



Ground Gas Risk Assessment

Small Drove, Weston

Presented to Brown Builders Ltd

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Delta-Simons Project No. 19-0423.02



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Table of Contents

1.0 INTRODUCTION	1
1.1 Appointment.....	1
1.2 Project Background	1
1.3 Scope of Works	1
1.4 Existing Information	1
1.5 Limitations.....	1
2.0 REVIEW OF EXISTING INFORMATION	2
2.1 Site Investigation Report (2017).....	2
2.2 Ground Gas Risk Assessment (2019).....	2
2.3 Ground Gas Sampling & Analysis (2019).....	3
3.0 SITE INVESTIGATION	4
4.0 INVESTIGATION FINDINGS	5
4.1 Ground Summary	5
4.2 Ground Gas Monitoring Results	5
5.0 LABORATORY TESTING RESULTS.....	7
5.1 Total Organic Carbon (TOC) Analysis.....	7
5.2 Groundwater Analysis	7
6.0 GROUND GAS RISK ASSESSMENT	8
6.1 Ground Gas Conceptual Site Model.....	8
6.1.1 Sources.....	8
6.1.2 Receptors.....	8
6.1.3 Pathways	9
6.2 Duration & Extent of Monitoring.....	9
6.3 Ground Gas Risk Assessment	9
6.3.1 Background.....	9
6.3.2 Spot Monitoring - Gas Screening Value (GSV)	10
6.3.3 TOC Analyses.....	11
6.3.4 Dissolved Methane	12
6.3.5 Risk Assessment	12
6.4 Ground Gas Risk Mitigation.....	14
6.4.1 Zone A	14
6.4.2 Zone B	14
7.0 CONCLUSIONS & RECOMMENDATIONS	16
7.1 Conclusions	16
7.2 Recommendations.....	16

Figures

Figure 1	Site Location Map
Figure 2	Exploratory Hole Location Plan
Figure 3	Proposed Development Plan (Client-Supplied)

Appendices

Appendix A	Limitations
Appendix B	Previous Reports
Appendix C	Borehole Logs
Appendix D	Monitoring Data
Appendix E	Chemical Analysis

1.0 Introduction

1.1 Appointment

Delta-Simons Environmental Consultants Limited ("Delta-Simons") was instructed by Brown Builders Ltd (the "Client") to undertake an assessment of potential hazardous ground gas risks associated with the re-development of a parcel of land off Small Drove, Weston, PE12 6HU (the "Site").

1.2 Project Background

The aim of the assessment is to obtain additional information regarding ground conditions, specifically relating to hazardous ground gases, from which risks to end-users, the environment and structures can be assessed, with mitigation measures outlined, if necessary.

Delta-Simons understands that the Site is to be redeveloped to a residential end use comprising 34 plots with associated gardens, access roads and soft landscaped areas.

A Site Location Plan is provided as Figure 1 and a proposed development plan provided as Figure 2.

1.3 Scope of Works

The scope of works for this assessment comprises the following:

- ▲ Undertake a review of previous investigations on the Site undertaken by third parties;
- ▲ Detail the results of an intrusive investigation completed by Delta-Simons at the Site in March 2019;
- ▲ Present the findings of associated laboratory testing of recovered soil and groundwater samples;
- ▲ Detail the results of ground gas monitoring, including of newly installed wells together with all existing wells, completed between 3rd March and 9th May 2019; and
- ▲ Outline any mitigation measures, where necessary, for the proposed development.

1.4 Existing Information

The following third-party reports have been provided to Delta-Simons for review:

- ▲ 'Site Investigation Report' by Ground Engineering Ltd (Ref: C14022) dated March 2017;
- ▲ 'Ground Gas Risk Assessment' letter report by Solmek Ltd (Ref: S181221/GAS) dated 16th January 2019; and
- ▲ 'Ground Gas Sampling and Analysis' letter report by Solmek Ltd (Ref: S181221/GAS) dated 20th February 2019.

1.5 Limitations

This document sets out the measures that will be carried out during the construction to mitigate potentially significant risks as identified by the investigations in the context of the proposed end-use of the Site, it does not provide a verification or completion statement for the works. The standard limitations associated with this assessment are presented in Appendix A.

2.0 Review of Existing Information

2.1 Site Investigation Report (2017)

A site investigation was undertaken by Ground Engineering Ltd (GE) in 2017 on behalf of South Holland District Council to provide information on the underlying ground conditions in relation to the proposed development, including a contamination assessment. At the time of the investigation, the Site was occupied by ten brick bungalows, associated gardens and open grassed areas. The Site is located in an area of reclaimed fenland standing at approximately 3.0 m AOD.

A historical review recorded the Site to comprise two fields adjacent to Small Lane with a drain defining the Site boundary. Farm buildings were located adjacent to the southwestern boundary of the Site. By 1958, ten bungalows were constructed on-Site. Domestic garages are now also recorded on-Site in the southwest, and the drain adjacent to Small Lane are now infilled (possibly culverted). St Mary's Primary School had been established with a playing field opposite to the Site on the north western side of Small Lane. Records from 1987 recorded a name change regarding Small Lane to Small Drove. The Site layout remains unchanged. No notable changes to the Site were recorded from 1987 until the 2016 map edition.

The scope of the GE investigation comprised ten window sampler boreholes (WS1 to WS10) with standard penetration tests (SPT's) to a depth of approximately 4.0 m bgl, three of which (WS1, WS6 and WS9) were extended by dynamic probing to approximately 10.0 m bgl. These three boreholes were also installed as permanent gas/groundwater monitoring wells.

The investigation recorded ground conditions comprising Made Ground between depths of 0.4 m bgl (across the majority of the Site) and 1.55 m bgl locally in WS8 where an infilled drainage ditch was located. Tidal Flat Deposits were identified underlying the Made Ground and comprised sandy silts, silts and clays. Organic clays were noted between 1.8 and 3.0 m bgl across the Site area. Dynamic probing indicated very soft Tidal Flat Deposits extending to depths of approximately 10.0 m bgl. Groundwater was encountered during drilling between 0.8 and 3.0 m bgl.

A programme of ground gas monitoring (3 No. visits) identified concentrations of methane up to 3.9 %v/v, and carbon dioxide up to 1.4 %v/v with marginally depleted oxygen levels. Flow rates of less than 0.1 l/hr were also recorded. The results are summarised in the table below. Barometric pressure ranged between 1018 and 1025 mB during monitoring. The Site was therefore classified by GE as CS1 in accordance with BS 8485:2015 (i.e. the modified Wilson & Card classification), or Green in accordance to the NHBC traffic light system.

A copy of the GE report is presented in Appendix B.

Exploratory Hole Location	Steady State Gas Concentrations (%v/v)						Maximum Flow Rate (l/hr)	Stratum	Well Completely Flooded (Frequency)?
	Methane		Carbon Dioxide		Oxygen				
	Min	Max	Min	Max	Min	Max			
WS1	<0.1	<0.1	<0.1	0.8	19.5	20.1	<0.1	Tidal Flat Deposits	Yes (3)
WS6	<0.1	3.9	0.3	1.4	18.1	19.4	<0.1		No
WS9	<0.1	<0.1	<0.1	1.3	19.8	20.3	<0.1		Yes (3)

2.2 Ground Gas Risk Assessment (2019)

A ground gas risk assessment was undertaken by Solmek Ltd (Solmek), which utilised data collected during three additional rounds of gas monitoring of the wells installed during the initial GE site investigation (WS1, WS6 and WS9). During the monitoring, the wells were purged of groundwater first and gas monitoring completed after a suitable time period (*Note: it is unclear from the Solmek report what the duration of this time period was; consequently, Delta-Simons are unable to assess whether a sufficient period of time had elapsed between*

purging the wells of standing water and monitoring gas concentrations/flows so as to obtain representative data).

The Solmek monitoring results are summarised in the following table. The monitoring over the three additional visits recorded carbon dioxide concentrations between 0.1 and 4.4 %v/v. There was evidence of oxygen depletion in WS1 on all three occasions with concentrations consistently <12.0 %v/v. Methane was not detected in boreholes WS6 or WS9 during the survey and no flow rates were recorded within these wells. However, within WS1, methane was detected on all three occasions with concentrations up to 87.4 %v/v and borehole flow rates up to 11.0 l/hr. Barometric pressure ranged between 1008 and 1025 mB during the Solmek monitoring programme.

