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SITE INVESTIGATION REPORT

LAND OFF HARRINGTON DRIVE

CROWLAND

LINCOLNSHIRE

Report Reference C15350

On behalf of:-

**Seagate Homes
Holbeach Manor
Fleet Road
Holbeach
PE12 7AX**

June 2021

SEAGATE HOMES

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FOR

PROPOSED RESIDENTIAL DEVELOPMENT

AT

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INTRODUCTION

The client, Seagate Homes, proposes to build a new residential development on land south of Harrington Drive, Crowland in Lincolnshire.

Ground Engineering Limited was commissioned by the client to carry out a site investigation to determine the nature and geotechnical properties of the underlying soils, and provide information for the design and construction of the foundations. A desk study checking past uses and a contamination assessment were also included within the scope of this report.

LOCATION, TOPOGRAPHY AND GEOLOGY OF THE SITE

The site of the proposed development is located to the south-east of the junction of Harrington Drive with Peterborough Road, on the southern side of Crowland in Lincolnshire. The National Grid Reference for the centre of the site is TF 2408 0934 and its location is shown on plans following this report text.

The approximately 1.75 hectare, irregular shaped site is approximately 70m wide fronting Peterborough Road, increasing to 240m wide behind houses fronting the road and Harrington Drive, and extends 130m south-east to the northern side of James Road. A drain is also present along the north-western boundary of the site with Peterborough Road, which extends southwards across the site connecting to a drain along the northern edge of James Road. The north-western part of the site contained an empty house, derelict wooden stables and shed, and a derelict corrugated roofed garage. The southern part of the site comprised two paddocks fronting James Road. The site is bounded by James Road to the south-east; by houses fronting Peterborough Road to the west and north-west; and by Harrington Drive to the north. Trees were present in the northern part of the site, and along the south-eastern boundary with James Road.

The level site stands at an elevation of about 2mOD fronting Peterborough Road to the north-west, and reduces to about 1mOD fronting James Road to the south-east, in an area of low-lying Fenland.

The geological maps for the area, sheet 158 at 1:50,000 scale, and sheet TF20NW at 1:10,000 scale, show the site to be underlain by a thick succession of Barroway Drove Beds, more recently identified as Tidal Flat Deposits. These silt and organic clay soils are indicated to rest on the solid geology of the Oxford Clay Formation at depth. Previous work in the vicinity has found a Marine Sand beneath the surface layer of Tidal Flat Deposits.

HISTORY OF THE SITE

Research into the site history involved reference to historical Ordnance Survey (OS) maps, photographs and information obtained from the internet. The map extracts and photographs studied are presented in the desk study map section, Appendix 1, and are described below. Distances are approximate.

<i>OS Map Extract</i>	<i>Description</i>
1886-87 Lincolnshire Sheets 148SW & 153NW Scale 1:10,560 Figure A	The site is undeveloped within fields on the south-east side of Kennulphôs Drove. Drains are present crossing the site. A corn mill is shown 160m north of the site. Greenbank Drain is 180m north-east of the site, which flows to the south-east. Green Bank, an earthworks (flood defence), is present north of Greenbank Drain. Crowland is to the north-north-west of the site.
1888 Lincolnshire Sheets 153.1 & 153.2 Scale 1:2500 Figure B	The site and immediate surrounding area appear unchanged.
1901-04 Lincolnshire Sheets 153.1 & 153.2 Scale 1:2500 Figure C	The site and immediate surrounding area appear unchanged.
1950 Lincolnshire Sheets 148SW & 153NW Scale 1:10,560 Figure D	New buildings are shown in the north-western part of the site. New buildings are also shown off-site to the north-west and north fronting Kennulphôs Drove, and to the north-east fronting Barberôs Drove.
1973-75 Sheets TF2309 & TF2409 Scale 1:2500 Figure E	Additional buildings are shown in the north-western part of the site, which is denoted as an Engineering Works. The road to the north-west of the site is now named Peterborough Road. A tree-lined drain is shown along the south-eastern boundary of the site, with a new road (James Road, A1073) beyond. A pumping station is shown 35m north of the site; poultry houses 60m north-west; a piggery 80m north-east; and a garage 80m south-west of the site. New houses are also shown along Barberôs Drove to the north-east of the site.
1978-79 Sheets TF20NW & TF21SW Scale 1:10,560 Figure F	The site and immediate surrounding area appear generally unchanged. The poultry houses are no longer shown to the north-west of the site.

<i>OS Map Extract</i>	<i>Description</i>
1989 Sheets TF2309 & TF2409 Scale 1:2500 Figure G	The site area appears unchanged but is no longer denoted as a works. New roads (Harrington Drive and Harrington Way) and housing have been built immediately north of the site. A new road, Tatwin Drive, has also been built to the north-west of the site on the other side of Peterborough Road.
1995 Sheets TF2309 & TF2409 Scale 1:2500 Figure H	The site area appears unchanged. Additional houses have been built fronting Harrington Drive to the north of the site.
1999-2014 GroundSure Aerial Photograph of Site (Pages 10-12, Appendix 2)	The site comprises a north-western part with buildings and trees, and southern and eastern field areas sub-divided by drain. Mature trees are also evident along the southern and eastern boundary with James Road. New buildings are shown at the (former) piggery site to the north-east of the site, including the foundations for a new house on its northern side.
2001 Sheets TF20NW & TF21SW Scale 1:10,000 Figure I	The site area appears unchanged. A new road, Harvester Way, and houses have been built 80m south-west of the site on the other side of Peterborough Road.
2003 Sheets TF2309SE & TF2409SW Scale 1:1250 Figure J	The site and immediate surrounding area appear unchanged.
2017-2020 GroundSure Aerial Photographs of Site (Pages 8-9, Appendix 2)	The site remained unchanged. A new road (A16) has been built to the south-east of the site (by 2012).
2021 Sheets TF20NW & TF21SW Scale 1:10,000 Figure K	The site and immediate surrounding area appear unchanged. The A16 Crowland bypass is clearly evident skirting the town to the south-east.
2021 Sheets TF2309 & TF2409 (BT) Not to Scale Figure L	The site is shown sub-divided into three parts, with the house and outbuildings (stable) in the north-western area, and two paddocks to the south and east. Some of the former works buildings have been cleared from the north-western part of the site.

Summary of Historical Information

The Ordnance Survey map of 1886-7 showed that the site was undeveloped within a rural area to the south of Crowland. The site remained undeveloped until a house and outbuildings were shown on the 1950 map extract, which was identified as an engineering works in the 1970s. The north-western part of the site was no longer denoted as a works by 1989, and some of the former buildings associated with the works had been cleared by 2021. The house and derelict outbuildings were present at the time of this investigation in April 2021.

The area around the site was initially fields to the south of Crowland. New houses had been built adjacent the site by 1950, and James Road (A1073) had been routed to the south-east by the 1970s. By the 1970s the area around the site had been partly developed which included a pumping station to the north; poultry houses to the north-west; a piggery to the north-east; and a garage to the south-west.

SUMMARY OF ENVIRONMENTAL DATA

Appendix 2 contains information derived from Environmental Databases for a radius of up to 2,000m from the site. The information covers datasets held by Groundsure with contributors including the local authority, the Environment Agency (EA), British Geological Survey, Ordnance Survey and the Coal Authority and the results, within a radius of 250m, are summarised below:

1-2. Historical Industrial Sites	On-Site	0 - 250m
Potentially Contaminative Uses (1:10,000 mapping)	1	8
Historical Tank Database	0	0
Historical Energy Features Database	0	3
Historical Petrol & Fuel Site Database	0	0
Historical Garage & Motor Vehicle Repair Database	0	3
3. Landfill and Other Waste Sites	On-Site	0 - 250m
Landfill Sites	0	0
Historical Landfill and Other Waste Sites	0	0
Waste Exemptions	0	2
4. Current Land Use	On-Site	0 - 250m
Current Industrial Sites Data	0	4
Records of Petrol and Fuel Sites	0	1
Underground Electricity, High Pressure Oil and Gas Pipelines	0	0
Sites Determined as Contaminated Land under Part IIA EPA 1990	0	0
Records of COMAH and NIHHS Sites	0	0
Environmental permits/pollution incidents/registers	0	4
5-6. Hydrogeology and Hydrology	On-Site	0 - 250m
Productive strata within superficial geology beneath the site	No	
Productive strata within solid geology	No	
Groundwater Abstraction Licences	0	0
Surface Water Abstraction Licences	0	0
Potable Water Abstraction Licences	0	0
Source Protection Zones	0	0
Water Network Entries	6	58
Surface Water Features	1	22

7-9. Flooding					
Risk of flooding from rivers & the sea (RoFRaS) rating				Medium	
Historical flood events				1	0
Flood defences within 250m of site				No	
Any areas benefitting from flood defences within 250m of site				No	
Flood storage areas within 250m of site				No	
Environment Agency indicative Zone 2 floodplains within 50m of site				Yes	
Environment Agency indicative Zone 3 floodplains within 50m of site				Yes	
Surface water flooding on site				1 in 30 year (0.10m to 0.30m)	
Groundwater flooding on site				Negligible	
10-13. Designated Environmentally Sensitive Sites				On Site	0 - 250m
Environmentally sensitive sites				2	0
14-16. Geology					
Artificial Ground or Made Ground records				0	0
Superficial Ground and Drift Geology records beneath the site				Yes	
17. Natural Hazards (on site)					
Hazard	Negligible	Very Low	Low	Moderate	High
Shrinking or Swelling Clay	-	-	-	On-site	-
Running Sand	-	-	-	On-site	-
Compressible Ground	-	-	-	-	On-site
Collapsible Rocks	On-site	-	-	-	-
Landslides	-	On-site	-	-	-
Soluble rocks	On-site	-	-	-	-
18. Mining					
Surface ground workings				0	0
Underground workings				0	0
Non coal-mining areas within 50m of site				0	0
Mining cavities				0	0
Brine affected areas on study site				No	
19. Radon					
The property is not in a Radon Affected Area, as less than 1% of properties are above the action level. No Radon Protective Measures are required for new properties or extensions.					

Database Summary

The engineering works (1976) is identified as a historical land use on the site. A pumping station is recognised 19m north of the site; a corn mill 158m north; and unspecified works/depot 190m north of the site. Electricity sub-stations are recorded 143m west and 181m north of the site. An historical garage (1965) is identified 54m south-west of the site. No petrol or fuel stations are recorded within 250m of the site. No historic landfills are recorded on, or within 250m of the site. Two waste exemptions for use of waste in construction are recorded 134m and 234m south-west of the site.

Recent industrial land uses around the site include electricity sub-stations to the north and west. An obsolete petrol station is recorded 54m to the south-west of the site. Three pollution incidents are recorded 6m north-west and 15m west of the site, for events which occurred in 2002, for atmospheric pollutants and effect, which had minor impact on air.

Superficial Tidal Flat Deposits are shown beneath the site, which are classified by the EA as an 'Unproductive' stratum. The solid geology Oxford Clay Formation underlying the site is also classified by the EA as an 'Unproductive' stratum. There are no groundwater abstractions within 250m of the site. The site is not within a source protection zone.

Surface water drains cross the site and are present along the south-eastern boundary of the site beside James Road. The site is within a Zone 2 and Zone 3 floodplain, and has a medium risk of flooding. The site flooded in 1947 from the River Welland. The site is within a nitrate vulnerable zone, and an SSSI impact zone, both environmentally sensitive areas.

There is a high hazard from compressible ground; a moderate hazard from shrinking and swelling clay and running sand; a very low hazard from landslides; and a negligible hazard from soluble rocks and collapsible rocks. The site is not in an area affected by mining.

The site is not in a radon affected area, and no radon protection measures are required for new properties on the site.

PRELIMINARY RISK ASSESSMENT

Potential sources of contamination present on or beneath the site would relate primarily to; the historical use of the site; the presence of contaminated soil; and the potential presence of hazardous or ground gas beneath the site.

In order to assess the risks associated with the presence of ground contamination the linkages between the sources and potential receptors to contamination need to be established and evaluated. This is in accordance with the Environmental Protection Act 1990, which provides a statutory definition of Contaminated Land. To fall within this definition it is necessary that, as a result of the condition of the land, substances may be present on or under the land such that;

- *Significant harm is being caused or there is a significant possibility of such harm being caused; or*
- *Pollution of controlled waters is being, or is likely to be, caused.*

There are three principal factors that are assessed whilst undertaking a qualitative risk assessment for any site. These are the presence of a contamination source, the existence of migration pathways and the presence of a sensitive target(s). It should be noted that it is necessary for each element of source, pathway and target to be present in order for exposure of a human or environmental receptor to occur.

UK Government guidance on the assessment of contaminated land, requires risk to human health and the environment to be reviewed using source – pathway – target relationships. If each of these elements is present, the linkage provides a potential risk to the identified targets.

Contaminants or ***potential pollutants*** identified as ***sources*** in relation to the identified previous uses are listed overleaf in Table 1.

Table 1: Identified Potential Contaminant Sources

<i>Contaminant Source</i>	<i>Comments</i>
Drainage/ Buildings	Effluent from existing field drains could provide a contaminant source. The house and outbuildings may include asbestos containing materials (ACM).
Soil Beneath Site	Contamination may be present within any made ground on the site.
Soil Gas	Potential soil gas generated from made ground or naturally deposited organic soils.
Ground Contamination Outside Site Boundary	Ground contamination migrating from adjoining sites.

A ***Pathway*** is defined as one or more routes through which a receptor is being, or could be, exposed to, or affected by, a given contaminant.

Potential ***Targets or Receptors*** fall within the categories of Human Health, Water Environment, Flora and Fauna, and Building Materials.

There are a number of possible pathways for the contaminants identified on the site to impact human and/or environmental receptors and these are summarised in Tables 2 and 3.

Table 2: Human Receptors and Pathways

<i>Human Receptor-Mechanism</i>	<i>Typical Exposure Pathway</i>
Human Inhalation	Breathing Dust and Fumes Breathing Gas emissions
Human Ingestion	Eating -contaminated soil, for example by small children -produce grown on contaminated soil Ingesting dust or soil on vegetables Drinking contaminated water
Human Contact	Direct skin contact with contamination Direct skin contact with contaminated liquids

Table 3: Water Receptors and Pathways

<i>Receptor-Water Environment</i>	<i>Typical Exposure Pathway</i>
Groundwater The superficial Tidal Flat Deposits and solid geology Oxford Clay are indicated to be 'Unproductive' strata. The site is not within a Source Protection Zone.	Surface infiltration of atmospheric waters into the soils beneath the site could wash or dissolve potential contaminants and migrate to underlying groundwater. Contamination leads to restriction/prevention of use as a resource, for example, drinking water, and can have secondary impacts on other resources, which depend on it.
Surface Water/Watercourses The nearest surface water feature is a drain crossing the site. The River Welland is approximately 1.6km north-west of the site.	Surface infiltration of atmospheric waters into the soils beneath the site could wash or dissolve potential contaminants and laterally migrate. Contamination leads to a restriction/prevention of use: -as drinking water resource -for amenity use Effects on aquatic life.

Preliminary Conceptual Model

Assessment of the potential linkage between ground contamination sources, human and environmental receptors have been assessed based on the desk study research documented in the preceding sections of this report.

A generalised preliminary conceptual model is presented below in Table 4.

Table 4: Preliminary Conceptual Model Relative to Residential Development

Receptors	Pathway	Estimated Potential for Linkage with Contaminant Sources			
		Drainage/ Buildings	Soil Beneath Site	Soil Gas	Ground Contamination Outside Site Boundary
Human Health i ground or construction workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Low likelihood/ Likely	Low likelihood	Low likelihood	Low likelihood
Human Health i end users	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	N/A	Low likelihood	Low likelihood	Low likelihood
Water Environment	Migration through ground into surface water or surrounding groundwater	Low likelihood	Low likelihood	Unlikely	Low likelihood
Flora	Vegetation on site growing on contaminated soil	Low likelihood	Low likelihood	Low likelihood	Unlikely
Building Materials	Contact with contaminated soil	Low likelihood	Low likelihood	Low likelihood	Low likelihood
<u>Key to Table 4</u> Estimated Potential for Linkage with Contaminant Source		Definition			
High likelihood		There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.			
Likely		There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.			
Low likelihood		There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term.			
Unlikely		There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.			
N/A		Not Applicable.			

SITE WORK

The site work conducted on 4th May 2021 comprised eight machine excavated trial pits (TP1 to TP8), and a shallow pit for sampling (CBR1). The positions are shown on the exploratory hole location plan following this report text.

Public utility service drawings were sourced and consulted prior to determining the exploratory hole positions. Prior to excavation, a service scan was made at each position using a CAT (Cable Avoidance Tool) to check for the absence of detectable buried services that may otherwise have been damaged by the investigation.

The exploratory hole records, presented following the plans, give the descriptions and depths of the various strata encountered, details of all samples taken, in-situ tests and the groundwater conditions observed during and on completion of excavation.

Machine Excavated Trial Pits

Trial pits TP1 to TP8 were excavated using a JCB 3CX to depths of between 1.30m and 3.50m. A 0.60m deep pit was also excavated for sampling at location CBR1. The exposed strata were sampled and recorded by a Geoenvironmental Engineer. Representative small, bulk and environmental jar samples of soil were taken at regular intervals throughout the depth of each trial pit.

An immediate assessment of the apparent shear strength of clay was made within the trial pits using a hand shear vane.

A Mackintosh Probe (MP) was used to provide an indication of the density of the soils within selected trial pits. The 25mm diameter solid cone point of the probe was screwed onto the rods and driven into the ground by repeated blows of a 4.5kg slide hammer with a fall of 0.30m. The depth penetrated for 100 blows was recorded and is presented on the trial pit records.

A soakaway test was carried out within trial pit TP1 in broad accordance with BRE Digest 365 (2016) in order to allow the assessment of the soil infiltration rate. The general

method of the test was to excavate the trial pit with vertical sides trimmed square to the base. The dimensions were accurately measured and recorded, and the pit was then filled with clean water. The rate of water dissipation from the pit was measured by recording the depth of water relative to a datum at frequent time intervals. After an initial 246 minute monitoring period the water had been so slow to drain the pit was not refilled and the test was abandoned. The results are presented and follow the respective trial pit record.

