmental survey of their site. e) A compound operated by Highways England is located in the northern portion of the site. A warehouse unit occupied by Blech of Lavant Limited (plan ref 6), which are a haulage company is also located in this area. Neither of the properties could be accessed during the walkover. f) A dome structure constructed of breeze block with a corrugated iron roof (plan ref 7) is located in the southern portion of the site. It is unknow what this structure is currently used for. g) A building constructed of breeze block with a steel structure is located in north western portion of the site (plan ref 8), and is used to store fertiliser. h) A disused structure is located to the north the Grundon site. The structure is partially buried beneath the ground, and appears to be one of the former airfield buildings (plan ref 9). i) A large stockpile of Maize is currently located in the north western portion of the site (plan ref 10). Some small piles of construction debris (bricks) were noted to the south of this stockpile. There are public footpaths located in the northern and in the southwestern portions of the site, which are regularly used by dog walkers.

2) Use and storage of chemicals	There was no evidence of chemical storage on-site. An above ground storage tank was noted in the Grundon waste treatment facility, but is of modern construction comprising a plastic bunded tank.
3) Evidence of made ground	An earth mound is situated along the eastern boundary of the Grundon waste recycling facility (plan ref 11), and is classified by the Environment Agency as an inert landfill (see Section 3.5). Large fragments of reinforced concrete were noted in the vegetation behind the disused building in the northern portion of the site (plan ref 12).
4) Hard standing	The former concrete runways and taxiways remain in the central and southern portions of the site. The concrete appears to be in good condition with few cracks. Any surface water on the former runway drains to a series of drain located along the edge of the runway. It is understood that the afield has it own dedicated surface water drainage system that discharges into the River Arundel.
5) Slopes / uneven ground, and water logging.	The ground is relatively flat across the site, however a there is small ridge along the north eastern boundary of the site (plan ref 13) where there is a height difference of around 1m between the two fields. There was no evidence of water logging on the fields, but the survey was carried out during a period of hot weather.
6) Services	A number of major services are known to be present across the site including a sewage main. A gas governor was also noted during the site walkover to the northeast of the Grundon site (plan ref 14).
7) Vegetation / invasive species	Mature hedge rows and trees are present across the site and are cited along field boundaries and around the various commercial premises and sewage works. Small areas of woodland are situated along the public footpath to the north of the Grundon site, and west of the Highways England site. RSK were notified by ecologists that Japanese Knotweed is present on the earth mound next to the Grundon site. It is understood that a full ecological study has been carried out across the site.
8) Surface water	No streams, ponds or ditches were noted during the site walkover on the site.

9) Off-site uses	Off site users noted during the walkover were, • Ford Lane Industrial Estate ~50m to the north / northeast of the site (includes scrap metal merchants and engineering company) • Viridor waste treatment facility to the ~30m east of the site boundary. • Rudford Industrial Estate ~directly south/southeast of the site boundary (includes electronic component manufacturers, packaging manufactures, and garage services) . • Ford Industrial Estate directly to the west of the site boundary (A Plant and H.D White Recycling was noted next to the boundary).
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The walkover survey identified a number of potentially contaminative activities on the former airfield, these include a highways compound/distribution centre to the north, and a waste treatment facilities, inert landfill, and sewage works located in the centre of the site. However, the site is predominantly used for agriculture, therefore any contamination associated with these sources is likely to be localised. Furthermore, the waste treatment facilities and sewage works fall outside of the current development proposals, and will be treated as off-site sources from hereon.

A number of industrial estates are located around the periphery of the site that including potentially contaminative activities such as engineering, garage services and manufacturing, and are therefore considered to be possible off-site sources of contamination.

However, the principal cause for concern with regards to land contamination is considered to be the site historic use as an airfield.

3.2 Ground conditions

3.2.1 Geology

The published geological records held by the British Geological Survey (BGS), and the finding of the geotechnical and contamination review carried out by Jacobs in 2007 have been used to characterise the geological succession beneath the site, as detailed in **Table 2** , below.

Table 2: Geology at the site

	Geological unit	Description	Estimated thickness (m)
Superficial Deposits	Brickearth	Orange brown sandy CLAY.	3 to 4 m.
	and/or River Terrace Deposits	Loose brown slightly silty SAND.	
Solid Geology	Lewes, Seaford and Newhaven Chalk Formations	Structureless highly weathered CHALK composed pf silty sub angular and sub rounded gravel and cobbles.	Proven to 15m, chalk is ~300 m thick in this area.

The geological map also indicates that raised beach deposits are present along the north eastern boundary of the site.

Also, given the historical development of the site the presence of made ground should be expected beneath the site.

In view of the prevailing ground conditions, with Chalk at shallow depth beneath the site, it is normal practice to consider the potential risk of ground subsidence related to the presence of swallow holes and other natural chalk solution features or man-made cavities.

Based on the Edmund's risk assessment model for natural dissolution features referred to in CIRIA Report C574 (Lord et al. 2002), the site falls into the low 'anticipated subsidence risk' category. With reference to Edmund's database of known natural and man-made chalk solution features there are no such features in the immediate vicinity of the site/give details of features within 500 m.

3.2.2 Radon

The environmental database report (Envirocheck report, June 2018) indicates that the site is not located within an 'Affected Area' as defined by the Documents of the National Radiological Protection Board (Radon Atlas of England and Wales, NRPB-W26-2002) and therefore the risk of significant ingress of radon into structures on-site is considered low.

3.3 Hydrogeology

3.3.1 Aquifer characteristics

Groundwater was encountered within the chalk at between 5.5 m to 8.5 m bgl during previous site investigations carried out the site (see **Section 3.8**), but is likely to be partially confined by the overlying superficial deposits.

Groundwater is anticipated to flow in a southerly/southeast direction towards the coast and River Arundel.

3.3.2 Vulnerability of groundwater resources

The site has been classified by the EA website to overlie a:

- Secondary A aquifer (Brickearth/Head Deposits): permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
- Principal aquifer (Chalk): layers of rock or drift deposit that have high intergranular and/or fracture permeability (usually providing a high level of water storage). They may support water supply and/or river base flow on a strategic scale.

The soils beneath the site are classified as having intermediate (I) leaching potential.

I – soils that have a moderate ability to attenuate diffuse source pollutants or where some non-adsorbed diffuse source pollutants and liquid discharges could penetrate the soil layer.

3.3.3 Licensed groundwater abstraction

The environmental database (Envirocheck report, June 2018) report indicates that there is one groundwater abstraction borehole located on the airfield site. The borehole is shown to be located in the Grondon waste treatment facility, and was licensed to Tarmac Heavy Building Materials for construction purposes. It is therefore likely that the borehole was only active during the construction of a building on this site.

There are three other licensed groundwater abstractions within a 2km radius of the site, all of which are for commercial purposes, and not for drinking water.

In terms of aquifer protection, the EA generally adopts a three-fold classification of source protection zones (SPZ) for public supply abstraction wells.

- Zone 1 or 'inner protection zone' is located immediately adjacent to the groundwater source and is based on a 50-day travel time from any point below the water table to the source. It is designed to protect against the effects of human activity and biological/chemical contaminants that may have an immediate effect on the source.
- Zone 2 or 'outer protection zone' is defined by a 400-day travel time from a point below the water table to the source. The travel time is designed to provide delay and attenuation of slowly degrading pollutants.
- Zone 3 or 'total catchment' is the area around the source within which all groundwater recharge is presumed to be discharged at the source.

Information available on the EA website indicates that the site does not lie within a currently designated groundwater Source Protection Zone.

3.3.4 Surface watercourses

The environmental database report shows that there is an unnamed stream located directly to the east of the site, which flows towards the River Arundel, located approximately 450 m to the east of the site boundary.

It is considered that the base flow of the unnamed stream and the River Arundel may be in part recharged by groundwater within the underlying chalk aquifer, and therefore a linkage between the river and any ground or groundwater contamination beneath the site may therefore exist.

3.3.5 Surface water abstractions

The environmental database report indicates that there are four surface water abstractions within a 2 km of the site. The nearest one is located approximately 1.4 km to the north and is licensed to Keith Langmead Limited for agricultural purposes.

3.3.6 Site drainage

Surface water drains are located along the edge of the former runways. It is understood that the airfield has its own dedicated surface water drainage system that discharges into the River Arundel.

3.3.7 Preliminary flood risk assessment

The indicative floodplain map for the area presented in the environmental database report shows that the floodplain (Zone 3) for the River Arundel extends on to a small area situated along the northern boundary of the site. The remainder of the site is not located on the floodplain.

This report is not intended to replace a full hydrological study and it is recommended that additional specialist studies be conducted to confirm flood risks at the site.

3.4 History of site and surrounding area

The history of the land-use and development of the site and surrounding area has been assessed based on the following sources:

- historical maps within the environmental database from 1879 to 2006;
- internet search (www.airfields.org of Britain Conversation Trust); and
- RAF archives held at Hendon.

Copies of OS and County Series maps are included in the environmental database report in **Appendix C**. Reference to historical maps provides invaluable information regarding the land use history of the site, but historical evidence may be incomplete for the period pre-dating the first edition and between successive maps.

The historical maps show that during the late 19th Century the site was undeveloped agricultural land with a number of farm buildings. The Chichester and Arundel Canal, now disused, transected the northern portion of the site from east to west. The surrounding area was also predominantly agricultural land with the villages of Ford, Yapton, and Burndell located to the northeast, northwest and west of the site. A small disused gravel pit was located approximately 150 m to the southeast of the site boundary.

The site was first used as an airfield from 1918 to 1920 by RAF and American flying squadrons. The site was re-opened ten years later for early experiments with air to air refuelling, and was subsequently re-occupied by the military before the beginning of the Second World War in 1937. The historical maps show the presence of aircraft hangers, and other buildings associated with the airfield located directly to the west of the site in the area of Ford Industrial Estate, and existing residential housing estate. However, the layout of the airfield is not shown again on the historical maps until the 1980's.

Plans of the airfield's layout during the 1950's have been obtained from the RAF museum in Hendon as well as a search of available on-line records. These are presented in **Appendix C1**. The plans show that the aircraft hangers and maintenance areas are located beyond the site boundary to the northwest and southeast of the airfield. Within the site boundary, the airfield comprised the runway/taxiways, dispersal pads (areas where aircraft were parked), and open land between the runways. Workshops were located in the north eastern portion of the site, explosive stores were situated in the northwest and southwest corner of the site, and a bulk fuel store was located next to the southern boundary of the site.

The airfield was used for training purposes until it was heavily bombed during 1940, following which the airfield was occupied by fighter squadrons. After the Second World War, the airfield was used for training purposes until military use ceased in 1958. The airfield continued to be used by a civilian flying club until 1980.

The historical maps from 1980 show that many of the structures associated with the military airfield had by this time been demolished/removed. However, two hangers are shown off-site within the existing Grundon compound. Many of the remaining structures located to the northeast of the site are now shown to be used as a prison. From the 1980s onwards the existing Grundon waste recycling facilities, sewage works, and commercial properties were constructed on the former airfield site. Industrial and trading estates were constructed to the north (Ford Lane Business Park), southeast (Rudford Industrial Estate), and northwest (Ford Industrial Estate) of the site boundary. The majority of the site is now used for agricultural purposes.

3.4.1 Sensitive land uses Mining and quarrying

Evidence has been sought to identify any mining and quarrying operations, past and present, which have taken place in the vicinity of the site. The sources of information referenced in this element of the desk study include:

- an environmental database report;
- old Ordnance Survey maps and plans (see **Section 3**); and
- geological maps (see **Section 4.1**).

With reference to the above data, the historical maps show the presence of a brickfield located approximately 800 m to the west of the site boundary, and a disused gravel pit 150m to the southeast during the early 20th Century. These are not shown on later historical maps and have possibly been infilled. However, records held by the Environmental Agency do not show that these features were used as landfills. Furthermore, given the distance of these feature from the site they are unlikely to impact the development.

3.5 Landfilling and land reclamation

Evidence has been sought to identify any landfilling or land reclamation operations, past and present, which have taken place in the vicinity of the site. The sources of information referenced in this element of the desk study include:

- environmental database report;
- old Ordnance Survey maps and plans (see **Section 3**); and
- geological maps (see **Section 4.1**).

There is one record of a historical landfill located on-site to the rear of the Grundon waste treatment facilities. The landfill is registered to RT Page & Sons Limited for the disposal of inert solid waste in 1985. It is stated that bio-degradable material, hazardous waste, and asbestos wastes were prohibited.

Part of the former canal located approximately 200 m southwest of the site boundary is also shown to have been used to deposit inert waste in 1980. The former canal across the site was also infilled within unknown materials as part of the construction of the airfield during the 1930s, but is not a registered as a landfill.

3.5.1 Licensed waste management facilities

There are number of waste transfer facilities located on and close to the site, these are listed in **Table 3**, overleaf.

Table 3: Licensed Waste Management Facilities

Operator	Description	Location
Southern Water Services Limited	Sludge Dryer	Sewage works on the southeast portion of the airfield
Grundon Waste Management Limited	HCI Waste (Household, Commercial and Industrial) + treatment	Northeast portion of the airfield.
H.D White Limited	Metal recycling	Located next to the north western boundary of the site.
Viridoor Waste Management Limited	Material recycling treatment facilities	Located off-site next to the southeast boundary.
TP Smart Limited	Metal recycling facilities	Located off-site next to the northern boundary.
T J Waste & Recycling Limited	Household, commercial and industrial transfer stations	~250 m west of the site boundary.

Under normal operating conditions these waste management facilities would not be expected to cause any adverse effect to the environment.

3.6 Environmental database report

A search of the environmental database report has been undertaken for any other relevant information pertaining to the site and surrounding area. Relevant information is listed below.

- There is one active discharge consent licensed to Southern Waters Limited for treated effluent. The exact location of the discharge point is unknown, but it stated that the effluent enters the River Arundel.

- There are three records active pollution prevent and control permits. The first relates to the Sewage treatment works and the second and to Dry Cleaners located off-site on Ford Industrial Estate.
- There are two records of pollution incidents to controlled waters within the vicinity of the site. The first report relates to the release of inert suspended solids in the unnamed stream located approximately 300 m east of the site. The second to the release of oils in a ditch located approximately 750 m west of the site. Both were classed as minor incidents.
- There are no environmentally sensitive site located within 250 m radius of the site (e.g SSSI).

3.7 Local authority environmental health department information

The environmental health department (EHD) Arundel District Council have contacted for information pertaining to the site. We are awaiting a response.

3.8 Previous site reports

A geotechnical and contaminated land assessment was carried out by Jacobs Limited in 2007 at area of land located (off-site) directly to the southwest of the former runway/site boundary (Report Ref B0545500\D2, dated April 2007). The assessment involved a review of previous site investigations undertaken by other consultants in relation to the construction of the sewage works and Viridor Waste management facility.

It was reported that the ground conditions in this area comprised a superficial layer of made ground up to 0.5 m in thickness, over Brickearth (sandy CLAY) and Head Deposits (gravelly SAND) which extended to 4.0 m bgl. These superficial deposits were further underlain by chalk. Groundwater was recorded between 5.5 m and 8.5 m bgl.

No visual or olfactory evidence of contamination was noted, and no elevated concentrations of contaminations were recorded in the soils samples taken. However, it was concluded that the extent of the previous investigations were limited, and further investigation would be required to fully characterise the ground conditions.

It was reported that a German unexploded ordnance from the Second World War was found during the construction of the sewage works. A British practice phosphorus bomb was also found by a UXO consultant whilst carrying out a survey of this site. Therefore, there is the potential for UXO on the remainder of the former airfield site (see **Section 3.9**)

3.9 UXO Risk Assessment

RSK commissioned Fellows International Limited to carry out a detailed UXO (unexploded ordnance) risk assessment of the site. The assessment concluded that due to the airfields previous military use, the fact that the site was heavily bombed during the Second World War, and that ordnance had been found on the afield previously, there is a medium risk level for encountering UXO. Mitigation measure were therefore

recommended for any intrusive site investigation and construction works. The full details of these measures can be found in Fellow report Ref 2078, dated July 2018.

3.10 Initial conceptual model

The information presented in **Sections 2 and 3.1 to 3.9**, has been used to compile an initial conceptual model. The identified potential sources of contamination, associated contaminants and receptors have been considered with plausible pathways that may link them. The resulting potential pollutant linkages are considered in **Section 3.10.4**. The risk classification has been estimated in accordance with information in **Appendix D**.

3.10.1 Summary of potential contaminant sources

Potential sources and contaminants of concern are summarised in **Table 4**.

Table 4: Potential sources and types of contamination

Potential sources	Contaminants of concern
On-site historical	
Former use of the site as an airfield from 1918 until the 1980s – Site was predominantly used for runways, and dispersal pads. Bulk fuel storage facilities were located along the southern boundary of the site. (Contaminants have been selected from DOE guidance on airports)	Aviation fuel (gasoline and kerosene), de-icers (glycols), asbestos, pesticides.
Inert landfill located in the north western portion of the site, to the rear of the Grundon waste treatment facilities.	Unknown fill materials, but will contain non-degradable and non-hazardous waste soils. These may contain heavy metals, polycyclic aromatic hydrocarbons (PAHs), and asbestos.
Made ground associated with the development of the site.	Unknown fill material but potentially including heavy metals, ash, clinker, sulphates, PAHs, asbestos etc.
Made ground associated with infilling of former canal across the centre of the site.	
On-site present day	
Agricultural (arable) use of the land between the former runways.	Pesticides.
Highways England Compound and haulage company located in the northern portion of the site.	Potential for oils/fuel associate with vehicles being stored/used on the site.
Off-site Historical	

Potential sources	Contaminants of concern
The remainder of the former airfield site. The main maintenance areas and hangers were located off-site to the southwest and north east of the current site boundary.	Numerous potential contaminants including heavy metals, PAH's, petroleum hydrocarbons (associate with re-fuelling and oils), solvents, and polychlorinated bisphenols (PCBs).
Off-site Current	
Sewage works	Heavy metals, PCBs, asbestos, acids/alkalis and micro-organisms.
Grundon waste recycling facilities	Depends of the activities carried out, but may include heavy metals, PAHs, fuel oils (petroleum hydrocarbons).
Various industrial activities surrounding the site including waste recycling / treatment facilities, dry cleaners, garage services, electronic component and packaging manufacturing.	Various potential contaminants including heavy metals, PAHs, chlorinated and non-chlorinated solvents, asbestos, petroleum hydrocarbons.

The principal source of contamination identified on-site is considered to be its former use as an airfield. However, with the exception of the bulk fuel storage area located along the southern boundary of the site the majority of the comprised the former runways/taxiways and dispersal pads. The main maintenance areas were located off-site to the northwest and southeast of the site, which are now occupied by industrial/residential estates, and a prison.

Furthermore, since the site has not been used as an airfield since the 1980's any contaminants such as de-icers have likely to have to under gone some degree of degradation/dispersion.

With regards to current sources of contamination a section of the former runway in the northern portion of the site is being used by a Haulage Company and as a Highways England storage compound. These premises could not be accessed during the walkover survey to assess whether there were any potentially contaminative activities, but the concrete hard standing from the runway is still present, and would provide some protection to prevent any contamination entering the underlying ground.

The majority of the site is currently used for arable farming, and therefore pesticides are likely to be used on the site. However, the use of pesticides in the UK is regulated, and therefore it is considered current agricultural practices are unlikely to adversely impact the underlying ground as long as best practice is followed.

With regards to off-site sources, the former airfield maintenance areas and hangers are all located off site. These areas are now occupied by industrial estates that include other potentially contaminative activities such as garage services, dry cleaners, waste recycling/treatment and manufacturing. A sewage works and waste recycling centre are also located on the former airfield but outside of the development redline boundary. There is the potential that an accidental releases of contaminants from one of these sources may have impacted the underlying groundwater beneath the site.

3.10.2 Summary of plausible pathways

The plausible pathways are summarised below:

- direct contact (soil, dust and vegetable ingestion, dermal contact, dust and fibre inhalation);
- ground gas (methane and carbon dioxide);
- soil gas inhalation (vapours from hydrocarbons);
- vertical and lateral migration including leaching;
- migration within the underlying groundwater;
- root uptake; and
- chemical attack of infrastructure (including water supply pipes) and buildings.

3.10.3 Sensitive receptors

Sensitive receptors at this site include:

- future site occupants;
- adjacent site users;
- vegetation;
- potable water supply pipes;
- groundwater beneath the site;
- groundwater in wider aquifer body (Principal Chalk Aquifer);
- surface watercourses (River Arundel); and
- building structures.

Please note that construction workers have not been identified in the conceptual model as receptors because risks are considered to be managed through health and safety procedures including CDM regulations.

3.10.4 Potentially complete pollutant linkages

The outline conceptual model is shown schematically in **Figure 5** and an estimate of the risk associated with each linkage is summarised in **Table 5**. The risk classification has been undertaken in accordance with CIRIA C552 (Rudland et al., 2001), a summary of which is included in **Appendix D**.

Table 5: Risk estimation for potentially complete pollutant linkages

Potential Contaminant	Possible pathway	Potential receptor	Likelihood	Severity	Risk and justification
On site sources					
1) Former use of the site as part of military and civilian airfield including workshops in the northern portion of the site and bulk fuel storage facilities along the southern boundary.	Direct contact Inhalation of ground gas soil gas (vapours) Root uptake	Future site users Vegetation	Likely	Medium	Moderate – It is possible for residue contamination to remain on-site especially within areas of the bulk fuel storage facilities. If significant contamination is present then there may a risk to future site users from vapours, but any fuels are likely to have degraded and this is not certain.
	Vertical migration into the underlying groundwater Migration within aquifer	Groundwater Surface water	Low likelihood	Medium	Moderate / Low – There is the possibility that groundwater contamination has occurred in the past, but this is not certain, and any contamination is likely to have degraded over time.
	Vertical migration into the underlying groundwater Inhalation of vapours	Future / adjacent site users	Low likelihood	Medium	Moderate / Low –Groundwater impacted with potentially volatile hydrocarbons may pose a risk to future / adjacent site users via the inhalation of vapours, but this is not certain, and any volatile fractions are likely to have degraded over time.
2) Inert landfill located to the rear of the Grundon Compound	Direct contact	Future site users	Low likelihood	Medium	Moderate / Low – Landfill comprises a heavily vegetated earth mound to rear of the waste treatment facilities, and therefore contact with this material by future site uses is likely to be limited. Furthermore, records indicate that the material contains inert materials that excludes hazardous waste and asbestos.
		Building structures	Likely	Medium	Moderate – An ecological survey indicated the presence of Japanese's Knotweed on the landfill that needs to be isolated and treated to prevent it spreading.
	Inhalation of ground gas	Future site users	Unlikely	Mild	Very low – It is reported that the landfilled material contains non-biodegradable materials. The landfill also comprises an earth mound and therefore any gas would escape into the atmosphere.