Exploratory Hole Location	Steady State Gas Concentrations (%v/v)						Maximum Flow Rate (l/hr)	Stratum	Well Completely Flooded (Frequency)?
	Methane		Carbon Dioxide		Oxygen				
	Min	Max	Min	Max	Min	Max			
WS1	36.2	87.4	1.7	4.4	0.1	11.1	11.0	Tidal Flat Deposits	Yes (3)
WS6	<0.1	<0.1	0.1	1.8	17.1	20.4	0.1		No
WS9	<0.1	<0.1	0.6	2.8	16.7	18.3	0.1		No

In accordance with the NHBC traffic light system, and taking into account the recorded methane concentrations, the Site was provisionally classified by Solmek as NHBC Red, where standard residential housing is unacceptable subject to risk assessment and remedial mitigation measures to reduce or remove the source of gas.

A copy of the Solmek report is presented in Appendix B.

2.3 Ground Gas Sampling & Analysis (2019)

Solmek subsequently collected ground gas samples from WS1 using Tedlar bags and a Gresham pump to further investigate the elevated concentrations of methane previously recorded in borehole WS1. The sample was analysed for methane, propane, butane and methane.

A methane concentration of 16.0% v/v was recorded, whilst the remaining three determinands were below detection limit. A mains gas leak was discounted as a potential source of the elevated gas concentrations, given that mains gas typically comprises higher alkanes (such as ethane, propane and butane).

The Tidal Flat Deposits, which were found during the GE investigation to predominantly comprise clay and silt, were noted to be of organic composition between 2.0 and 2.8 m bgl to >3.45 m bgl. Organic clays and silts were deemed by Solmek to be a plausible source of the methane gas due to anaerobic microbial decomposition. The shallow clay layer was conjectured by Solmek to be an effective seal, trapping the ground gas and allowing methane accumulation. By installing the borehole (WS1) and piercing the clay seal, it was proposed, by Solmek, that a pathway could have been opened allowing methane to be omitted under a pressure gradient, particularly during low atmospheric pressure conditions.

A copy of the Solmek report is presented in Appendix B.

3.0 Site Investigation

An intrusive investigation was completed at the Site on 29th March 2019 to further assess the ground gas regime at the Site. The investigation comprised the following:

- ▲ Eight dynamic sampler boreholes (DS101 to DS108) with standpipe installations to depths between 2.0 and 6.0 m bgl;
- ▲ Chemical testing of soil arisings for Total Organic Carbon (TOC);
- ▲ Chemical testing of silt samples collected from the base of WS1, WS6 and WS9 during ground gas monitoring for TOC;
- ▲ Chemical testing of groundwater for Dissolved Methane; and
- ▲ Nine return visits for monitoring ground gas and groundwater level in the newly installed monitoring wells (DS101-DS108) and the three existing wells installed during the GE 2017 site investigation (WS1, WS6 and WS9). The first three monitoring rounds were completed prior to the Delta-Simons intrusive works and therefore included monitoring of WS1, WS6 and WS9 only. The remaining six monitoring rounds included readings from all eleven monitoring wells.

The locations of the intrusive holes are shown on Figure 2, attached and were chosen to:

- ▲ Target the area around WS1, where elevated methane concentrations and flow rates had previously been recorded; and
- ▲ To provide good coverage across the Site in relation to the proposed development.

It is noted that piled foundations were recommended by GE in the previous site investigation report in an area where DS108 was undertaken. DS108 was therefore advanced and installed as a monitoring well to 6.0 m bgl to investigate the possibility of a deeper ground gas source than the organic clay strata identified by Solmek.

4.0 Investigation Findings

4.1 Ground Summary

A summary of the observed ground conditions at the Site is provided below:

Summary of Observed Ground Conditions				
Strata	Typical Strata Description	Depth Range of Strata Base (m bgl)	Maximum Proven Thickness (m)	Comments
Made Ground	Brownish black slightly clayey SAND and crushed concrete overlying soft brown sandy CLAY (reworked material).	0.1 – 0.7	0.7	Clay in DS104 only.
River Terrace Deposits	Brown/brownish grey slightly clayey SAND; Soft grey SILT; and/or Brown/greyish brown sandy CLAY.	Unproven	Unproven	Organic silt was recorded between 2.0 and 6.0 m bgl in DS108.

Groundwater strikes were noted during drilling operations at typically between 1.0 and 2.0 m bgl, with a second strike noted in DS108 at 5.0 m bgl, which rose to 4.6 m bgl after ten minutes.

No visual or olfactory evidence of contamination or potential sources of ground gas (deep Made Ground or significantly organic-rich soil) were encountered during the Site investigation and the ground conditions were generally consistent with the findings of the previous investigation.

Borehole records from the intrusive works are included as Appendix C.

4.2 Ground Gas Monitoring Results

Preliminary gas monitoring results are presented in Appendix D and summarised in the following table. The results include three initial monitoring rounds (Visits 1-3) on all existing wells (WS1, WS6 and WS9) followed by the first five of six rounds of gas monitoring (visits 4-9) to be completed on all existing and newly installed wells (DS101-DS108).

Barometric pressures ranged from 980mB (visit 3) to 1027mB (visit 5).

Exploratory Hole	Steady Gas Concentration (%v/v)						Steady Flow Rate (l/hr)		Response Zone (m bgl)		Stratum	Completely flooded? (frequency ¹)
	Methane		Carbon Dioxide		Oxygen							
	Min	Max	Min	Max	Min	Max	Min	Max	From	To		
DS101	<0.1	<0.1	<0.1	1.8	11.7	19.9	-1.0	0.4	1.0	3.0	Tidal Flat Deposits	No
DS102	<0.1	<0.1	<0.1	2.7	14.3	20.3	-0.1	7.6	1.0	2.0		Yes (5)
DS103	<0.1	<0.1	<0.1	1.1	13.7	20.3	4.9	13.5	1.0	3.0		Yes (1)
DS104	<0.1	<0.1	<0.1	1.0	13.7	20.3	-0.9	0.1	1.0	3.0		Yes (1)
DS105	<0.1	<0.1	<0.1	2.3	13.2	20.4	0.1	0.1	1.0	2.0		No
DS106	<0.1	<0.1	<0.1	2.9	13.9	20.1	0.2	0.2	1.0	3.0		No
DS107	<0.1	<0.1	0.6	2.4	12.8	18.8	-0.1	0.3	1.0	3.0		No
DS108	<0.1	<0.1	<0.1	1.0	14.2	20.4	0.1	0.3	2.0	6.0		Yes (6)
WS1	<0.1	76.9	<0.1	6.1	3.1	20.5	0.1	84.6	1.0	3.0		Yes (5)
WS6	<0.1	27.7	<0.1	4.4	10.7	20.3	-2.7	13.9	1.0	3.0		No
WS9	<0.1	40.8	<0.1	2.5	8.1	20.5	-0.1	0.1	1.0	3.0	Yes (6)	
Notes ¹ = Maximum potential frequency of flooded wells for DS101-DS108 is 6 monitoring rounds, and maximum potential frequency for WS1, WS6 and WS9 is 9 monitoring rounds.												

5.0 Laboratory Testing Results

5.1 Total Organic Carbon (TOC) Analysis

Fifteen samples of soil obtained during the intrusive works were sent to a UKAS and MCERTS accredited laboratory for Total Organic Carbon (TOC) testing. The recorded TOC values ranged between 0.4% and 4.6%. The highest recorded TOC content of 4.6% was from a clay stratum within DS103.

Subsequently, samples of silt were also collected from the base of the three existing monitoring wells (WS1, WS6 and WS9) for TOC analysis. The results ranged between 2.1% (WS9) and 4.5% (WS6).

The TOC chemical data is included as Appendix E.

5.2 Groundwater Analysis

Dissolved methane analysis was conducted on groundwater samples collected from each of the existing monitoring wells via disposable bailers. The recorded concentrations ranged between <0.1 mg/l (WS9) to 2.6 mg/l (WS6).