On completion, the trial pit was emptied of water, backfilled with arisings and the surfaces reinstated.

LABORATORY WORK

The samples were inspected in the laboratory and assessments of the soil characteristics have been taken into account during preparation of the trial pit records. The soil descriptions have been made in accordance with BS5930:2015. The geotechnical test results, undertaken in accordance with BS1377:1990 & 2016, are presented following the exploratory hole records. The chemical test results follow the geotechnical test results.

The moisture content and index properties of selected soil samples were determined as a guide to soil classification and behaviour. The liquid limit was determined by a cone penetrometer.

The particle size distribution of selected samples of silt and sand were determined by sieve analysis. The particle size distribution passing the 63µm sieve was obtained by pipette sedimentation on selected samples. Results of these tests have been combined and are presented as particle size distribution curves at the end of this report.

California Bearing Ratio (CBR) tests were performed on selected recompacted near surface samples in accordance with Lincolnshire County Council's specification. The samples were recompacted using a 2.5kg rammer (BS light), and the test consisted of jacking into the soil a cylindrical plunger with a cross sectional area of 1935mm². A force of 50N was applied initially to seat the plunger on the soil surface and then the plunger was made to penetrate the soil at a uniform rate of 1mm/min. Readings of force were taken at intervals of penetration of 0.25mm to a penetration not exceeding 7.50mm. The CBR value is the ratio of the force required to achieve 2.5mm or 5.0mm penetration to standard forces expressed as a percentage.

Selected samples of soil and groundwater were analysed to determine the concentration of soluble sulphates. The pH values were also determined.

Chemical analysis of soil samples recovered from the exploratory holes was undertaken, by an independent laboratory, primarily for characterisation purposes. The samples were tested for a suite encompassing a wide range of potential contaminants outlined by the

Environment Agency (EA) and National House Building Council (NHBC) document R&D 66;
2008 'Guidance for the Safe Development of Housing on Land Affected by Contamination'

GROUND CONDITIONS

The ground conditions have been plotted as a soil profile in Figure 1. The ground conditions comprised a surface layer of made ground or topsoil to between 0.20m and at least 0.60m depth, underlain by superficial Tidal Flat Deposits comprising sandy, silty clay. In the northern part of the site the Tidal Flat Deposits were encountered to between 0.65m and 1.10m depth, and overlay slightly clayey, silty Marine Sand at least the base of the pits at between 1.30m to 3.00m depth. In the southern part of the site, the Tidal Flat Deposits became very soft and slightly organic below between 0.80m and 1.90m depth, to at least the base of the trial pits at between 2.80m (TP4) and 3.40m (TP8) depth. Abbey Sand and Gravel was encountered at 3.40m to at least 3.50m depth in TP5 in the south-eastern part of the site. Groundwater was recorded between 0.80m and 2.20m depth during the investigation.

Made Ground/Topsoil

Made ground was encountered in the north-western part of the site to between 0.20m and at least 0.60m depth. The made ground comprised firm, friable, brown, slightly sandy, slightly gravelly, silty clay fill in TP2, and brown, clayey and silty, sand and gravel fill with occasional cobbles of brick and plastic in TP3. The gravel fraction comprised angular to rounded flint, limestone, concrete and brick fragments.

In pit CBR1, in the central part of the site, firm, friable, brown and dark brown, slightly sandy, slightly gravelly, silty clay fill was encountered to at least 0.60m depth. The gravel fraction comprised fine and medium grained, sub-angular and sub-rounded, flint, siltstone and shell fragments.

In TP1 in the garden to the house, and in TP4 to TP8 in the paddocks to the south, topsoil comprising firm, friable, brown and dark brown, slightly sandy, silty clay was encountered to between 0.30m and 0.40m depth.

Tidal Flat Deposits

Beneath the surface made ground and topsoil at between 0.20m and at least 0.60m depth, firm or soft, orange brown, light brown and light grey, sandy, silty clay with silty sand partings was encountered to between 0.65m and 1.90m depth, which were considered to represent the anticipated superficial Tidal Flat Deposits.

In the paddocks in the southern and eastern parts of the site (TP4 to TP8), the Tidal Flat Deposits became very soft, light grey, silty, slightly organic clay below 0.80m to 1.90m depth, and extended to between at least 2.80m and 3.40m depth.

Marine Sand

In the north-western part of the site, in TP1 to TP3, medium dense, light brown and orange brown, initially slightly clayey, very silty to silty sand was encountered, and was found to at least the base of these trial pits at a maximum 3.00m depth. The sand fraction was generally fine grained, and these soils were considered to represent superficial Marine Sand.

Abbey Sand and Gravel

Beneath the Tidal Flat Deposits, at 3.40m to at least 3.50m depth in TP5, yellow and grey, very clayey sand and gravel was encountered, which were considered to represent superficial Abbey Sand and Gravel. The gravel fraction comprised angular to rounded flint, limestone and quartz.

Groundwater

Groundwater was recorded during excavation of the trial pits at between 0.80m (TP7) and 3.40m (TP5) depth.

Observations

Live roots were observed in all of the pits, and to a maximum depth of 1.80m in TP2. Trial pit TP2 was amongst the trees in the north-western part of the site. Running sand

conditions were encountered in TP1, TP2, TP3 and TP5, associated with groundwater and the presence of Marine Sand and Abbey Sand and Gravel.

Excavation Stability

The trial pit sides were generally unstable and collapsed.

Evidence of Contamination

The made ground encountered during this investigation was not noted to have olfactory or visual evidence of fuel contamination. The made ground contained occasional brick, concrete and plastic fragments. No asbestos containing materials were noted in the soils during this investigation, or during testing.

COMMENTS ON THE GROUND CONDITIONS IN RELATION TO FOUNDATION DESIGN AND CONSTRUCTION

This investigation found made ground and topsoil to depths of between 0.20m and 0.60m, covering superficial firm or soft clay Tidal Flat Deposits. The north-western part of the site was underlain by medium dense, slightly clayey, silty Marine Sand below 0.65m to 1.10m depth, and the southern and eastern parts of the site by very soft, slightly organic clay below 0.80m to 1.90m depth. Groundwater was met as shallow as 0.80m depth during the investigation.

The proposed development was understood to comprise construction of forty-nine dwellings, associated parking, gardens, open space and access roads. Excavations may encounter groundwater which would need to be controlled.

The superficial deposits in the north-western area (silty sand) could offer support for lightly loaded traditional foundations for the proposed housing development. The silty fine sand was generally medium dense at shallow depths, which may be capable of supporting lightly loaded structures.

The clay and silt in the southern and eastern parts of the site rapidly became very soft and organic with increasing depth, which could offer very limited support for lightly loaded traditional foundations for the proposed development, and the prospect of high total settlements, with potentially damaging differential movements. Houses in these areas are likely to require piled foundations.

Localised deepening of traditional foundations will be required where proposed houses are located close to the existing trees, which will be removed. Foundations will need to penetrate the zones of root influence within the clay soils. In the southern part of the site, the underlying very soft and slightly organic clays locally found as shallow as 0.80m depth, are poorly consolidated, variable and unlikely to provide adequate support for deepened traditional strip foundations. Thus some of the deepened foundations will apply stress to the underlying very soft, grey, slightly organic clay soils, which offer very limited support for traditional

foundations. The proposed houses should not be supported on traditional foundations unless the structures are lightly loaded, regular in shape, and could tolerate potentially significant total and differential consolidation movements.

Any proposed properties close to existing trees, could adopt traditional foundations if all root affected clay soils above the groundwater table are removed and replaced with coarse-grained granular material, otherwise buildings close to trees, would require a piled foundation scheme in order to transfer loads into the expected Oxford Clay below at least 6m depth.

In the north-western part of the site, foundations should extend through any desiccated, root affected clays, into the underlying very silty to silty Marine Sand 0.65m to 1.10m below ground level, which offers modest support for traditional foundations. Following site clearance, a series of pits could be excavated to determine the extent of the sand which is suitable for traditional foundations.

Floor slabs could be ground bearing in areas where they are well away from the influence of trees, or where sand forms the sub-grade, although differential movements are likely to occur.

Traditional Shallow Foundations

Large scale processes of natural sedimentation allow a certain degree of confidence to be placed in the absence of important variation of the engineering properties of natural soils across sites. The made ground had variable bearing properties and was found to a maximum depth of 0.40m, and root affected clay Tidal Flat Deposits were encountered to between 0.90m to 1.60m depth. The made ground and root affected clay soils should both be avoided as bearing strata.

The silty sand soils would be classed as non-shrinkable and where present could enable foundations to be cast at a minimum foundation depth of 0.60m.

Samples of the near surface Tidal Flat Deposits had modified plasticity indices of between 31% and 80%, which rate the soils as having a medium to high volume change potential

based on NHBC Standards Chapter 4.2 'Building near trees' (2021). A minimum foundation depth of 1.00m in the naturally deposited clay soils beneath this site where remote from trees, would be considered appropriate in order to penetrate the zone affected by seasonal moisture content and volume change.

In summary, foundations for the new dwellings will need to be a minimum of 0.60m deep if present in silt or fine sand soils in the north-western part of the site, but must be deepened in order to penetrate any root affected clay Tidal Flat Deposits were encountered to between 0.90m to 1.60m depth. In areas within the zones of root influence, raft foundations could provide an economic foundation alternative. This will require any underlying root affected clay soils to be removed and replaced with non-shrinkable compacted stone to between 0.45m and 1.25m below ground level in accordance with section 4.2.9 of the NHBC Standards referenced earlier. This solution would also avoid requirement for anti-heave precautions, such as void forming or compressible materials, which should be incorporated alongside strip foundations within root affected clay soils.

Bearing Capacity

In the north-western part of the site, the non-shrinkable, orange brown and brown, very silty fine sand, found beneath the surface clay soils at between 0.65m and 1.10m depth, offers a maximum safe bearing pressure of 80kN/m² for foundations up to 1.20m width, where present above the groundwater table. The above bearing pressure should ensure that settlement beneath such foundations would be within 25mm. Settlement within the underlying sand should occur as the loads are applied.

The very soft locally organic clay soils at 1.00m depth, offers a maximum safe bearing capacity of only 25kN/m² beneath a 0.60m wide strip footing, with a factor of safety of 3.0 applied against shear failure, with settlement beneath such foundations in the order of 25mm, and may not be sufficient to support the loads of the structures.

Structures founded within the Tidal Flat Deposits would have to tolerate potentially large total and differential settlements, which may be exaggerated where the

foundations cross any natural variation different soil types. Differential settlements are likely to occur across individual building plots where foundations partially bear within the clay, due to variation in thickness and compressibility of the underlying soils. Further differential movements will occur if and where foundation pressures locally increase along foundation runs. Movements could be further exacerbated by effects of desiccation, which could also locally generate upward heave movements. New strip foundations should incorporate reinforcement in order to minimise differential movements along or between them.

Piled Foundations

Piled foundations could support the proposed dwellings and avoid the potential problems with limited bearing pressures, differential settlement and water bearing ground. The ground conditions should be proved by cable percussion boreholes to an estimated 15m to 20m below ground level to provide the soil properties for piled foundation design. The advice of a specialist piling contractor should be sought with regard to suitable methods of pile installation. The superficial deposits will require use of casing for bored piles and attention should be made to the possibility of 'necking' of concrete within such soils. Driven, bored or Continuous Flight Augered (CFA) piles could be used.

The advice of a specialist piling contractor should be sought prior to design.

Excavations

The underlying soils should be easily removed within excavations for the proposed buildings, although the remnant foundations from former buildings may be more difficult to remove and require the use of a breaker. The sides of excavations within any made ground, Tidal Flat Deposits and Marine Sand, are likely to be unstable and should not be relied upon to stand unsupported.

Excavations could be expected to encounter groundwater at depths between 0.80m and 2.20m, which is likely to reflect the water level in nearby drains. The groundwater levels may fluctuate seasonally and such inflows would locally be accompanied by 'running sand'

conditions and resulting instability. Care should be taken not to excavate below the water table in the absence of suitable groundwater control, such as dewatering via screened sumps or well points and side support by interlocking sheeting. The clay, silt and sand are prone to softening, deterioration and loosening in the presence of water, with loss of their already limited bearing properties. Care should be taken to keep the excavations dry.

Attention should be given where personnel are to enter deep excavations, when sides should either be safely battered back, or close side support provided, in order to comply with statutory safety requirements and prevent sidewall collapse.

Floor Slabs

Ground bearing floor slabs could be adopted for the new properties where they are beyond the zones of influence from trees, and the naturally deposited clay/silt and non-shrinkable silty sand soils are present at shallow depth.

Ground bearing floor slabs could be adopted for proposed buildings, even within influencing distance of neighbouring trees, if root infested clays are removed and replaced with suitable well-graded coarse-grained fill. Damaging differential heave movements could occur across such slabs, particularly where they cover any clay affected by recently severed tree roots. Suspended floor slabs will be required to avoid the anticipated large total and differential consolidation settlements, any negative skin friction, together with any volume change movements within root affected clays, providing that the sub-floor gaps recommended in Table 7 of the NHBC Standards Chapter 4.2 (2021), are adopted.

Hardstanding

Naturally deposited, firm or soft, silty clays were encountered at sub-grade level across this site.

Based on IAN 73/06, Table 5.1 recommends a design CBR value of 1.0% for silt, 2.0% for silty clay with a plasticity index of 60%, and 20% for a poorly graded sand.

Laboratory CBR tests yielded CBR values ranging between 0.2% and 4.6%. A design CBR value of 1.0% for the naturally deposited very silty sand, and 2.0% for silty clay should be adopted for hardstanding design on this site, although the pavement construction will need to be at least 450mm thick since the silty soils are considered to be potentially frost susceptible in accordance with Road Note 29, Appendix 1.

The sub-grade should be suitably compacted and inspected, with any made ground, topsoil, very soft, organic or desiccated clays, being removed and replaced with suitable well-graded coarse-grained fill. Care should be taken not to allow exposed silt/clay soils at sub-grade level to become exposed to inclement weather conditions, since they are prone to rapid softening and deterioration. A permeable geotextile should be incorporated in order to prevent both loss of any sub-base material into the sub-grade and migration of sub-grade soils into the overlying sub-base.

Drainage

The soakaway test in TP1 determined an extrapolated soil infiltration rate (f) of 1.26×10^{-6} m/s, for the sandy, silty clay covering slightly clayey, silty fine sand. This result rates the soil as having a 'poor' drainage potential according to BS8004:1986 Figure 6.

Groundwater was met during excavation of the trial pits at depths of between 0.80m and 2.20m. The soakaway drainage on this site may deteriorate over time as the chambers become blocked with silt. Provision should be made for regular cleaning. There would be no advantage in excavating soakaway chambers below the groundwater level, which reduces the effective volume of the soakaway.

Sulphate Conditions

Sulphate analysis of selected samples of soil and groundwater yielded soluble sulphate concentrations within Design Sulphate Classes DS-1, DS-2 and DS-3, of the BRE Special Digest 1, Table C1 (2001), presented in Appendix 3. The pH results of the samples

ranged between 3.9 and 8.4 indicating acidic to alkaline conditions. The characteristic pH value is 4.75.

These results indicate an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-4 for buried concrete. This ACEC Class should be considered when specifying a Design Chemical Class (DC Class) for buried concrete on this site, as detailed in the above cited BRE document.

COMMENTS ON THE SOIL CHEMICAL TEST RESULTS

The results of the laboratory chemical testing on near surface soil samples have primarily been compared to soil screening values (SSVs) produced by Land Quality Management Limited (LQM) and the Chartered Institute for Environmental Health (CIEH) presented in their document 'The LQM/CIEH S4ULs for Human Health Risk Assessment: 2015 (Publication Number S4UL3608)'. The LQM/CIEH S4ULs are intended for use in assessing the potential risks posed to human health by contaminants in soil and are transparently-derived and cautious 'trigger values' above which further assessment of the risks or remedial action may be needed. The S4ULs (Suitable for Use Levels) have been derived, in accordance with UK legislation and Environment Agency policy, using a modified version of the Environment Agency CLEA 1.06 software.

Reference has also been given to ATRISKsoil soil screening values produced by Atkins Limited and provided under licence to Ground Engineering Limited. Atkins SSVs have been derived in line with the Environment Agency 2009 guidance using the CLEA 1.071 software. With the absence of a S4UL for cyanide the ATRISKsoil SSV has been used as the soil screening criteria within this report.

In 2014 the Department for Environment Food and Rural Affairs (DEFRA) published, in their document SP1010, Category 4 Screening Levels (C4SL) for several contaminants including lead. The C4SL represent screening levels below which the land could be considered suitable for a specified use and definitely not contaminated land in respect of those determinands. With the absence of S4UL for lead the C4SL has been used as the soil screening criteria within this report.

For each contaminant the adopted soil screening criteria have been calculated for the following land uses:

- Residential use with home grown produce
- Residential use without home grown produce
- Commercial and industrial usage

The intended purpose of the SSVs are as 'intervention values' in the regulatory framework for assessment of human health risks in relation to land use. These values are not binding standards, but are intended to inform judgements about the need for action to ensure that a new use of land does not pose any unacceptable risks to the health of the intended users.

Table 5 compares the test results for the made ground with the SSVs in relation to the specified uses. The number of test results, which exceed these values, are also provided.

Table 5: Comparison of Chemical Test Results with SSVs for Near Surface Soils

Determinand	Number of Samples	Min Value mg/kg	Max Value mg/kg	Number of Samples Exceeding SSV for			Measured 95 th Percentile mg/kg	Assessment Method	Soil Screening Criteria 1.0% SOM		
				Residential with home grown produce	Residential without home grown produce	Commercial/ Industrial			Residential with home grown produce mg/kg	Residential without home grown produce mg/kg	Commercial/ Industrial mg/kg
Organic Matter	8	1.1%	19%	-	-	-	-	-	-	-	-
Arsenic	8	14	33	0	0	0	27.59	S4UL	37	40	640
Cadmium	8	0.10	0.64	0	0	0	0.36	S4UL	11	85	190
Chromium (III)	8	26	38	0	0	0	33.61	S4UL	910	910	8600
Chromium (VI)	8	<0.5	<0.5	0	0	0	<0.5	S4UL	6	6	33
Lead	8	25	56	0	0	0	44.08	C4SL	200	310	2330
Mercury	8	<0.10	0.31	0	0	0	0.20	S4UL	11	15	320
Selenium	8	<0.20	1.2	0	0	0	0.92	S4UL	250	430	12,000
Nickel	8	21	33	0	0	0	30.04	S4UL	130	180	980
Phenols	8	<0.10	0.11	0	0	0	0.10	S4UL	120	440	440
Benzo[a]pyrene	8	<0.10	0.92	1	0	0	0.40	S4UL	0.79	1.2	15
Copper	8	15	30	0	0	0	24.64	S4UL	2400	7100	68,000
Zinc	8	53	99	0	0	0	85.58	S4UL	3700	40,000	730,000
Free Cyanide	8	<0.50	0.50	0	0	0	<1	ATRISK	34	34	34

Notes

S4UL and C4SL for metals were derived using 6% SOM. These values are not sensitive to SOM and would also be applicable for 1% SOM and 2.5% SOM.