Potential Contaminant	Possible pathway	Potential receptor	Likelihood	Severity	Risk and justification
	Root up take	Vegetation	Unlikely	Minor	Very low – The landfilled material was noted to be heavily vegetated and therefore the risk to vegetation is considered to be very low.
	Vertical migration into the underlying groundwater	Groundwater	Unlikely	Medium	Low – Landfilled material is reported to contain inert soils. Any contaminants are unlikely to leachate in concentrations that would pose a risk to the underlying groundwater.
3) Made ground associated with the development of the site and infilling of the former canal. Potential for ground gas associated with the made ground.	Direct contact	Future site users	Likely	Medium	Moderate – There is likely to be made ground across the site associated with the former buildings / structures, and also infilling of the canal. It is unknown whether the made ground contains potentially deleterious materials without further investigation, but it anticipated that the made ground is likely to largely comprise construction type materials.
	Inhalation of ground gas		Low	Medium	Moderate / Low – Unless made ground contains significant quantities of bio-degradable materials then it is considered unlikely that sufficient volumes of ground gas would be generated that would pose a risk to future site users.
	Root up-take	Vegetation	Low	Minor	Very low – There does not appear to be any adverse impact on the agricultural land.
	Vertical migration into the underlying groundwater	Groundwater	Low	Medium	Moderate / Low – Made ground is likely to comprised construction type materials. Contaminants associated with the made ground are not expected to be leachable in significant concentrations.
4) Current use of the site as agricultural land	Direct contact Vertical migration into the underling groundwater	Future site users	Unlikely	Medium	Low – Current use of pesticides is regulated and therefore unlikely to pose risk to the environment is best practice is followed.
5) Haulage company/ highways compound located in the northern portion of the site.	Direct contact Root uptake Vertical migration into underlying groundwater	Future site users Vegetation Groundwater	Likely	Medium	Moderate – These premises were not accessed during the site walkover and therefore it is uncertain if there are any contaminative activities. However, the underlying hard standing would afford some protection to the underlying ground. This source is considered to be a moderate risk until further investigation is carried out.

Potential Contaminant	Possible pathway	Potential receptor	Likelihood	Severity	Risk and justification
Off site sources					
6) Former airfield maintenance areas.	Vertical migration into the underlying groundwater. Lateral migration of groundwater beneath the site. Inhalation of vapours	Groundwater Future site users	Unlikely	Medium	Low – There is the possibility that some residue contamination remains, however with the former maintenance areas have been redeveloped since the airfield was close in 1980. It is likely where houses have been built some assessment with regards to land contamination has been carried out. Also, given the length of time since site has been used as an airfield any contamination is likely to have degraded by now.
7) Existing sewage works, Grundon Waste recycling facilities located on the airfield, and industrial estates surrounding the airfield.	Vertical migration into the underlying groundwater. Lateral migration of groundwater beneath the site. Inhalation of vapours	Groundwater Future site users	Low	Medium	Moderate / Low – There is the possibility of an accidental release of pollutants from one of these sources which may have impacted the underlying groundwater. If hydrocarbons or solvents have been released, then this may pose a risk from vapours. However, this is not a certainty and under normal operation these sources should not be causing pollution.

4 SITE INVESTIGATION METHODOLOGY

RSK carried out intrusive investigation works from the 6th to the 31st August 2018 with subsequent ground gas and groundwater monitoring to confirm the potential linkages identified in the outline conceptual model and to inform geotechnical constraints.

4.1 Sampling strategy and methodology

The techniques adopted for the investigation were chosen considering the anticipated ground conditions, existing land use and the proposed development.

The site works comprised the activities summarised in **Table 6**, along with a justification for each exploratory hole location. The exploratory points were positioned to target potential source of contamination identified with the conceptual site model and also to provide good spatial coverage of the site.

The investigation and the soil descriptions were carried out in general accordance with BS5930: 2015 - Code of Practice for Ground Investigations. The exploratory hole logs and other site work records are presented in **Appendix E**.

Table 6: Exploratory hole and monitoring well location rationale

Investigation Type	Exploratory hole number	Rationale
Boreholes – Cable percussive rig to 20 m depths	BH1 to BH5	To characterise the shallow deep ground conditions for foundation design, and allow installation of groundwater monitoring wells. With regards to contamination sources the boreholes were positioned in the vicinity of, BH1 – the former bulk fuel storage area. BH3 – next to former maintenance area and existing industrial estate located off-site. BH4 – next to the sewage works. The remaining boreholes provide spatial coverage in order to assess groundwater levels, and direction of flow.
Boreholes – drive in sampler to 5 m depths.	WS1 to WS10	To characterise the shallow ground conditions for contamination purposes and allow installation of dedicated ground gas monitoring wells. In-situ testing was also carried out for foundation design. With regards to contamination sources the boreholes were positioned in the vicinity of: WS1 – the former bulk fuel storage area. WS4 and WS8 – next to the former next to former maintenance area and existing industrial estate located off-site. WS8 and WS7 – next to the former infilled canal. WS5, WS6 and WS7 – next to the existing sewage works and Grondon treatment facilities. The remaining boreholes provided spatial coverage of the site.

Investigation Type	Exploratory hole number	Rationale
Trial pits by Mechanical Excavator to 3.0 m depths	TP1 to TP47	To characterise the shallow ground conditions and allow soil sampling for contamination purposes. The following sources were targeted by the trial pits,
	TP1 to TP3, TP8, TP9, TP16 to TP21, TP25, TP27, TP31, TP34 to TP38	Target former RAF buildings and structures located around the periphery of the airfield.
	TP14, TP15, TP35, and TP39 and TP45	Target former infilled canal.
	TP40 to TP42 and TP47	Target inert landfill/earth mound.
Trial pits by Mechanical Excavator to 3.0 m depths	S1 to S9	Trial pits were excavated in order to carry out infiltration tests, and to characterise the shallow soils in these areas.
Concrete coring	CR1 to CR7	Concrete coring was carried out on the runway and taxi way to determine the thickness of the concrete. CBR values of the subbase was carried out using a dynamic cone penetrometer (DCP) at CR5, CR6 and CR7
CBR Determinations using a DCP	WS1D to WS10D	DCP's were carried out next the window sample positions to determine CBR values for infrastructure design.

The locations of the intrusive investigations are shown in **Figure 4**. The investigation location of the exploratory points were surveyed following the completion of the site works using a Leica GPS device.

4.1.1 Health, safety and environment considerations

Prior to carrying out any intrusive works the exploratory points were screened for buried services by a service clearance specialist (EMF detection).

A UXO consultant from Fellows International was present during the site works to clear the borehole positions of UXO using a down-hole probe, and also to provided a watching brief during trial pitting operations.

An ecologist from ECOSA Limited carried out a visual assessment of the former landfill/earth mound before this area was investigated to assess the extent of any Japanese Knotweed contamination. Following the visual assessment four areas were marked out by the ecologist where trial pits could be excavated. Upon completion of the trial pit the spoil was placed back from where it had come from.

4.1.2 Site Investigation Limitations

The limitations of the investigations are as follows,

- Parts of the site such the Highways England Compound and Haulage company premises were being used, and therefore could not be accessed during the investigation.
- When targeting potential sources, the exploratory points were placed in the approximate location using the historic maps and the remaining airfield structures. Some of these may have missed the mark.
- The position of the cable percussive boreholes and drive in sampler (window sample) boreholes were agreed in advance of the site works with the landowner in order to prevent disruption to farm machinery during the harvest. As a consequence, the majority of these borehole were located along the edges of fields.
- A land drain was encountered at exploratory point S6A and therefore a second trial pit was excavated next to this one (S6B) so that the infiltration test would not be affected by the land drain. Also, a concrete slab was encountered at TP31A, and therefore a second pit was excavated approximately 2 m from this position and off the slab in order to characterise the soils in this area.

4.1.3 Soil sampling, in-situ testing and laboratory analysis

Environmental

The sampling strategy was designed to characterise the made ground and natural soils beneath the site to confirm the presence or absence of contamination associated with the identified sources in the outline conceptual site model.

Soil samples taken for environmental laboratory analysis are recorded together with their depths on the exploratory hole records in **Appendix E**. The samples were transported to the laboratory in chilled cool boxes. Laboratory chain of custody forms can be provided if required.

Selected samples were scheduled for laboratory analysis, the rationale for this is presented in **Table 7**.

Table 7: Scheduled environmental analysis – soil

Exploratory hole no. and sample depth (m bgl)	Analytes	Rationale
WS1 0.2 m, 0.8 m, TP1 0.6 m (3 samples in total)	Metals, pH, asbestos screen, PAH Speciated EPA-16, Petroleum Hydrocarbons	Target areas within the vicinity of the former bulk fuel storage area.
TP40 0.1 m, TP40 0.5 m, TP40 1.4 m, TP41 0.3m, TP41 0.7 m, TP41 1.4m, TP42 0.3 m, TP42 0.7 m, TP42 1.4 m, TP47 0.5 m, TP47 1.0 m (11 samples in total)	Metals, pH, asbestos screen, PAH Speciated EPA-16	Target inert landfill / earth mound.

Exploratory hole no. and sample depth (m bgl)	Analytes	Rationale
WS7 0.2 m, TP46 0.5 m, S2 0.5 m, S6B 0.5 m, S7 0.4 m, TP39 0.3 m, TP31 0.5 m, TP35 0.2 m, TP46 0.5 m (8 samples in total)	Metals, pH, TOC, asbestos screen, PAH Speciated EPA-16, petroleum hydrocarbons	Target made ground identified within the exploratory holes, possibly associated with former airfield buildings/structures, and the former landfill. With the exception of possible re-worked natural soils, no made ground was recorded in the trial pits that targeted the former canal.
WS2 0.5 m, WS4 0.4 m, WS5 0.2 m, WS10 0.4 m, WS10 0.9 m, TP4 0.4 m, TP5 0.25 m, TP9 0.25 m, TP9 0.5 m, TP9 1.0 m, TP11 0.1 m, TP12 0.25 m, TP14 0.1 m, TP33 0.5 m, TP36 0.1 m, TP36 0.5 m, TP15 0.3 m, TP17 0.5 m, TP18 0.4 m, TP20 0.2 m, TP22 0.5 m, TP24 0.3 m, TP26 0.4 m, S3 0.2 m, S4 0.4 m, TP38 0.5 m, S6A 0.45 m, S8 0.5 m, TP27 0.2 m, TP29 0.4 m, TP27 0.2 m, TP29 0.4 m, TP30 0.6 m, TP32 0.5 m, TP37 0.3 m, TP33 0.5 m, TP36 0.5 m, S5 0.5 m, TP2 0.4 m, TP7 0.2 m, TP43 0.6 m, TP44 0.5 m, TP45 0.3 m. (43 samples in total)	Metals, pH, TOC, asbestos screen, PAH Speciated EPA-16, Selected samples for Petroleum hydrocarbon screen and Pesticides.	To assess the contamination status of the soils across the remainder of the site. Selected samples were tested for pesticides to determine the risk from the agricultural use of the land.
Notes: Metals = Ar, pb, Cd, Cu, Hg, Cr, Ni, Se, Zn		

The laboratory test certificates are presented in **Appendix F**.

Geotechnical

During the field works standard penetration tests (SPTs) were carried out within the underlying natural deposits at 1.0m intervals within the top 5 m and approximately 1.5 m intervals below 5.0 m, with part 9 of BS 1377:1990 (BSI, 1990). U100 samples were also taken within the cohesive portion of the Superficial Deposits. The results of the in-situ testing are given on the borehole records presented in **Appendix E**, and are summarised within **Section 5** of this report.

Disturbed samples were taken from each stratum encountered for subsequent geotechnical analysis along with the undisturbed U100 samples. A summary of the geotechnical testing carried out is presented in **Table 8**.

Table 8: Scheduled geotechnical analysis

Strata	Geotechnical test	Number of samples
Made Ground	WS sulphate and pH	1
Brickearth/River Terrace Deposits	Atterberg Limits	15
	Particle size distribution (PSD)	4
	Triaxial	4
	WS sulphate and pH	14
Chalk	Saturated moisture content	6
	WS sulphate and pH	4

The laboratory test certificates for the geotechnical testing are presented in **Appendix F2**.

Furthermore, testing was carried out using a dynamic cone penetrometer next to the window sample positions to obtain CBR values of the near surface soils to aid infrastructure design. CBR values were also obtained of the subbase beneath the existing runway by using the DCP through three of the holes corded through the concrete (CR5 to CR7). The DCP results are presented in **Appendix E**.

4.1.4 Groundwater monitoring and levelling

To date, three rounds of monitoring have been carried out in order to collect groundwater samples and carry out gas monitoring, these were on the 29th August, 5th, and 13th September 2018.

Groundwater levels were also recorded using an electronic dip meter. Monthly monitoring of the groundwater levels will continue for a 12 month period to assess seasonal changes. The monitoring results are discussed in **Section 5.1.4**.

4.1.5 Groundwater developing, sampling and analysis

Groundwater samples were retrieved using a United States Environment Protection Agency (USEPA) approved low-flow purging and sampling methodology. The low-flow method relies on moving groundwater through the well screen at approximately the same rate as it flows through the geological formation. This results in a significant reduction in the volume of water extracted before sampling and significantly reduces the amount of disturbance of the water in the monitoring well during purging and sampling. Drawdown levels in the monitoring well and water quality indicator parameters (pH, temperature, electrical conductivity, redox potential and dissolved oxygen) are monitored during low-flow purging and sampling, with stabilisation indicating that purging is complete and sampling can begin. As the flow rate used for purging, in most cases, is the same or only slightly higher than the flow rate used for sampling, and because purging and sampling are conducted as one continuous operation in the field, the process is referred to as low-flow purging and sampling.

In-situ water quality measurements undertaken during the low-flow sampling process are provided in **Appendix G**.

The groundwater samples were collected in a containers appropriate to the anticipated testing suite required. The containers were filled to capacity and placed in a cool box to minimise volatilisation. Samples were transported directly to the testing laboratory under chain of custody documentation. The rationale for groundwater analysis is presented in **Table 9**.

Table 9: Scheduled analysis – groundwater

Exploratory hole	Analyte	Rationale
BH1 to BH6, and WS1	Heavy metals (Ar, pb, Cd, Cu, Hg, Cr, Ni, Se, Zn), PAH's, Volatile Organic Compounds, petroleum hydrocarbon speciate CWG, pesticides, ammoniacal nitrogen as NH ₃ and NH ₄ , hardness, pH, and sulphate.	Suite of potential contaminants associated with the on and off-site sources identified.

The laboratory certificates are presented in **Appendix F1**.

4.1.6 Ground gas monitoring

To assess the risk from ground gas monitoring pipe were installed within the window sample boreholes. A total of three round of ground gas monitoring having been carried out which included a period of falling pressure on the 5th September 2018.

An infrared gas meter was used to measure gas flow, concentrations of carbon dioxide (CO₂), methane (CH₄) and oxygen (O₂) in percentage by volume, while hydrogen sulphide (H₂S) and carbon monoxide (CO) were recorded in parts per million. Initial and steady state concentrations were recorded. In addition, during the first monitoring round, all wells were screened with a PID to establish if there are any interferences and cross-sensitivity of other hydrocarbons with the infrared gas meter.

The atmospheric pressure before and during monitoring, together with the weather conditions, was recorded.

All monitoring results together with the temporal conditions are contained within **Appendix H** and discussed in **Section 5.3**.

4.1.7 In-situ infiltration testing

Soakaway tests were carried out in trial pits S1 to S9 to establish the infiltration rate of the superficial deposits. The tests were carried out in accordance with the method described in BRE Digest 365 (BRE, 2016). This involved filling the pits with water from a tanker and recording the change in water level with time as the water infiltrated into the ground. The data are presented in **Appendix I** including the calculations in accordance with BS 5930 (BSI, 1999).

5 GROUND CONDITIONS

The results of the intrusive investigation and subsequent laboratory analysis undertaken are detailed below. The descriptions of the strata encountered, notes regarding visual or olfactory evidence of contamination, list of samples taken, field observations of soil and groundwater, in-situ testing and details of monitoring well installations are included on the exploratory hole records presented in **Appendix E**.

5.1 Soil

The exploratory holes revealed that ground conditions comprise localised areas of made ground over Brickearth/River Terrace Deposits with the Lewes, Seaford and Newhaven Chalk Formations (Part of the White Chalk Sub Group). This generally confirms the stratigraphical succession described within the initial conceptual model. For the purposes of discussion, the ground conditions are summarised in **Table 10** and the strata discussed in subsequent subsections.

Table 10: General succession of strata encountered

Strata	Exploratory holes encountered	Depth to top of stratum m bgl	Thickness (m)
Made ground	S2, S6A and S6B, S7, TP31A, TP31B, TP35, TP39, TP40 to TP42, TP46, TP47, WS7, BH1	GL	0.4 to 3.0 ¹
Topsoil	All other exploratory points	GL	0.2 to 0.4
'Brickearth' (cohesive)	All exploratory points with exception of TP40 to TP42 and TP47 that targeted the former landfill.	0.2-0.4	0.3 to 4.3
River Terrace Deposits (granular)	S5, S6B, TP1, TP5, TP12 to TP14, TP18, TP20, TP23, TP38, TP44, WS1 to WS3, WS5 to WS8, WS10, BH1, BH6	1.4 to 3.8	0.2 to 1.8
White Chalk Sub Group	S5, S8, S9, TP1, TP7, TP17, TP18, TP22, TP23, TP28, TP29, TP30, TP39, TP43 to TP45, WS1 to WS3, WS5 to WS8, WS10, BH1 to BH6	0.7 to 4.7	17.5 ¹ proven
¹ Basal depth not proven			

5.1.1 Made ground/Topsoil

Made ground was encountered at a number of locations across the site as described below,

- S2, S6A and S6B, TP31A and TP31B, TP39, TP46 and WS7 – Made ground varied from 0.4 m to over 3.0 m at these positions and generally comprises a layer of topsoil over granular or cohesive material with occasional fragment of brick, ash and flint. It is considered the presence of made ground may be associated with former or existing development of the site. A concrete slab was encountered at 0.5 m bgl at TP31A.
- S7 – Made ground was encountered to 1.2 m within this trial pit and comprised sandy gravel with type 1 material, concrete, carbonaceous material and glass. This may be associated with the construction type debris that had been noted to have been deposited in this area during the walkover survey.
- TP35 – A clayey sand was noted beneath the topsoil in this area, and was designated as possibly re-worked as this layer was not consistent with the findings from other exploratory points which recorded a cohesive material within the top metre. This exploratory point was positioned to target the former canal and may be an indication of materials that were re-used to backfill the canal.
- TP40 to TP42 and TP47 – These trial pits targeted the inert landfill located behind the Grondon waste treatment facilities, which comprises a raised earth mound. The made ground comprised both granular and cohesive deposits with varying amount of anthropogenically derived materials including brick, concrete, ash, clinker, plastic, metal nails, wood and cloth.

Topsoil was recorded across the remainder (and majority) of the exploratory points and generally comprised a brown, slightly gravelly sandy CLAY with roots and rootlets.

With regards to visual and olfactory evidence of contamination, a variety of non-biodegradable waste materials including ash and clinker were noted in the landfill. Fragments of ash were also noted within the made ground where present across the other parts of the site.

Core samples

Concrete coring was carried out at seven positions across the former runway (CR1 To CR7). The runway was found to comprise between 0.21 m and 0.25 m of concrete over a granular subbase material comprising bitumen, flint, and chalk. Anecdotal evidence from the landowner indicates that the thickness of concrete varies over different part of the runway.

5.1.2 Brickearth

This stratum was encountered beneath the made ground/topsoil and was found to be variable in consistency and strength comprising a firm to stiff, low to high strength orange brown and grey slightly sandy, slightly gravelly silty CLAY which typically increased in sand content with depth. The top metre of this stratum was noted to be highly friable and desiccated.

Table 11: Summary of in-situ and laboratory test results for Brickearth.

Soil parameters	Range		Reference
Grading (%)	Gravel	3	Appendix F2
	Sand	42	
	Silt	26	
	Clay	29	
Liquid limit (%)	32 to 66 (85*)		
Plastic limit (%)	15 to 21 (31*)		
Plasticity index (%)	15 to 49 (54*)		
Modified plasticity (%)	14 to 49 (51*)		-
Plasticity term	Low to high (locally very high)		Appendix F2
Volume change potential	Low to high		-
Moisture content (%)	11 to 21		Appendix F2
SPT 'N' values	4 to 28		Appendix E
Undrained shear strength (kN/m ²) from shear vane	45 to 99		
Undrained shear strength (kN/m ²) from undrained triaxial tests	50 to 114		Appendix F2
Strength term	Low to high		Appendix E
Consistency term	Firm to stiff		
Water soluble sulphate (WSO ₄) (mg/l)	<10 to 18		Appendix F2
pH value	7.14 to 8.08		

5.1.3 River Terrace Deposits

A gradational boundary between overlying cohesive brickearth deposits and subcropping granular material was reported in a number of locations, whereby cohesive materials increased in their sand content with depth. The underlying granular material comprised largely clayey sand / gravelly clayey sand and has been provisionally characterised as River Terrace Deposits.

No visual or olfactory evidence of contamination was noted within this stratum.

A summary of the in-situ and laboratory test results in this stratum is presented in **Table 12**.

Table 12: Summary of in-situ and laboratory test results for granular River Terrace Deposits.

Soil parameters	Range		Reference
Grading (%)	Gravel	3 to 26	Appendix F2
	Sand	48 to 59	
	Silt	13	
	Clay	13	
	Silt/Clay	21 to 47	
SPT 'N' values	7 to 44		Appendix E
Density term	Loose to dense		
Water soluble sulphate (WSO ₄) (mg/l)	<10		Appendix F2
pH value	8.14 to 8.39		

5.1.4 Chalk

The depth of chalk beneath the site was found to be extremely variable ranging from 0.7 m bgl at TP29 to 4.7m at BH2. The initial layer of comprised highly weathered and structureless chalk composed of gravelly CLAY/SILT, which was underlain by granular material comprising a silty gravel with low to medium density chalk clasts. The chalk was noted to be increasingly competent below 6 m bgl.

No visual or olfactory evidence of contamination was noted within this stratum.

A summary of the in-situ and laboratory test results in this stratum is presented in **Table 13**.