The results are included within Appendix E.

6.0 Ground Gas Risk Assessment

6.1 Ground Gas Conceptual Site Model

6.1.1 Sources

Potential Shallow Gas Sources

Historically, the Site comprises an area of reclaimed fenland, and the most plausible shallow source of hazardous ground gases identified on the Site is the Made Ground resulting from these reclamation operations. Historical mapping from the 1880s onwards (reviewed as part of the GE report) indicates the Site to have comprised the western end of two fields adjacent to Small Lane (now Small Drove), with drains indicated to be present along the western and southwestern Site boundaries, with another drain crossing the northern part of the Site. This suggests that the reclamation works appear to have been completed prior to the date of the earliest available mapping, and that the age of emplacement of the Made Ground associated with reclamation of the former fenland is likely to be well in excess of 100 years.

The 2019 Delta-Simons ground investigation found the Made Ground to predominantly comprise crushed concrete overlying sandy clay and clayey fine to medium sand (reworked superficial deposits). This is generally consistent with the findings of the 2017 GE investigation, which encountered a Made Ground stratum typically between 0.4 and 0.9 m in thickness (locally up to 1.55 m corresponding to an infilled ditch) and comprising a gravelly silt or clay fill with an anthropogenic component including asphalt, brick, pottery, textiles, coal and ash, with some wood recorded on a localised basis in the location of the infilled drainage ditch.

Given that the proportion of biodegradable materials appears to be generally low, the Made Ground stratum is considered unlikely to have a significant gas-generating potential, and no further assessment of these materials is deemed warranted.

Potential Deeper Gas Sources

The superficial geology underlying the Site comprises Tidal Flat Deposits. The shallow soils were typically sandy clays, and are considered unlikely to be a plausible source of hazardous ground gases. The deeper Tidal Flat Deposits were described in the GE report as becoming more organic rich, typically from 1.8 to 3.0 m bgl and extending to at least 3.45 m bgl (total thickness of these organic clays not proven as part of the GE investigation).

There is a high groundwater table below the Site which also appears to be confined by a clay layer within the sequence of Tidal Flat Deposits, which may be acting as an aquitard as evidenced by initial groundwater strikes in both the GE and Delta-Simons at approximately 1 to 2 m bgl, rising to 0.6 to 0.9 m bgl during the GE investigation, and to between 0.9 to 1.3 m bgl in the Delta-Simons investigation. This high groundwater table suggests that the organic-rich clays are likely to be anaerobic in nature, and may therefore be a plausible source of ground gases as a result of microbial activity under such conditions, although the rate of gas generation from such a source is considered unlikely to be significant.

The bedrock geology is characterised by mudstones and siltstones of the West Walton Formation strata. These are not considered to represent a plausible source of hazardous ground gases, and will not be considered further as part of the risk assessment.

Off-Site Gas Sources

It is anticipated that the infilled drainage ditch encountered as part of the GE investigation may also extend off-Site. Furthermore, Delta-Simons has anecdotal evidence of other infilled ditches beyond the Site boundary which could pose a plausible off-Site source of hazardous ground gases in the event that the fill materials have a significant biodegradable content. Delta-Simons has also been advised of the presence of diesel storage tanks beyond the southwestern corner of the Site, with a diesel-like odour also present. The potential for gases, generated by the degradation of spilled hydrocarbon fuels, cannot therefore be discounted.

6.1.2 Receptors

The principal receptors under consideration are future residents. Other receptors include adjacent site occupiers and future maintenance / construction workers.

6.1.3 Pathways

The underlying geology is likely to be of variable permeability with respect to ground gases. The Made Ground is relatively heterogeneous and may allow preferential migration locally. The underlying Tidal Flat Deposits are predominantly cohesive in nature (silts and clays) and are therefore likely to limit vertical migration from below and also lateral migration from both on- and off-Site sources.

Based on the above, significant migration of hazardous ground gases from any off-Site sources is also considered unlikely to be significant, although cannot be discounted if there are potential migration pathways such as those posed by infilled drainage ditches or roddens should the infill materials be relatively granular in nature (i.e. more permeable to ground gases).

The most significant pathways with respect to future residents relate to the potential for gases to enter future dwellings. At present, no gas protection measures are assumed. Consequently, ingress into dwellings may be possible through voids in the floor including service entry points and cracks.

Future maintenance / construction workers may come into contact with hazardous ground gases via entry into below-ground confined spaces such as excavations or service entries / inspection points. Whilst this is a real and credible risk, no work within a confined space should be carried out without appropriate assessment and mitigation in place.

6.2 Duration & Extent of Monitoring

Tables 5.5a and 5.5b within CIRIA C665 detail current recommended monitoring duration and frequency for sites in the UK. The gas generation potential of the Site is considered to be low, and the sensitivity of the proposed development (residential with gardens) is high in accordance with the rankings outlined in Tables 5.5a and 5.5b of CIRIA C665. On this basis, CIRIA C665 recommends 9 visits over a period of 6 months.

A programme of spot monitoring was implemented by Delta-Simons utilising all existing and new monitoring wells, which began on 6th March 2019 and concluded on 9th May 2019. This supplemented the earlier monitoring carried out in 2017 and 2018 (i.e. as part of the original GE assessment and subsequent monitoring carried out by Solmek). The monitoring completed at the Site is, therefore, considered to generally accord with the recommended frequency and duration requirements detailed in CIRIA C665.

Barometric pressures ranged from 1018mB to 1025mB during the GE monitoring, from 1008mB to 1025mB during the Solmek monitoring and from 980mB (visit 3) to 1027mB (visit 5) during the Delta-Simons monitoring. The barometric pressure trends for the three days leading up to the monitoring were falling on one out of the three GE monitoring rounds, on one out of the three Solmek monitoring rounds and on five out of the nine Delta-Simons monitoring rounds. The monitoring data is therefore considered to be suitably representative of 'worst case' conditions.

6.3 Ground Gas Risk Assessment

6.3.1 Background

Based on the proposed residential end use, the following documents have been consulted when assessing the gas regime at the Site:

- ▲ NHBC/RSK Group PLC (2007), 'Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present', Report Edition No. 4;
- ▲ CIRIA C665 (2007) 'Assessing Risks Posed by Hazardous Ground Gases to Buildings'; and
- ▲ CL:AIRE Research Bulletin RB 17 (2012), 'A Pragmatic Approach to Ground Gas Risk Assessment'; and
- ▲ British Standards Institute (BSI, 2015+A1:2019): 'Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings', BS:8485.

The presence of a source of hazardous gas within the ground does not necessarily indicate a risk will be present. Consideration of recorded gas flows together with source concentrations can allow an initial assessment to be made of the potential both for generation and subsequent migration of gas. A Characteristic Situation (CS) is derived from an assessment of the ground gas data and forms the basis of determining mitigation measures.

Given that the majority of the existing and new monitoring wells incorporate response zones that are at least partially inundated by the high groundwater table below the Site, it is proposed to adopt a 'lines of evidence' approach to assessing the Site's ground gas regime. This includes:

- ▲ A programme of ground gas monitoring;
- ▲ Analysis of arisings from the 2019 Delta-Simons boreholes for Total Organic Carbon (TOC);
- ▲ Analysis of recovered silt samples from the 2017 GE boreholes for Total Organic Carbon (TOC); and
- ▲ Analysis of recovered groundwater samples for dissolved methane.

Such an approach is considered to allow a more robust assessment of the Site's ground gas regime than can be achieved solely using gas monitoring data from permanent monitoring wells, which is subject to external influences that can affect the quality of the data obtained.

6.3.2 Spot Monitoring - Gas Screening Value (GSV)

The Gas Screening Value (gas concentration as a fraction multiplied by maximum recorded flow) is used to provide an initial assessment of risks to future site users. The GSVs calculated for the monitoring wells (without removing flooded wells) are presented in the following table and are based upon maximum steady state concentrations and flow rates for each monitoring well.