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ATRISKsoil SSVs produced by Atkins Limited and provided under licence to Ground Engineering Limited.

Discussion of Soil Results

Apart from a marginally elevated benzo[a]pyrene concentration in TP2 at 0.10m depth, levels of all elements and compounds in the samples tested were within the associated soil screening values for both residential end uses and for commercial/industrial end use.

Statistical analysis, using the mean value test, indicates that none of the US95 values exceeded the screening values for the most sensitive end uses of residential with home grown produce and residential without home grown produce, nor the screening values for a commercial or industrial usage.

The made ground encountered during this investigation was not noted to have olfactory or visual evidence of fuel contamination.

No asbestos containing materials (ACM) were observed within the made ground soils during site work or testing in the laboratory.

In conclusion, the near surface soils would be suitable for use in the proposed gardens and landscaped areas of the residential development, and also beneath buildings and areas of permanent hardstanding if geotechnically suitable.

UPDATED CONCEPTUAL MODEL

Assessment of the potential linkage between ground contamination sources, human and environmental receptors have been assessed based on the desk study research and the intrusive ground investigation documented in the preceding sections of this report.

A generalised conceptual model relative to the existing site and proposed residential use of the site is presented in Table 6 below.

Table 6: General Conceptual Model Relative to Future Residential Development

Receptors	Pathway	Estimated Potential for Linkage with Contaminant Sources			
		Drainage/ Buildings	Soil	Soil Gas	Off-Site Sources
Human Health i ground workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Low/ Moderate	Low	Low	Very Low
Human Health i users of completed development	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	N/A	Very Low	Low	Very Low
Water Environment	Migration through ground into surface water or groundwater	Low	Very Low	Very Low	Low
Flora	Vegetation on site growing on contaminated soil	Very Low	Very Low	Very Low	Very Low
Building Materials	Contact with contaminated soil	Very Low	Very Low	Very Low	Very Low

<u>Key to Table 6</u> Risk	Definition
Very High	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, or, there is evidence that severe harm to a designated receptor is currently happening. The risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) and remedial works may be necessary in the short term and likely over the long term.
Moderate	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.
Low	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.
N/A	Not Applicable because the proposed development will remove the source.

COMMENTS ON GROUND CONTAMINATION IN RELATION TO PROPOSED DEVELOPMENT

Anticipated exposure scenarios relating to the existing site, the site history and proposed residential end use of the site, in the context of the conceptual model, are discussed as follows.

This investigation may not have revealed the full extent of contamination on the site and appropriate professional advice should be sought if subsequent site work reveals materials that may appear to be contaminated.

Contaminated Soil

On the basis of the ground investigation, the site is underlain by between 0.20m and 0.60m of made ground and topsoil. The chemical testing has identified no significant elevated concentrations in the soils tested in respect to the proposed gardens or soft landscaping in the residential development, and would be suitable beneath buildings or areas of permanent hardstanding. The absence of contaminants in the made ground indicates that there is a low risk of contaminants affecting groundworkers during any construction works, and there will be a very low risk of affecting future end users of the site.

The underlying naturally deposited soils encountered beneath the site would generally be considered suitable for retention and re-use within the development if required.

Existing Drainage

Redundant drain runs, where encountered, should be removed from beneath the site and precautions should ensure that any remaining effluent is directly disposed off-site. The integrity of existing drainage should be checked, and if they are to be retained any damaged sections should be replaced prior to development. The latter measures should minimise any future risk to human health and the water environment.

Buildings

The existing house and outbuildings within the site may have asbestos containing materials within them and an asbestos survey should be undertaken prior to demolition for the proposed redevelopment. Suitable precautions, in line with current best practice, should be put in place to protect workers from the effects of asbestos material, during the site clearance and redevelopment phases.

There is a very low risk of contamination affecting the existing and proposed structures, and their foundations.

Soil Gas

According to the environmental database there are no landfills recorded within 250m of the site. The site is generally underlain by a thin layer of made ground and topsoil, covering variable Tidal Flat Deposits and in turn Marine Sand at depth.

There is a low risk that hazardous gases would affect groundworkers during the construction phase and a low risk of hazardous gases affecting future users of the site.

Consideration should be given to gas monitoring within deep or confined spaces, particularly where thick made ground and organic soils are present, to ensure safety of personnel entering them, since carbon dioxide could accumulate within any excavations, service chambers or sub-structures. If additional boreholes are to be undertaken, it would provide the opportunity to install gas monitoring standpipes to check on the gas regime at the site.

The site is not in a radon affected area, and no radon protection measures are required for new properties on the site.

Human Health - Construction Workers

Based on the chemical test results, no special precautions would be required during the development of the site by workers who may come into contact with the soil during groundworks, providing standard precautions are adopted which should generally include the procedures given by the Health and Safety Executive (The Blue Book) HS(G)66.

For the protection of workers during groundworks the following is recommended:

- a) Limit repeated or prolonged skin contact with soils by wearing gloves with sleeves rolled down.
- b) Washing facilities should be made available to groundworkers, so as to minimise the potential for inadvertent ingestion of soil.
- c) If any soils are revealed which are different to those encountered by this ground investigation, the advice of a specialist should be sought in view of classifying the material and ascertaining its risk to groundworkers.
- d) Suitable precautions, in line with current best practice, should be put in place to protect workers from the effects of asbestos containing material, during the site clearance phase.
- e) Consideration should be given to gas monitoring within deep or confined spaces, particularly where thick made ground and organic soils are present, to ensure safety of personnel entering them, since carbon dioxide could accumulate within any excavations, service chambers or sub-structures.

Human Health - Users of Completed Development

The results of the chemical analysis undertaken would indicate that the made ground and near surface soils should be considered suitable for re-use at the surface in any new garden, landscaped or planted areas.

The made ground could be considered for re-use beneath proposed buildings and permanent hardstanding, if suitable for engineering purposes, where it is unlikely to affect future users of the site, however these soils could affect buried services.

Any soil imported to site must be certified as "suitable for use".

Water Environment

The site is underlain by superficial Tidal Flat Deposits and solid geology Oxford Clay at depth, which are indicated by the EA to be 'Unproductive' strata. The Marine Sand

beneath the site would be anticipated to be a 'Secondary (A) Aquifer'. The nearest surface water feature is the drain crossing the site, and along the north-western and south-eastern boundaries of the site. The site does not lie within a source protection zone.

Groundwater seepages were recorded as shallow as 0.80m below ground level during the investigation.

The risk to the water environment from soil contaminants is considered very low as it is unlikely that the proposed development and contaminants within the made ground soils would impact the quality of the water environment.

Effects on Building Materials and Buried Services

The sulphate requirements for buried concrete have been discussed in the previous section of this report.

The local water supply company should be consulted if new buried plastic water pipes are to be installed within the made ground soils on this site.

Off-Site Disposal of Soil Arisings

The results of chemical analysis are provided following the exploratory hole records and can be used within the information necessary for basic characterisation of the soil destined for landfill. The Environment Agency publication Hazardous Waste, Technical Guidance WM3 outlines the methodology for classifying wastes and should be referenced for guidance. The test results (total metals, hydrocarbons and cyanide) should be compared to the relevant thresholds to determine whether they fall into the primary categories of non-hazardous or hazardous waste and will help indicate the likely European Waste Catalogue (EWC) code which is determined by the waste type.

Excavated material and excess spoil should always be classified prior to removal from site as required by 'Duty of Care' (Environmental Protection Act, 1990) legislation. This means that material has to be given a proper description and waste classification prior to removal. Basic characterisation is the responsibility of the waste producer, whilst compliance

checking and on-site verification are generally the responsibility of the landfill operator. The landfill operator will need to liaise with the waste producer, as the approach relies on the information from basic characterisation.

It is expected that arisings of natural soils from the excavations across this site would fall into the inert category under the European Waste Catalogue description 'Soil and Stones', EWC code 17 05 04 with restrictions excluding topsoil and peat.

GROUND ENGINEERING LIMITED

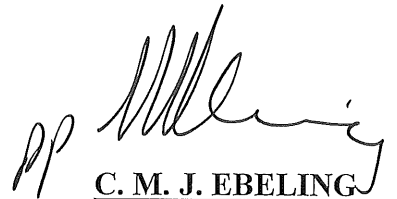


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C. M. J. EBELING

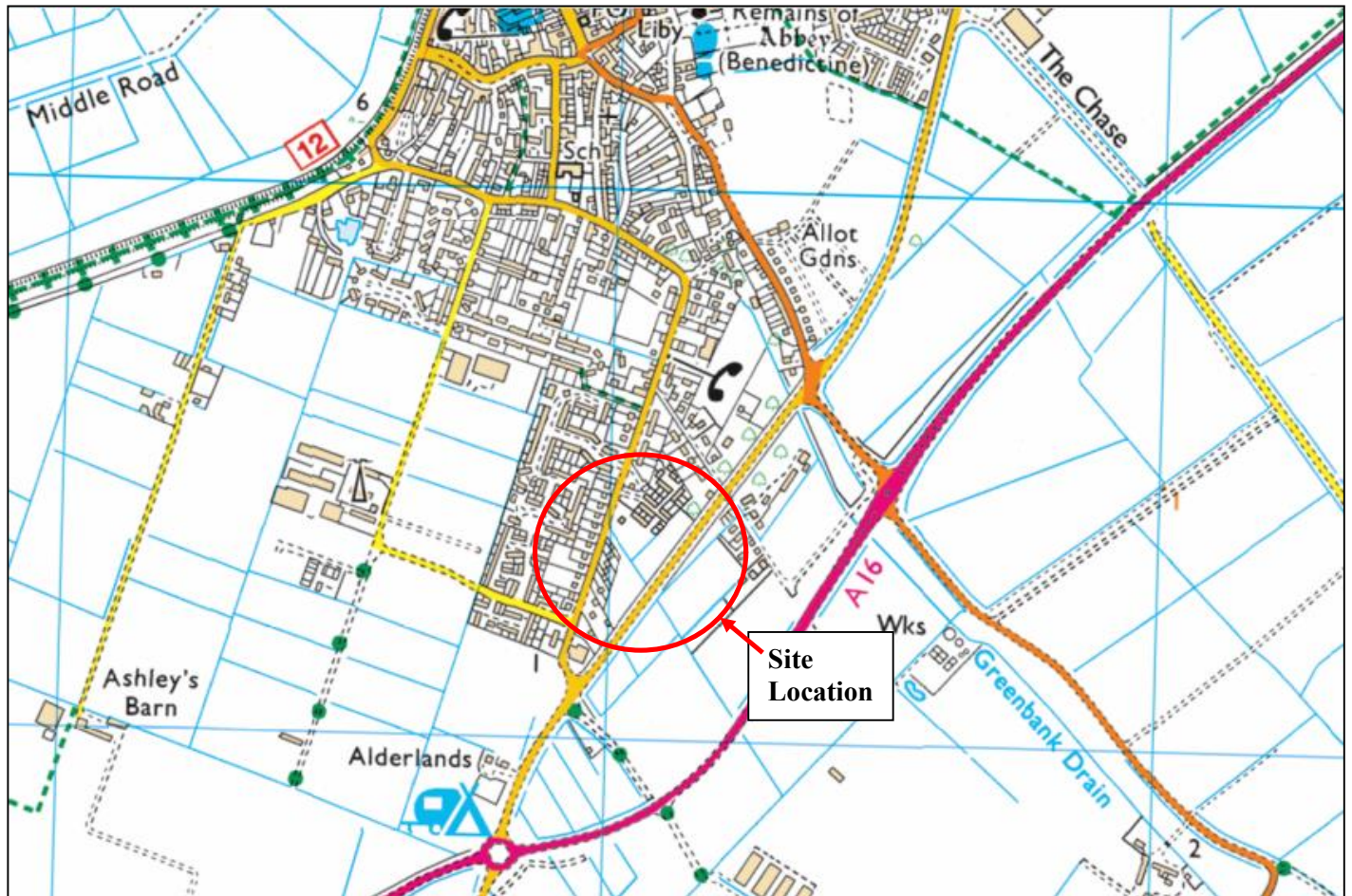
M.Sc.(Eng.), M.A.E.G.,

C.Geol., F.G.S.

Director

Site Location Plan

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Not To Scale



Project : Land off Harrington Drive, Crowland, Lincolnshire

Client : Seagate Homes

**GROUND
ENGINEERING
LIMITED**

Peterborough

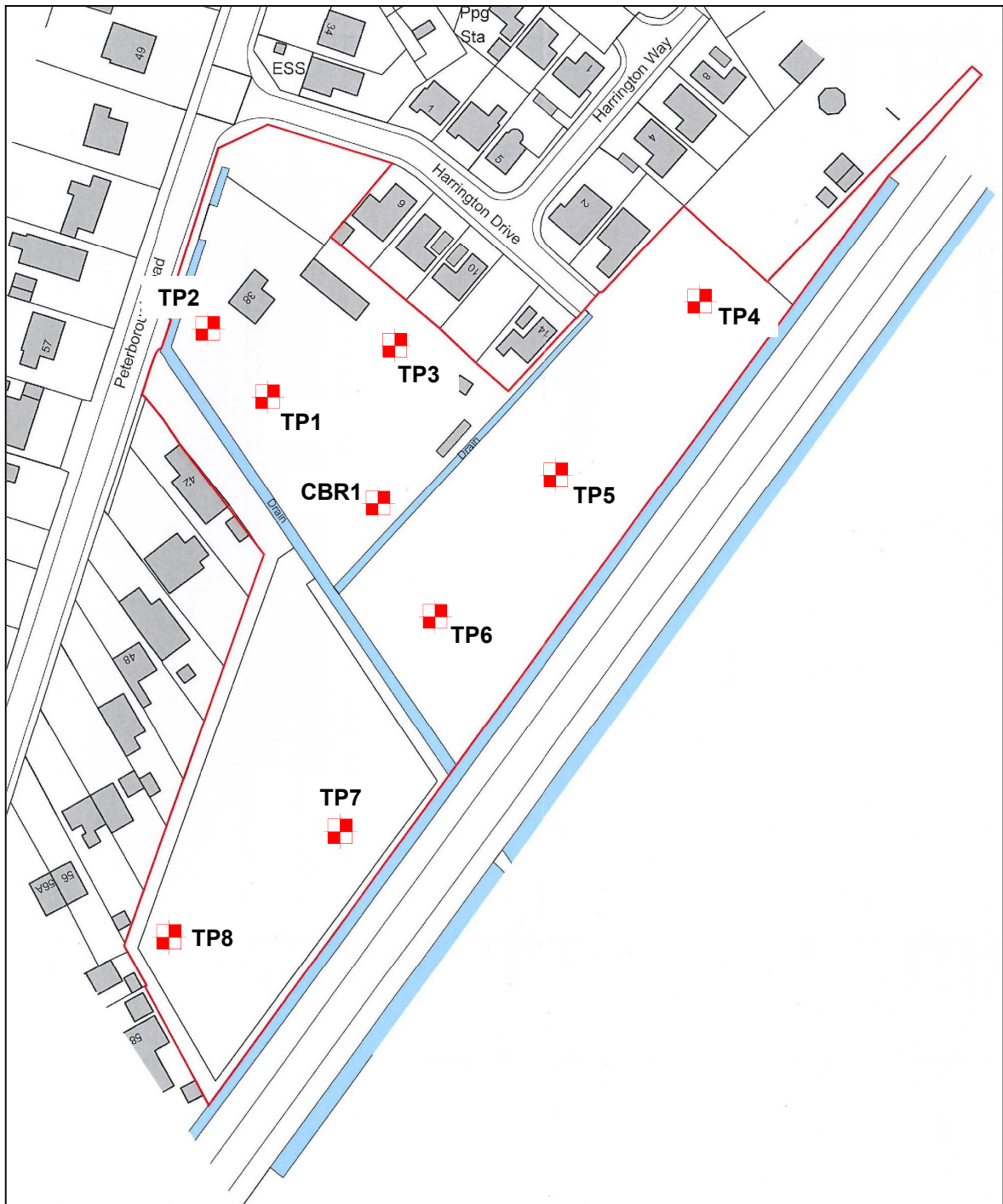
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Project No.