Table 13: Summary of in-situ and laboratory test results for chalk

Soil parameters	Range	Reference
Moisture content (%)	17 to 25	Appendix F2
Saturated moisture content (%)	17 to 25	
Dry density (kN/m ³)	1.60 to 1.84	
Density term	Medium to high	Appendix E
SPT 'N' values	10 to >50	

5.1.5 Groundwater

Groundwater was encountered during the investigation as detailed in **Table 14**.

Table 14: Groundwater results during investigation

Exploratory point	Groundwater strike (m bgl)	Groundwater level (m bgl) 29/8/18	Groundwater level (m AOD) 29/8/18	Groundwater level (m bgl) 5/9/18	Groundwater level (m AOD) 5/9/18	Groundwater level (m bgl) 13/9/18	Groundwater level (m AOD) 13/9/18
WS1	3.2	1.73	3.07	1.88	2.92	1.93	2.87
TP1	2.6						
TP2	3.0						
BH1	7.0	2.15	3.001	2.29	2.861	2.37	2.781
BH2	-	3.13	3.159	3.26	3.029	3.31	2.979
BH3	6.1	4.218	2.888	4.42	2.686	4.57	2.536
BH4	5.5	4.592	1.979	4.74	1.831	4.95	1.621
BH5	4.0	4.78	0.877	4.85	0.807	4.81	0.847
BH6	6.1	5.368	1.473	5.41	1.431	5.52	1.321

The groundwater levels are believed to reflect the water table within the underlying chalk. It should be noted that groundwater levels may fluctuate for a number of reasons including seasonal and tidal variations. Monitoring is currently being carried to establish the changes in groundwater levels over a twelve month period.

5.2 Desiccation assessment

An assessment of the state of desiccation of a soil can be made by comparison of measured moisture contents with those calculated using Driscoll's criteria based on soil index properties. Using Driscoll's criteria the onset of desiccation occurs when the natural moisture content of the soil drops below 50% of its liquid limit, and a soil is considered to be significantly desiccated when the natural moisture content drops below 40% of its liquid limit, or is below the plastic limit plus 2%.

A summary of results of this comparison is presented in **Table 15** below.

Table 15: Comparison of soil water content and soil index properties

Hole Ref.	Depth (m)	Liquid Limit (%)	Plastic Limit (%)	Modified Moisture (%)	Liquid Limit $\times 0.5$	Liquid Limit $\times 0.4$	Inference of desiccation
TP12	1	38	17	14	19	15.2	Significant
TP12	2	36	17	14	18	14.4	Significant
TP34	0.5	40	17	17	20	16	Onset
TP34	1.5	30	15	15	15	12	N/A

Hole Ref.	Depth (m)	Liquid Limit (%)	Plastic Limit (%)	Modified Moisture (%)	Liquid Limit x 0.5	Liquid Limit x 0.4	Inference of desiccation
WS2	0.5	33	18	11	16.5	13.2	Significant
WS9	0.4	32	17	15	16	12.8	Onset
WS9	2.3	35	15	19	17.5	14	N/A
BH2	1	42	19	16	21	16.8	Significant
BH2	2	66	17	20	33	26.4	Significant
BH3	2	42	21	21	21	16.8	Onset
BH4	1.2	66	17	21	33	26.4	Significant
BH6	0.5	85	31	17	42.5	34	Significant
BH6	1.2	41	16	16	20.5	16.4	Significant
TP14	2	42	25	24	21	16.8	N/A
TP36	1	35	17	17	17.5	14	Onset

The exploratory level assessment has inferred the onset of desiccation within a number of the samples tested. Significant desiccation was inferred within the samples recovered from a depth of 0.5 m to 2.0 m in TP12, WS2, BH2, BH4 and BH6.

5.3 Ground gas regime

The results of the ground gas monitoring and testing carried out are given in **Appendix H**. The minimum and maximum results are recorded in **Table 16**.

Table 16: Summary of ground gas monitoring results

Borehole	Response zone/strata	Number of monitoring visits	Max Methane (%)	Max Carbon dioxide (%)	Min Oxygen (%)	Steady state Flow rate (l/hr)	Water level (m b TOC)	Atmospheric pressure (mbar)
WS1	BR	3	<0.1	1.2 – 1.5	18.8-18.9	0-0.1	1.73-1.93	1014- 1022
WS2	BR/C H	3	<0.1-0.2	0.7-2.0	18.4-19.2	-0.2-0	Dry	1014-1022
WS3	BR	3	<0.1	1.9-2.0	18.4-18.7	0	Dry	1014-1022
WS4	BR/C H	3	<0.1	1.4-2.2	17.8-18.5	0	Dry	1014-1022

Borehole	Response zone/strata	Number of monitoring visits	Max Methane (%)	Max Carbon dioxide (%)	Min Oxygen (%)	Steady state Flow rate (l/hr)	Water level (m b TOC)	Atmospheric pressure (mbar)
WS5	BR	3	<0.1	1.5-3.4	15.8-18.6	0	Dry	1014-1023
WS6	BR	3	<0.1-0.1	1.1-1.4	18.7-19.3	0	Dry	1014-1023
WS7	BR/C H	3	<0.1	2.3-2.7	18.4-18.9	0	Dry	1014-1023
WS8	BR	3	<0.1	5.6-7.1	13.4-15.5	-0.1-0	Dry	1014-1023
WS9	BR	3	<0.1	4.2-4.5	14.9-15.3	0-0.1	Dry	1014-1023
WS10	BR	3	<0.1	1.0-1.6	18.8-19.6	0	Dry	1014-1023
BH1	CH	3	<0.1	0.3-0.5	19.6-19.8	-0.2-0	2.15- 2.37	1014-1021
BH2	CH	3	<0.1	0.3-18	18.7-19.8	0	3.1- 3.31	1014-1022
BH3	CH	3	<0.1	0.7-3.8	15.5-20.0	0-0.1	4.2- 4.57	1014-1022
BH4	CH	3	<0.1	0.7-1.1	19.3-20.0	0	4.5- 4.95	1014-1022
BH5	CH	3	<0.1	0.5-2.0	18.9-19.9	-0.1-0	4.78- 4.9	1014-1022
BH6	CH	3	<0.1	0.6-1.4	15.9-17.4	0-0.1	5.36- 5.52	1014=1023
BR=Brickearth, CH=Chalk								

The results of the ground gas monitoring show that low concentrations of both methane and carbon dioxide have been recorded on the site with low flow rates, which are typical of natural carbonate soils.

5.4 Refinement of the initial conceptual site model

The findings of the intrusive works indicate that made ground is present locally across the site, but with the exception of the existing landfill there was little evidence of potential contamination associated with the sites former use as an airfield or current land uses. Furthermore, there was no evidence to suggested that the canal had been infilled with waste materials.

With regards to the landfill, this comprised a raised earth mound to the rear of the Grundon waste treatment facility. The trial pits excavated into the mound confirmed that the waste materials are deposited are largely inert construction type wastes. However, it

must be noted that the presence of Japanese Knotweed has been identified on this mound which would need to be treated by a specialist to ensure that it does not impact on the proposed development.

Chemical testing of the soils and groundwater have been carried out to in order to further test the outline conceptual site model with regards to on-site and off-site sources, the findings of which are reported in the next section.

Potential sources of ground gas identified on-site include the presence of made ground, and the inert landfill. However, given that there was no evidence of potentially bio-degradable materials within the made ground/waste materials it is considered that the potential for ground gas generation is low. Carbonate soils such as chalk may also generate ground gas, but these are defined in the British Standard BS8576:2013 as having a very low ground gas generation potential. Low concentrations of ground gas were recorded during the monitoring which provides further evidence of low ground gas regime typical of carbonate soils. The risk from ground gas is further discussed in **Section 6.2.6**.

6 QUANTITATIVE RISK ASSESSMENT

In line with CLR11 (EA, 2004), there are two stages of quantitative risk assessment, generic and detailed. The GQRA comprises the comparison of soil, groundwater, soil gas and ground gas results with generic assessment criteria (GAC) that are appropriate to the linkage being assessed. This comparison can be undertaken directly against the laboratory results or following statistical analysis depending upon the sampling procedure that was adopted.

6.1 Linkages for assessment

Section 5.3 presents the refined conceptual model which identified the linkages that required assessment after the findings of the site investigation had been considered. These linkages together with the method of assessment are presented in **Table 17**.

Table 17: Linkages for generic quantitative risk assessment

Potentially relevant pollutant linkage	Assessment method
1. Direct contact with impacted soil by future residents.	Human health GAC in Appendix J for a proposed residential end use with private gardens since proposed end use includes residential gardens. Due to the limited number of exceedances against the GACs no statistical assessment has been carried out.
2. Uptake of contaminants by vegetation potentially impacting plant growth.	Comparison of soil data to GAC in Appendix K .
3. Contaminants permeating potable water supply pipes.	Comparison of soil data to GAC in Appendix L for plastic water supply pipes using UKWIR (2010) guidance.
4. Leaching of soil contaminants into the underlying principal chalk aquifer.	Qualitative assessment based on the soil results.
5. Leaching of contaminants from unidentified on-site sources and off-site sources into the underlying groundwater. Lateral migration within the groundwater.	The site is not located within a source protection zone for a groundwater abstraction borehole, and therefore the nearest identified receptor is the River Arundel located approximately 450 m to the east of the site. As the River Arundel the groundwater results have been screened against environmental water quality standards (EQS) for transitional estuaries and coastal waters presented in Appendix M . Where these are not available for ammonia or these have been compared against the EQS values for a freshwater environment.

Potentially relevant pollutant linkage	Assessment method
6. Concentrations of methane and carbon dioxide in ground gas entering and accumulating in: Depressions and excavations that could affect workers. Enclosed spaces or small rooms in new buildings, which could affect future residents. In the case of methane this could create a potentially explosive atmosphere, while death by asphyxiation could result from carbon dioxide.	The risk from ground gas has been assessed using by various lines of evidence to develop the conceptual site model as required by CIRIA report C665 and BS8576.

6.2 Methodology and results

The methodology and results of the GQRA are presented for each relevant pollutant linkage in turn.

6.2.1 Direct contact with impacted soil by future residents

Exceedances against the GAC's are summaries in the **Table 18**, below.

Table 18: Data summary table

Determinant	No. of samples tested	GAC (mg/kg)	No of exceedances	Exceedances above the GAC	
				Value (mg/kg)	Location / depth
Lead	58	200	1	410	TP39 0.3 m
PAH: Benzo-a-pyrene	58	5	2	5.87	TP39 0.3 m
				5.22	TP42 0.3 m
PAH: Benzo(b)fluoranthene	58	2.6	4	5.98	TP39 0.3 m
				3.65	TP41 1.4 m
				5.49	TP42 0.3 m
				4.04	S6B 0.5 m
PAH: Dibenzo(ah)anthracene	58	4	0.24	0.6	TP39 0.3 m
				0.39	TP41 1.4 m
				0.61	TP42 0.3 m
				0.33	S6B 0.5 m
Asbestos	56	None detect	2	Chrysotile Fibres	TP41 1.4 m
				Amosite Fibres	TP47 1.0 m

The results of the soil testing identified elevated concentrations of PAH's above the adopted GAC's, as well as the presence of asbestos fibres within the inert landfill material (TP41, TP42 and TP47). Further quantification testing for asbestos indicated that the concentration of asbestos was below 0.001% in both samples that tested positive. Given that the waste material is confined to a heavily vegetated raised earth embankment it is considered that the potential for exposure to this material by future site users is likely to be limited, and therefore the risk is considered to be low. Simple remedial techniques such as fencing off the area or using a capping layer are likely to be adequate to address the issue, but this will need to be assessed once the layout of the development is known.

Exceedances against the GAC's were only recorded at two exploratory points located outside of the landfill. Lead and PAH's were detected above their respective GAC's at TP39, and PAH's at S6B. It is considered that the exceedances may be attributable to the fragments of ash noted in the shallow made ground at these positions. The concentrations of PAHs at both exploratory points were only marginally above the GACs, and are therefore not considered to pose a risk to future site users. Further assessment of with regards to the lead should be undertaken once further details of the proposed development become available.

None of the other samples tested from the made ground or elsewhere on the site recorded elevated concentrations of potential contaminants including petroleum hydrocarbons and pesticides. This ties in with the observations made during the ground works, and suggests that the majority of the site is free from contamination.

It must also be noted that as no potentially volatile contamination such as petroleum hydrocarbons was identified in the soil, it is considered that there is no risk from the inhalation of vapours.

6.2.2 Uptake of contaminants by vegetation potentially inhibiting plant growth

The results have been compared with the GAC presented in **Appendix K** for this linkage (pH above 7). The assessment shows that the concentrations of lead at TP39 (410mg/kg) was recorded above the GAC for of 300mg/kg at TP39. No other exceedances were recorded and as the site is predominate used for agricultural purposes it is considered that this linkage does not exist.

6.2.3 Impact of organic contaminants on potable water supply pipes

For initial assessment purposes, the results of the investigation have been compared with the GAC presented in **Appendix L** for this linkage, which are reproduced from *UKWIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (UKWIR, 2010).

The results indicate that a relevant linkage is unlikely to exist associated with organic contaminants and therefore pollutant polyethylene (PE) and/or polyvinyl chloride (PVC) water supply pipes are expected to be suitable for use on the development.

It should be noted that at the time of this investigation the future routes of water supply pipes had not been established, hence the investigation and sampling strategy may not be fully compliant with UKWIR recommendations. Consequently, a targeted investigation

and specific sampling/analytical strategy may be required at a later date once the route(s) of the supply pipe(s) are known. In addition, it is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements for assessment, which may not necessarily be the same as those recommended by UKWIR.

6.2.4 Leaching of contaminants from the soils in to the underlying principal aquifer

Based on the soil results, no significantly elevated concentrations of contaminants were recorded that are likely to leach in sufficient concentrations to impact the underlying groundwater.

6.2.5 Leaching of unidentified on-site sources and off-site sources into the underlying aquifer. Lateral migration of groundwater beneath the site.

A comparison of the water results against the adopted EQS values recorded two exceedances,

- The concentration of mercury at BH6 was 0.2 µg/l against a EQS value of 0.007 µg/l.
- The concentration of fluoranthene at BH4 was 0.03 µg/l against a EQS value of 0.0063 µg/l.

Both EQS values for these determinants are conservative as they are based on the annual average of a particular contaminants recorded within a surface water. It is considered that concentrations recorded in the groundwater beneath the site are low and following dilution within the aquifer that these concentrations would not cause any adverse impact to the surface water. No elevated concentrations of contaminants were recorded at BH5 located hydraulically down-gradient of the other boreholes (see below).

The results of results did not record any other exceedances against the EQS values. Both the concentrations of petroleum hydrocarbon, volatile organic compounds and pesticides were below the detection limit. This indicates that no on or off-site source appears to be impacting the underlying groundwater.

Groundwater contour plots have been generated (see **Appendix N**) using the information from the first three rounds of monitoring carried out to determine the direction of groundwater flow beneath the site. The direction may be skewed by the positioning of some of the borehole, but the plots generally indicate that the groundwater is flowing in an easterly direction towards BH5, and the River Arundel.

6.2.6 Ground gas assessment

A lines of evidence approach has been used to characterise the risk from ground gas, which is presented below.

- The outline conceptual site model identified two potential sources of contamination associated with the former use of the site, these were the inert landfill, and made ground associated with former structures/infilled canal. However, it is considered that the landfill can be discounted as the waste materials are located above ground and therefore any gas generated (which is likely to be negligible as the mound comprises inert materials) would not impact any properties.

- With regards to the made ground across the remainder of the site, in generally only a superficial layer was recorded which did not contain any potentially bio-degradable materials. Furthermore, the soil results show that concentrations of organic matter in the shallow are typically below 5%. Made ground with low concentrations of organic matter (below 5%) are classified as having a very low ground gas generation potential within British Standard 8576:2013.
- The underlying natural chalk is also considered to be a potential source of ground gas, but is characterised by very low rates of ground gas generation as indicated in BS8576:2013.
- The results of the ground gas monitoring recorded low concentrations of methane of up to 0.2% v/v, and carbon dioxide of up to 7.1% v/v with negligible flow rates ranging from -0.2 to 0.1 l/h. Using the methodology set out in C665 to calculate the gas screening value for low rise residential properties (Situation B), the site would be classified as Green where by no special gas protection measures are required.
- The guidance indicates that consideration should be given to increasing the risk level if the concentrations of carbon dioxide are typically above 5% v/v. The concentrations of carbon dioxide only exceed 5% v/v at WS8 during the three monitoring rounds. The concentrations at the borehole considered to be within the range expected from a carbonate soils, and not believed to be linked to a nearby source given the surrounding cohesive soils (which would restrict the movement of ground gas) and low flow rates. Therefore, it is considered that the risk level should not be increased.

Based on the above lines of evidence it is considered that no viable source of ground gas has been identified on the site which would impact on the proposed development, and therefore no ground gas protection measures are deemed necessary. As no source has been identified it is also believed that the worst case scenario is likely to have been realised and no further monitoring is required at this stage.

However, this investigation was exploratory in nature and additional more detail investigation should be carried out to fully characterise the site. If potential sources are identified during these works then further assessment should be carried out.

7 GEOTECHNICAL SITE ASSESSMENT

7.1 Engineering considerations

It is understood that the proposed development is to involve a number of different land uses comprising the construction of approximately 1500 residential properties of low-rise design, new retail, commercial and community facilities, a library and new healthcare facilities as well as education provision in the form of two new schools. At this stage no specific information relating to building loads has been provided.

7.2 Geotechnical hazards

A summary of commonly occurring geotechnical hazards is given in **Table 19** together with an assessment of whether the site may be affected by each of the stated hazards.

Table 19: Summary of main potential geotechnical hazards that may affect site

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
Sudden lateral changes in ground conditions	✓	Laterally discontinuous Made Ground found to be present on site. Undulating surface of chalk bedrock.		Likely to affect ground engineering and foundation design and construction
Shrinkable clay soils	✓	Cohesive 'Brickearth' exhibits largely low to intermediate plasticity characteristics, however, there are locally very high plasticity soils noted. Volume change potential ranges from low to high.		Design to NHBC Standards Chapter 4 or similar
Highly compressible and low bearing capacity soils, (including peat and soft clay)		✓		Likely to affect ground engineering and foundation design and construction
Silt-rich soils susceptible to rapid loss of strength in wet conditions	✓	Brickearth and Chalk deposits silt rich – may be prone to collapse/solution upon wetting.		Likely to affect ground engineering and foundation design and construction
Running sand at and below water table	✓	Groundwater table recorded within granular soils.		Likely to affect ground engineering and foundation design and construction
Karstic dissolution features (including 'swallow holes' in Chalk terrain)		✓ Potentially exist but not encountered.		May affect ground engineering and foundation design and construction – refer to Section 4.1.2

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
Evaporite dissolution features and/or subsidence			✓	May affect ground engineering and foundation design and construction
Ground subject to or at risk from landslides			✓	Likely to require special stabilisation measures
Ground subject to peri- glacial valley cambering with gulls possibly present			✓	Likely to affect ground engineering and foundation design and construction
Ground subject to or at risk from coastal or river erosion			✓	Likely to require special protection/stabilisation measures
High groundwater table (including waterlogged ground)	✓	Shallow groundwater reported locally beneath site (principally towards the south)		May affect temporary and permanent works
Rising groundwater table due to diminishing abstraction in urban area			✓	May affect deep foundations, basements and tunnels
Underground mining			✓	Likely to require special stabilisation measures
Existing sub-structures (e.g. tunnels, foundations, basements, and adjacent sub- structures)	✓	Concrete slab encountered @ 0.50 m bgl (TP31). Site comprises former airbase with removal of former structures documented on historic mapping. Presence of subsurface infrastructure likely.		Likely to affect ground engineering and foundation design and construction
Filled and made ground (including embankments, infilled ponds and quarries)	✓	Localised Made Ground deposits present on site. Historic canal route traversed site – likely backfilled with unknown materials.		Likely to affect ground engineering and foundation design and construction
Adverse ground chemistry (including expansive slags and weathering of sulphides to sulphates)			✓ (See Section 7.3.7)	May affect ground engineering and foundation design and construction
Note: Seismicity is not included in the above table as this is not normally a design consideration in the UK.				

7.3 Foundations

7.3.1 General suitability

The ground conditions at the site typically comprise a slightly variable ground profile, generally consisting either a surface of topsoil/made ground (locally significant in places >3.0 m within TP46), overlying a thickness of firm to stiff, low to high strength, sandy slightly gravelly silty clay (Brickearth) with a gradational increase in sand content generally recorded towards the stratum base. Predominantly granular materials, inferred as River Terrace Deposits, were encountered subcropping beneath cohesive 'Brickearth' between the depths of 1.4 m to 3.8 m. These materials were variable in density, reported as loose clayey sands in some areas, whilst medium dense to dense gravelly sands were encountered at some exploratory locations. The underlying chalk bedrock surface was encountered at variable depths, reported between 0.7 m within TP29 in the north of the site, deepening to 4.7 m within BH1 at the sites southern limit. This stratum was composed of an upper weathered surface of the White Chalk Subgroup recovered as a structureless gravelly silt/clay, grading into a clast supported material.

Traditional spread foundations constructed within the superficial soils are considered technically feasible to support lightly loaded low-rise residential structures at the site. Based on the exploratory level desiccation assessment undertaken to date it is likely that some spread foundations bearing within shrinkable cohesive soils will need to be assessed and designed in accordance with NHBC standards. This will be particularly prevalent for proposed structures in vicinity to existing trees and hedgerows which are to be retained within the development. It is recommended that a detailed tree survey be undertaken in order to facilitate the production of a foundation zoning plan to refine foundation design, once finalised layouts have been confirmed.

For structures of higher loadings, the adoption of piled foundations end bearing within the underlying White Chalk Subgroup, may provide the most suitable option for which preliminary advice is provided in the sections below.

7.3.2 Spread foundations

The recommendations for the design and construction of spread foundations in relation to the ground conditions are set out in **Table 20**.

Table 20: Design and construction of spread foundations

Design/construction considerations	Design/construction recommendations
Founding stratum	'Brickearth'
Depth	Foundations should be taken to a minimum depth of 1.0 m below the final or existing ground level, whichever is lower, and at least 0.1 m into the founding stratum below any overlying made ground or to any greater depth required in respect of the special design considerations given below.