Location	Maximum Methane (%v/v)	Maximum Carbon Dioxide (%v/v)	Maximum Flow Rate (l/hr)	GSV/Characteristic Situation				Flooded well (Frequency)
				Methane		Carbon Dioxide		
				GSV	CS	GSV	CS	
DS101	<0.1	1.8	0.4	<0.001	1	0.007	1	No
DS102	<0.1	2.7	7.6	0.008	1	0.205	2	Yes (5)
DS103	<0.1*	1.1	13.5	0.014	1	0.149	2	Yes (1)
DS104	<0.1	1.0	0.1	<0.001	1	0.001	1	Yes (1)
DS105	<0.1	2.3	0.1	<0.001	1	0.002	1	No
DS106	<0.1	2.9	0.2	<0.001	1	0.006	1	No
DS107	<0.1	2.4	0.3	<0.001	1	0.007	1	No
DS108	<0.1	1.0	0.3	<0.001	1	0.003	1	Yes (6)
WS1	76.9	6.1	84.6	65.057	6	5.161	4	Yes (5)
WS6	27.7	4.4	13.9	3.850	4	0.612	2	No
WS9	40.8**	2.5	0.1	0.041	2**	0.003	1	Yes (6)
Notes								
* Elevated concentration of methane recorded in this borehole on one occasion considered to be an anomalous result.								
** Calculated GSV is CS1; however, if the peak methane exceeds 1%v/v and / or peak carbon dioxide exceeds 5% v/v, consideration should be given to increase the CS value.								

As the response zone within some of the monitoring wells was flooded during one or more of the monitoring rounds, the data recorded may not be truly representative of the ground gas regime at the Site. As such, data recorded when the monitoring well was completely flooded has been removed and the remaining data used to inform conclusions and recommendations. Removal of the flooded wells indicates the following GSV values:

Location	Maximum Methane (%v/v)	Maximum Carbon Dioxide (%v/v)	Maximum Flow Rate (l/hr)	GSV/Characteristic Situation			
				Methane		Carbon Dioxide	
				GSV	CS	GSV	CS
DS101	<0.1	1.8	0.4	<0.001	1	0.007	1
DS102	<0.1	2.7	<0.1	<0.001	1	0.003	1
DS103	<0.1*	1.1	4.9	0.005	1	0.054	1
DS104	<0.1	1.0	0.1	<0.001	1	0.001	1
DS105	<0.1	2.3	0.1	<0.001	1	0.002	1
DS106	<0.1	2.9	0.2	<0.001	1	0.006	1
DS107	<0.1	2.4	0.3	<0.001	1	0.007	1
DS108	Well completely flooded during all monitoring rounds						
WS1	40.4**	2.3	0.1	0.040	2*	0.002	1
WS6	27.7**	4.4	13.9**	3.850	4	0.612	2
WS9	<0.1	<0.1	<0.1	<0.001	1	<0.001	1
Notes * Elevated concentration of methane recorded in this borehole on one occasion considered to be an anomalous result. ** Calculated GSV is CS1; however, if the peak methane exceeds 1%v/v and / or peak carbon dioxide exceeds 5% v/v, consideration should be given to increase the CS value.							

6.3.3 TOC Analyses

Analysis of samples obtained from the 2019 Delta-Simons borehole investigation indicated TOC values of typically between 0.4 % and 1.7 %, with a sample of the deeper silty clays (i.e. the organic-rich clays identified in the GE report) exhibiting the highest recorded TOC content of 4.6 %. These values are, as expected, broadly consistent with the TOC values of recovered silt samples (e.g. 4.5% TOC in a silt sample from WS6).

The TOC content of soils in the context of their gas generation potential is not discussed in detail in CIRIA C665, although CL:AIRE publication RB17 considers an alternative approach to ground gas risk assessment, based upon a consideration of the gas-generating potential of a source to be estimated, and is considered to be a useful point of reference when considering the context of the recorded TOC values.

The recorded TOC values are considered to be low and not representative of soils with a significant gas-generating potential. The recorded methane concentrations may reflect gas that has been generated historically within the organic clay layer, remaining trapped at depth due to the overlying clay aquitard until such times as the aquitard is penetrated during monitoring well installation. Any carbon dioxide generated is likely to preferentially dissolve in the high groundwater table (the aqueous solubilities of methane and carbon dioxide at

25 °C are 2,610 and 2.57E+04 mg/l respectively) and result in a higher percentage of methane being recorded than might otherwise be the case.

6.3.4 Dissolved Methane

Dissolved methane concentrations varied between the monitoring wells sampled, and ranged between <0.1 to 2.6 mg/l. Given the Site's environmental setting, the dissolved methane is considered to be biogenic in origin (i.e. produced as a result of microbial activity) rather than thermogenic (i.e. formed via thermal decomposition of matter at depth, such as that associated with coal reserves). The significance of the recorded concentrations is discussed further in Section 6.3.5.

6.3.5 Risk Assessment

Probable Source(s)

The shallow Tidal Flat Deposits are characterised by sandy clays that are not typically regarded to be a plausible source of hazardous ground gases, and this is borne out by the results of ground gas monitoring within monitoring wells in DS102 and DS105, with no elevated gas concentrations or borehole flow rates.

As outlined in Section 6.1.1, the deeper organic-rich clay deposits are considered to be the most likely source of ground gases identified on the Site, and these are discussed in greater detail in the following section where elevated methane and/or carbon dioxide concentrations have been encountered during monitoring carried out both by Delta-Simons and other third parties. As outlined in Section 6.3.3, the TOC content of the Tidal Flat Deposits is typically 1 to 2%; whilst the readily degradable proportion of this TOC is likely to be high (i.e. it is unlikely to comprise non-degradable carbon sources such as ash or coal), such TOC values are unlikely to result in significant gas generation rates, and this is borne out by the monitoring to date.

Methane is widely encountered within groundwater bodies, though typically at low concentrations (up to 1 to 2 mg/l) in non-polluted aquifers and higher where there has been detrimental impact to the groundwater quality, such as by way of hydrocarbon spills or migration of landfill leachate. A maximum concentration of 2.6 mg/l of dissolved methane was encountered, which is not considered to be elevated in the context of the Site's environmental setting i.e. Tidal Flat Deposits with an anaerobic groundwater environment. Groundwater may be liberating some methane via de-gassing whilst the borehole head space comes into equilibrium with the atmosphere during the monitoring events (this may also be via egress of small volumes of gas from soil pore spaces), but is not in itself, considered to be a significant source of hazardous ground gases below the Site.

Methane and Carbon Dioxide Concentrations

There is no evidence from monitoring data from the newer (Delta-Simons) wells that the deeper Tidal Flat Deposits are a significant source of ground gases, with no elevated concentrations of either methane or carbon dioxide (the value of 60% methane recorded in DS103 on one occasion is considered to be an anomalous reading given that no depleted oxygen concentrations were observed during this monitoring round).

Elevated methane concentrations have been detected within all three of the previous monitoring wells (WS1, WS6 and WS9). These monitoring wells have response zones constructed within the same sequence of Tidal Flat Deposits as a number of the Delta-Simons wells in which no elevated methane concentrations have been detected. The elevated methane concentrations may be a consequence of the drilling operations introducing oxygen into a previously anaerobic environment, followed by pulling silt into the wells during the GE and Solmek groundwater sampling, since these wells are significantly more silted up than the Delta-Simons wells.

The likely source of this methane is considered to be microbial activity within the monitoring well, although gas generation rates via such activity are likely to be low, and this is borne out by the low to negligible flow rates where flows are not influenced by groundwater level changes within the monitoring well (see following section). The highest concentrations recorded (both by Delta-Simons and others) was when there had been a substantial period of time elapsed since the previous monitoring event, since methane concentrations were typically much lower during the later monitoring rounds than the initial (Delta-Simons) monitoring round. The high methane concentrations are considered likely to be a consequence, at least in part, of the relatively small headspace within the monitoring wells due to the high groundwater levels, since a small *volume* of gas may give rise to high *concentrations* in such scenarios. Repeat monitoring visits on a weekly basis preclude a build-up of gas during the subsequent monitoring programme.

The monitoring wells may also be facilitating the release of small quantities of gas generated in the deeper organic clays and trapped by the overlying clay aquitard at approximately 1 - 2 m bgl.