C15350

Exploratory Hole Location Plan

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Project: Land off Harrington Drive, Crowland

Client: Seagate Homes

**GROUND
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Peterborough

Tel : 01733 566566

**Project No.
C15350**

Proposed Development Plan

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Not To Scale



Project : Land off Harrington Drive, Crowland, Lincolnshire

Client : Seagate Homes

**GROUND
ENGINEERING
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Peterborough Tel : 01733 566566

**Project No.
C15350**

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: HARRINGTON DRIVE, CROWLAND		TRIAL PIT TP1	
			Date: 04/05/21	Pit Size: 1.70m L x 0.60m W x 1.30m D.		Ground Level:
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m
Depth m	Type	Result				
0.15	D1		1 1/2	TOPSOIL - Firm, friable, brown and dark brown, silty CLAY.		0.30
0.60-0.90	B1			Firm, orange brown, brown and light grey, sandy, silty CLAY.		
0.70	D2			(TIDAL FLAT DEPOSIT)		1.10 1.30
1.30	D3			Orange brown, slightly clayey, silty, fine SAND. (MARINE SAND)		
				Pit completed at 1.30m depth		
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample 1/2 - Water Strike 1/2 - Water Rise 1/2c - Level on completion MP - Mackintosh Probe P () - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa			REMARKS 1. Live roots observed to 0.90m depth 2. Water seepage at 1.30m depth 3. Pit sides unstable below 1.10m depth 4. Soakaway test undertaken at 1.30m depth			
			Project No 15350		Scale 1:25	Page 1/1

SOAKAWAY TEST RESULTS

BRE DIGEST 365 - SOIL INFILTRATION RATE

Project: Harrington Drive, Crowland
Client: Seagate Homes

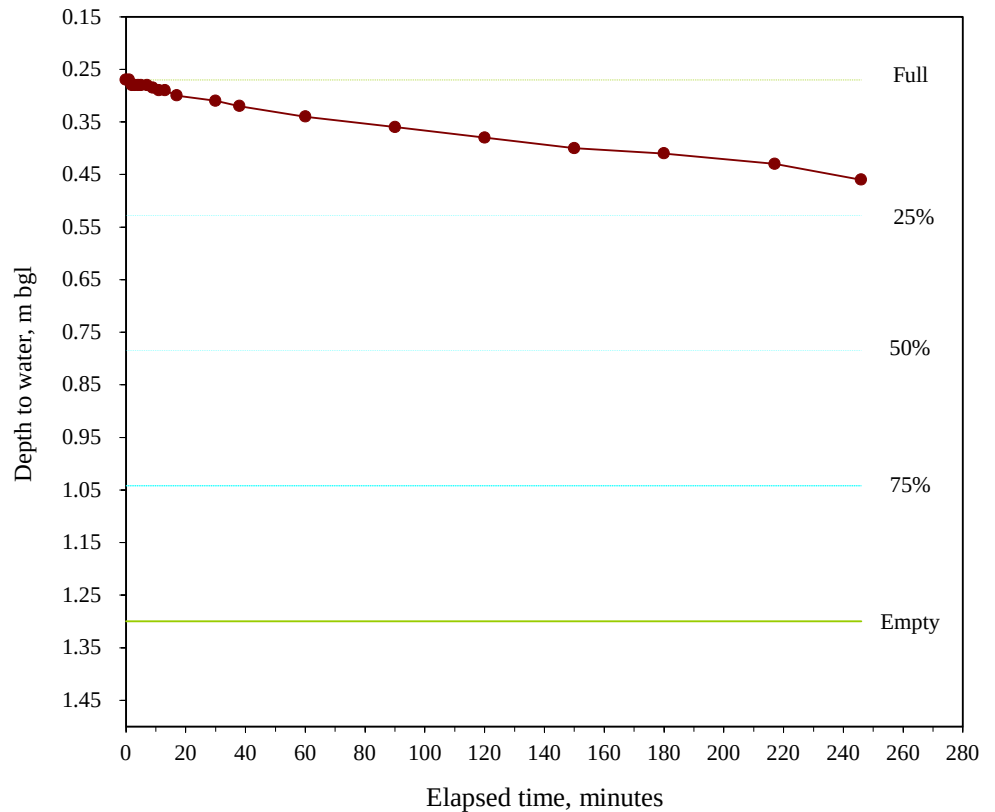
Project No: C15350
Sheet No: 1\1

Trial Pit: 1 FIRST FILLING
Depth: 1.30
Length: 1.70
Width: 0.60

Description of Stratum under test: Firm, sandy, silty CLAY to 1.10m depth
over slightly clayey, silty SAND
Depth to water prior to test: 1.30m
(below ground level)

Elapsed Time min	Depth to Water m
0	0.27
1	0.27
2	0.28
3	0.28
4	0.28
5	0.28
7	0.28
9	0.29
11	0.29
13	0.29
17	0.30
30	0.31
38	0.32
60	0.34
90	0.36
120	0.38
150	0.40
180	0.41
217	0.43
246	0.46

DEPTH TO WATER vs ELAPSED TIME



All dimensions given in metres

$$f = (V75-V25)/A50(T75-T25)$$

$$V75-V25 = 0.525$$

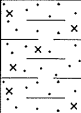
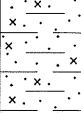
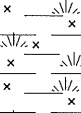
$$A50 = 2.771$$

$$T75-T25 = 2500$$

Soil Infiltration Rate $f = \underline{\underline{1.26E-06}} \text{ m/s}$

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: HARRINGTON DRIVE, CROWLAND		TRIAL PIT TP2	
Date: 04/05/21			Pit Size: 2.70m L x 0.55m W x 3.00m D.		Ground Level:	
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m
Depth m	Type	Result				O.D. Level m
0.10	D1	65		MADE GROUND - Firm, friable, brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is angular to rounded limestone and occasional brick fragments.		0.20
0.45	D2			Firm, red and orange brown, slightly sandy, silty CLAY.		0.65
0.45	ES1			(TIDAL FLAT DEPOSIT)		
0.90-1.20	MP1			Medium dense, light brown and orange brown, slightly clayey, very silty, fine SAND.		2.20
1.00	D3			(MARINE SAND)		
2.40	D4	Grey, silty SAND. Sand is fine and medium grained.				
3.00	D5			(MARINE SAND)		3.00
				Pit completed at 3.00m depth		
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample  Water Strike  Water Rise  Level on completion MP - Mackintosh Probe P () - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa			REMARKS 1. Live roots observed to to 1.80m depth 2. Water seepage at 2.20m depth 3. Pit sides collapsed when pit reached 3.00m depth			
Project No 15350						Scale 1:25
Page 1/1						

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: HARRINGTON DRIVE, CROWLAND		TRIAL PIT TP3	
			Date: 04/05/21	Pit Size: 0.00m L x 0.00m W x 2.40m D.		Ground Level:
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m
Depth m	Type	Result				
0.20 0.20	D1 ES1		▼ c	MADE GROUND - Brown, clayey and silty SAND AND GRAVEL with occasional cobbles of brick and plastic. Gravel is angular to rounded brick, concrete, limestone and flint.		0.40
0.55	D2			Firm, brown and grey, slightly organic SILT/CLAY. (TIDAL FLAT DEPOSIT)		0.90
1.00	D3			Grey and brown, slightly clayey, silty fine SAND. (MARINE SAND)		2.40
1.60	D4					
2.00	D5					
2.40	D6					
			Pit completed at 2.40m depth			
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample ∇ - Water Strike ▼ - Water Rise ▼ c - Level on completion MP - Mackintosh Probe P () - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa			REMARKS 1. Live roots observed to 0.40m depth 2. Pit sides unstable below 0.90m depth 3. Water standing at 1.80m depth on completion			
			Project No 15350		Scale 1:25	
					Page 1/1	

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: HARRINGTON DRIVE, CROWLAND		TRIAL PIT TP4	
			Date: 04/05/21	Pit Size: 2.00m L x 0.60m W x 2.80m D.		Ground Level:
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m
Depth m	Type	Result				
0.20	D1	(47)		TOPSOIL - Firm, friable, brown and dark brown, silty CLAY.		0.40
0.60	V1			Firm, light grey and orange brown, slightly sandy, silty CLAY with occasional silty sand partings.		
0.80-1.10	MP1			(TIDAL FLAT DEPOSIT)		
1.00	D2					
1.20-1.60	B1					
2.50	D3	1 Very soft, light grey, silty, organic CLAY. (TIDAL FLAT DEPOSIT)		1.90		
Pit completed at 2.80m depth					2.80	
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample ∇ - Water Strike ▽ - Water Rise ▽c - Level on completion MP - Mackintosh Probe P() - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa			REMARKS 1. Live roots observed to 1.40m depth 2. Water seepage at 2.10m depth 3. Pit sides unstable and collapsed when pit reached 2.80m depth			
			Project No 15350			
			Scale 1:25			
			Page 1/1			

L I M I T E D
Tel: 01733-566566
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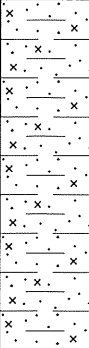
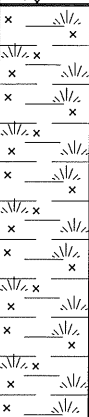
Date: 04/05/21

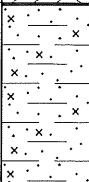
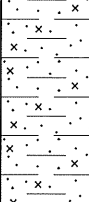
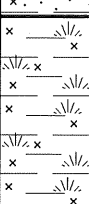
TRIAL PIT
TP5

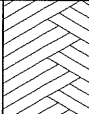
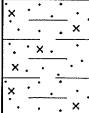
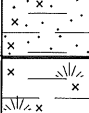
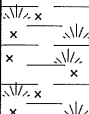
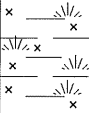
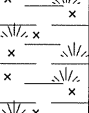
Ground
Level:

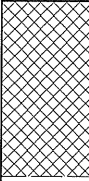
KEY	REMARKS		
D - Disturbed Sample	1. Live roots observed to 1.00m depth		
B - Bulk Sample	2. Water seepage at 1.00m depth		
U - Undisturbed Sample	3. Pit sides unstable below 0.80m depth		
R - Root Sample	4. Water met at 3.40m depth		
W - Water Sample			
ES - Environmental Sample			
☒ Water Strike			
☒ Water Rise			
☒c Level on completion			
MP - Mackintosh Probe		Project No 15350	
P() - Hand Penetrometer		Scale	Page
Cohesion () kPa		1:25	1/1
V - Vane Shear Test			
Cohesion () kPa			

Scale	Page
1:25	1/1

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: HARRINGTON DRIVE, CROWLAND		TRIAL PIT TP6	
			Date: 04/05/21	Pit Size: 2.70m L x 0.60m W x 3.00m D.		Ground Level:
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m
Depth m	Type	Result				O.D. Level m
0.20	D1			TOPSOIL - Firm, friable, brown and dark brown, silty CLAY.		
				Soft, orange brown and grey, slightly sandy, silty CLAY.		0.40
1.00	D2			(TIDAL FLAT DEPOSIT)		
				Very soft, light grey, silty, slightly organic CLAY.		1.60
2.00	D3		$\frac{1}{\nabla}$	(TIDAL FLAT DEPOSIT)		
2.45	D4		∇c			
3.00	D5					3.00
				Pit completed at 3.00m depth		
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample $\frac{1}{\nabla}$ - Water Strike ∇ - Water Rise ∇c - Level on completion MP - Mackintosh Probe P () - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa			REMARKS 1. Live roots observed to 1.60m depth 2. Water seepage at 2.20m depth 3. Water standing at 2.50m depth on completion 4. Pit sides unstable			
						Project No 15350
						Scale 1:25
						Page 1/1

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: HARRINGTON DRIVE, CROWLAND		TRIAL PIT TP7	
			Date: 04/05/21	Pit Size: 2.90m L x 0.55m W x 3.00m D.		Ground Level:
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m
Depth m	Type	Result				O.D. Level m
0.15	D1			TOPSOIL - Firm, friable, brown and dark brown, slightly sandy, silty CLAY.		0.30
0.60-0.90	MP1	40		Firm, orange brown and light grey, slightly sandy, silty CLAY with abundant sand partings.		
1.00	D2			(TIDAL FLAT DEPOSIT)		
1.70	D3			Very soft, light grey, silty, slightly organic CLAY.		1.60
3.00	D4			(TIDAL FLAT DEPOSIT)		
				Pit completed at 3.00m depth		3.00
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample  Water Strike  Water Rise  Level on completion MP - Mackintosh Probe P () - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa			REMARKS 1. Live roots observed to 1.00m depth 2. Water seepage at 0.80m depth 3. Pit sides unstable below 0.30m depth			
						Project No 15350
						Scale 1:25
						Page 1/1

GROUND ENGINEERING LIMITED Tel: 01733-566566 www.groundengineering.co.uk			Site: HARRINGTON DRIVE, CROWLAND		TRIAL PIT TP8	
			Date: 04/05/21	Pit Size: 2.70m L x 0.60m W x 3.40m D.		Ground Level:
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m
Depth m	Type	Result				O.D. Level m
0.20	D1			TOPSOIL - Firm, friable, brown and dark brown, slightly sandy, silty CLAY.		0.40
0.70	D2			Soft, orange brown and grey, slightly sandy SILT/CLAY.		
1.00	W1		1 √	(TIDAL FLAT DEPOSIT)		1.00
1.20 1.20-1.50	D3 MP1	9		Very soft, light grey, silty, slightly organic CLAY.		
				...With black pseudofibrous PEAT partings		
				(TIDAL FLAT DEPOSIT)		
3.30	D4					
3.40	D5					3.40
				Pit completed at 3.40m depth		
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample √ - Water Strike √ - Water Rise √c - Level on completion MP - Mackintosh Probe P () - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa			REMARKS 1. Live roots observed to 1.00m depth 2. Water seepage at 1.00m depth 3. Pit sides unstable and collapsing			
			Project No 15350		Scale 1:25	
			Page 1/1			

GROUND ENGINEERING LIMITED Tel: 01733-666566 www.groundengineering.co.uk			Site: HARRINGTON DRIVE, CROWLAND		TRIAL PIT CBR1	
Date: 04/05/21			Pit Size: 2.25m L x 0.55m W x 0.60m D.		Ground Level:	
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m
Depth m	Type	Result				O.D. Level m
0.30-0.60	B1			MADE GROUND - Firm, friable, brown and dark brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is fine and medium, sub-angular and sub-rounded flint, siltstone and shell fragments.		0.60
				Pit completed at 0.60m depth		
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample ▽ - Water Strike ▼ - Water Rise ▼c - Level on completion MP - Mackintosh Probe P() - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa			REMARKS 1. Live roots observed to at least 0.60m depth 2. Pit dry 3. Pit sides stable			
				Project No 15350		
				Scale 1:25		
				Page 1/1		

LABORATORY TEST RESULTS

CONTRACT HARRINGTON DRIVE, CROWLAND

Trial-pit	Sample	Depth m	Classification				Density		Triaxial Compression					Sulphates (SO ₄)				C.B.R.		Remarks
			Liquid Limit %	Plastic Limit %	Plasticity Index %	Moisture Content %	Bulk Mg/m ³	Dry Mg/m ³	Type	Principal Stress Difference kPa	Cell Pressure kPa	Shear Strength kPa	Angle of Shear Resistance degrees	Total % Dry Wt.	Soil Aqueous Extract mg/l	Water mg/l	pH	Top %	Base %	
TP7	D2	1.00	68	33	35	44								611			6.1			SOIL CLASSIFICATION = CH/ MH 0% retained on 425µm sieve
	D3	1.70	62	23	39	51														SOIL CLASSIFICATION = CH 0% retained on 425µm sieve
	D2	0.70	78	38	40	59														SOIL CLASSIFICATION = MV 1% retained on 425µm sieve
TP8	W1	1.00														552	5.1			
	D3	1.20	124	44	80	109								2496			3.9			SOIL CLASSIFICATION = CE 0% retained on 425µm sieve

LABORATORY TEST RESULTS

CONTRACT HARRINGTON DRIVE, CROWLAND

Trial-pit	Sample	Depth m	Classification				Density		Triaxial Compression					Sulphates (SO ₄)				C.B.R.		Remarks
			Liquid Limit %	Plastic Limit %	Plasticity Index %	Moisture Content %	Bulk Mg/m ³	Dry Mg/m ³	Type	Principal Stress Difference kPa	Cell Pressure kPa	Shear Strength kPa	Angle of Shear Resistance degrees	Total Dry Wt. %	Soil Aqueous Extract mg/l	Water mg/l	pH	Top %	Base %	
CBR1	B1	0.30 – 0.60				44	1.64	1.14										4.4	4.6	0% retained on 20mm sieve
TP1	B1	0.60 – 0.90				34	1.83	1.37										0.2	0.2	0% retained on 20mm sieve
TP3	D2	0.55	82	48	34	40														SOIL CLASSIFICATION = MV 3% retained on 425µm sieve
TP4	D2	1.00	59	28	31	36								1224			8.0			SOIL CLASSIFICATION = CH 1% retained on 425µm sieve
TP5	D3	1.00	103	44	59	79								1805			6.8			SOIL CLASSIFICATION = ME 1% retained on 425µm sieve
TP6	D2	1.00	72	32	40	58									1828	1828	7.4			SOIL CLASSIFICATION = CV 1% retained on 425µm sieve
	D3	2.00	72	28	44	63									1862		7.5			SOIL CLASSIFICATION = CV 0% retained on 425µm sieve



8180

GROUND ENGINEERING

Newark Road Peterborough
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TEST CERTIFICATE**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Wet Sieving Method and Sedimentation by Pipette

Client: Ground Engineering Ltd
Client Address: Newark Road
Peterborough
PE1 5UA

Certificate Number: PL7460-1/6/710-2

Client Reference: C15350

Lab Job Number: PL7460-1

Date Sampled: Unknown

Date Received: 11.05.2021

Date Tested: 25.05.2021

Certificate of Sampling: N/A

Sampling Certificate No.: N/A

Sampled By: Client

Contact: Simon Weatherley

Site Name: Harrington Drive

Site Address: Crowland

TEST RESULTS

Laboratory Reference: PL7460-1/6

Client Reference: D3

Pre-treatment for
organic material: No

Brown slightly clayey silty SAND.