Design/construction considerations	Design/construction recommendations
Special design considerations	Owing to the presence of locally present shrinkable clay soils, foundations should be designed taking into account all the normal precautions, including minimum founding depths, to minimise the risk of future foundation movements in accordance with NHBC standards or similar. Mature trees and hedgerows have been identified on the site. Should proposed structures be located within a zone of tree influence, localised deepening of foundations to accommodate ground movements may be a requirement. The findings of the ground investigation indicate that foundations should be designed for shrinkable soils of a worse case high volume change potential, despite the highest proportion of the tests results indicating primarily low to medium volume change potential across the site.
Bearing capacity	<u>Strip Foundations</u> Strip foundations with a width of up to 1.0 m and constructed on the medium to high strength cohesive soils at a minimum depth of 1.0 m may be designed using a net allowable bearing pressure of 85 kN/m². <u>Pad Foundations</u> Pad foundations with a width of up to 2.0 m and constructed in the medium to high strength clay at a depth of 1.0 m may be designed using a net allowable bearing pressure of 100 kN/m².
Factor of safety	The allowable bearing capacity includes an overall safety factor of 3 against bearing capacity failure and with total settlements associated with the bearing pressure estimated to be less than 25 mm .
Stability of excavations	Generally, the trial pits remained stable during excavation which indicates that foundation excavations should also remain stable in the short term. In the event that excavations are to remain open for longer periods, consideration should be given to the use of trench support systems.
Dewatering	Groundwater was generally not encountered during the excavation of trial pits. However, post site investigation monitoring has indicated groundwater levels in the region of 1.7 m below ground surface (towards the south). The cohesive nature of the upper ground profile (i.e. bearing stratum) encountered suggests that pumping from open sumps should be sufficient to keep the excavations reasonably dry in the event of any seepages/water accumulation.
Construction considerations	All foundation excavations should be inspected, and any made ground and soft, organic or otherwise unsuitable materials removed and replaced with mass concrete. The proposed founding stratum is a relatively silt-rich soil, hence susceptible to rapid softening once exposed. All foundation excavations should immediately be blinded with concrete or the full foundation constructed.

7.3.3 Piled foundations

Recommendations for the design and construction of piled foundations in relation to the ground conditions are set out in **Table 21**.

Table 21: Design and construction of piled foundations

Design/construction considerations	Design/construction recommendations	
Pile type	The construction of both bored and driven piles is considered technically feasible at this site.	
Possible constraints on choice of pile type	Given the close proximity of the site to residential areas it is considered possible that the vibration/noise associated with pile driving may not be acceptable.	
Temporary casing	Given the presence of groundwater strikes recorded within the ground profile, bored piles will require temporary casing throughout their depth. Alternatively, the use of continuous-flight-auger (CFA) injected bored piles or driven piles usually overcomes this issue.	
Soft superficial deposits	For the purpose of assessing preliminary pile capacities any made ground should be presumed not to contribute to the load-carrying capacity for the piles.	
Man-made obstructions	The presence of buried sub-structures or other obstructions within made ground associated with the sites former use may lead to some difficulty during piling. The majority of the shallow obstructions are likely to be removed during the demolition process. However, it may be prudent that once proposed pile layouts have been determined, to allow for pre-pile probing to be carried out within areas of former development. Where buried obstructions are encountered, it will be necessary to either relocate the pile(s) or make allowance for removing the obstruction.	
Hard strata	An allowance should be considered for the presence of hard flint bands within the White Chalk.	
Pile design parameters for Brickearth	Undrained shear strength, c_u (kN/m ²)	50
	Adhesion factor, α	0.5
Pile design parameters for Kempton Park Gravel	Shaft Friction Factor ($k_s \cdot \tan \delta$)	0.22
	Average limiting shaft friction (kN/m ²)	110
Pile design parameters for White Chalk Subgroup	Shaft Resistance (τ_{sf})	0.45 σ_v' for SPT 'N' < 10 0.8 σ_v' for SPT 'N' > 10
	Base Resistance	Q = 200N, limited to: Q _{all} = 600 to 800 kN/m ² for SPT 'N' < 25 Q _{all} = 1000 to 1800 kN/m ² for SPT 'N' > 25

Design/construction considerations	Design/construction recommendations	
General parameters	Limiting concrete stress (kN/m ²)	7.5 N/mm ²
	Limiting shaft friction stress	110 kN/m ²
	Global margin of safety	2.5
Special precautions relating to bored pile shafts and bases	Bored pile concrete should be cast as soon after completion of boring as possible and in any event the same day as boring. Prior to casting the base of the pile bore should be clean, otherwise a reduced safe working load will be required. Similarly, if the pile bore is left open the shaft walls may relax/soften, leading to a reduced safe working load.	

The design procedure for piles varies considerably, depending on the proposed type of pile. However, for illustrative purposes **Table 22** gives likely working pile loads for CFA piles of various diameters and lengths, based on the design parameters given in **Table 21**. For this purpose, the soil profile in BH1 has been considered.

Table 22: Illustration of typical pile working loads for bored cast-in-situ piles

Depth of pile below existing ground level (m)	Typical pile working loads (kN)		
	Pile diameter		
	300mm	350mm	450mm
12	230	276	376
14	299	357	480
16	368	437	584
18	437	518	687
20	506	599	791

It should be stressed that the above capacities do not take into consideration pile group effects which is more pronounced for a large number of closely spaced piles.

Notwithstanding the above, we recommend that a specialist piling contractor be contacted at an early stage for their advice on the most suitable pile type and capacity for the soils encountered at this site.

7.3.4 Foundation works risk assessment

It is not anticipated that a foundation works risk assessment report will be required for the development given the absence of significant contamination within the subsurface across the majority of the site.

7.3.5 Floor slabs

Given the cohesive nature of the upper soil profile and the variable thickness of made ground across the site it is recommended that ground floor slabs for residential structures be suspended. Floor slabs should be designed in accordance with NHBC guidelines (Chapter 5.2, 'suspended ground floors') assuming a worse case high shrinkage potential soils.

Ground bearing floor slabs for any commercial structures may be appropriate assuming a California bearing ratio (CBR) of 3% for design purposes. Careful examination and rolling of the formation, and replacement of exceptionally hard and soft material with well compacted, suitable granular fill will be necessary.

7.3.6 Roads, hardstanding and drainage

In the 1.0 m to 1.5 m below the proposed finished ground level the exploratory holes have revealed a soil profile comprising a surface of topsoil underlain by cohesive ground conditions of generally firm to stiff sandy silty slightly gravelly clay. Some areas of localised made ground were also identified associated with former infrastructure, whilst historical mapping has indicated the presence of a canal (now infilled) which historically bisected the site.

In pavement design terms, the groundwater conditions are anticipated to comprise a low water table, i.e. at least 1 m below the pavement formation level.

In-situ CBR testing by dynamic cone penetrometer (DCP) was undertaken along the line of an existing area of hardstanding, formerly a section of runway to the historic airfield towards the south west (through concrete cored locations), for the purposes of assessing suitability for reuse within the development. Additional DCP testing was undertaken across the remainder of the site in order to provide general coverage of the upper ground profile for CBR value determination. The results of in-situ testing indicate that the near surface soils have a CBR value that ranges between 3% and >15%. The results are summarised in **Table 23**.

Table 23: Summary of CBR values derived from in-situ DCP tests

Test location		Material type	Minimum CBR value determined at or just below anticipated formation level
Core DCP	Core 4	Unknown (assumed sandy clay)	>15% at ~500 mm
	Core 5		>15% at ~600 mm
	Core 6		>15% at ~400 mm
	Core 7		>10% at ~500 mm
WS DCP	WS02	Firm to stiff slightly gravelly sandy clay	>10% from ~150 mm, 5% at ~400 mm, > 15% at ~400 mm
	WS03		>4% from 100 mm, >15% at ~200 mm
	WS04		>3% from 200 mm, > 15% at ~250 mm
	WS05		>15% at ~100 mm
	WS06		>15% at ~150 mm

Test location		Material type	Minimum CBR value determined at or just below anticipated formation level
	WS07		>6% from ~100 mm, >15% at 250 mm
	WS08		>8% from ~120 mm, >15% at 150 mm
	WS09		>10% at ~200 mm
	WS10		>7% from ~100 mm, >15% at 170 mm

The recommended sub-grade soil CBR value for road pavement design is therefore 3%. This value assumes that during construction the formation level will be inspected, and should soft spots be identified, these be removed and replaced with well-compacted granular fill. Following this, the formation level should be compacted throughout. A non-vibratory roller is recommended for cohesive subgrade.

The cohesive sub-grade soils can be regarded as being frost susceptible based upon the criteria given in Appendix 1 of TRRL (1970) Report Road Note 29. When the sub-grade is frost-susceptible the thickness of sub-base must be sufficient to give a total thickness of non-frost-susceptible pavement construction over the soil of not less than 450 mm.

7.3.7 Chemical attack on buried concrete

This assessment of the potential for chemical attack on buried concrete at the site is based on *BRE Special Digest 1: Concrete in aggressive ground*, which represents the most up-to-date guidance on this topic currently available in the UK.

Based upon the information obtained through the desk study and subsequent site investigation, the site should be considered as brownfield development whilst the natural underlying ground conditions are not anticipated to contain pyrite.

The results of the chemical tests carried out on soils samples on site indicate characteristic 2:1 water soil extract sulphate contents below 10 mg/l within made ground, 18 mg/l within cohesive dominant strata of the 'Brickearth', whilst 47 mg/l was reported within the chalk bedrock with generally slightly alkaline pH values recorded.

These results indicate that, in accordance with current BRE guidance, the Aggressive Chemical Environment for Concrete (ACEC) classification for the site is AC-1 with a Design Sulphate Class for the site of DS-1. This assumes nominally mobile groundwater conditions.

7.3.8 Soakaways

Soakage testing was carried out in general accordance with BRE 365 across nine trial pits, designated S1 to S9. The tests were generally carried out over a 24 hours period, allowing for repeat tests to be undertaken at a number of locations.

In general, infiltration characteristics across the site were found to be poor with the lack of permeability within the upper cohesive ground conditions rendering some infiltration rates incalculable. Where infiltration was observed across the test period, infiltration rates ranging 2.29E-06 m/s (S1) to 4.76E-06 m/s (S5) – i.e. upper bound of poor drainage characteristics.

The results of the infiltration tests are presented in **Appendix I**.

The results indicate that pit soakaways may technically be feasible in areas where greater infiltration has been observed however, depending upon the surface area to be drained, attenuation is likely to be required.

Whilst groundwater was generally encountered between approximately 3 m and 7 m below ground surface during the investigation, subsequent monitoring indicates resting groundwater levels to be potentially shallower, particularly towards the south of the site (1.73 m bgl/ WS01). Careful consideration must therefore be given to the location and design of any soakaways to ensure that their bases are terminated above the unsaturated zone.

In addition to pit soakaways, consideration should also be given to the adoption of swales and/or permeable paving.

Owing to the risk of soakaways triggering instability in infilled chalk dissolution features or causing new dissolution, no soakaway should be located within ideally 10 m of any building, structure or highway, and certainly no closer than 5 m.

The EA should be contacted at the design stage in order to obtain a 'consent to discharge'. This may not be forthcoming where soakage will be into or just above the water table, particularly in the Agency's sensitive aquifer protection zones. In addition, planning approval will have to be sought for their use.

8 REUSE OF MATERIALS AND WASTE

8.1 Reuse of suitable materials

Under the Waste Framework Directive, naturally occurring soils are not considered waste if reused on the site of origin for the purposes of development.

In accordance with the definition provided in the Waste Framework Directive, materials are only considered waste if 'they are discarded, intended to be discarded or required to be discarded, by the holder'. Thus, soils that are not of clean and natural origin, i.e. made ground (whether contaminated or not) and other materials such as recycled aggregate, do not become waste until the aforementioned criteria are met.

The Definition of Waste: Development Industry Code of Practice (CL:AIRE, 2011) (CoP) was developed in consultation with the Environment Agency and development industry to enable the re-use of materials under certain scenarios and subject to demonstrating that specific criteria are met. The current reuse scenarios covered by the CoP comprise

- reuse on the site of origin (with or without treatment)
- direct transfer of clean and natural soils between sites
- use in the development of land other than the site of origin following treatment at an authorised Hub site (including a fixed soil treatment facility).

The importation of made ground soils (irrespective of contamination status) or crushed demolition materials is not permitted currently under the CoP and requires either a standard rules environmental permit or a U1 waste exemption (see below).

In the context of excavated materials used on sites undergoing development, four factors are considered to be of particular relevance in determining if the material is a waste or when it ceases to be waste:

- the aim of the Waste Framework Directive is not undermined, i.e. if the use of the material will create an unacceptable risk of pollution of the environment or harm to human health it is likely to be waste
- the material is certain to be used
- the material is suitable for use both chemically and geotechnically
- only the required quantity of material will be used.

The CoP requires the preparation of a materials management plan (MMP) that confirms the above factors will be met. This plan needs to be reviewed by a 'Qualified Person' (QP) who will then issue a declaration form to the EA. As the project progresses, data must be collated and on completion a verification report produced that shows the MMP was followed and describes any changes.

The MMP establishes whether specific materials are classified as waste and how excavated materials will be treated and/or reused in line with the CoP. The MMP is likely to form part of the site waste management plan.

The site has been developed previously and the investigation has confirmed the presence of made ground. Therefore, before any excavation works begin on-site, an MMP will need to be prepared, reviewed by a QP; and a Declaration lodged with the EA.

As noted above, under the Waste Framework Directive naturally occurring soils are not considered waste and therefore arisings of clean natural soils, e.g. from foundation and drainage excavations, may be reused on the site. However, it is important that these soils should be stockpiled separately and not become cross-contaminated with made ground/contaminated soils or construction wastes.

If it were proposed to import clean and naturally occurring soils direct from another site, the receiving site's MMP would need to be updated in advance of importation.

8.2 Treatment to meet suitable-for-use criteria

Where materials do not meet the suitable for use criteria, it may be possible to treat them under an environmental permit (mobile treatment licence) to enable them to be reused on-site.

To enable the treatment options to be determined, an options appraisal and a remediation strategy document will be necessary to support discussion of the issues with regulators and third parties.

8.3 Reuse of waste materials

If material is discarded as waste then its reuse on site may still be possible. Waste soils and recycled aggregate can be reused on site under a standard rules environmental permit or a U1 waste exemption from the Environmental Permitting (England and Wales) Regulations 2010 provided that they are suitable for the proposed use, i.e. not cause harm to human health or the environment. However, it should be noted that these have strict limits on the quantity of material that can be reused.

8.4 Wastes for landfill disposal

Wastes require pre-treatment prior to disposal at landfill. Pre-treatment must be a physical, thermal, chemical or biological process (including sorting) that changes the characteristics of the waste to reduce its volume, reduce its hazardous nature, facilitate its handling and enhance its recovery.

The latest edition of the EA's 'Technical Guidance WM3' (2018), Guidance on the classification and assessment of waste, requires that within a mixed waste the separately identifiable wastes are assessed separately. Mixing of different types of hazardous waste and hazardous waste with other waste substances is prohibited under the Waste Framework Directive. Wastes that have been mixed must be separated whenever possible.

It is best practice to provide your waste carrier (or the disposal site) with details of how the waste has been treated. Your waste carrier may provide a pre-treatment confirmation form or space on the waste transfer note to detail the pre-treatment.

The classification of waste soil is a two-stage process, the first being an assessment of whether the soil is considered hazardous or not following the guidance within Technical Guidance WM3. For off-site disposal to landfill the results of Waste Acceptance Criteria (WAC) testing must then be reviewed to establish if the soil is acceptable at the relevant class of landfill or requires pre-treatment to reduce specific hazardous properties.

8.4.1 Waste acceptance criteria

All inert, stable non-reactive hazardous and hazardous wastes have limit values (waste acceptance criteria) set out in legislation that must be met before that class of landfill can accept the waste. Currently, no WAC are in place for non-hazardous waste.

Soil and other materials that are found not to be hazardous may be classified as either non-hazardous or inert. In order to determine whether they can be classed as inert the soil must be tested and found to be below the inert waste acceptance criteria.

8.4.2 Waste sampling plan

Technical Guidance WM3 sets out in Appendix D requirements for waste sampling. It is a legal requirement to correctly assess and classify waste. The level of sampling should be proportionate to the volume of waste and its heterogeneity. At this stage, RSK consider that the level of soil sampling is/is not sufficient to categorise the material robustly/fully.

RSK recommends that a Sampling Plan be prepared to support any waste classifications and hazardous waste assessments, prior to development.

8.4.3 Preliminary waste assessment

The following assessment should be considered indicative and further assessment should be undertaken following the preparation of a waste sampling plan.

EnviroLab, an RSK company, has developed a waste soils characterisation assessment tool (HASWASTE), which follows the guidance within Technical Guidance WM3. The analytical results have been assessed using this tool for potential off-site disposal of materials in the future.

The results of the assessment indicate that the made ground across the site (excluding the landfill) would be classified as non-hazardous waste. Further testing Waste Acceptance Criteria (WAC) testing would be required in order to assess whether this material could be disposed of in a inert or non-hazardous landfill.

8.4.4 Landfill tax

Waste producers disposing of material to landfill are required to pay landfill tax by HM Revenue and Customs.

The tax is chargeable by weight (tonnage) and two rates apply, either standard or lower rate. The lower rate only applies to those less polluting wastes as set out in the Landfill Tax (Qualifying Material) Order 2011, which include naturally occurring rock and soil, concrete, some minerals, some furnace slags and ash, and some low-activity organic compounds. Evidence confirming that the waste qualifies for the lower rate will be

required, and standard rate tax will apply for the whole waste load for any loads of mixed waste.

Currently (since 1 April 2018), standard rate landfill tax is £88.95 per tonne.

The lower rate of landfill tax applicable to less polluting wastes (i.e. 'inert' wastes) remains at £2.80 per tonne.

Material disposed of at a soil treatment centre will not be subject to landfill tax.

8.5 Groundwater

When there is an intention to discard groundwater, chemical test results will indicate the appropriate disposal options. This could include disposal to treatment facility, via consent (issued by the water authority) to foul sewer or via consent (issued by the EA) to a watercourse or land.

8.6 Recommendations

RSK recommends that consideration as to how potentially waste soils will be dealt with as part of this development/remediation is given as early in the project planning process as possible. Such planning can lead to cost savings where potentially waste soils are viewed as a resource and retained on-site as part of the development. We also recommend, where off-site disposal is being considered, that appropriate facilities are identified and discussions initiated to confirm suitability of the facility to take the material. Potentially, these may include soil treatment facilities as well as landfills.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Environmental

The findings of the desk study identified that the site was used both as a military and civilian airfield from 1918 until 1980. The main hangers and aircraft servicing areas were located off-site to the east and west of the development area, but the bulk fuel storage facilities were situated on the southern boundary of the site. An infilled canal is also known to be present across the northern portion the site. The site is currently used predominantly for arable farming, but some commercial properties are present on parts of the former runway. A sewage works and waste treatment facilities are located on the airfield but are situated outside of the redline boundary for the development.

An intrusive investigation was carried out on the site to assess the potential for contamination associated with the site's former and current land uses. The investigation recorded localised presence of made ground ranging from 0.4 m to over 3.0 m in thickness which comprised sandy clay/clayey sand with occasional fragments of brick, ash, and flint. An inert landfill consisting a raised earth mound is also situated in the northeastern portion of the site next to the Grundon waste treatment facilities. However, the majority the site was found to be underlain by natural soils comprising topsoil over firm to stiff/very stiff low to high strength sandy slightly gravelly silty clay (Brickearth) with a gradational increase in sand content generally recorded towards the stratum base. Predominantly granular materials, inferred as River Terrace Deposits, were encountered sub cropping beneath cohesive 'Brickearth' between the depths of 1.4 m to 3.8 m. These materials were variable in density, reported as loose clayey sands in some areas, whilst medium dense to dense gravelly sands were encountered at some exploratory locations.

The underlying chalk bedrock surface was encountered at variable depths, reported between 0.7 m within TP29 in the north of the site, deepening to 4.7 m within BH1 at the sites southern limit. This stratum was composed of an upper weathered surface of structureless chalk recovered as a gravelly silt/clay, grading into a clast supported material. In-situ testing within this material would indicate an increase in competency with depth.

Groundwater was recorded between 1.73 and 5.5 m bgl during monitoring carried out following the main field works.

Soil testing carried out recorded elevated concentrations of PAH's and the presence of asbestos within the inert landfill, which may require remedial measures depending on the final layout of the development. Japanese knotweed has also been noted on this landfill and will need to be treated by a specialist.

Very little in the way of contamination was recorded across the remainder of the site as only two other sample from the made recorded a single elevated concentration of lead (TP39) and marginally elevated concentration PAHs (TP39 and S6B). However, it was concluded that concentrations PAH's in these samples were unlikely to pose a risk to risk to future site users.

Also, the results of groundwater testing carried indicated that the groundwater within the underlying chalk aquifer did not appear to have been significantly impacted by any existing or historical on or off-site sources.

Gas monitoring recorded low concentrations of carbon dioxide which are typical of an areas underlain by carbonate geology. Based on the findings of this investigation no ground gas protection measures are considered necessary for the proposed development.

In conclusion, the findings of this investigation have found that the site is virtually free from contamination. However, it must be noted that this investigation was exploratory in nature and it is recommended that some additional works are carried out in order to full characterise the ground conditions across the site. It is noted that a geophysical survey has recently been undertaken at the site by Magnitude Surveys (Report Ref MSSU353 dated September 2018) which should be used to help aid targeting of future exploratory points. It is recommended that the following works are carried out,

- Further investigation/assessment of the inert landfill once the proposed development plans have been advanced.
- Further assessment of soils impacted with lead at TP39 once the proposed development plans have been advanced.
- Additional intrusive works on the land currently occupied by the Highway Agency Compound and Haulage company when the area becomes vacant.
- Additional intrusive works to target or possible former buried structures/features identified on the geophysical survey, including additional exploratory points to further target the bulk fuel facilities.

A remediation strategy should be developed for the site if the additional works indicate that there is a potential risk to future site users or the surrounding environment,

9.2 Geotechnical

It is understood that the proposed development is to involve a number of different land uses comprising the construction of approximately 1,500 residential properties of low-rise design, new retail, commercial and community facilities, a library and new healthcare facilities as well as education provision in the form of two new schools.

Based on the ground conditions encountered traditional spread foundations constructed within the medium to high strength superficial soils are considered technically feasible to support lightly loaded low-rise residential structures at the site. Strip foundations with a width of up to 1.0 m and constructed within the cohesive soils at a minimum depth of 1.0 m may be designed using a net allowable bearing pressure of **85 kN/m²**. Pad foundations with a width of up to 2.0 m and constructed in the medium to high strength clay at a depth of 1.0m may be designed using a net allowable bearing pressure of **100 kN/m²**. For structures with higher loadings, a piled foundation solution may be adopted for the site.