Flow Rates & Differential Pressures

The typically low to negligible borehole flow rates and differential pressures suggest that microbial degradation of an organic substrate does not appear to be resulting in high gas generation rates.

Where significant flow rates have been recorded during the Delta-Simons monitoring, this appears to be, at least in part, a function of changes in groundwater levels having a piston effect within the monitoring well. This appears to be either due to an initial rise in groundwater levels following drilling activities penetrating the clay aquitard (e.g. monitoring wells DS101 and DS103) or as a result of later changes in groundwater levels during the monitoring programme (e.g. monitoring well DS102).

The recorded flows may also be a function of groundwater de-gassing, with methane (and/or carbon dioxide) coming out of solution as the monitoring well is opened to atmosphere. Methane has an inherently low aqueous solubility (circa 30 mg/l) and is controlled by, inter alia, pressure, temperature and the presence of other dissolved species. The principal driver to the solubility of methane will be pressure, and this may explain why there was an audible pressure release and bubbling groundwater noted in WS1 during the first monitoring round i.e. dissolved methane coming out of solution as the sampling valve was opened, resulting in a marked effect on both gas concentrations and flows. This may also account for the recorded borehole flow rates from this monitoring well during the Solmek monitoring, with the time elapsed between the last GE and first Solmek monitoring rounds (nearly 24 months) allowing dissolved methane concentrations to build up within the well.

Previous Site Development

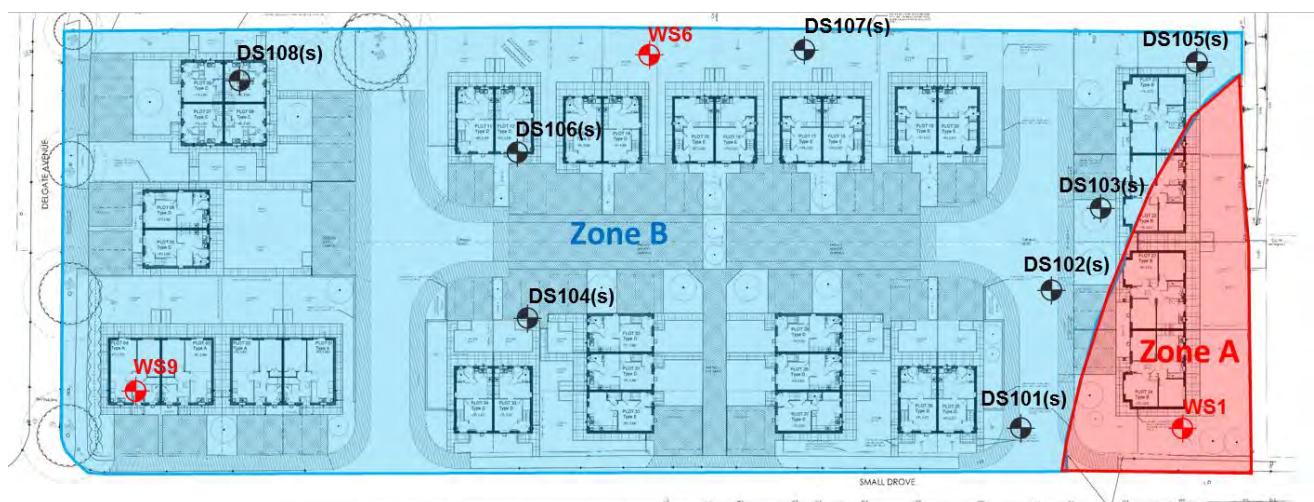
The Site has been previously developed to a residential end use during the 1950s; it is unlikely that any ground gas protection measures were incorporated during the build programme, and Delta-Simons has been advised that the recent demolition programme established that buildings on the Site adopted a raft foundation solution, with no gas protection measures evident in the building construction.

Site Zoning and Risk Assessment

Further assessment of the southwestern corner of the Site is ongoing to establish whether there may be an off-Site source of ground gases that may be having an influence on the monitoring results from WS1. It is therefore proposed to provisionally zone the Site as follows:

- ▲ Zone A: southwestern corner of the Site; and
- ▲ Zone B: remainder of the Site.

These zones are identified as follows.



For Zone B, it is considered that a CS1 / NHBC 'Green' ground gas regime categorisation is considered appropriate on the basis that:

1. Gas generation rates within the organic clays are unlikely to be significant;
2. There is considered unlikely to be a plausible pathway between these deeper clays and the underside of future buildings on the Site (see Section 6.4.2);
3. The conditions prevalent within the headspace of a monitoring well are unlikely to be representative of those beneath building footprints on the re-developed Site; and
4. No protection measures were incorporated into the construction of previous residential properties on the Site, indicating that hazardous ground gases are unlikely to be a significant development constraint.

This risk assessment will be updated, and an appropriate ground gas regime categorisation assigned for Zone A, following further data acquisition and risk assessment.

6.4 Ground Gas Risk Mitigation

6.4.1 Zone A

Mitigation measures for Zone A, if required, will be determined following additional data acquisition and risk assessment.

6.4.2 Zone B

Under the requirements of BS 8485:2015+A1:2019, for a CS1/Green ground gas regime and 'Type A' building, a gas protection score of 0 is required (Table 4 of BS 8485:2015+A1:2019).

It is anticipated that wide strip foundations together with beam and block floors will be adopted as part of the proposed development. Such a foundation solution is unlikely to fully penetrate the upper sequence of the Tidal Flat deposits, consequently there is a low risk of creating a migration pathway to the deeper organic-rich clays. The design will also incorporate a ventilated sub-floor void, which will further mitigate against ingress of ground gases into the overlying building.

It should also be noted that BS 8485:2015+A1:2019 acknowledges that a pre-cast suspended segmental sub-floor with a ventilated sub-floor void does, in itself, afford protection against the ingress of ground gases into a building. A Damp Proof Membrane is also likely to afford some protection, and these elements of the future build construction are discussed further in the following table:

Item	Protective Action
DPM (comprising Visqueen Ecomembrane Damp Proof Course or similar), lapped into the walls, all joints constructed with Visqueen double-sided tape, and all penetrations sealed by way of 'top hat' collars and jubilee clips.	Installed membrane likely to be a DPM rather than a proprietary gas resistant membrane, however it is considered to provide some mitigation against upward migration of methane (the gas of potential concern on the Site) - a nominal score of 0.5 has therefore been applied.
Pre-cast suspended segmental sub-floor (i.e. beam and block) with passive sub-floor dispersal layer	Degree of protection afforded depends on performance of dispersal layer (in turn determined by factors including transmissivity of medium, side ventilation spacings etc). BS 8485:2015+A1:2019 indicates scores of 1.5 (good performance) to 2.5 (very good performance) – a nominal score of 1.5 has therefore been applied (subject to detailed design of ventilation spacings).

The above table indicates that, although not specifically designed as gas protection measures, future building construction will incorporate measures that inherently mitigate against gas ingress into the building.

In the event that a piled foundation solution is adopted, for example in areas of deeper Made Ground, the piles are anticipated to found at a depth greater than the underside of the clay aquitard i.e. they are likely to penetrate this layer and thus potentially provide a mechanism for ground gases to migrate vertically upwards to beneath buildings on the Site.

The potential for gas migration up the side of piled foundation solutions has been the subject of much discussion in the past. The Institute of Civil Engineers (ICE) publication '*Piled Foundations and Pathways for Ground Gas Migration in the UK*' presents a summary of evidence on the influence of piles on the permeability of the surrounding ground, and whether piles could pose a preferential migration pathway to hazardous ground gases. The document concludes that displacement-driven or replacement piles will not cause preferential pathways where diffusive flow of gas through the ground is the dominant migration pathway.

This is considered to be the case on the subject Site, where any movement of gases both vertically or laterally is likely to be predominantly via diffusive, rather than advective, flow i.e. along a concentration (rather than a pressure) gradient given the low rates of gas generation considered likely to be taking place within the identified gas source (deeper Tidal Flat Deposits with a low organic matter content). It should also be noted that migration of ground gases towards and, subsequently, up the sides of piles will be dependent upon:

1. The pressure of the gas at source;
2. The permeability of the ground to lateral gas migration; and
3. The permeability of the pile annulus (if created).