Sample Description:

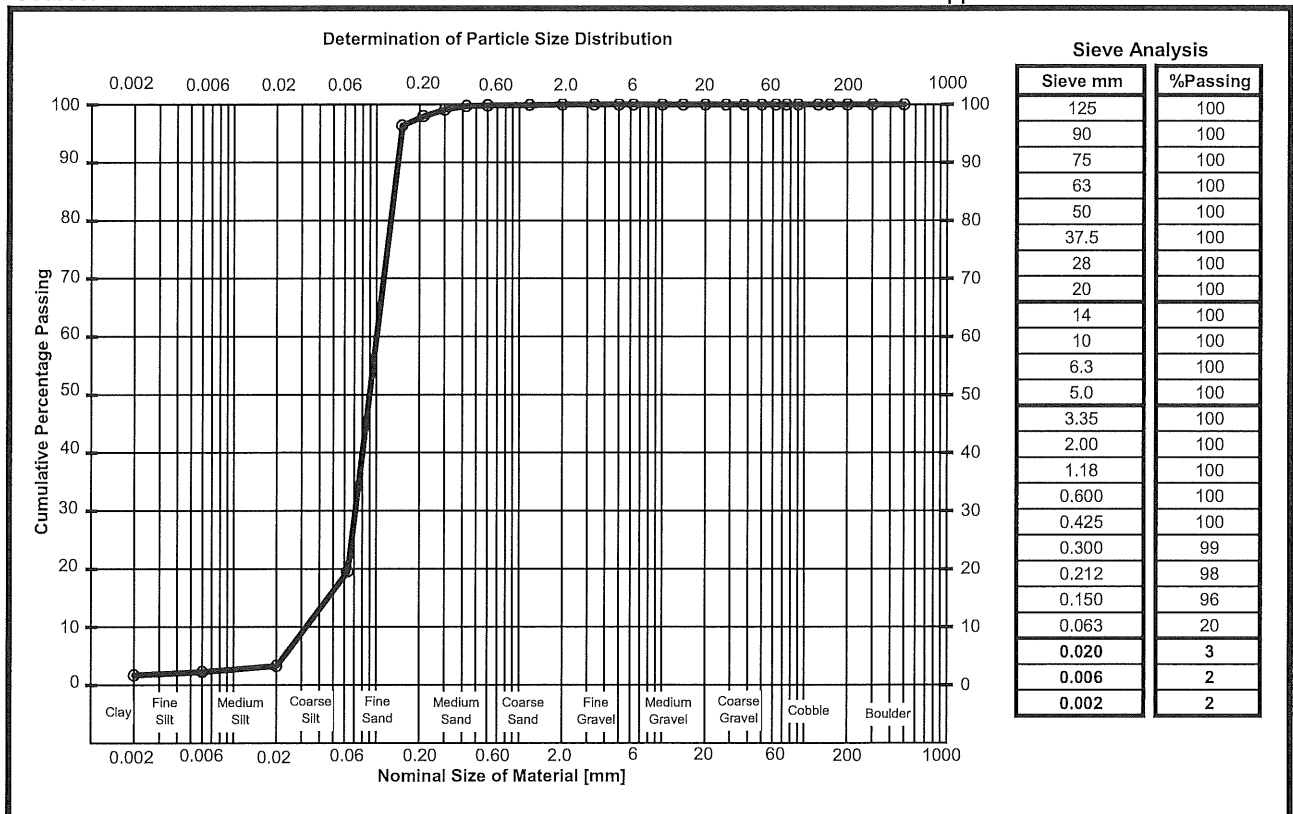
Material Specification: Not Required

Depth: 1.00m

Location: TP3

Source:

Supplier:



Comments: Data relevant to material below 63 microns is outside the current scope of UKAS accreditation

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 15.06.2021 Page 1 of 1

Form Number: GELab/C/709-2 Version 56

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Registration Number: 6929574
Reg Office: Ground Engineering Ltd
Newark Rd, Peterborough PE1 5UA



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GROUND ENGINEERING

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TEST CERTIFICATE**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Wet Sieving Method and Sedimentation by Pipette

Client: Ground Engineering Ltd
Client Address: Newark Road
Peterborough
PE1 5UA

Certificate Number: PL7460-1/4/710-2

Client Reference: C15350

Lab Job Number: PL7460-1

Date Sampled: Unknown

Date Received: 11.05.2021

Date Tested: 25.05.2021

Certificate of Sampling: N/A

Sampling Certificate No.: N/A

Sampled By: Client

Contact: Simon Weatherley

Site Name: Harrington Drive

Site Address: Crowland

TEST RESULTS

Laboratory Reference: PL7460-1/4

Client Reference: D3

Pre-treatment for
organic material:

No

Brown slightly clayey silty SAND.

Sample Description:

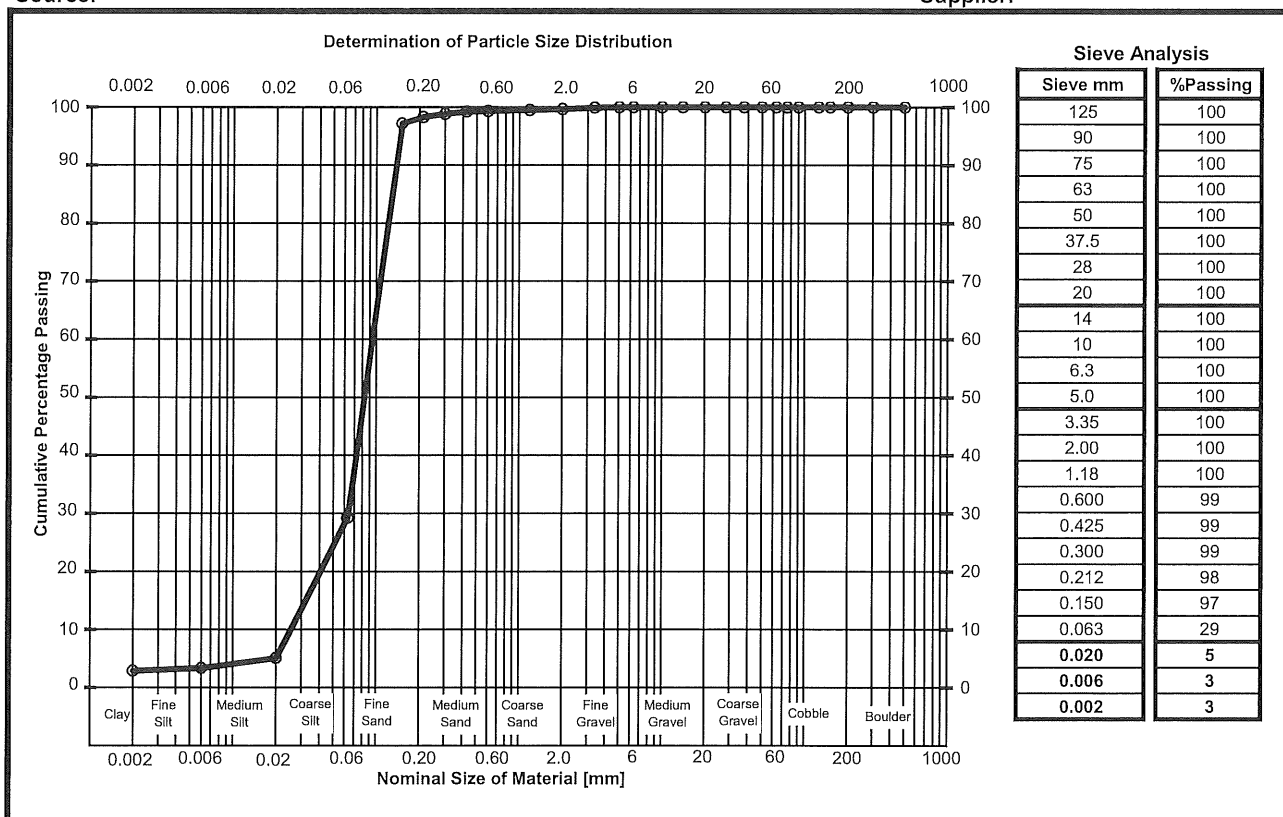
Material Specification: Not Required

Depth: 1.00m

Location: TP2

Source:

Supplier:



Comments: Data relevant to material below 63 microns is outside the current scope of UKAS accreditation

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 15.06.2021 Page 1 of 1

Form Number: GELab/C/709-2 Version 56

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Newark Rd, Peterborough PE1 5UA



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TEST CERTIFICATE**GROUND ENGINEERING**

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t: 01733 566566
e: admin@groundengineering.co.uk

Determination of Particle Size Distribution

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Wet Sieving Method and Sedimentation by Pipette

Client: Ground Engineering Ltd
Client Address: Newark Road
Peterborough
PE1 5UA

Certificate Number: PL7460-1/3/710-2

Client Reference: C15350

Lab Job Number: PL7460-1

Date Sampled: Unknown

Date Received: 11.05.2021

Date Tested: 25.05.2021

Certificate of Sampling: N/A

Sampling Certificate No.: N/A

Sampled By: Client

Contact: Simon Weatherley

Site Name: Harrington Drive

Site Address: Crowland

TEST RESULTS

Laboratory Reference: PL7460-1/3

Client Reference: D3

Orange-brown slightly clayey silty SAND.

Pre-treatment for
organic material:

No

Sample Description:

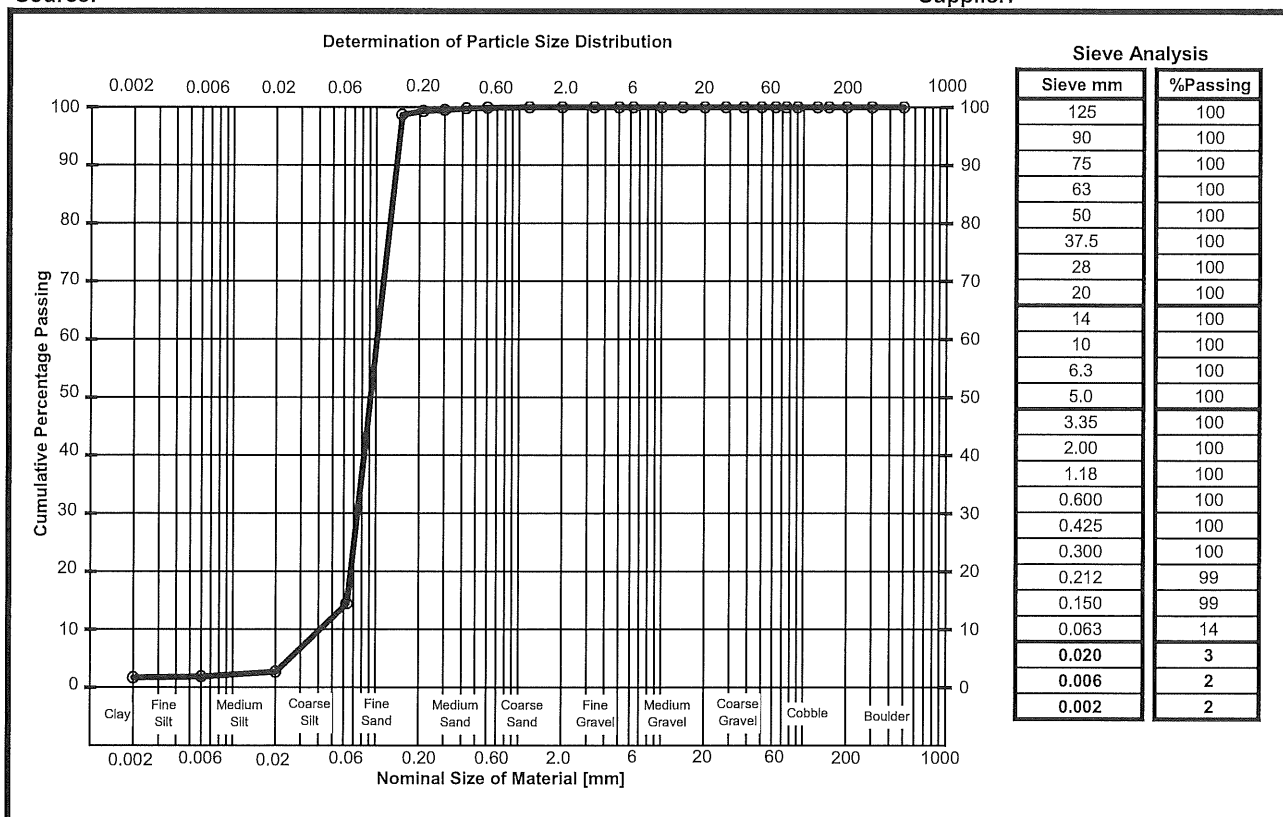
Material Specification: Not Required

Location: TP1

Source:

Depth: 1.30m

Supplier:



Comments: Data relevant to material below 63 microns is outside the current scope of UKAS accreditation

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 15.06.2021 Page 1 of 1

Form Number: GELab/C/709-2 Version 56

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Registered in England & Wales
Registration Number: 6929574
Reg Office: Ground Engineering Ltd
Newark Rd, Peterborough PE1 5UA



Final Report

Report No.: 21-15529-1
Initial Date of Issue: 17-May-2021
Client Ground Engineering Limited
Client Address: Newark Road
Peterborough
Cambridgeshire
PE1 5UA
Contact(s): Simon Weatherley
Project SW/C15350 Land off Harrington Drive,
Crowland

Quotation No.: **Date Received:** 11-May-2021

Order No.: SW/C15350 **Date Instructed:** 11-May-2021

No. of Samples: 8

Turnaround (Wkdays): 5 **Results Due:** 17-May-2021

Date Approved: 17-May-2021

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: SW/C15350 Land off Harrington Drive, Crowland

Client: Ground Engineering Limited	Chemtest Job No.:				21-15529	21-15529	21-15529	21-15529	21-15529	21-15529	21-15529	21-15529
Quotation No.:	Chemtest Sample ID.:				1198003	1198004	1198005	1198006	1198007	1198008	1198009	1198010
Order No.: SW/C15350	Client Sample Ref.:				D1	D1	D1	D1	D1	D1	D1	D1
	Sample Location:				TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP8
	Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				0.15	0.10	0.20	0.20	0.15	0.20	0.15	0.20
	Date Sampled:				04-May-2021	04-May-2021	04-May-2021	04-May-2021	04-May-2021	04-May-2021	04-May-2021	04-May-2021
Determinand	Accred.	SOP	Units	LOD								
pH	M	2010		4.0	7.3	8.0	8.4	6.7	6.2	5.9	5.6	5.7
Moisture	N	2030	%	0.020	41	24	9.3	32	32	32	34	36
Stones and Removed Materials	N	2030	%	0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	2.2	1.9	0.94	1.0	1.1	1.2	0.87	0.94
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	0.040	< 0.010	0.024	0.013	< 0.010	0.012	0.025	0.024
Cyanide (Free)	M	2300	mg/kg	0.50	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0.50
Cyanide (Total)	M	2300	mg/kg	0.50	0.60	< 0.50	< 0.50	0.70	0.90	1.2	1.3	1.7
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	< 0.50	< 0.50	2.5	< 0.50	0.63	< 0.50	< 0.50	< 0.50
Arsenic	M	2450	mg/kg	1.0	14	33	25	24	18	21	26	28
Cadmium	M	2450	mg/kg	0.10	0.11	0.34	0.64	0.21	0.10	0.17	0.10	0.24
Chromium	M	2450	mg/kg	1.0	26	31	28	35	27	30	32	38
Copper	M	2450	mg/kg	0.50	23	22	30	21	15	18	18	25
Mercury	M	2450	mg/kg	0.10	0.14	0.11	< 0.10	< 0.10	0.11	0.15	0.21	0.31
Nickel	M	2450	mg/kg	0.50	22	33	29	31	21	23	22	32
Lead	M	2450	mg/kg	0.50	31	45	56	28	25	34	37	47
Selenium	M	2450	mg/kg	0.20	0.57	0.35	< 0.20	0.79	0.68	0.87	0.95	1.2
Zinc	M	2450	mg/kg	0.50	77	99	96	70	53	59	58	80
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Organic Matter	M	2625	%	0.40	14	6.7	1.9	14	19	2.1	19	1.1
Acenaphthene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	M	2700	mg/kg	0.10	1.1	1.3	< 0.10	< 0.10	< 0.10	2.6	< 0.10	3.4
Benzo[a]pyrene	M	2700	mg/kg	0.10	< 0.10	0.92	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	M	2700	mg/kg	0.10	< 0.10	2.2	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	M	2700	mg/kg	0.10	< 0.10	0.62	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	M	2700	mg/kg	0.10	1.2	1.4	< 0.10	< 0.10	< 0.10	2.1	< 0.10	2.5
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	M	2700	mg/kg	0.10	0.21	1.9	< 0.10	0.35	< 0.10	0.28	< 0.10	0.49
Fluorene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Naphthalene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Pyrene	M	2700	mg/kg	0.10	0.36	1.7	< 0.10	0.49	< 0.10	0.38	< 0.10	0.54
Total Of 16 PAH's	M	2700	mg/kg	2.0	2.9	10	< 2.0	< 2.0	< 2.0	5.4	< 2.0	6.9
Total Phenols	M	2920	mg/kg	0.10	0.11	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Soil Colour	N	2040		N/A	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown

Results - Soil

Project: SW/C15350 Land off Harrington Drive, Crowland

Client: Ground Engineering Limited	Chemtest Job No.:				21-15529	21-15529	21-15529	21-15529	21-15529	21-15529	21-15529	21-15529	21-15529
Quotation No.:	Chemtest Sample ID.:				1198003	1198004	1198005	1198006	1198007	1198008	1198009	1198010	1198010
Order No.: SW/C15350	Client Sample Ref.:				D1	D1	D1	D1	D1	D1	D1	D1	D1
	Sample Location:				TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP8	TP8
	Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				0.15	0.10	0.20	0.20	0.15	0.20	0.15	0.20	0.20
	Date Sampled:				04-May-2021	04-May-2021	04-May-2021	04-May-2021	04-May-2021	04-May-2021	04-May-2021	04-May-2021	04-May-2021
Determinand	Accred.	SOP	Units	LOD									
Other Material	N	2040		N/A	Stones and Roots	Stones and Roots	Stones and Roots	Roots and Stones	Stones and Roots	Stones and Roots	Stones and Roots	Stones and Roots	Stones and Roots
Soil Texture	N	2040		N/A	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2325	Sulphide in Soils	Sulphide	Steam distillation with sulphuric acid / analysis by 'Aquakem 600' Discrete Analyser, using N,N-dimethyl-p-phenylenediamine.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenzo[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container
- E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