Additional investigation is required in order to assess the risk from desiccated soils on properties located within the vicinity of hedgerows and trees. Foundations that are affected should be designed in accordance with NHBC guidance.

Based on the results of field testing, the recommended sub-grade soil CBR value for road pavement design is 3%. This value assumes that during construction the formation level will be inspected, and should soft spots be identified.

In general, infiltration characteristics across the site were found to be poor with the lack of permeability within the upper cohesive ground conditions rendering some infiltration rates incalculable. Where infiltration was observed across the test period, infiltration rates ranging 2.29E-06 m/s (S1) to 4.76E-06 m/s (S5) – i.e. upper bound of poor drainage characteristics.

Additional site investigation will be required aid infrastructure design once the final layout of the development is known.

BIBLIOGRAPHY

- British Standards Institution (BSI) (1990), 'BS 1377:1990. Methods of test for soils for civil engineering purposes'.
- British Standards Institution (2015), 'BS 5930:2015. Code of practice for ground investigations'.
- British Standard Institution (BSI) (2015), 'BS 8485:2015. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings '.
- British Standards Institution (2011), 'BS 10175:2011 + A2:2017. Investigation of potentially contaminated sites: Code of practice'.
- British Standards Institution (2013), BS8576:2013. Guidance on investigations for ground gas – permanent gases and volatile organic compounds (VOCs)
- Building Research Establishment (2005), *BRE Special Digest 1: Concrete in aggressive ground* (London: BRE).
- Building Research Establishment (2016) *BRE Digest 365. Soakaway design* (London: BRE).
- Chartered Institute for Environmental Health and Land Quality Management (2009), 'The LQM/CIEH Generic Assessment Criteria for Human Health', second edition.
- Chartered Institute of Environmental Health (CIEH) and CL:AIRE (2008), *Guidance on Comparing Soil Contamination Data with a Critical Concentration* (London: CIEH).
- CL:AIRE (2009), *Soil Generic Assessment Criteria for Human Health Risk Assessment* (London: CL:AIRE).
- CL:AIRE (2011), *CL:AIRE Code of Practice. The Definition of Waste: Development Industry Code of Practice, Version 2* (London: CL:AIRE).
- Dangerous Substances Directive (76/464.EEC).
- Department for Environment, Food and Rural Affairs (2010), *The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010* (London: HMSO).
- Department of the Environment (1996), *Code of Practice for Agricultural Use of Sewage Sludge* (London: HMSO).
- Environment Agency (2018), 'Technical Guidance WM3. Guidance on the classification of and assessment of waste. 1st Edition.
- Environment Agency (2004), *Model Procedures for the Management of Contaminated Land. Contaminated Land Report Number 11 (CLR11)*, September (Bristol: Environment Agency).
- Environment Agency (2004b), 'Policy Number 199_04, dated 9 March 2004, Part IIA – Detailed Quantitative Assessment of Chronic Risks to Human Health from Contaminated Soils'.
- Environment Agency (2006b), 'The Knotweed Code of Practice – managing Japanese Knotweed on development sites'.
- Environment Agency (2008), *Science Report SC050021/SR7. Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values* (Bristol: Environment Agency).

Environment Agency (2009a), Contaminated Land Exposure Assessment (CLEA) software, version 1.07.

Environment Agency (2009b), *Human health toxicological assessment of contaminants in soil. Science Report – Final SC050021/SR2*, January (Bristol: Environment Agency).

Environment Agency (2009c), 'Science Report SC050021/benzene SGV, toluene SGV, ethylbenzene SGV, xylene SGV, mercury SGV, selenium SGV, nickel SGV, arsenic SGV, cadmium SGV, phenol SGV, dioxins, furans and dioxin like PCBs SGVs', 'Supplementary information for the derivation of SGV for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', and 'Contaminants in soil: updated collation of toxicological data and intake values for humans: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', March 2009, May 2009 and September 2009.

Environment Agency (2009d), *Science Report – SC050021/SR3. Updated technical background to the CLEA model* (Bristol: Environment Agency).

Environment Agency (2010a), 'GPLC1 – Guiding Principles of Land Contamination', 'GPLC2 – Frequently Asked Questions, Technical Information, Detailed Advice and References', and 'GPLC3 – Reporting Checklists', all March.

Environment Agency (no date) Freshwater environmental quality standards.

Environment Agency www.environment-agency.gov.uk/.

Environmental Permitting (England and Wales) Regulations 2010 (London: HMSO).

Hazardous Waste Regulations 2005 (London: HMSO).

Lord, J. A., Clayton, C. R. I. and Mortimore, R. N. (2002), *CIRIA Report C574 Engineering in chalk* (London: CIRIA).

National House-Building Council (1999), 'Chapter 5.2: Suspended Ground Floors' in *NHBC Standards*, revised September 1999, effective January 2000.

Part IIA of the Environmental Protection Act (Contaminated Land Regulations (England) 2002 (London: HMSO).

Transport and Road Research Laboratory (1970), 'TRRL Road Note 29 (Appendix 1). Road pavement design'.

Transport and Road Research Laboratory (1984), 'TRRL Report LR1132 (Table C1)'.

UK Water Industry Research (2010) *UKWIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (London: UKWIR).

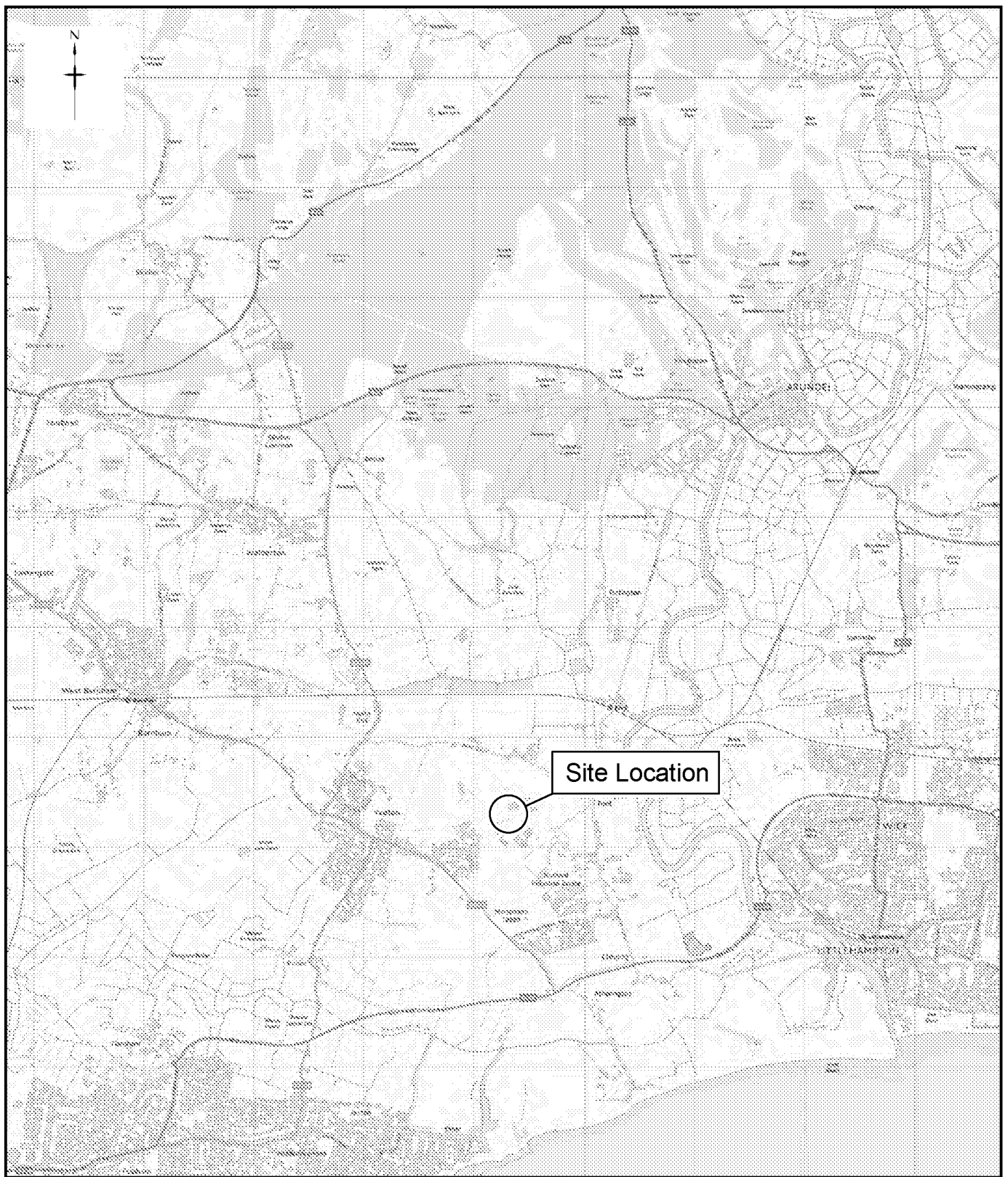
Water Framework Directive (2000/60/EC).

Wilson, S., Oliver, S., Mallet, H., Hutchings, H. and Card, G. (2007), *CIRIA Report C665: Assessing risks posed by hazardous ground gases to buildings* (London: CIRIA).

World Health Organization (2004), *Guidelines for drinking-water quality*, 3rd edn (Geneva: WHO).

WRc plc (2002), 'Polycyclic Aromatic Hydrocarbons (PAH): Priorities for Environmental Quality Standard Development, R&D Technical Report P45'.

FIGURES



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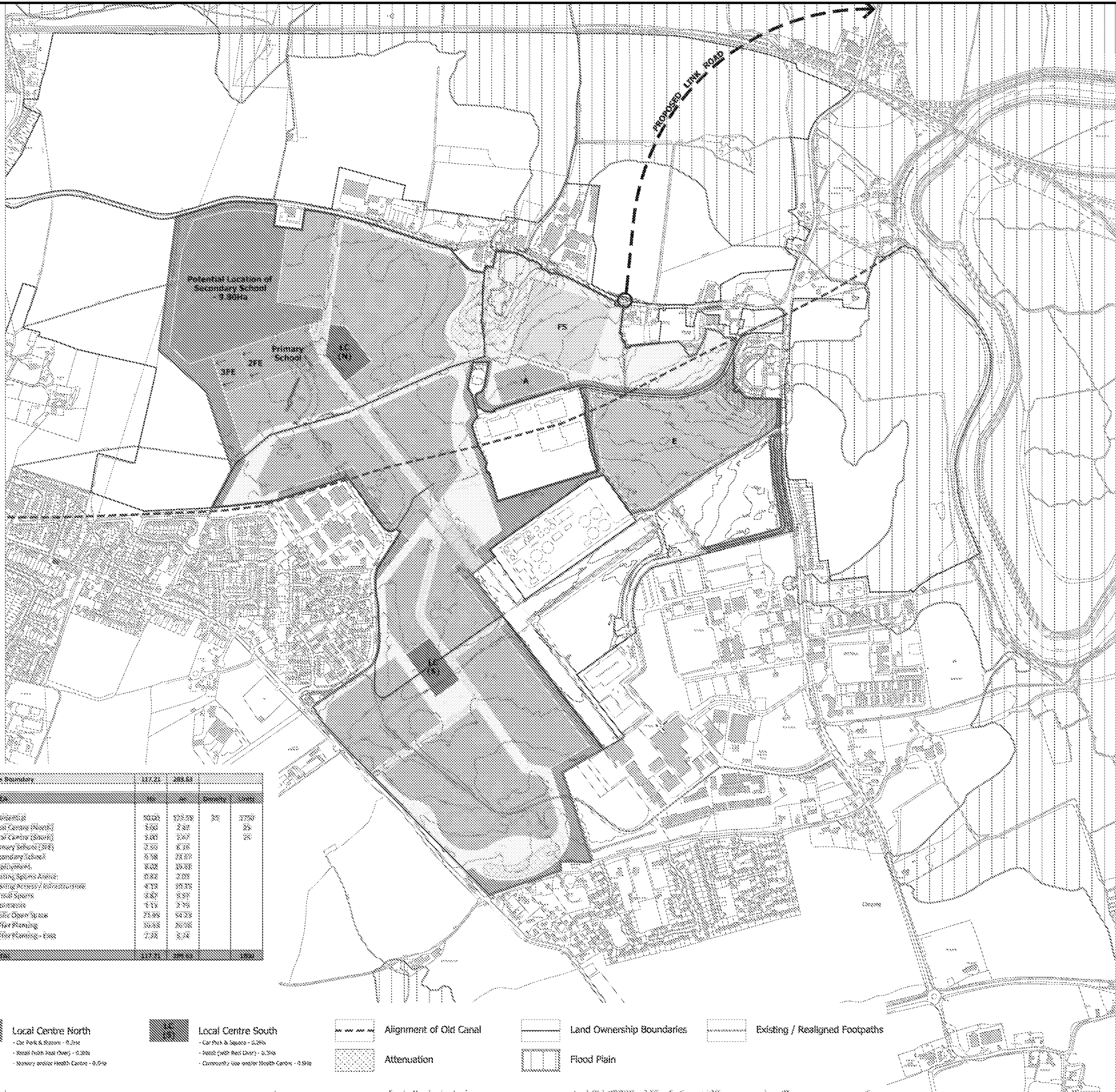
Client
REDROW HOMES LIMITED AND WATES DEVELOPMENTS LIMITED

Project Title
FORD AIRFIELD

Drawing Title
SITE LOCATION MAP

Rev	Drawn	Date	Checked	Date	Approved	Date
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Dimensions		Scale		Original Size		
m		1:50,000		A4		

Project Number	Drawing File	Drawing Number
29228 - R01 (00)	29228 - SLP.dwg	FIGURE 1



Rev.	Date	Amendment	Drawn	Chkd.	Appd.



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Project Title
FORD AIRFIELD

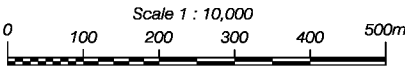
Drawing Title
**PROPOSED DEVELOPMENT
PLAN**

Drawn	Date	Checked	Date	Approved	Date
AP	19.10.18	AT	19.10.18	AT	19.10.18

Scale	Orig Size	Dimensions
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Project No.	Drawing File
29228 - R01(00)	29228 - (R01-00) Fig 2.dwg

Drawing No.	Rev.
FIGURE 2	P1





Rev.	Date	Amendment	Drawn	Chkd.	Appd.



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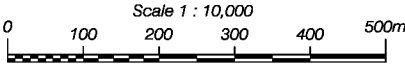
Project Title
FORD AIRFIELD

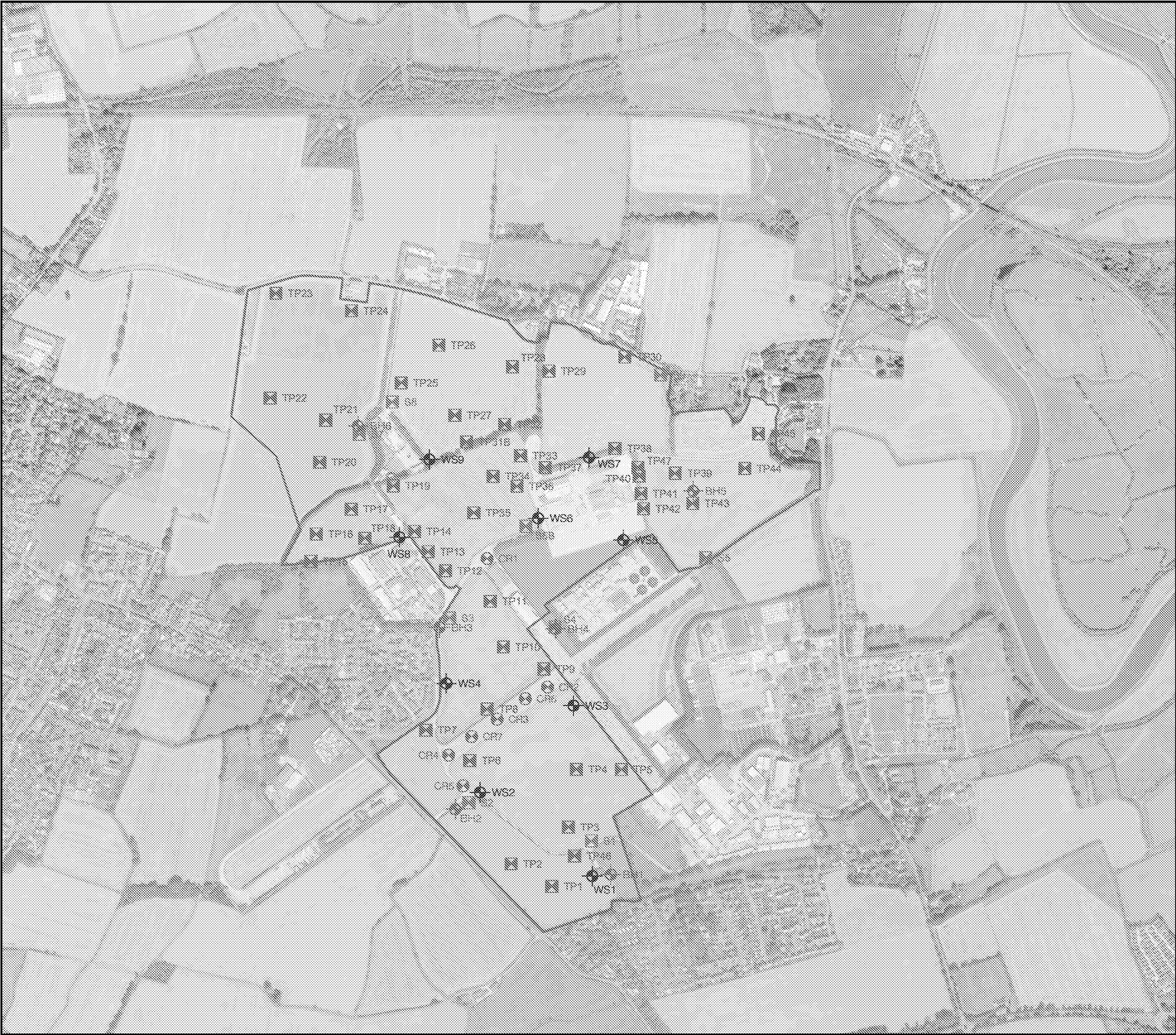
Drawing Title
SITE WALKOVER PLAN

Drawn AP	Date 19.10.18	Checked AT	Date 19.10.18	Approved AT	Date 19.10.18
Scale 1:10000	Orig Size A3	Dimensions m			

Project No. 29228 - R01(00)	Drawing File 29228 - (R01-00) Fig 3.dwg
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Drawing No. FIGURE 3	Rev. P1
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LEGEND

Site Boundary

Cable Percussion Borehole Location

Window Sample Location

Trial Pit Location

Infiltration Test Location

Coring of Runway

Rev.

Date

Amendment

Drawn

Chkd.

Appd.

RSK

18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT
United Kingdom

Tel: +44 (0) 1442 437500
Fax: +44 (0) 1442 437550
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client

REDROW HOMES LIMITED AND
WATES DEVELOPMENT LIMITED

Project Title

FORD AIRFIELD

Drawing Title

EXPLORATORY HOLE
LOCATION PLAN

Drawn

Date

Checked

Date

Approved

Date

AP

19.10.18

AT

19.10.18

AT

19.10.18

Scale

Orig Size

Dimensions

1:10000

A3

m

Project No.

Drawing File

29228 - R01(00)

29228 - (R01-00) Fig 4.dwg

Drawing No.

Rev.