The Tidal Flat clays and silts are considered likely to have an inherently low permeability to lateral gas migration. Consequently, even if were an annulus to form around the circumference of each pile (considered to be of low likelihood given that the organic clays are typically soft and are anticipated to undergo settlement following piling activities, thus reducing the likelihood of a higher permeability annulus to form around each pile), the low rate of lateral gas migration is such that gas would be unlikely to flow towards the pile at a rate sufficient to pose a risk of excessive gas emission from the top of the pile. Piled foundations are, therefore, considered unlikely to increase the risk from ground gases on the Site.

Furthermore, whilst the ICE document identifies the potential for a risk to exist where driven piles penetrate confining layers that are trapping gas in the ground at depth, the report goes on to acknowledge that such a risk is only likely to exist where gas is under a pressure that is maintained after the initial release of gas caused by pile installation. There is no evidence from the gas monitoring to date that there is a sustained gas pressure within the organic clay layer below the Site i.e. gas generation rates in this stratum appear to be low.

7.0 Conclusions & Recommendations

7.1 Conclusions

The Site has been subject to two separate phases of intrusive investigation and three phases of ground gas monitoring to assess its ground gas regime.

Elevated methane concentrations have been detected within three of the previously installed monitoring wells on several occasions however, in general, monitoring of the more recently installed (Delta-Simons) wells exhibited negligible methane concentrations and what can be considered to be typical background concentrations of carbon dioxide. Recorded borehole flows were considered to be a function of changes in groundwater levels within the monitoring wells.

On this basis, the detected methane concentrations are considered to be the result of microbial activity within the deeper Tidal Flat Deposits, as a consequence of the drilling operations introducing oxygen into a previously anaerobic environment and/or through construction of the monitoring wells facilitating the release of small quantities of gas generated in the deeper organic clays (with the high methane concentrations potentially reflecting preferential dissolution of carbon dioxide into the high groundwater table). This is not considered to generate significant quantities of gas, and this is borne out by the typically low flow rates where these are not influenced by changes in the groundwater table.

It is considered appropriate to assign a CS1/Green categorisation for the majority of the Site (Zone B), and it should be noted that:

1. There is considered unlikely to be a plausible pathway between these deeper organic-rich clays and the underside of future buildings on the Site, since the former are present below a clay layer which appears to be acting as an aquitard;
2. The conditions prevalent within the headspace of a monitoring well are unlikely to be representative of those beneath building footprints on the re-developed Site;
3. No protection measures were incorporated into the construction of previous residential properties on the Site, indicating that hazardous ground gases are unlikely to be a significant development constraint; and
4. Building construction incorporating strip foundations, a beam and block floor and ventilated sub-floor void, together with the incorporation of damp-proof membranes is considered likely to mitigate against ingress of ground gases into new buildings.

Zone A is currently subject to further investigation; once this is complete the risk assessment will be updated, and an appropriate ground gas regime categorisation assigned for Zone A.

7.2 Recommendations

It is recommended that further investigation of Zone A be undertaken to investigate the elevated concentrations of methane detected within borehole WS1, since these appear to be ongoing in comparison to boreholes WS6 and WS9 where gas concentrations and flows are more consistent with those in the Delta-Simons monitoring wells. Such investigation may include one or more of the following:

- ▲ Further groundwater sampling to assess whether the elevated methane concentrations could be a result of hydrocarbon impact given olfactory observations in this part of the Site;
- ▲ Removal of sediment from the base of WS1 to establish whether silts drawn into the well during groundwater sampling could be a possible source of gas; and
- ▲ Further monitoring wells in the part of the Site i.e. in closer proximity to WS1 to see whether there may be off-Site sources of hazardous ground gases that may be influencing the monitoring data obtained in this part of the Site.

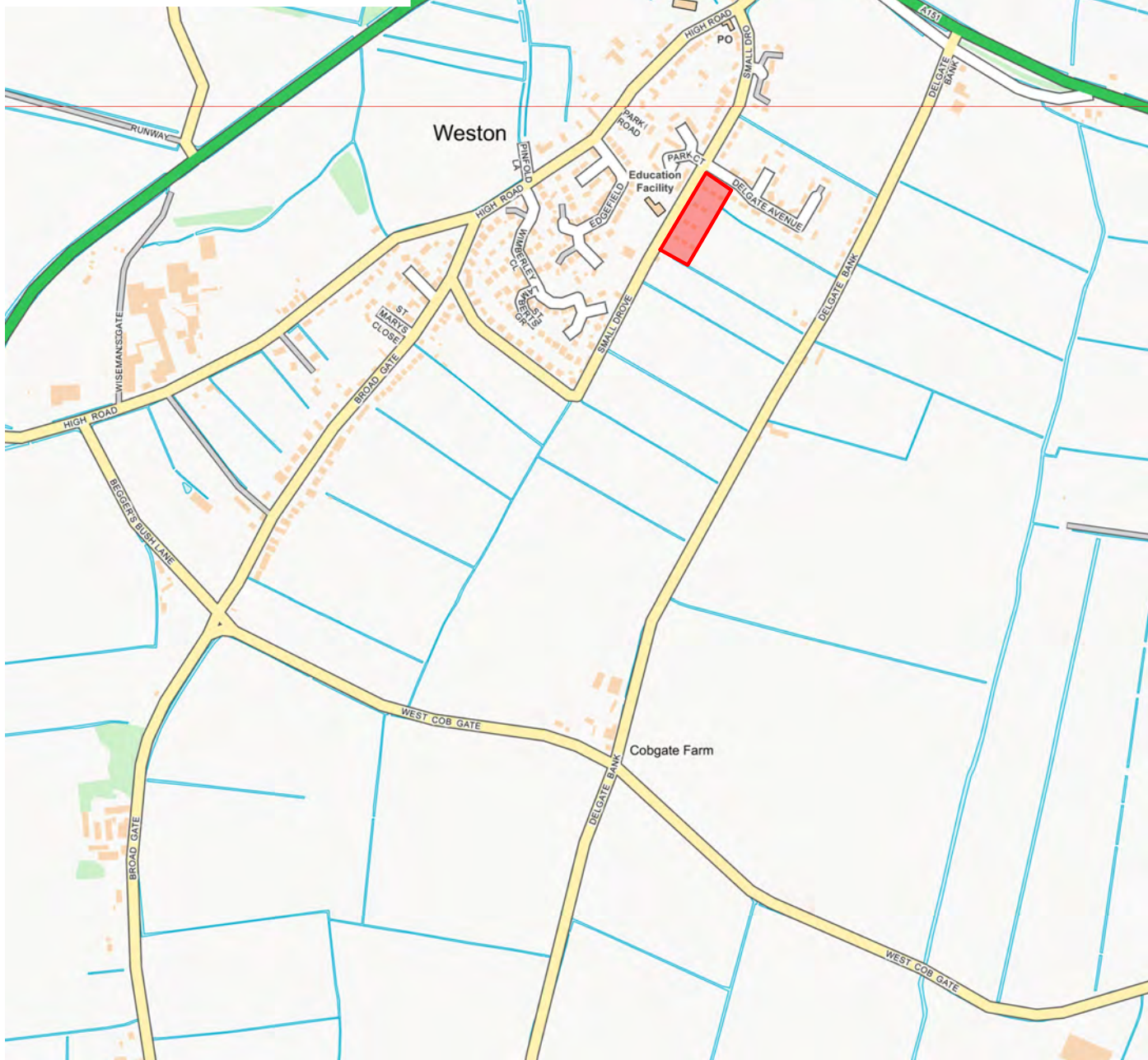
The findings of this further investigation will allow the risk assessment to be updated and an appropriate gas regime categorisation assigned to Zone A.