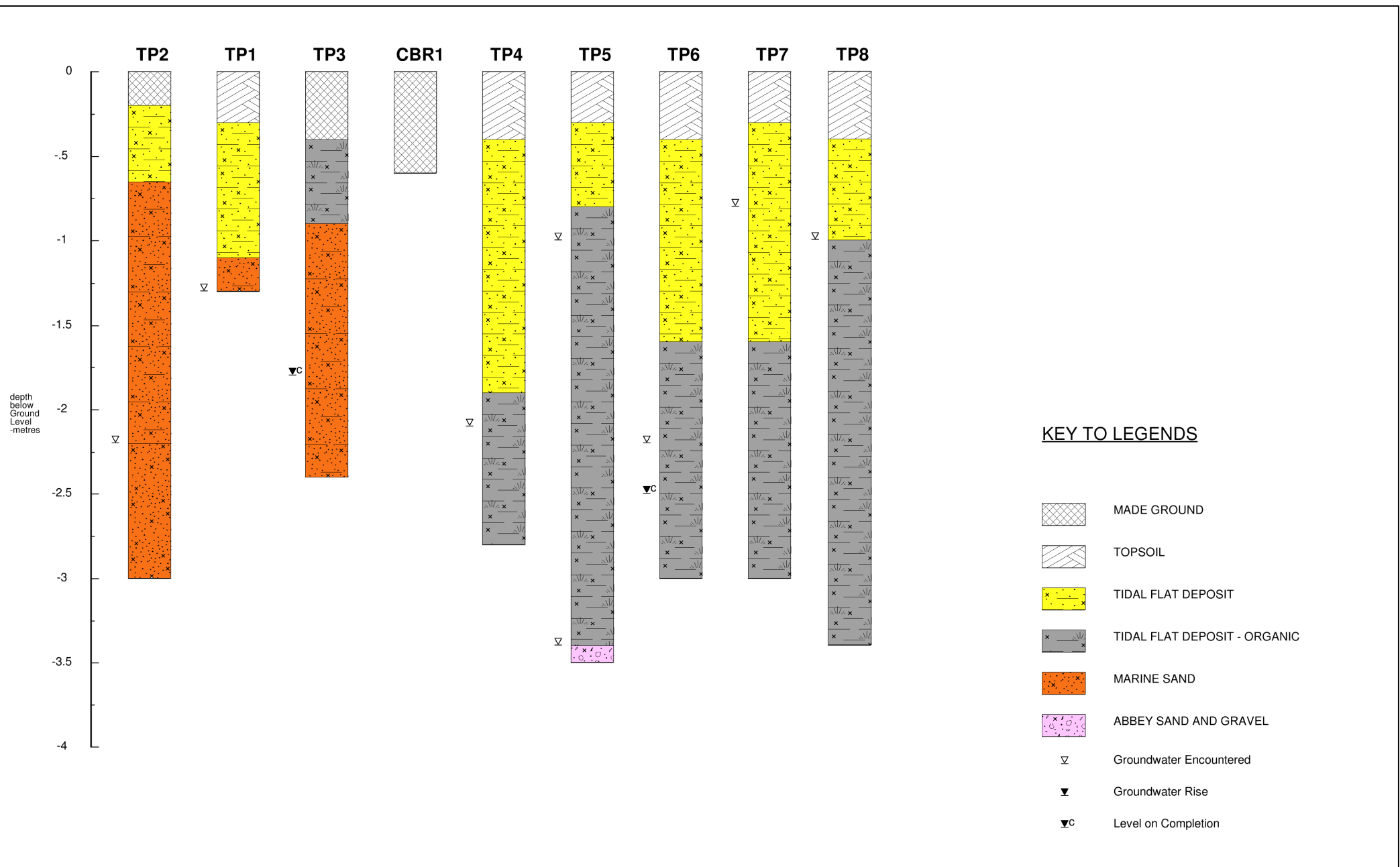
All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

customerservices@chemtest.com



Project : Harrington Drive, Crowland

Client : Seagate Homes Limited

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Tel: 01733 566566

SOIL PROFILE

Fig No. 1

Project No
C15350

Vertical Scale 1:25

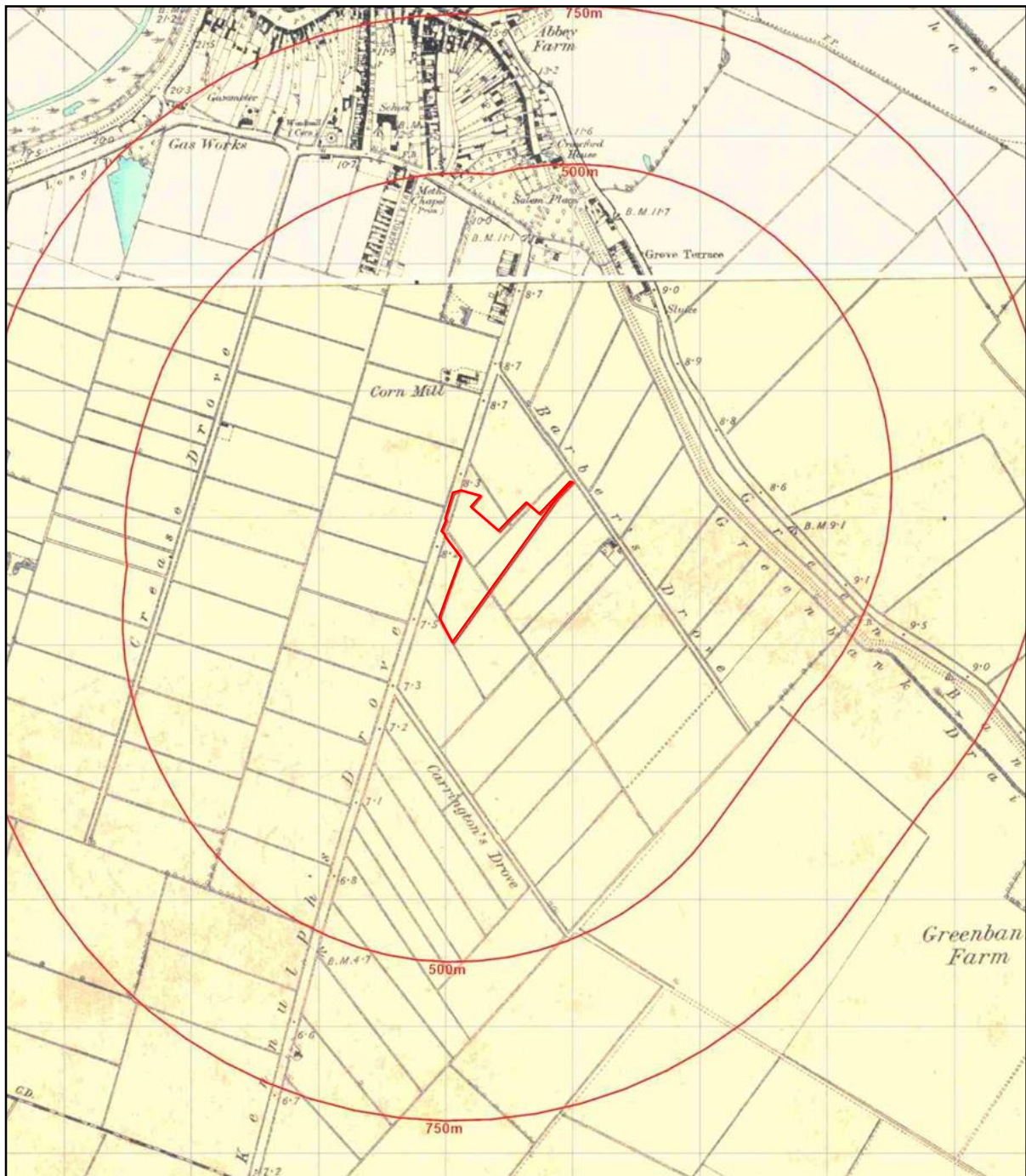
APPENDIX 1

HISTORICAL MAP EXTRACTS

Site History

Figure A

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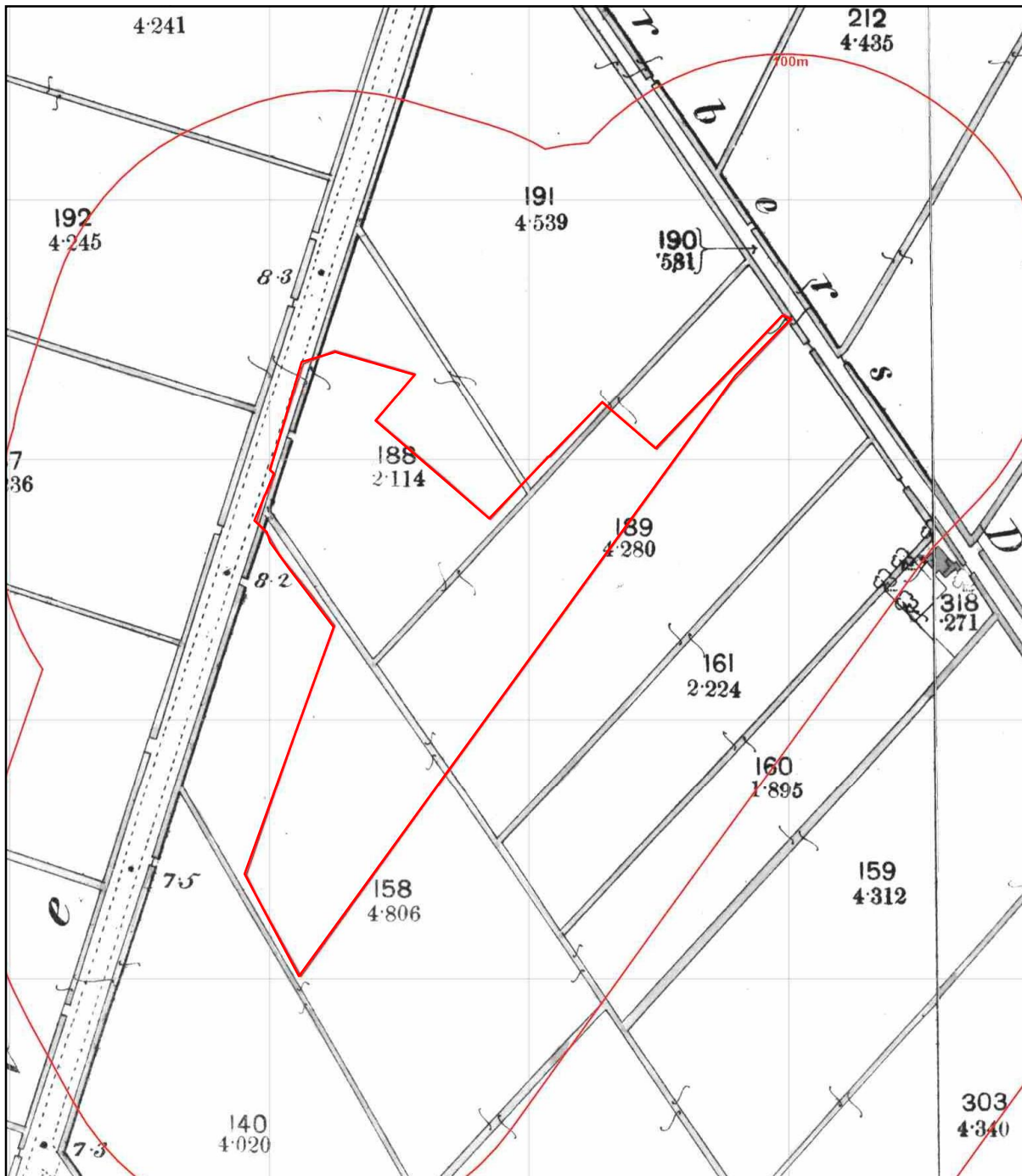
Project No.

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Site History

Figure B

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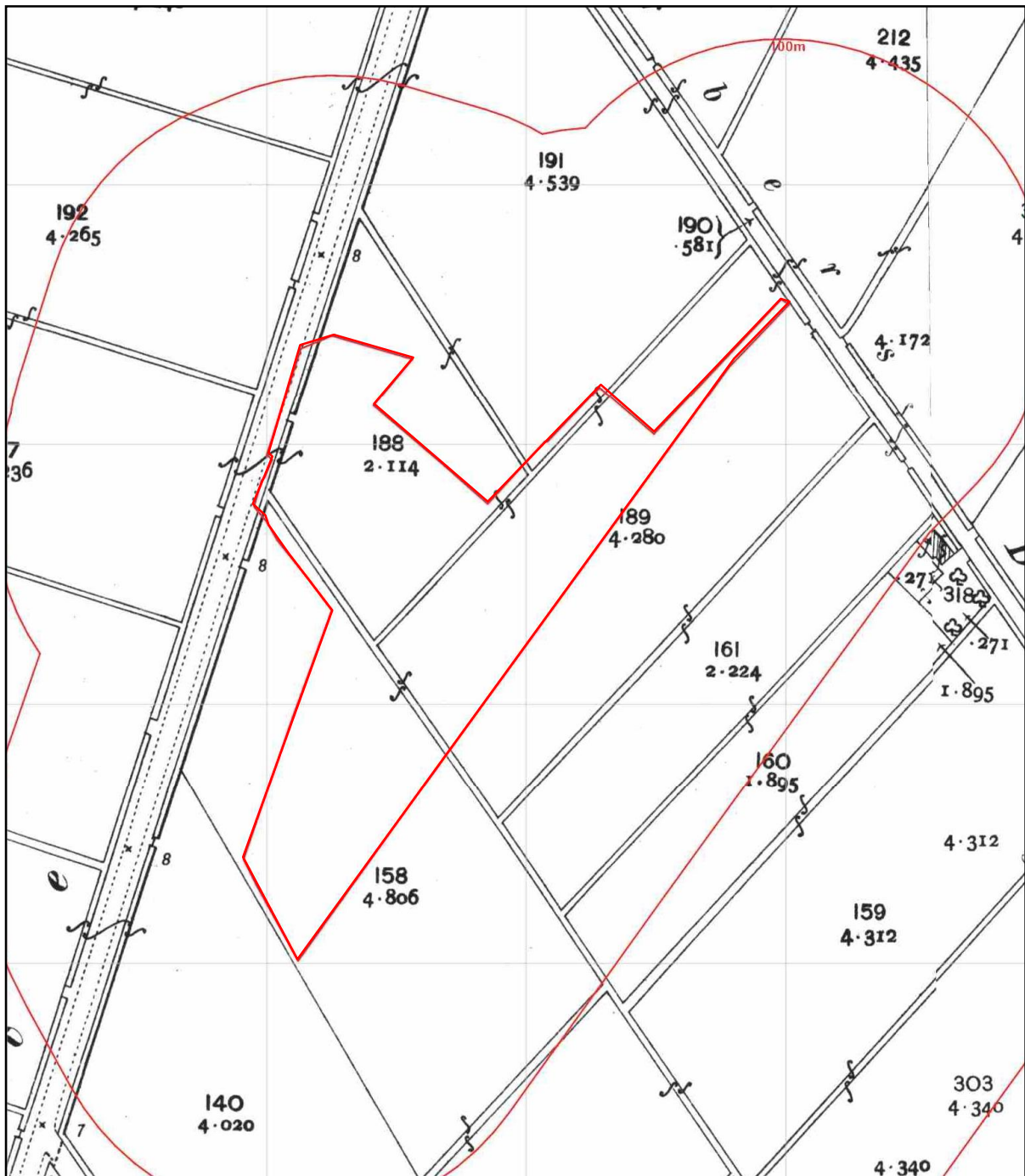
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Site History

Figure C

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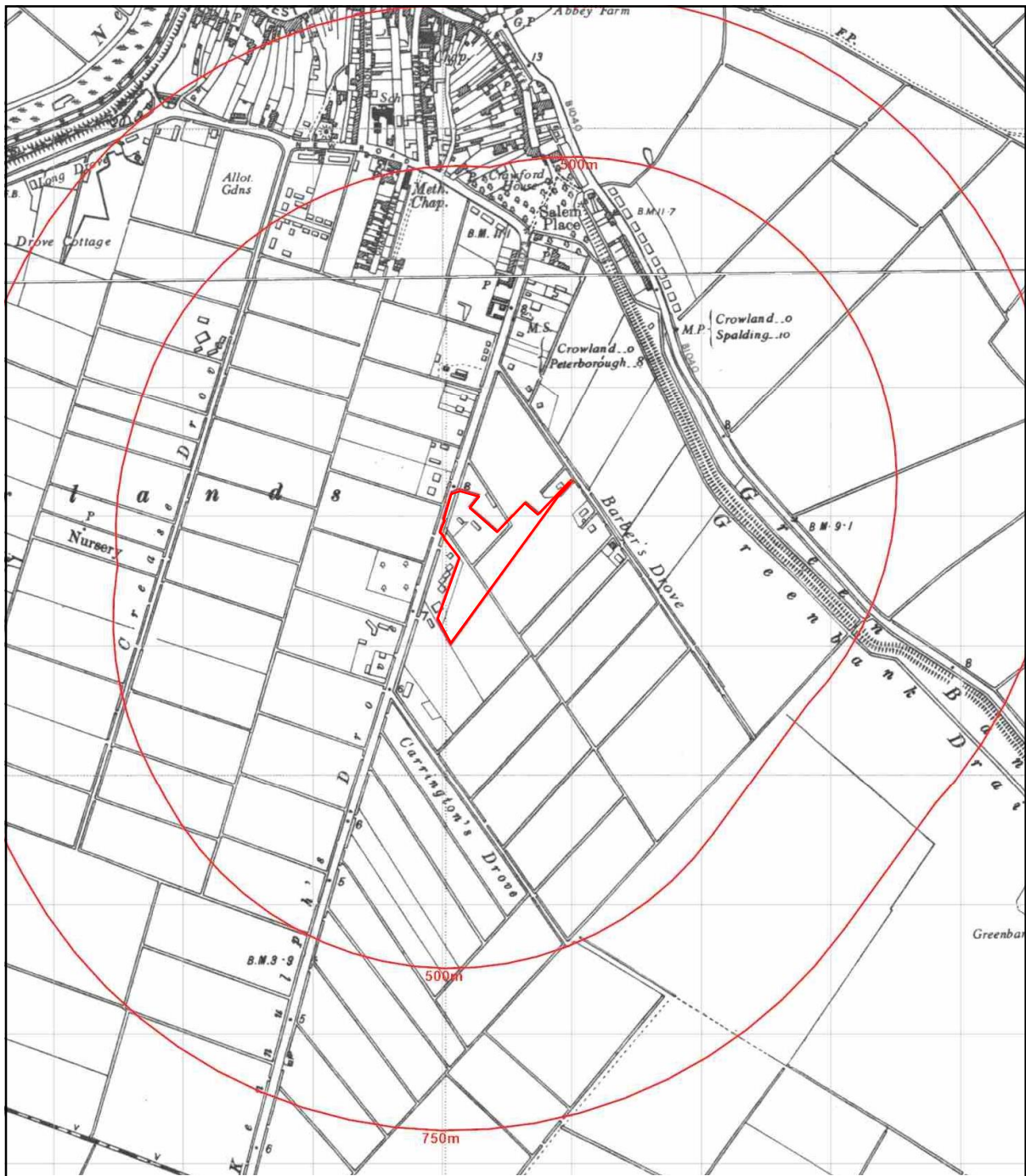
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Site History