FIGURE 4

P1

Scale 1 : 10,000

0

100

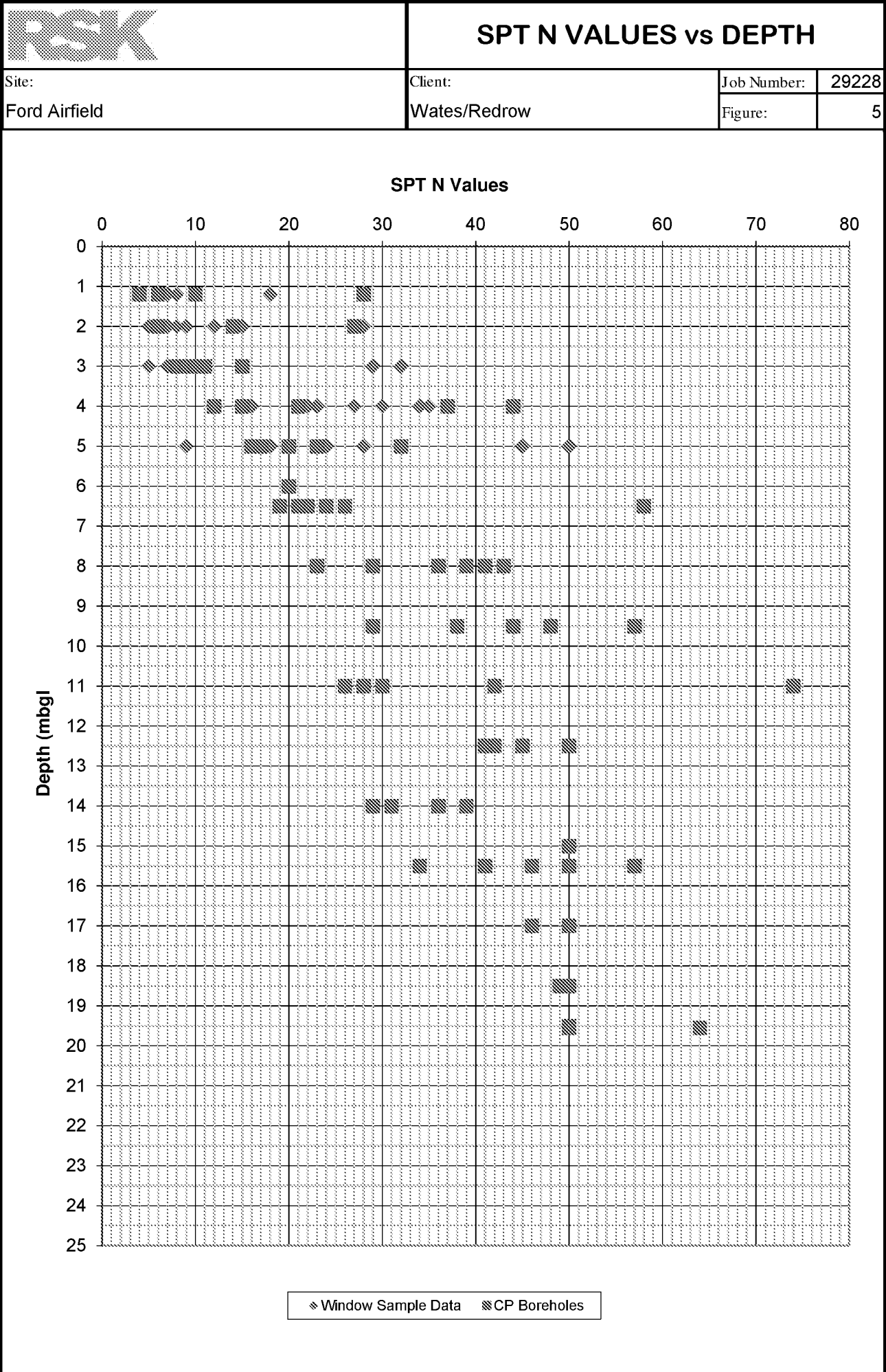
200

300

400

500m

ARUN DISTRICT COUNCIL F/4/20/OUT





Undrained Shear Strength Vs Depth

Site:

Ford Airfield

Client:

Wates/Redrow

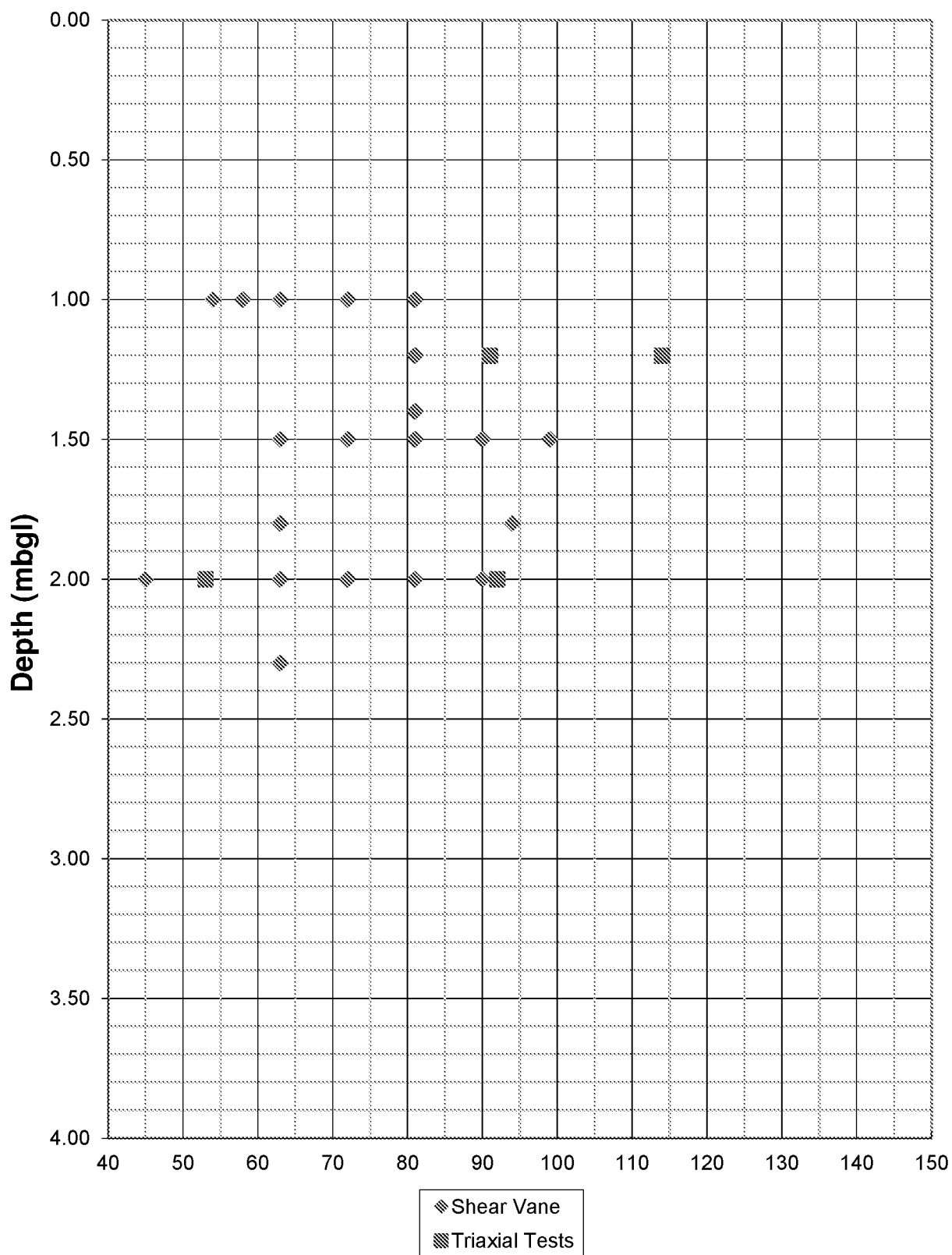
Job Number:

29228

Figure:

6

Undrained Shear Strength Cu



APPENDIX A

SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Redow Homes Limited and Wates Developments Limited (the "clients") in accordance with the terms of a contract between RSK and the "client". The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.
2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed in writing the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.
8. The intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.
9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (boreholes, trial pits etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.

APPENDIX B

PHOTOGRAPHIC RECORD



Report No: 29228

PHOTOGRAPHIC LOG

Client name:
Redrow / Wates

Site Location:
Ford Airfield

Date:
25th July 2018

No.
1

Description:
Commercial premises on the former
runway (site walkover ref 1)



No.
2

Description
Football pitches in the centre of the site,
sewage works screened by hedgerow
(site walkover ref 3).



No.
3

Description:
Grundon waste recycling facilities in the
northeastern portion of the site (site
walkover ref 5).



No.
4

Description
Highways England compound in
northern portion of the site (site
walkover ref 6).



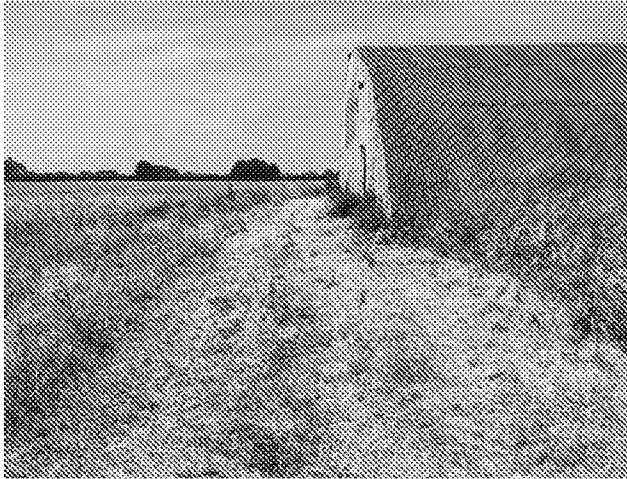
Client name:
Redrow / Wates

Site Location:
Ford Airfield

Date:
25th July 2018

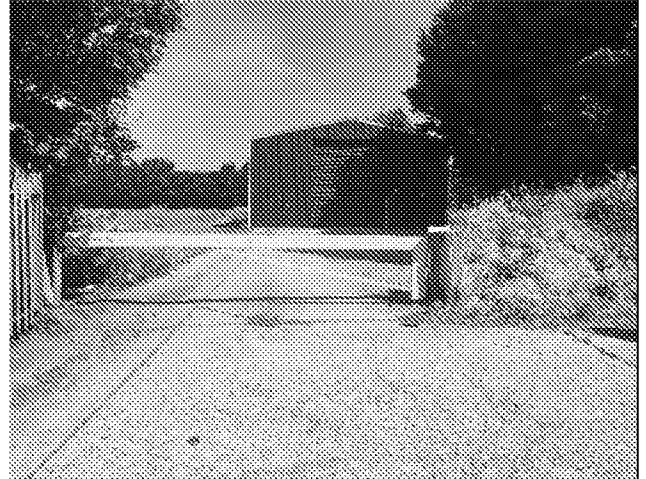
No.
5

Description:
Dome structure in southern portion of the site near former bulk fuel storage facilities (site walkover ref 7).



No.
6

Description
Building located in western portion of the site (site walkover ref 8).



No.
7

Description:
Stockpile of maize (site walkover ref 100



No.
8

Description
Earth mound located to the rear of the Grundon waste facilities (site walkover ref 11)



Client name:
Redrow / Wates

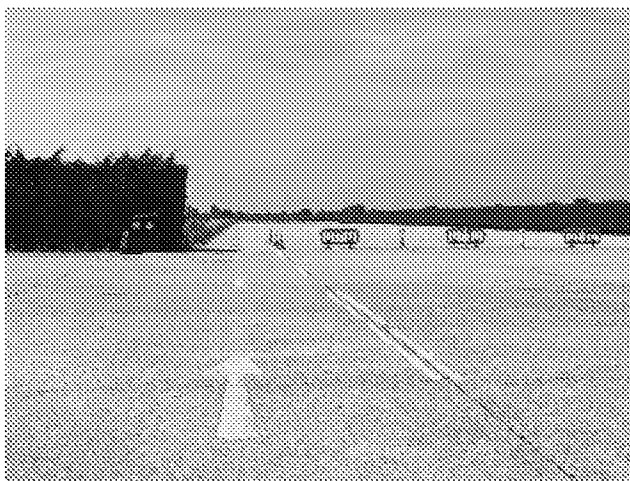
Site Location:
Ford Airfield

Date:
25th July 2018

No.
9.

Description:

General pic – looking west from centre of former runway



No.
10

Description

General pic – looking southeast towards the Flying Fortress play centre.



No.
11

Description:

General pic – looking north from the access road to the Flying Fortress play centre.



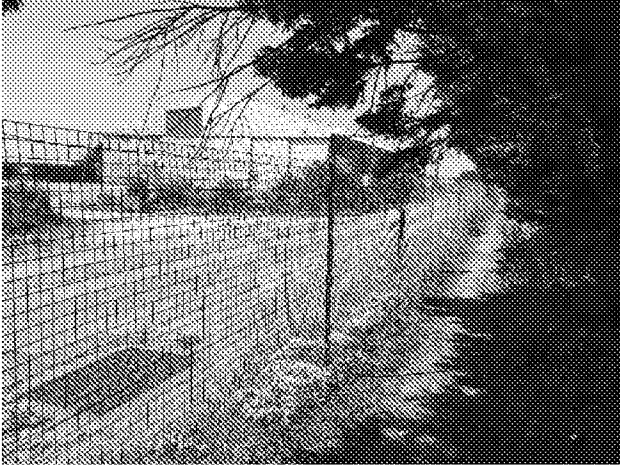
No.
12

Description

General pic- looking northwest from northern boundary of the Grondon waste treatment facilities.



	Report No: 29228	PHOTOGRAPHIC LOG
Client name: Redrow / Wates	Site Location: Ford Airfield	Date: 25 th July 2018

No.	Description:
13	General pic – former hanger in Grundon waste facilities.
	

No.	Description:
14	General pic - Former taxi-way located along the western boundary of the site.
	

No.	Description:
15	General pic – Looking south from the end of the western leg of the former runway.
	

No.	Description
16	General pic – Ford industrial estate located along the northwestern boundary of the site.
	



APPENDIX C

ENVIRONMENTAL DATA BASE REPORT

Geology 1:50,000 Maps Legends

Artificial Ground and Landslip

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	MGR	Made Ground (Undivided)	Artificial Deposit	Not Supplied - Holocene

Superficial Geology

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ALV	Alluvium	Clay, Silt, Sand and Gravel	Not Supplied - Holocene
	RTDU	River Terrace Deposits (Undifferentiated)	Sand, Silt and Clay	Not Supplied - Quaternary
	RBD1	Raised Beach Deposits, 1	Sand and Gravel	Not Supplied - Quaternary
	RMD	Raised Marine Deposits	Clay, Silt, Sand and Gravel	Not Supplied - Quaternary
	HEAD	Head	Gravel, Sand, Silt and Clay	Not Supplied - Quaternary

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	LC	London Clay Formation	Clay, Silt and Sand	Not Supplied - Ypresian
	LMBE	Lambeth Group	Clay, Silt and Sand	Not Supplied - Thanetian
	LPCK	Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation (Undifferentiated)	Chalk	Not Supplied - Turonian



Geology 1:50,000 Maps

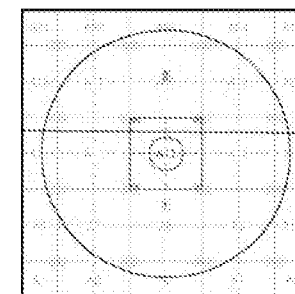
This report contains geological map extracts taken from the BGS Digital Geological map of Great Britain at 1:50,000 scale and is designed for users carrying out preliminary site assessments who require geological maps for the area around the site. This mapping may be more up to date than previously published paper maps.

The various geological layers - artificial and landslip deposits, superficial geology and solid (bedrock) geology are displayed in separate maps, but superimposed on the final 'Combined Surface Geology' map. All map legends feature on this page. Not all layers have complete nationwide coverage, so availability of data for relevant map sheets is indicated below.

Geology 1:50,000 Maps Coverage

Map ID:	1	Map ID:	2
Map Sheet No:	332	Map Sheet No:	317
Map Name:	Chichester and I	Map Name:	Chichester and I
Map Date:	1996	Map Date:	1996
Bedrock Geology:	Available	Bedrock Geology:	Available
Superficial Geology:	Available	Superficial Geology:	Available
Artificial Geology:	Available	Artificial Geology:	Available
Faults:	Not Supplied	Faults:	Not Supplied
Landslip:	Available	Landslip:	Available
Rock Segments:	Not Supplied	Rock Segments:	Not Supplied

Geology 1:50,000 Maps - Slice A



Order Details:

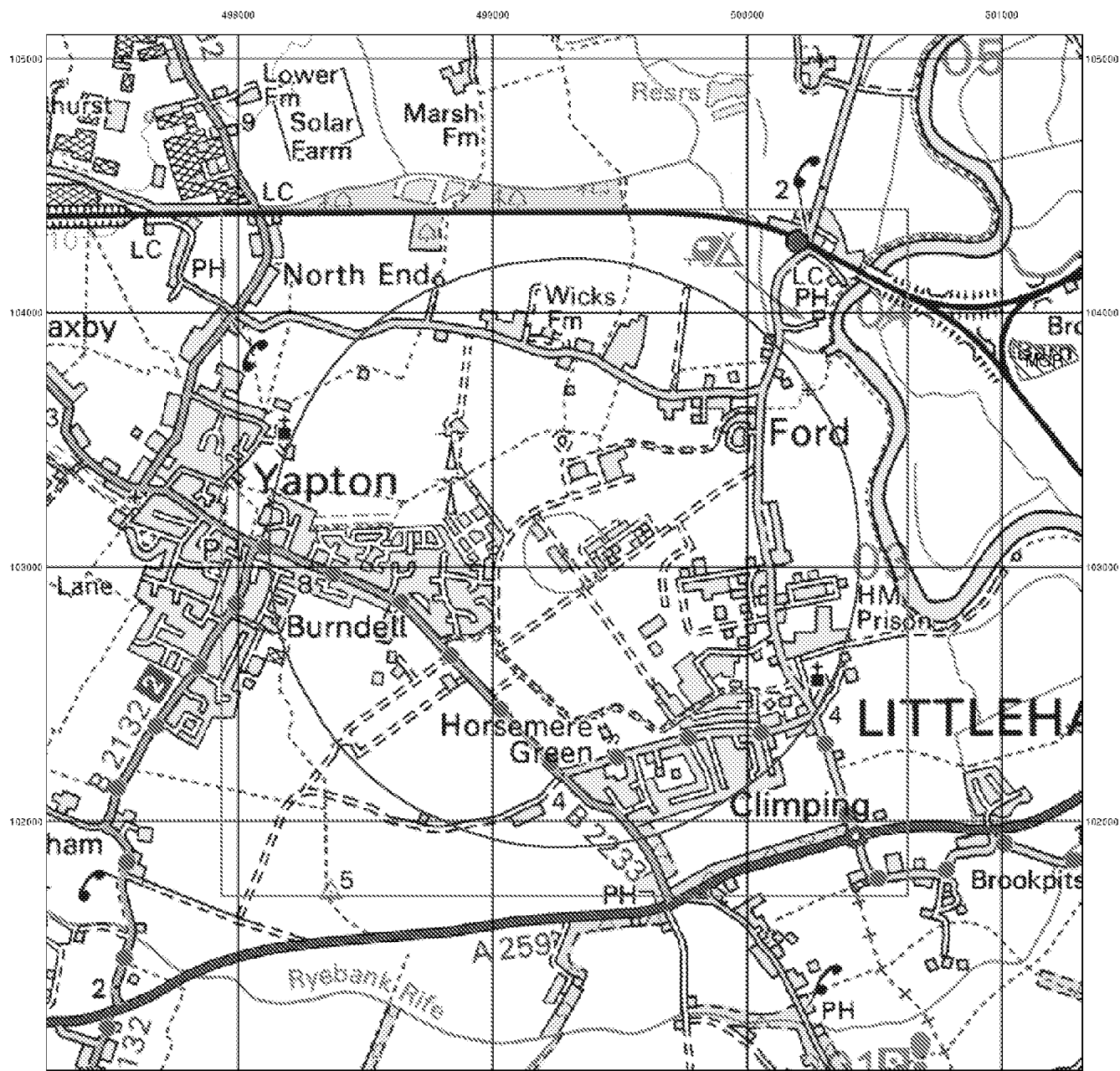
Order Number: 171435319_1_1
 Customer Reference: 29228
 National Grid Reference: 499280, 103060
 Slice: A
 Site Area (Ha): 8.11
 Search Buffer (m): 1000

Site Details:

Ford Airfield, Ford Road, ARUNDEL, BN18 0FL

Landmark
 Environmental Services

Tel: 0544 544 5922
 Fax: 0544 544 5951
 Web: www.environmental.co.uk



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Artificial Ground and Landslip

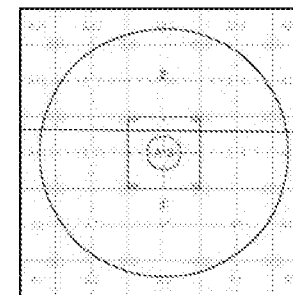
Artificial ground is a term used by BGS for those areas where the ground surface has been significantly modified by human activity. Information about previously developed ground is especially important, as it is often associated with potentially contaminated material, unpredictable engineering conditions and unstable ground.

Artificial ground includes:

- Made ground - man-made deposits such as embankments and spoil heaps on the natural ground surface.
- Worked ground - areas where the ground has been cut away such as quarries and road cuttings.
- Infilled ground - areas where the ground has been cut away then wholly or partially backfilled.
- Landscaped ground - areas where the surface has been reshaped.
- Disturbed ground - areas of ill-defined shallow or near surface mineral workings where it is impracticable to map made and worked ground separately.

Mass movement (landslip) deposits on BGS geological maps are primarily superficial deposits that have moved down slope under gravity to form landslips. These affect bedrock, other superficial deposits and artificial ground. The dataset also includes foundered strata, where the ground has collapsed due to subsidence.

Artificial Ground and Landslip Map - Slice A

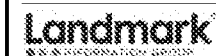


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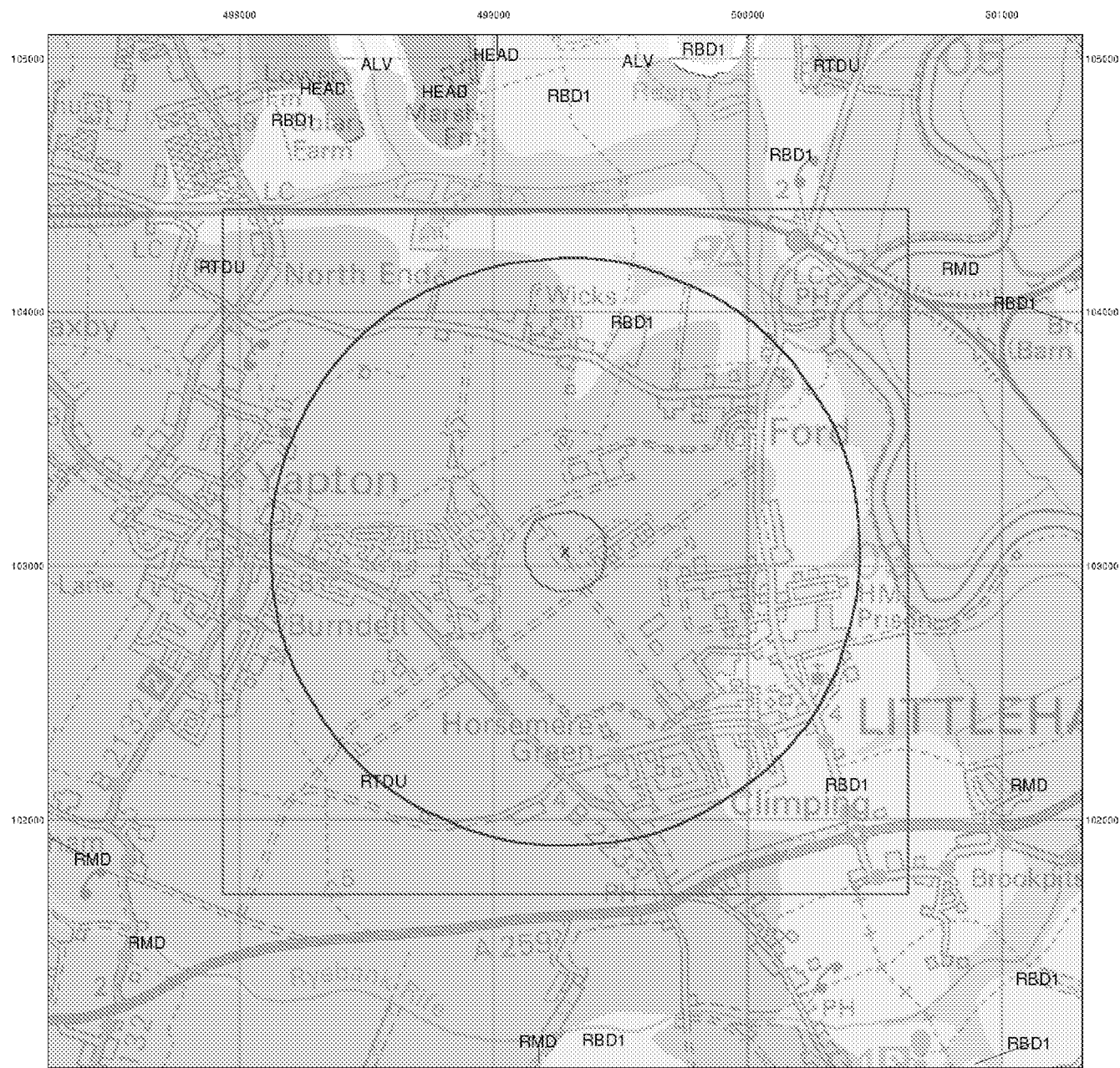
Order Number: 171435319_1_1
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 Slice: A
 Site Area (Ha): 8.11
 Search Buffer (m): 1000

Site Details:

Ford Airfield, Ford Road, ARUNDEL, BN18 0FL



Tel: 0544 544 5922
 Fax: 0544 544 5951
 Web: www.eorinfect.co.uk



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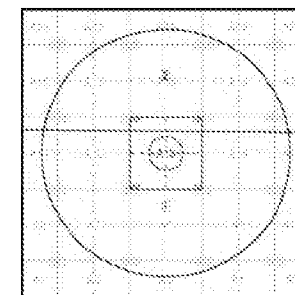
Superficial Geology

Superficial Deposits are the youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 1.8 million years from the present.