Figure 1 – Site Location Map



LEGEND

Site Boundary



Scale: 1 / 10,000 @ A4

Contains OS data © , Crown Copyright and Database Right (2018)

Figure 2 – Exploratory Hole Location Plan



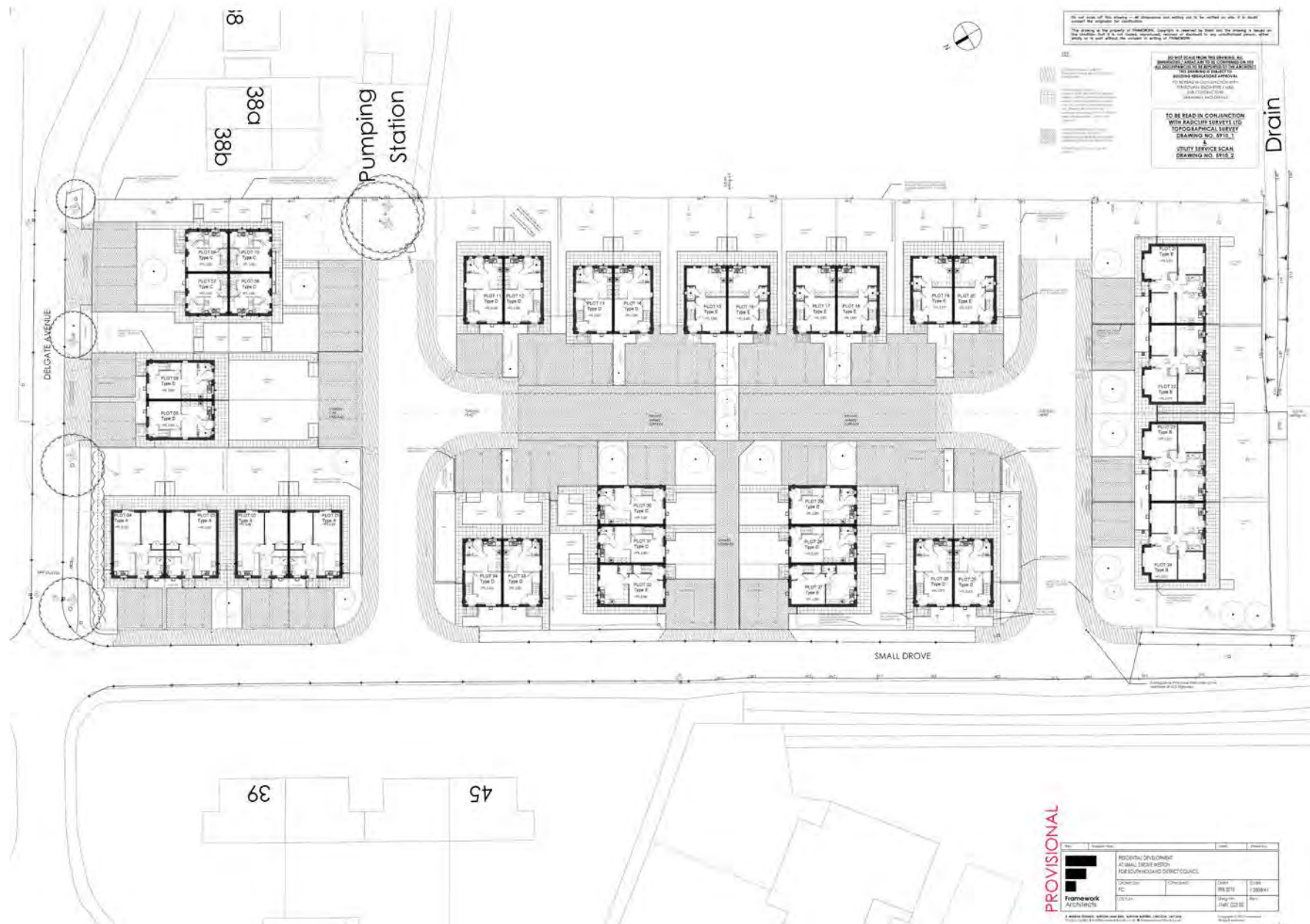
LEGEND

- DSx Dynamic Sampler
- WSx Third Party Borehole
- (s) Standpipe



Site Plan Provided by Client

Figure 3 – Proposed Development Plan (Client-Supplied)



Plan provided by Client

Appendix A – Limitations

Limitations

The recommendations contained in this Report represent Delta-Simons professional opinions, based upon the information listed in the Report, exercising the duty of care required of an experienced Environmental Consultant. Delta-Simons does not warrant or guarantee that the Site is free of hazardous or potentially hazardous materials or conditions.

Delta-Simons obtained, reviewed and evaluated information in preparing this Report from the Client and others. Delta-Simons conclusions, opinions and recommendations has been determined using this information. Delta-Simons does not warrant the accuracy of the information provided to it and will not be responsible for any opinions which Delta-Simons has expressed, or conclusions which it has reached in reliance upon information which is subsequently proven to be inaccurate.

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Appendix B – Previous Reports

Site Investigations



Geologists



Environmental &
Geotechnical
Engineers



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FAO: D Brown Building Contractors Ltd
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PE12 6JX

Date: 20th February 2019

GROUND GAS SAMPLING AND ANALYSIS SMALL DROVE, WESTON S181221/GAS

INTRODUCTION

Authorisation

The ground gas sampling and analysis carried out by Solmek was to the instructions of William Saunders, on a parcel of land to the east of Small Drove, Weston.

Sources of information, including previous work undertaken at the site, are detailed below:

- *Ground Engineering Ltd Phase 2 Site Investigation (Project No C14022A).*
- *Solmek Ground Gas Risk Assessment – dated 16th January 2019.*

Reference should be made to the above report for details of the site's history, underlying geological conditions, environmental setting and Ground Gas Assessment.

Scope of Works

The proposed development is outlined to be residential housing with gardens, soft landscaping and areas of hardstanding. A drawing showing the borehole locations are shown in Figure 1 attached.

Within the Ground Engineering Site Investigation Report three visits were made to monitor the ground gas from WS1, WS6 and WS9 between December 2016 and January 2017. Results showed methane up to 3.9%, carbon dioxide up to 1.4% and marginally depleted oxygen levels. Recorded flows were <0.1l/hr. The gas screening value fell within Characteristic Situation CS1. Atmospheric Pressures between 1018mb and 1025mb were recorded during the three monitoring visits.

Solmek were asked to undertake three further ground gas monitoring visits. During the Ground Gas Risk Assessment undertaken by Solmek, methane was not detected in boreholes WS6 and WS9 during the survey and no flow rates were recorded. However within WS1, methane was detected on all three occasions at levels of 87.4%, 36.2% and 70.5% respectively with related flows ranging between 4.0l/hr and 11.0l/hr. The gas concentrations from the monitoring visits would place the site in **NHBC Red**.

GROUND GAS ASSESSMENT

It was decided to take samples of the ground gas using a Gresham Pump from borehole WS1 and harvest in Tedlar Bags and analyse it in a Laboratory in an attempt to determine whether it may originate from leaking mains. Mains gas contains heavier hydrocarbons (ethane, propane and butane) so these determinands, along with methane were analysed.

Ground Gas Results

The Tedlar Bags were sent to Chemtest and the results of analysis are appended to this letter report. The results show that within the sample analysed, levels of Ethane, Propane and Butane are all below the level of detection. Methane was recorded at 16%.

Ground Gas Sample Analysis and Discussion

It would appear that the gas collected from borehole WS1 did not originate from mains gas. The heavier hydrocarbons Ethane, Propane and Butane usually present in mains gas were not present.

It is noted that within the boreholes sunk by Ground Engineering, a layer of very soft slightly sandy, silty organic clay locally containing peat and root traces was proven to underlie the shallow natural silty clay across the site at depths of between 2.00mbgl and 2.80mbgl within WS1, WS6 and WS9. These deposits were all water bearing.

It is possible that the methane is originating from this layer of peaty organic clay. Decomposition of organic matter can cause peat to accumulate. Incomplete cycling and conservation of peat is caused by waterlogging with its associated low temperatures, anaerobic conditions and small microbial populations. Under anaerobic conditions microbial decomposition continues. The final step in anaerobic decomposition produces methane microorganisms. When the boreholes have been sunk, through this layer of organic peaty clay, and with the inclusion of monitoring pipes, a pathway could have opened allowing methane to be omitted during monitoring visits particularly during times of low atmospheric pressure conditions. This could have resulted in methane build up in the monitoring pipes explaining the relatively high flows and levels of methane in WS1.