Figure D

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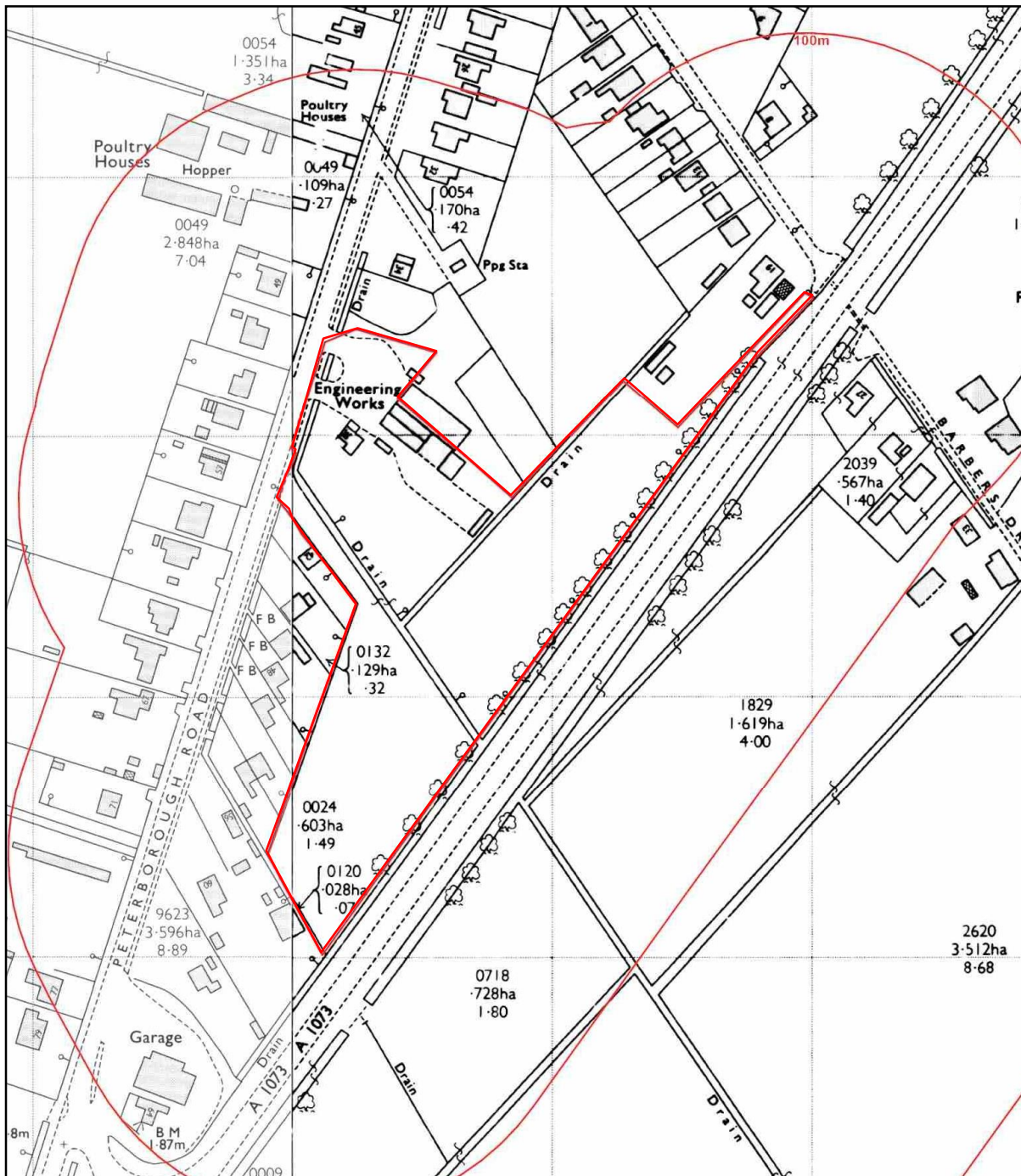
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Site History

Figure E

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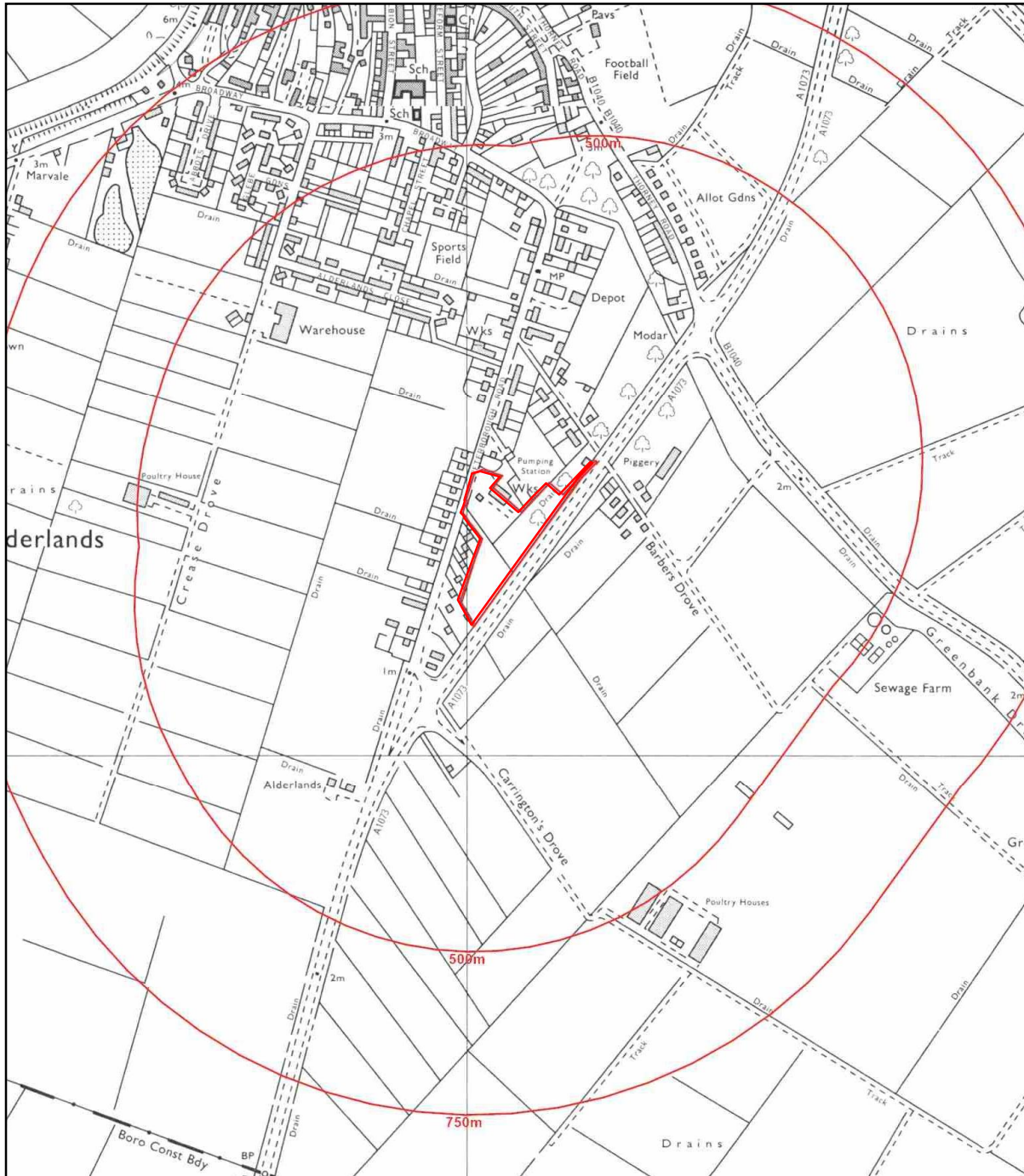
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Site History

Figure F

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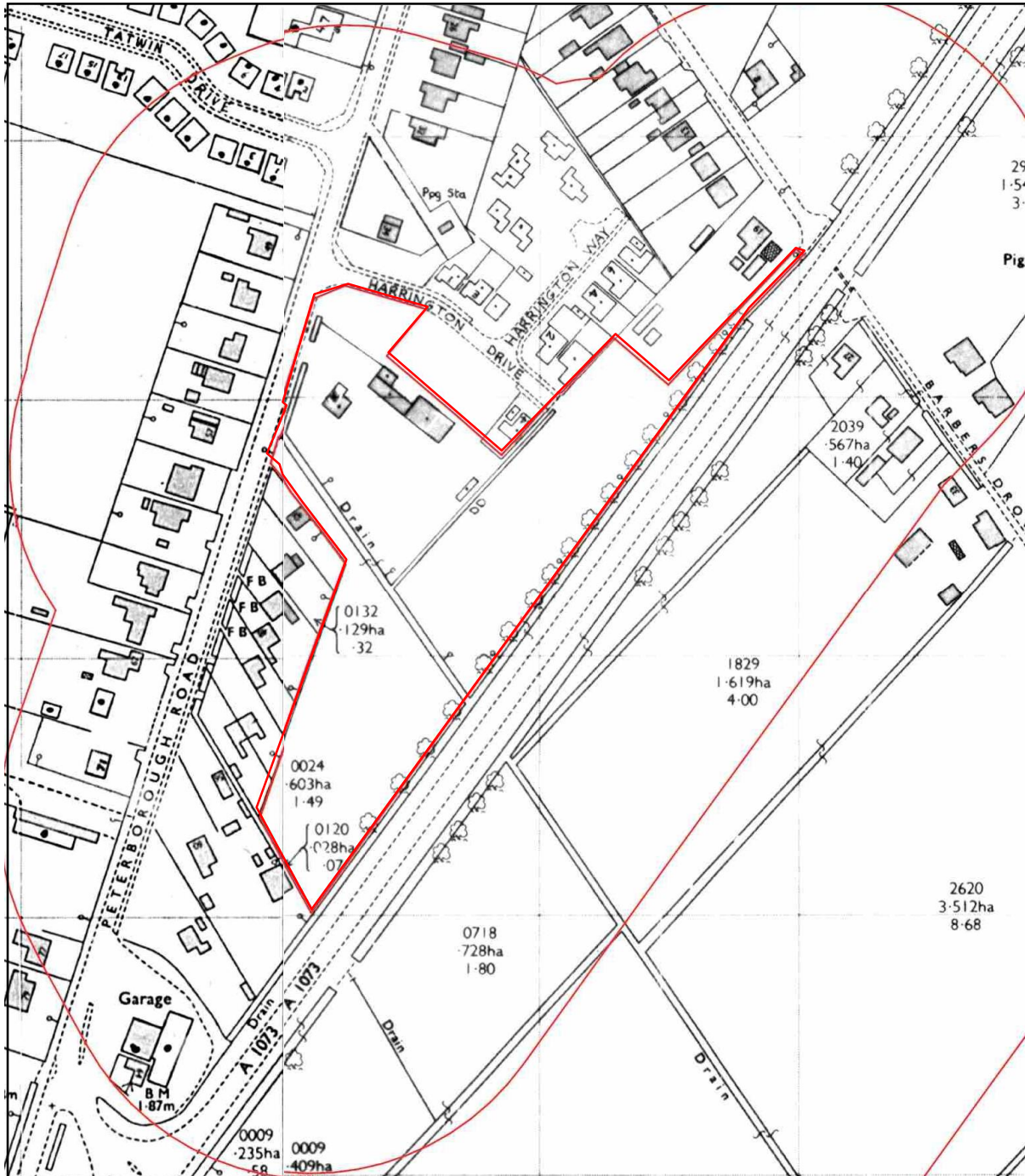
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Site History

Figure G

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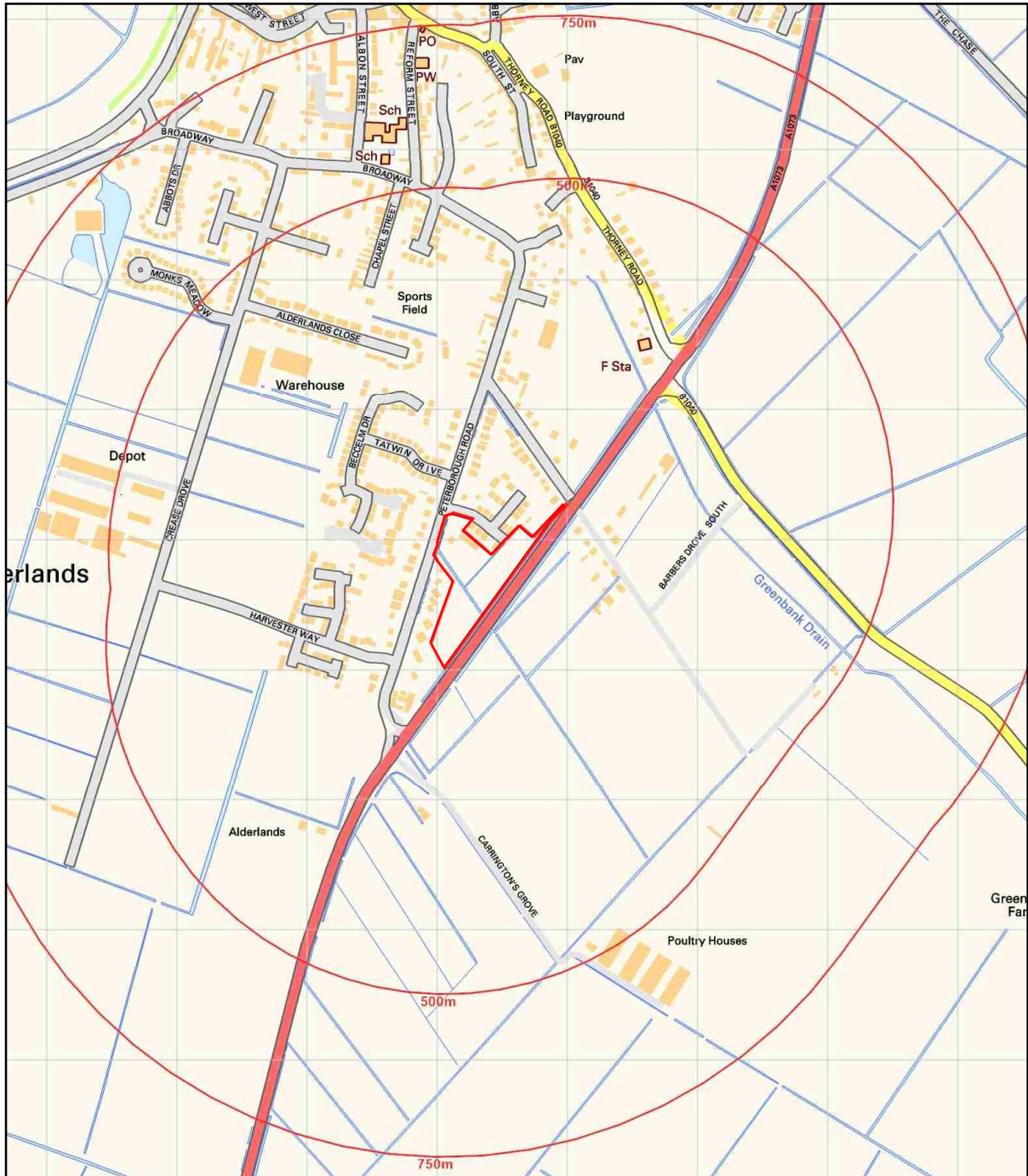
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Site History

Figure I

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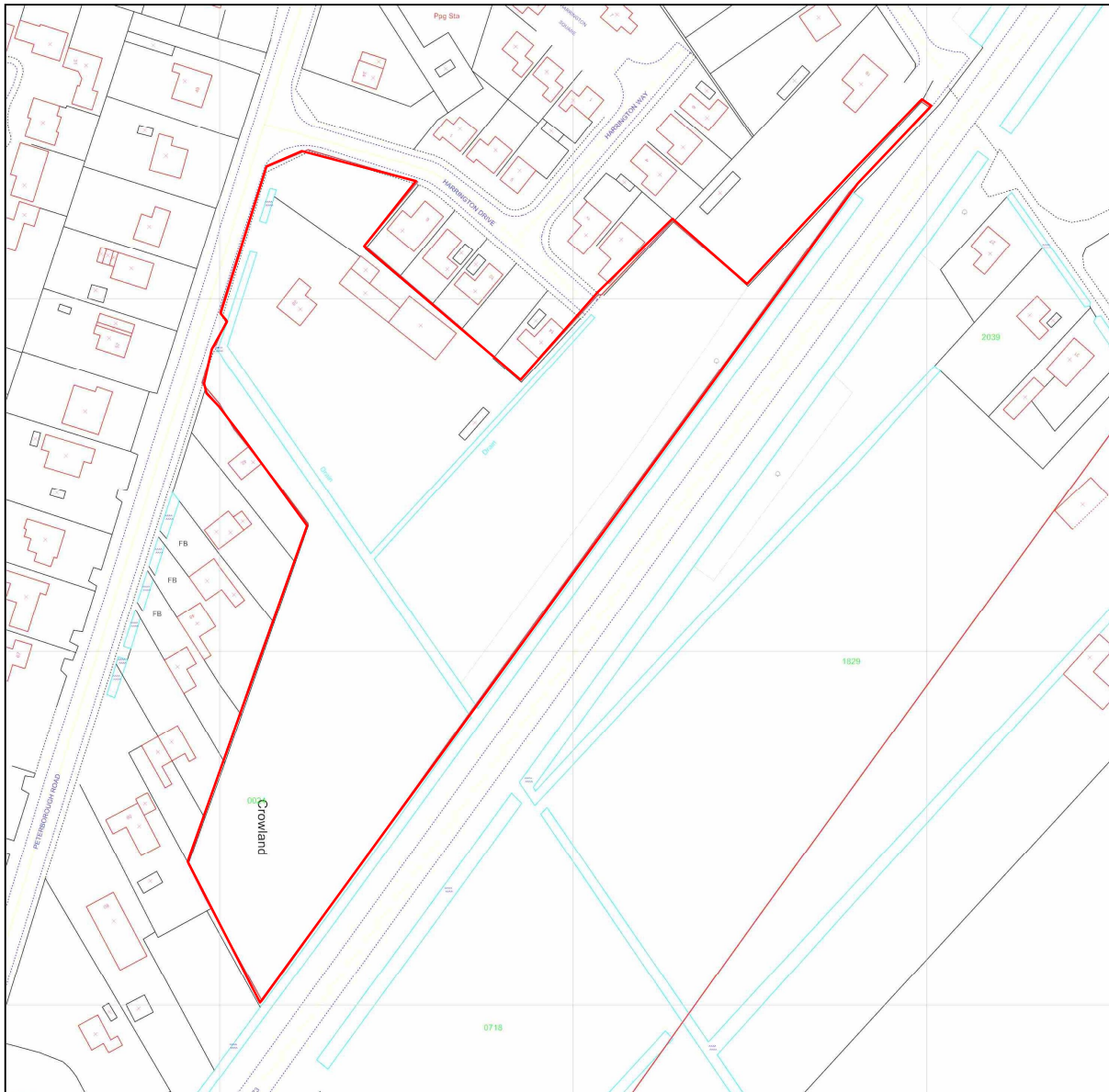
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Site History