They rest on older deposits or rocks referred to as Bedrock. This dataset contains Superficial deposits that are of natural origin and 'in place'. Other superficial strata may be held in the Mass Movement dataset where they have been moved, or in the Artificial Ground dataset where they are of man-made origin.

Most of these Superficial deposits are unconsolidated sediments such as gravel, sand, silt and clay, and onshore they form relatively thin, often discontinuous patches or larger spreads.

Superficial Geology Map - Slice A

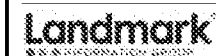


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 Customer Reference: 29228
 National Grid Reference: 499280, 103060
 Slice: A
 Site Area (Ha): 8.11
 Search Buffer (m): 1000

Site Details:

Ford Airfield, Ford Road, ARUNDEL, BN18 0FL



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Bedrock and Faults

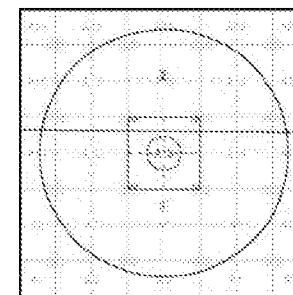
Bedrock geology is a term used for the main mass of rocks forming the Earth and are present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

The bedrock has formed over vast lengths of geological time ranging from ancient and highly altered rocks of the Proterozoic, some 2500 million years ago, or older, up to the relatively young Pliocene, 1.8 million years ago.

The bedrock geology includes many lithologies, often classified into three types based on origin: igneous, metamorphic and sedimentary.

The BGS Faults and Rock Segments dataset includes geological faults (e.g. normal, thrust), and thin beds mapped as lines (e.g. coal seam, gypsum bed). Some of these are linked to other particular 1:50,000 Geology datasets, for example, coal seams are part of the bedrock sequence, most faults and mineral veins primarily affect the bedrock but cut across the strata and post date its deposition.

Bedrock and Faults Map - Slice A

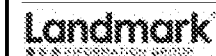


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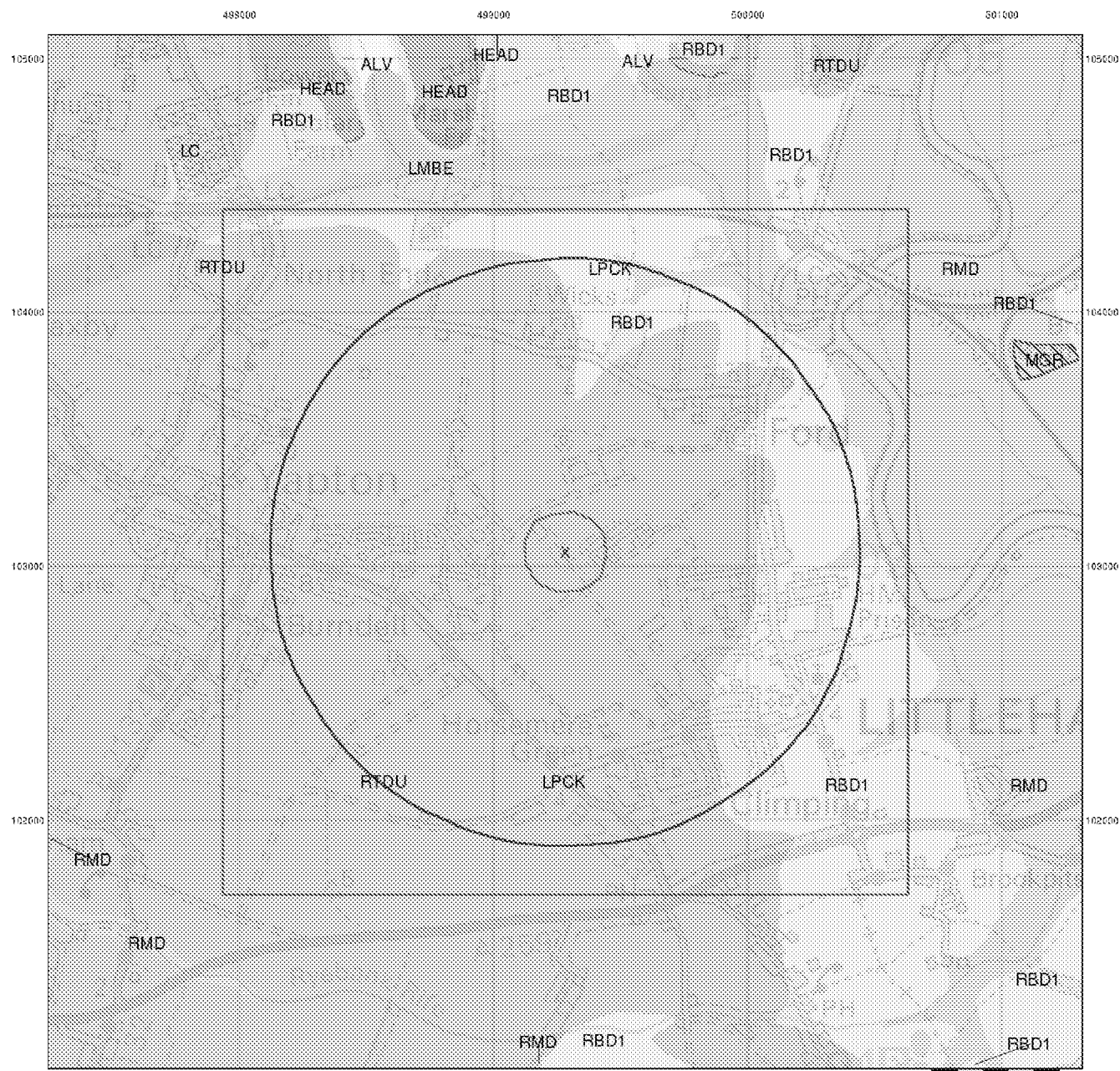
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 Search Buffer (m): 1000

Site Details:

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 Fax: 0244 264 9551
 Web: www.eorinstruct.co.uk



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Combined Surface Geology

The Combined Surface Geology map combines all the previous maps into one combined geological overview of your site.

Please consult the legends to the previous maps to interpret the Combined "Surface Geology" map.

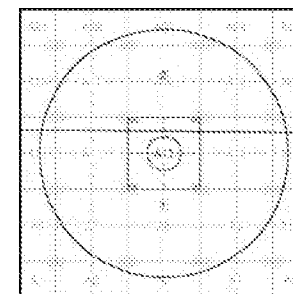
Additional Information

More information on 1:50,000 Geological mapping and explanations of rock classifications can be found on the BGS website. Using the LEX Codes in this report, further descriptions of rock types can be obtained by interrogating the 'BGS Lexicon of Named Rock Units'. This database can be accessed by following the 'Information and Data' link on the BGS website.

Contact

British Geological Survey
Kingsley Dunham Centre
Keyworth
Nottingham
NG12 5GG
Telephone: 0115 936 3143
Fax: 0115 936 3276
email: enquiries@bgs.ac.uk
website: www.bgs.ac.uk

Combined Geology Map - Slice A

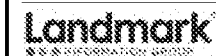


Order Details:

Order Number: 171435319_1_1
Customer Reference: 29228
National Grid Reference: 499280, 103060
Site: A
Site Area (Ha): 8.11
Search Buffer (m): 1000

Site Details:

Ford Airfield, Ford Road, ARUNDEL, BN18 0FL



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v15.0 27-Jun-2018

Page 5 of 5

Historical Mapping Legends

Ordnance Survey County Series 1:10,560

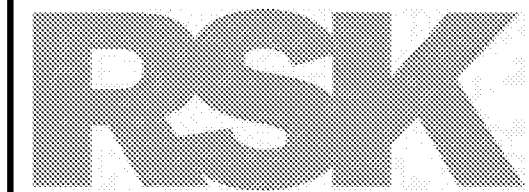
	Gravel Pit		Sand Pit		Other Pits
	Quarry		Shingle		Orchard
	Osiers		Reeds		Marsh
	Mixed Wood		Deciduous		Brushwood
	Fir		Furze		Rough Pasture
	Arrow denotes flow of water		Trigonometrical Station		
	Site of Antiquities		Bench Mark		
	Pump, Guide Post, Signal Post		Well, Spring, Boundary Post		
	285 Surface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

Ordnance Survey Plan 1:10,000

	Chalk Pit, Clay Pit or Quarry		Gravel Pit
	Sand Pit		Disused Pit or Quarry
	Refuse or Slag Heap		Lake, Loch or Pond
	Dunes		Boulders
	Coniferous Trees		Non-Coniferous Trees
	Orchard		Scrub
	Bracken		Heath
	Marsh		Reeds
	Building		Glasshouse
	Sloping Masonry		Pylon
	Cutting		Embankment
	Road Under		Road Over
	Level Crossing		Foot Bridge
	Standard Gauge Multiple Track		Standard Gauge Single Track
	Siding, Tramway or Mineral Line		Narrow Gauge
	Geographical County		
	Administrative County, County Borough or County of City		
	Municipal Borough, Urban or Rural District, Burgh or District Council		
	Borough, Burgh or County Constituency		
	Civil Parish		
	Boundary Post or Stone		Police Station
	Church		Post Office
	Club House		Public Convenience
	Fire Engine Station		Public House
	Foot Bridge		Signal Box
	Fountain		Spring
	Guide Post		Telephone Call Box
	Mile Post		Telephone Call Post
	Mile Stone		Well

1:10,000 Raster Mapping

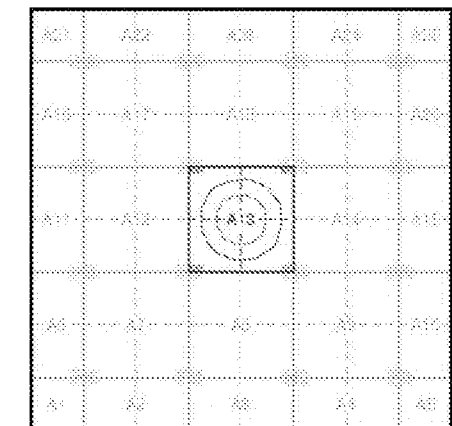
	Gravel Pit		Refuse tip or slag heap
	Rock		Rock (scattered)
	Boulders		Boulders (scattered)
	Shingle		Mud
	Sand		Sand Pit
	Slopes		Top of cliff
	General detail		Underground detail
	Overhead detail		Narrow gauge railway
	Multi-track railway		Single track railway
	County boundary (England only)		Civil,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



Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Sussex	1:10,560	1879 - 1880	2
Sussex	1:10,560	1899	3
Sussex	1:10,560	1913	4
Sussex	1:10,560	1913	5
Sussex	1:10,560	1913	6
Sussex	1:10,560	1932	7
Sussex	1:10,560	1938 - 1951	8
Historical Aerial Photography	1:10,560	1947	9
Ordnance Survey Plan	1:10,000	1962	10
Ordnance Survey Plan	1:10,000	1962 - 1967	11
Ordnance Survey Plan	1:10,000	1977	12
Ordnance Survey Plan	1:10,000	1980 - 1982	13
Ordnance Survey Plan	1:10,000	1992 - 1993	14
10K Raster Mapping	1:10,000	2000	15
10K Raster Mapping	1:10,000	2006	16
VectorMap Local	1:10,000	2018	17

Historical Map - Slice A



Order Details

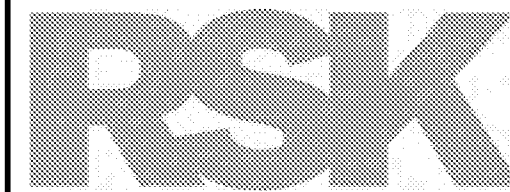
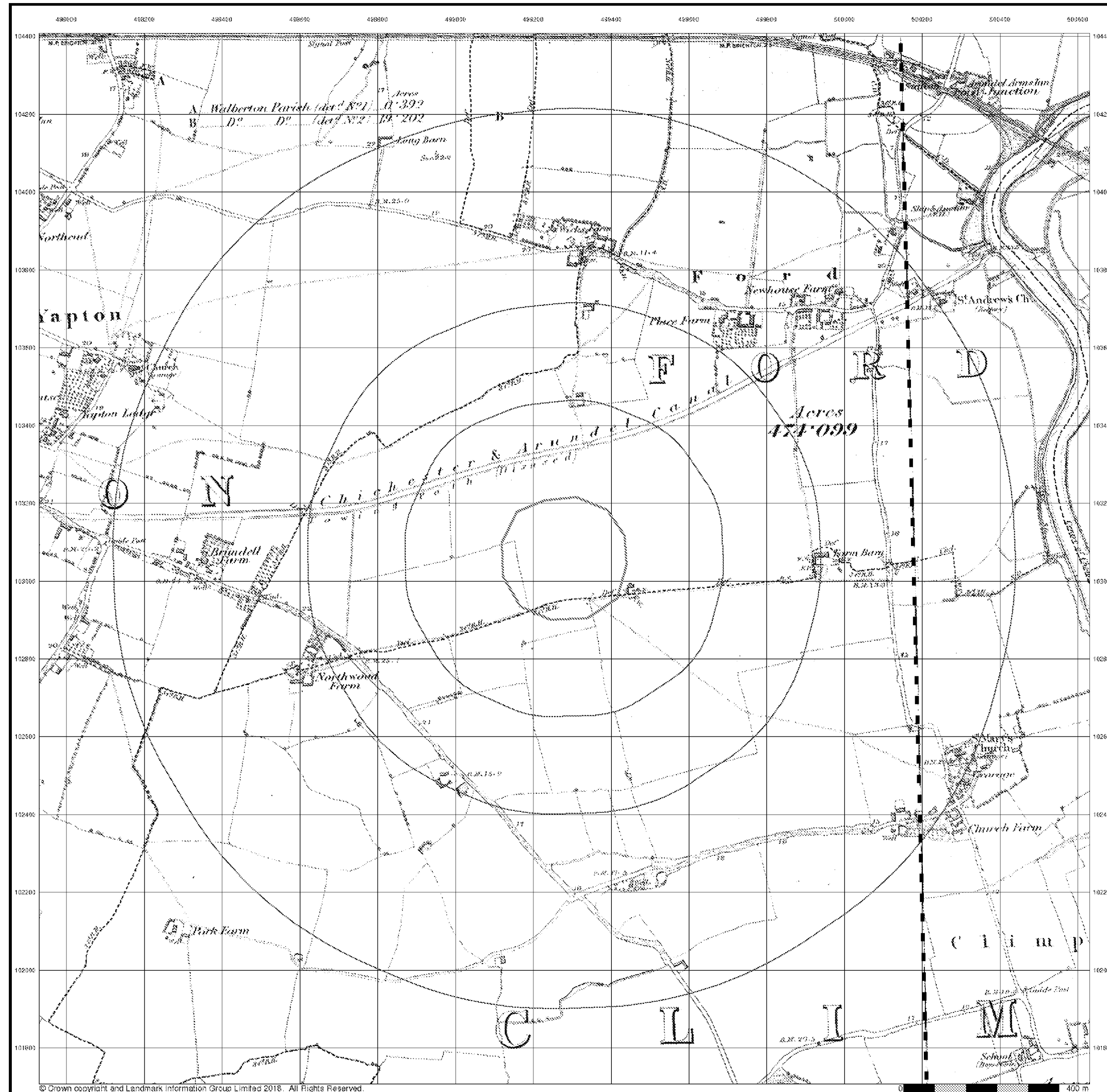
Order Number: 171435319_1_1
 Customer Ref: 29228
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 Slice: A
 Site Area (Ha): 8.11
 Search Buffer (m): 1000

Site Details

Ford Airfield, Ford Road, ARUNDEL, BN18 0FL



Tel: 0844 844 9852
 Fax: 0844 844 9851
 Web: www.envisagecheck.co.uk



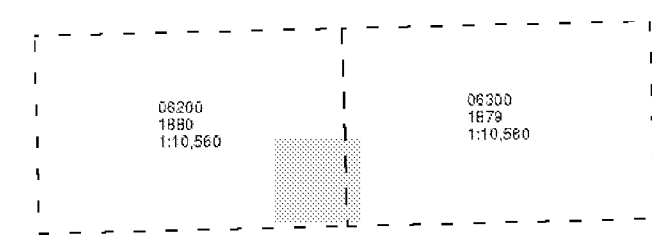
Sussex

Published 1879 - 1880

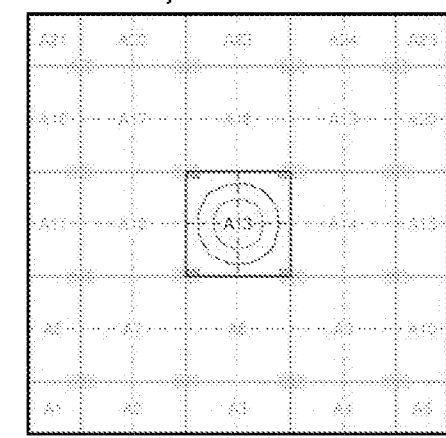
Source map scale - 1:10,560

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

Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number: 171435319_1_1
Customer Ref: 29228
National Grid Reference: 499280, 103060
Slice: A
Site Area (Ha): 8.11
Search Buffer (m): 1000

Site Details

Ford Airfield, Ford Road, ARUNDEL, BN18 0FL

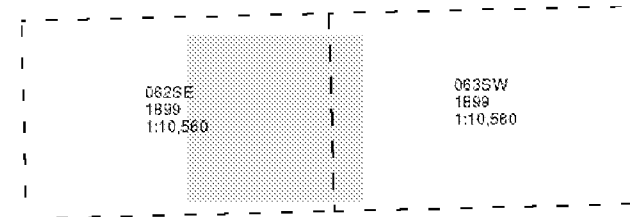


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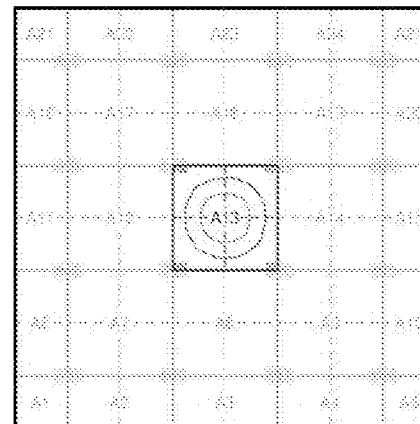


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Historical Map - Slice A



Order Details

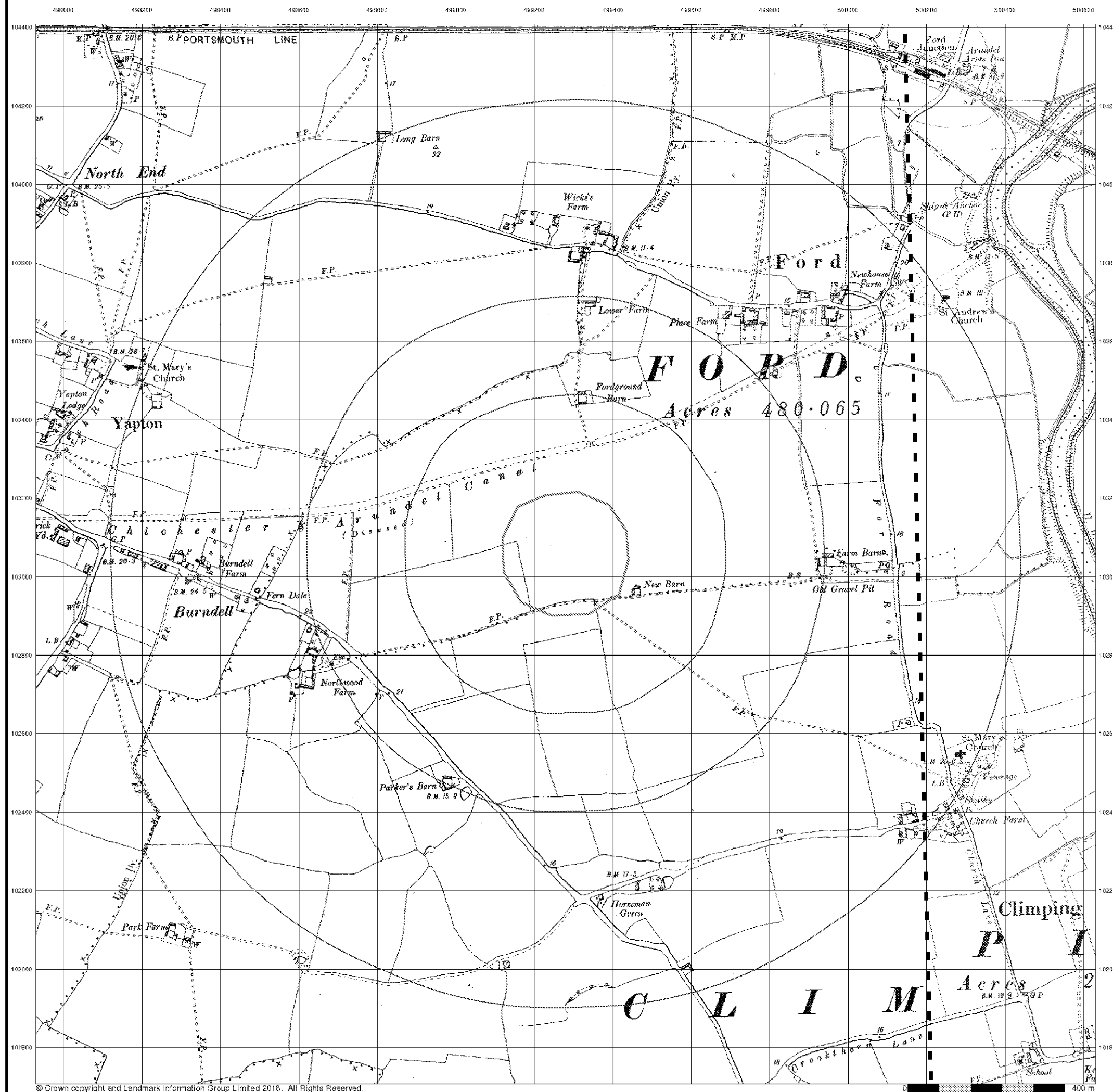
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Site Details