Figure J

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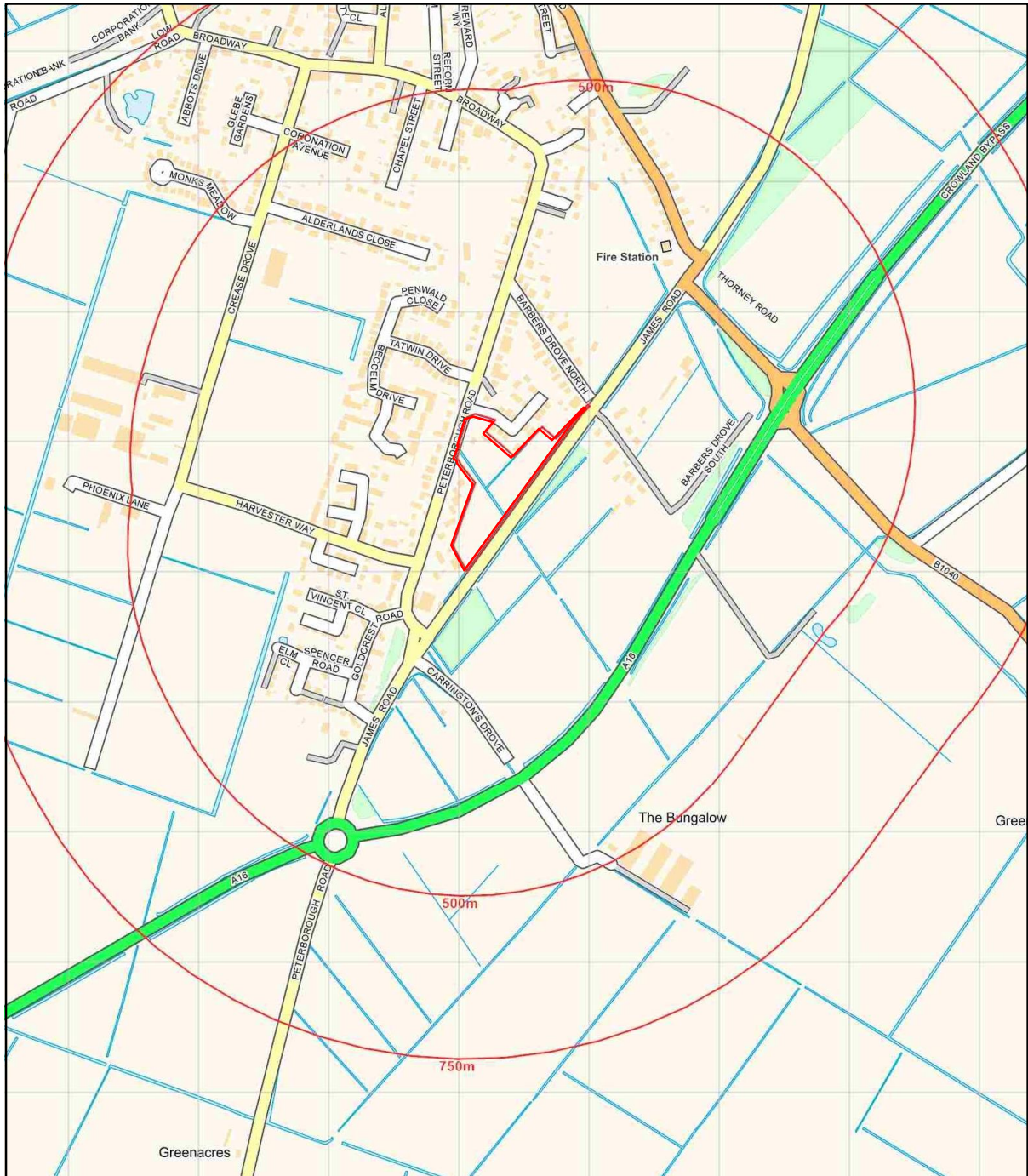
Project No.

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Site History

Figure K

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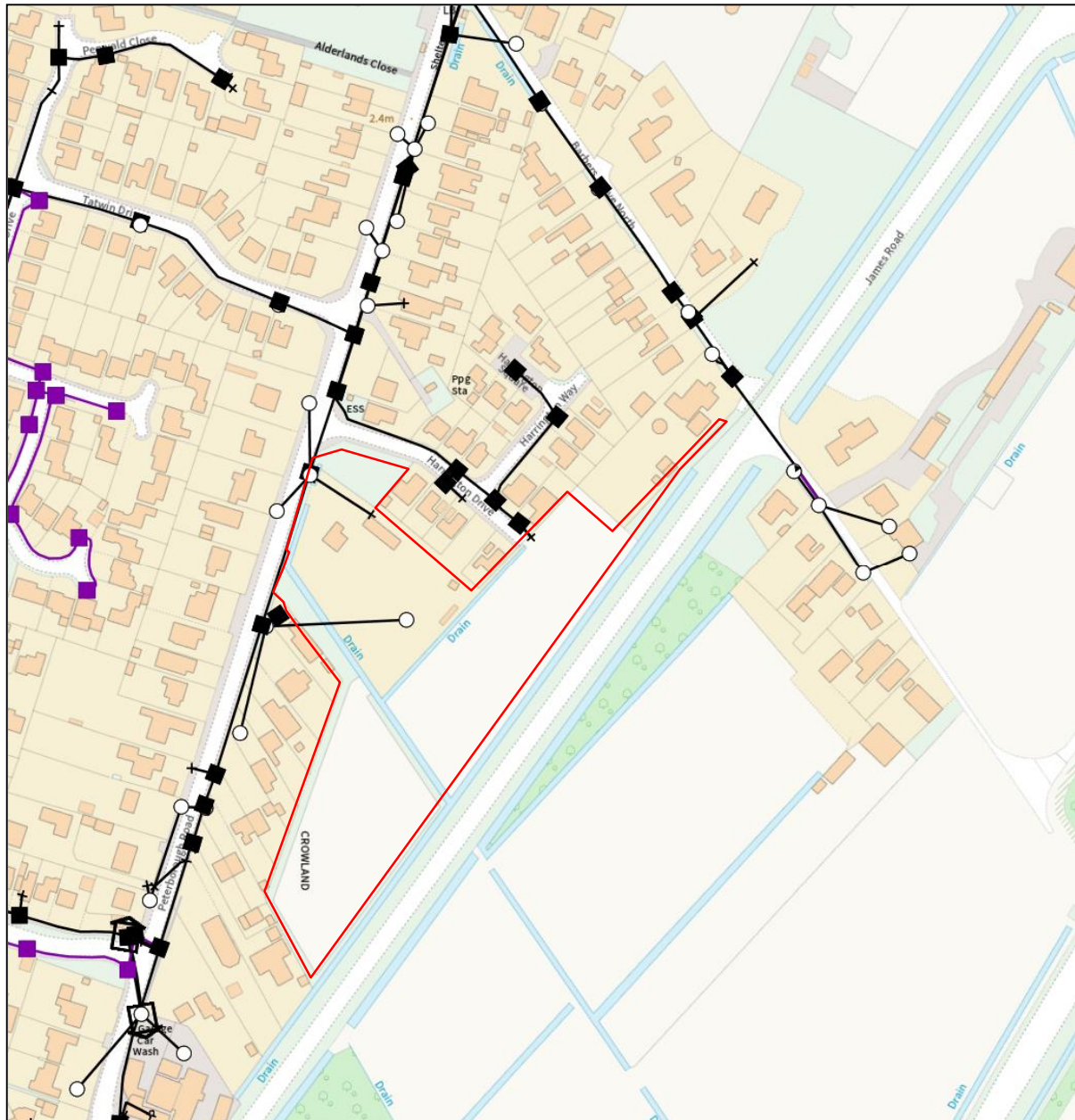
Project No.

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Site History

Figure L

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Project No.

C15350

APPENDIX 2

ENVIRONMENTAL DATABASE SEARCH

HARRINGTON DRIVE, CROWLAND, PETERBOROUGH, PE6 0AT

Order Details

Date: 15/04/2021
Your ref: SWC15350
Our Ref: GS-7749592
Client: Ground Engineering Limited

Site Details

Location: 524075 309344
Area: 1.74 ha
Authority: [South Holland District Council](#)



Summary of findings

p. 2

Aerial image

p. 8

OS MasterMap site plan

p.13

groundsure.com/insightuserguide

Summary of findings

Page	Section	Past land use	On site	0-50m	50-250m	250-500m	500-2000m
<u>14</u>	<u>1.1</u>	<u>Historical industrial land uses</u>	1	1	7	6	-
<u>15</u>	<u>1.2</u>	<u>Historical tanks</u>	0	0	0	5	-
<u>16</u>	<u>1.3</u>	<u>Historical energy features</u>	0	0	3	1	-
16	1.4	Historical petrol stations	0	0	0	0	-
<u>17</u>	<u>1.5</u>	<u>Historical garages</u>	0	0	3	2	-
17	1.6	Historical military land	0	0	0	0	-
Page	Section	Past land use - un-grouped	On site	0-50m	50-250m	250-500m	500-2000m
<u>18</u>	<u>2.1</u>	<u>Historical industrial land uses</u>	1	1	9	8	-
<u>19</u>	<u>2.2</u>	<u>Historical tanks</u>	0	0	0	7	-
<u>20</u>	<u>2.3</u>	<u>Historical energy features</u>	0	0	5	2	-
20	2.4	Historical petrol stations	0	0	0	0	-
<u>21</u>	<u>2.5</u>	<u>Historical garages</u>	0	0	4	4	-
Page	Section	Waste and landfill	On site	0-50m	50-250m	250-500m	500-2000m
22	3.1	Active or recent landfill	0	0	0	0	-
22	3.2	Historical landfill (BGS records)	0	0	0	0	-
23	3.3	Historical landfill (LA/mapping records)	0	0	0	0	-
23	3.4	Historical landfill (EA/NRW records)	0	0	0	0	-
23	3.5	Historical waste sites	0	0	0	0	-
23	3.6	Licensed waste sites	0	0	0	0	-
<u>23</u>	<u>3.7</u>	<u>Waste exemptions</u>	0	0	2	5	-
Page	Section	Current industrial land use	On site	0-50m	50-250m	250-500m	500-2000m
<u>25</u>	<u>4.1</u>	<u>Recent industrial land uses</u>	0	1	3	-	-
<u>26</u>	<u>4.2</u>	<u>Current or recent petrol stations</u>	0	0	1	0	-
26	4.3	Electricity cables	0	0	0	0	-
26	4.4	Gas pipelines	0	0	0	0	-
27	4.5	Sites determined as Contaminated Land	0	0	0	0	-



27	4.6	Control of Major Accident Hazards (COMAH)	0	0	0	0	-
27	4.7	Regulated explosive sites	0	0	0	0	-
27	4.8	Hazardous substance storage/usage	0	0	0	0	-
27	4.9	Historical licensed industrial activities (IPC)	0	0	0	0	-
28	4.10	Licensed industrial activities (Part A(1))	0	0	0	0	-
28	4.11	<u>Licensed pollutant release (Part A(2)/B)</u>	0	0	1	2	-
28	4.12	Radioactive Substance Authorisations	0	0	0	0	-
29	4.13	<u>Licensed Discharges to controlled waters</u>	0	0	0	6	-
30	4.14	Pollutant release to surface waters (Red List)	0	0	0	0	-
30	4.15	Pollutant release to public sewer	0	0	0	0	-
30	4.16	List 1 Dangerous Substances	0	0	0	0	-
30	4.17	List 2 Dangerous Substances	0	0	0	0	-
30	4.18	<u>Pollution Incidents (EA/NRW)</u>	0	3	0	0	-
31	4.19	Pollution inventory substances	0	0	0	0	-
31	4.20	Pollution inventory waste transfers	0	0	0	0	-
31	4.21	Pollution inventory radioactive waste	0	0	0	0	-
Page	Section	Hydrogeology	On site	0-50m	50-250m	250-500m	500-2000m
33	5.1	<u>Superficial aquifer</u>	Identified (within 500m)				
34	5.2	<u>Bedrock aquifer</u>	Identified (within 500m)				
35	5.3	<u>Groundwater vulnerability</u>	Identified (within 50m)				
36	5.4	Groundwater vulnerability- soluble rock risk	None (within 0m)				
36	5.5	Groundwater vulnerability- local information	None (within 0m)				
37	5.6	<u>Groundwater abstractions</u>	0	0	0	0	1
38	5.7	<u>Surface water abstractions</u>	0	0	0	1	29
44	5.8	Potable abstractions	0	0	0	0	0
45	5.9	Source Protection Zones	0	0	0	0	-
45	5.10	Source Protection Zones (confined aquifer)	0	0	0	0	-
Page	Section	Hydrology	On site	0-50m	50-250m	250-500m	500-2000m
46	6.1	<u>Water Network (OS MasterMap)</u>	6	15	43	-	-



52	6.2	<u>Surface water features</u>	1	7	15	-	-
52	6.3	<u>WFD Surface water body catchments</u>	1	-	-	-	-
52	6.4	<u>WFD Surface water bodies</u>	0	0	0	-	-
53	6.5	WFD Groundwater bodies	0	-	-	-	-
Page	Section	River and coastal flooding	On site	0-50m	50-250m	250-500m	500-2000m
54	7.1	<u>Risk of Flooding from Rivers and Sea (RoFRaS)</u>	Medium (within 50m)				
55	7.2	<u>Historical Flood Events</u>	1	0	0	-	-
55	7.3	Flood Defences	0	0	0	-	-
55	7.4	Areas Benefiting from Flood Defences	0	0	0	-	-
56	7.5	Flood Storage Areas	0	0	0	-	-
57	7.6	<u>Flood Zone 2</u>	Identified (within 50m)				
58	7.7	<u>Flood Zone 3</u>	Identified (within 50m)				
Page	Section	Surface water flooding					
59	8.1	<u>Surface water flooding</u>	1 in 30 year, 0.1m - 0.3m (within 50m)				
Page	Section	Groundwater flooding					
61	9.1	<u>Groundwater flooding</u>	Negligible (within 50m)				
Page	Section	Environmental designations	On site	0-50m	50-250m	250-500m	500-2000m
62	10.1	Sites of Special Scientific Interest (SSSI)	0	0	0	0	0
62	10.2	Conserved wetland sites (Ramsar sites)	0	0	0	0	0
62	10.3	Special Areas of Conservation (SAC)	0	0	0	0	0
62	10.4	Special Protection Areas (SPA)	0	0	0	0	0
63	10.5	National Nature Reserves (NNR)	0	0	0	0	0
63	10.6	Local Nature Reserves (LNR)	0	0	0	0	0
63	10.7	Designated Ancient Woodland	0	0	0	0	0
63	10.8	Biosphere Reserves	0	0	0	0	0
64	10.9	Forest Parks	0	0	0	0	0
64	10.10	Marine Conservation Zones	0	0	0	0	0
64	10.11	Green Belt	0	0	0	0	0
64	10.12	Proposed Ramsar sites	0	0	0	0	0



64	10.13	Possible Special Areas of Conservation (pSAC)	0	0	0	0	0
65	10.14	Potential Special Protection Areas (pSPA)	0	0	0	0	0
65	10.15	Nitrate Sensitive Areas	0	0	0	0	0
65	10.16	<u>Nitrate Vulnerable Zones</u>	2	0	0	0	1
66	10.17	<u>SSSI Impact Risk Zones</u>	1	-	-	-	-
67	10.18	SSSI Units	0	0	0	0	0
Page	Section	Visual and cultural designations	On site	0-50m	50-250m	250-500m	500-2000m
68	11.1	World Heritage Sites	0	0	0	-	-
68	11.2	Area of Outstanding Natural Beauty	0	0	0	-	-
68	11.3	National Parks	0	0	0	-	-
68	11.4	Listed Buildings	0	0	0	-	-
69	11.5	Conservation Areas	0	0	0	-	-
69	11.6	Scheduled Ancient Monuments	0	0	0	-	-
69	11.7	Registered Parks and Gardens	0	0	0	-	-
Page	Section	Agricultural designations	On site	0-50m	50-250m	250-500m	500-2000m
70	12.1	<u>Agricultural Land Classification</u>	Grade 2 (within 250m)				
71	12.2	Open Access Land	0	0	0	-	-
71	12.3	Tree Felling Licences	0	0	0	-	-
71	12.4	Environmental Stewardship Schemes	0	0	0	-	-
72	12.5	Countryside Stewardship Schemes	0	0	0	-	-
Page	Section	Habitat designations	On site	0-50m	50-250m	250-500m	500-2000m
73	13.1	<u>Priority Habitat Inventory</u>	0	1	2	-	-
74	13.2	Habitat Networks	0	0	0	-	-
74	13.3	Open Mosaic Habitat	0	0	0	-	-
74	13.4	Limestone Pavement Orders	0	0	0	-	-
Page	Section	Geology 1:10,000 scale	On site	0-50m	50-250m	250-500m	500-2000m
75	14.1	<u>10k Availability</u>	Identified (within 500m)				
76	14.2	Artificial and made ground (10k)	0	0	0	0	-
77	14.3	<u>Superficial geology (10k)</u>	2	0	0	2	-