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Landmark
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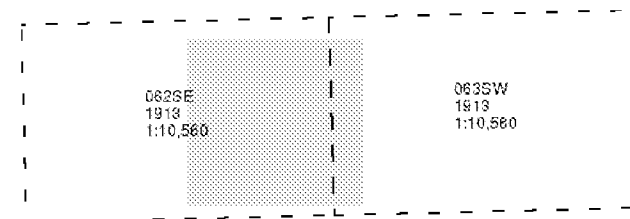
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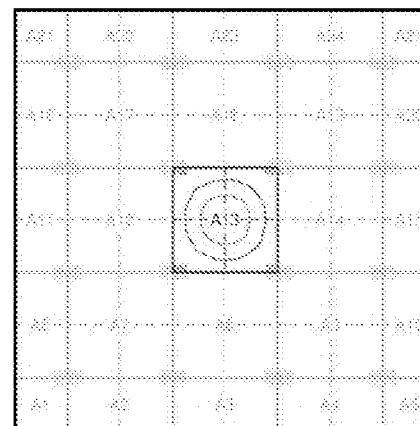


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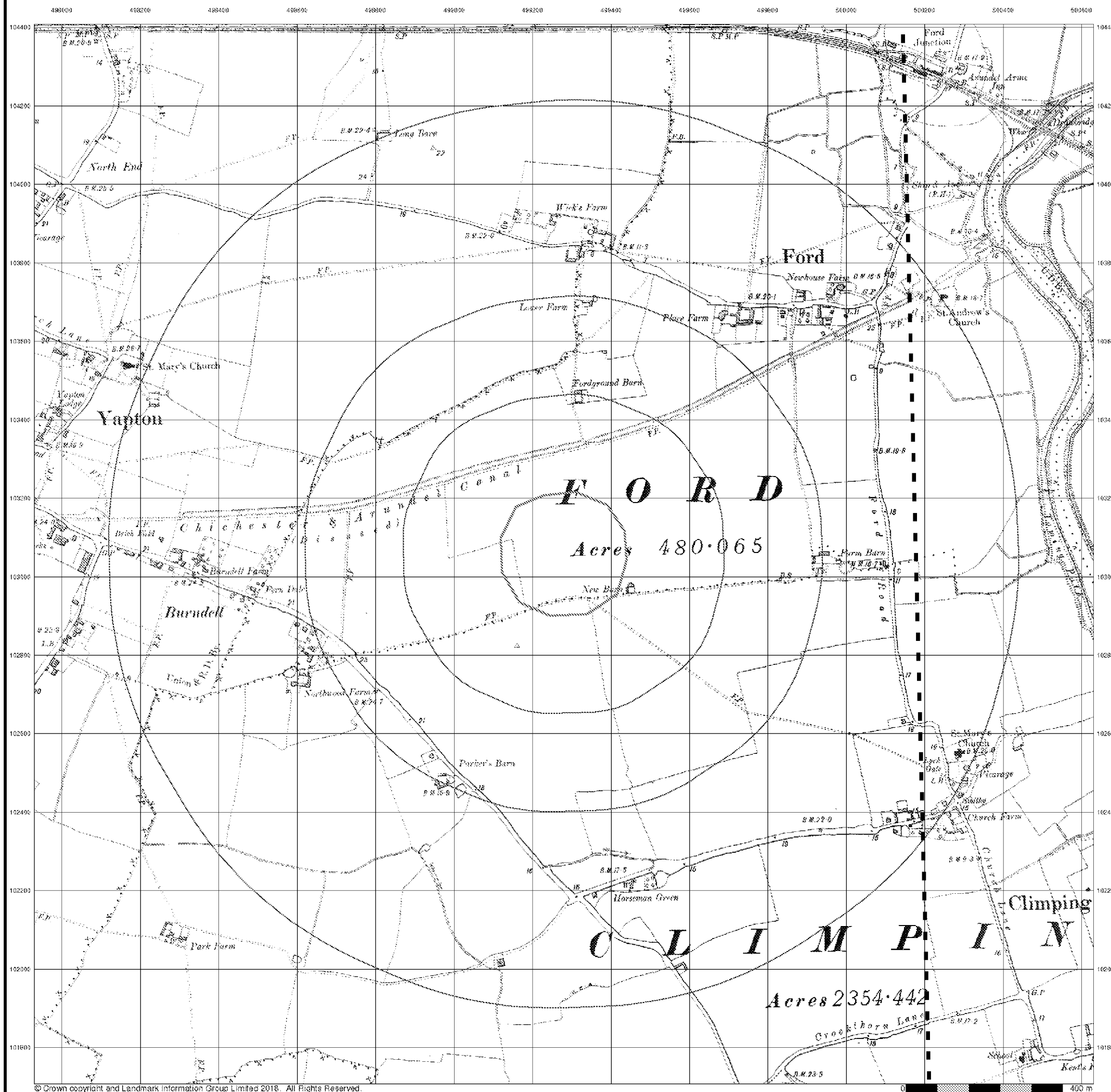
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Landmark
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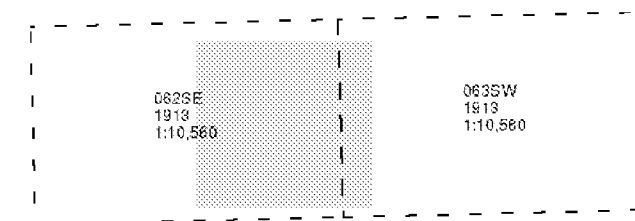
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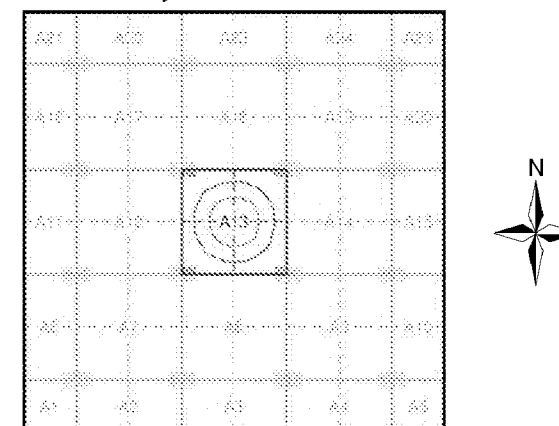


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Order Details

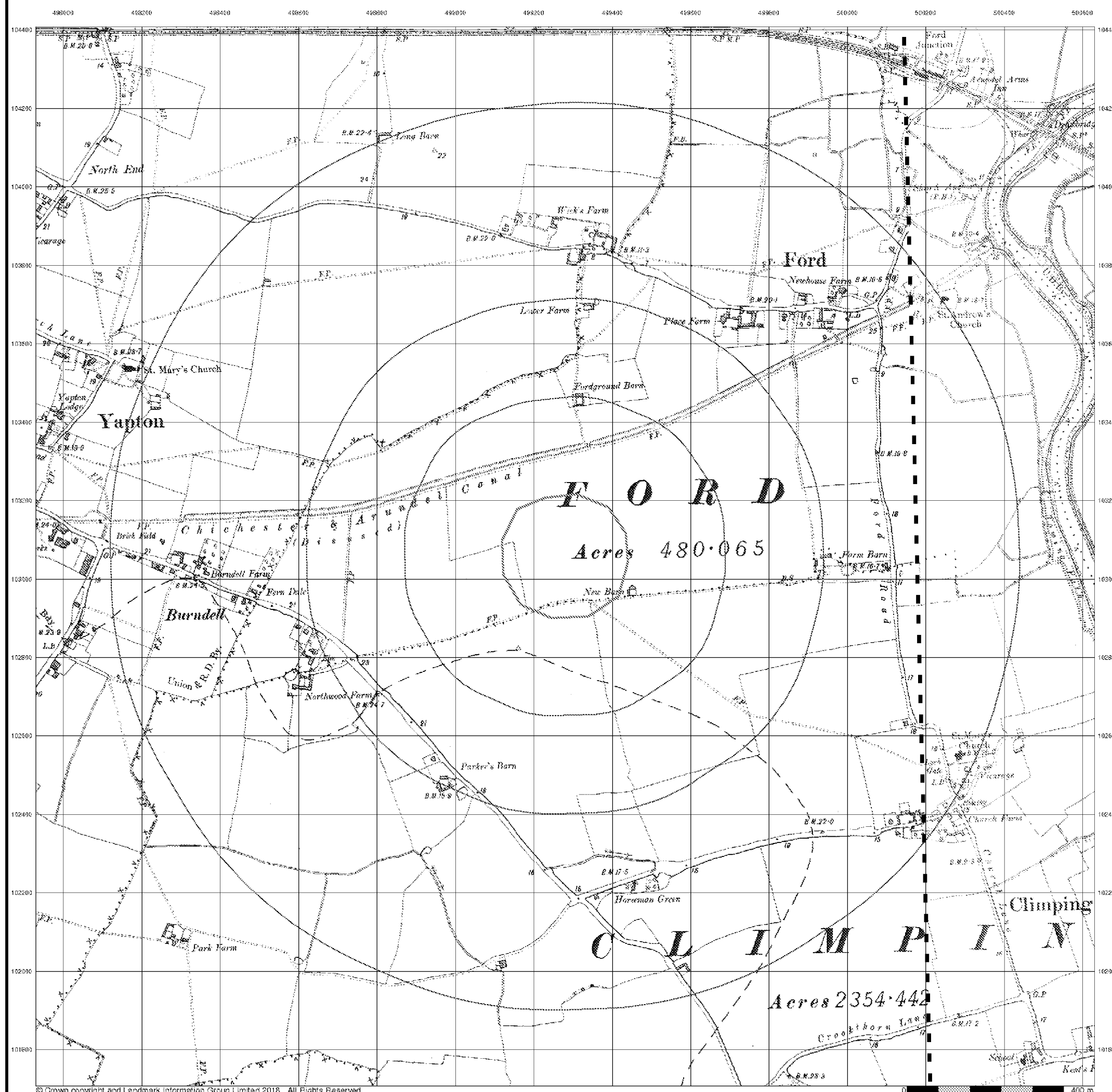
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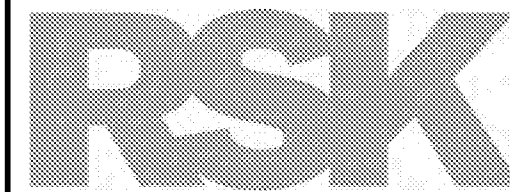
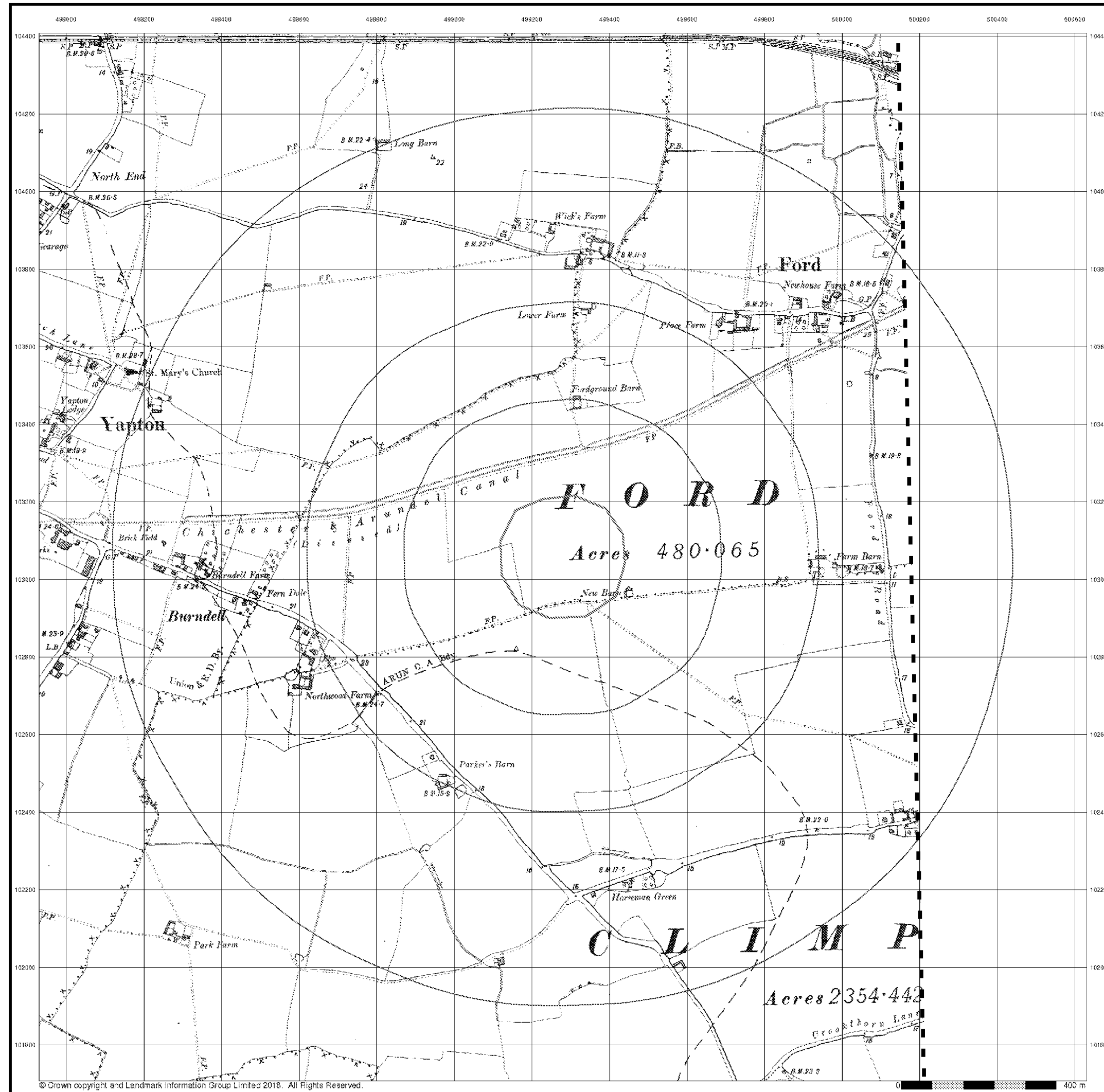
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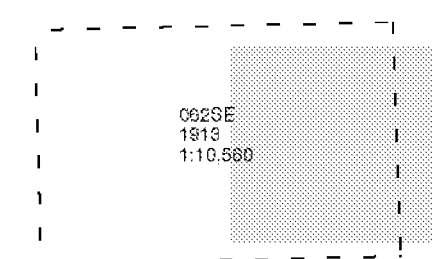
Sussex

Published 1913

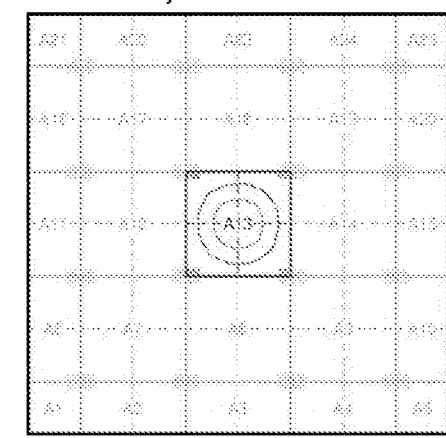
Source map scale - 1:10,560

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Map Name(s) and Date(s)



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Order Details

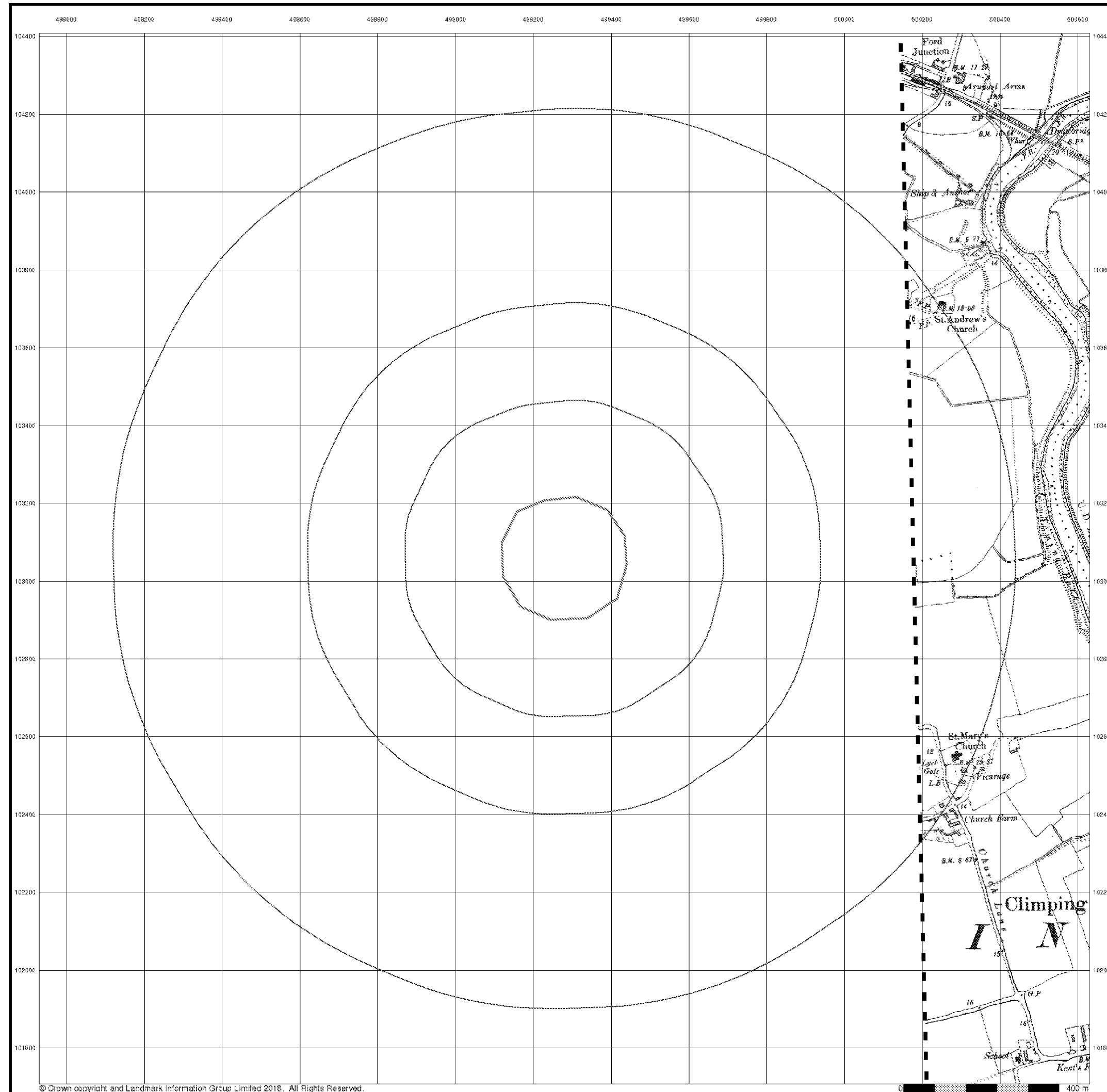
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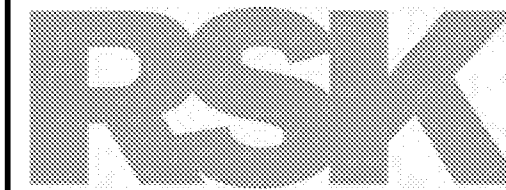
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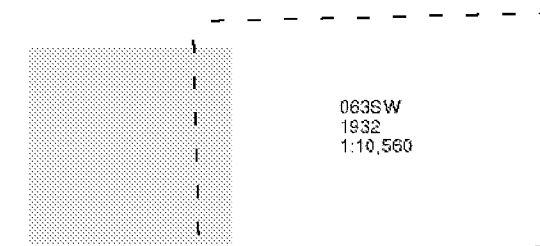
Sussex

Published 1932

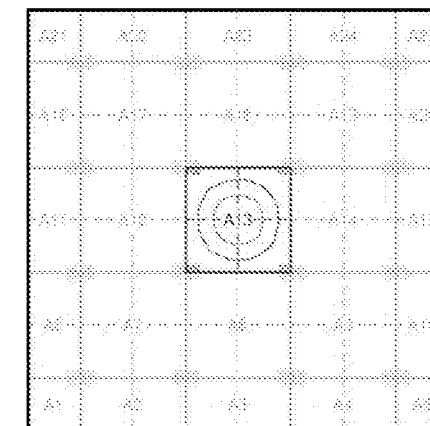
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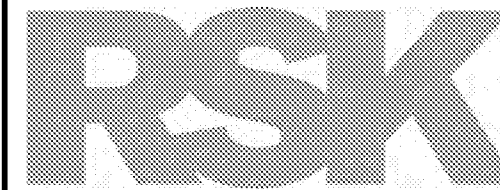
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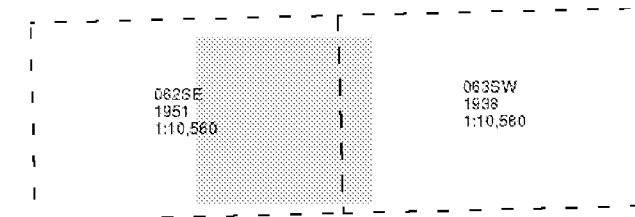
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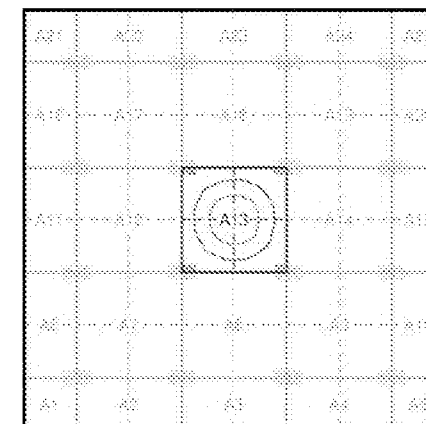
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