Yours sincerely,



Deryck Simpson
On behalf of Solmek Ltd.



Title
Borehole Location Plan
Project
Small Drove, Weston
Client
William Saunders
Date
February 2019
Fig No.
Figure 1
Scale
NTS
Key
 N
<p style="text-align: right;">Solmek Ltd. 12 Yarm Road Stockton-on-Tees TS18 3NA</p> <p style="text-align: right;">Tel: +44 (0) 1642 607083 Fax: +44 (0) 1642 612355 e-mail: south@solmek.com www.solmek.com</p> <p style="text-align: right;">  </p>

Final Report

Report No.:	19-04922-1		
Initial Date of Issue:	19-Feb-2019		
Client	Solmek Ltd		
Client Address:	12 Yarm Road Stockton-on-Tees TS18 3NA		
Contact(s):	Deryck Simpson Kathryn Watkin Office		
Project	S181221 - Small Drove, Weston Gas Analysis		
Quotation No.:	Q19-15911	Date Received:	11-Feb-2019
Order No.:		Date Instructed:	11-Feb-2019
No. of Samples:	1		
Turnaround (Wkdays):	7	Results Due:	19-Feb-2019
Date Approved:	19-Feb-2019	Subcon Results Due:	19-Feb-2019
Approved By:			
Details:	Glynn Harvey, Laboratory Manager		

Project: S181221 - Small Drove, Weston Gas Analysis

Client: Solmek Ltd	Chemtest Job No.:				19-04922
Quotation No.: Q19-15911	Chemtest Sample ID.:				771595
	Client Sample ID.:				WS1
	Sample Type:				GAS
Determinand	Accred.	SOP	Units	LOD	
Ethane	SN		% v/v	0.00050	< 0.00100
Propane	SN		% v/v	0.00050	< 0.00100
Butane	SN		% v/v	0.00050	< 0.00100
Methane	S		% v/v	0.50	16

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"

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

These conditions accompany our tender and supercede any previous conditions issued. Solmek will prepare a report solely for the use of the Client (the party invoiced) and its agent(s). No reliance should be placed on the contents of this report, in whole or in part by 3rd parties. The report, its content and format and associated data are copyright, and the property of Solmek. Photocopying of part or all of the contents, transfer or reproduction of any kind is forbidden without written permission from Solmek. A charge may be levied against such approval, the same to be made at the discretion of Solmek. Solmek was a trading name of Hymas Geoenvironmental Ltd.

Solmek cannot be held liable and do not warrant, or otherwise guarantee the validity of information provided by third parties and subsequently used in our reports. Solmek are not responsible for the action negligent of otherwise of subcontractors or third parties.

Site investigation is a process of sampling. The scope and size of an investigation may be considered proportional to levels of confidence regarding the ground and groundwater conditions. The exploratory holes undertaken investigate only a small volume of the ground in relation to the overall size of the site, and can only provide a general indication of site conditions. The opinions provided and recommendations given in this report are based on the ground conditions as encountered within each of the exploratory holes. There may be different ground conditions elsewhere on the site which have not been identified by this investigation and which therefore have not been taken into account in this report. Reports are generally subject to the comments of the local authority and Environment Agency. The comments made on groundwater conditions are based on observations made at the time that site work was carried out. It should be noted that mobile contamination, ground gas levels and groundwater levels may vary owing to seasonal, tidal and/or weather related effects. Solmek cannot be held liable for any unrecorded or unforeseen obstructions between exploratory boreholes and trial pits. This includes instances where previous structures on the site (buried man made structures) or the presence of boulder clay (cobbles and/or boulder obstructions) have been anticipated. All types of piling operations should make allowance for obstructions within the construction budget to accommodate this. Unrecorded ancient mining may occur anywhere where seams that have been worked and influence the rock and soil above. Dissolution cavities can occur where gypsum or chalk is present. Rotary drilling is the recommended technique to prove the integrity of the rock.

Where the scope of the investigation is limited via access to information, time constraints, equipment limitations, testing, interpretation or by the client or his agents budgetary constraints, elements not set out in the proposal and excluded from the report are deemed to be omitted from the scope of the investigation.

Desk studies are generally prepared in accordance with RICS guidelines. Environmental site investigations are generally undertaken as 'exploratory investigations' in accordance with the definitions provided in paragraph 5.4 of BS 10175:2001 in order to confirm the conceptual assumptions. You are advised to familiarize yourself with the typical scope of such an investigation. No pumping of water will be undertaken unless a licence or facilities/equipment have been arranged by others.

Where the type, number or/and depth of exploratory hole is specified by others, Solmek cannot and will not be responsible for any subsequent shortfall or inadequacy in data, and any consequent shortfall in interpretation of environmental and geotechnical aspects which may be required at a later date in order to facilitate the design of permanent or temporary works.

All information acquired by Solmek in the course of investigation is the property of Solmek, and, only also becomes the joint property of the Client only on the complete settlement of all invoices relating to the project. Solmek reserve the right to use the information in commercial tendering and marketing, unless the Client expressly wishes otherwise in writing. The quoted rates do not include VAT, and payment terms are 30 days from dispatch of invoice from our offices. Quotes are subject to a site visit.

We have allowed for 1 mobilisation and normal working hours unless otherwise stated. The scope of the investigation may be reviewed following the desk study and/or fieldwork. The presence or otherwise of Japanese Knotweed or other invasive plants can be difficult to identify especially during winter months. If Japanese Knotweed or other invasive species are suspect, it should be confirmed by an ecologist. We have not allowed for acquiring services information, and cannot be responsible for damage to underground services or pipes not shown to us or not clearly shown on plans. Costs incurred will be passed on to you, and in commissioning Solmek you understand and accept that you/your agent have a contractual relationship with Solmek & you accept this. Our rates assume unobstructed, reasonably level and firm access to the exploratory positions and adequate clear working areas and headroom. We have priced on the basis that you or your client have the necessary permissions, wayleaves and approvals to access land. All boreholes and pits are backfilled with arisings except where gas monitoring pipes are installed with stopcock covers. Solmek are not responsible for any uneven surfaces as a result of siteworks and rutting and backfilled excavations may require re-levelling and/or making good by others after fieldwork is complete, and Solmek has not allowed for this. No price has been provided or requested for a return visit to remove pipework and covers. Hourly rates apply to consultancy only and do not include expenses unless otherwise shown. If warranties are required, legal costs incurred will be passed on to you assuming Solmek agree to complete such warranties, modified or otherwise and you understand and agree to pay all costs.

We reserve the right to pursue full payment of the invoice prior to release of any information including reports. We advise you/your client that we may elect to pursue our statutory rights under late payment legislation, and will apply 8% to the base rate for unreasonably late payments. Solmek are exempt from the CIS Scheme. Solmek offer to undertake work only in strict accordance with conditions covered by our current insurances, which are available for inspection. Solmek are not responsible for acts, negligent or otherwise of subcontractors and as a matter of policy cannot indemnify any other parties. Professional indemnity Insurance is limited to ten times the invoice net total except where stated otherwise by Solmek. Solmek give notice that consequential loss as a direct or indirect result of Solmek's activities or omission of the same are excluded.

GROUND ENGINEERING

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SITE INVESTIGATION REPORT

SMALL DROVE
WESTON
NEAR SPALDING
LINCOLNSHIRE

Report Reference No. C14022

On behalf of:-

**South Holland District Council
Council Offices
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CONTENTS

	Page
INTRODUCTION	1
LOCATION, TOPOGRAPHY & GEOLOGY OF THE SITE	2
SITE HISTORY	4
Summary of Historical Background	5
ENVIRONMENTAL DATABASE INFORMATION	6
PRELIMINARY RISK ASSESSMENT	9
Preliminary Conceptual Model	11
SITE WORK	12
LABORATORY WORK	15
GROUND CONDITIONS	17
Made Ground & Topsoil	17
Tidal Flat Deposits	17
Groundwater	18
Live Roots	18
Evidence of Contamination	19
COMMENTS ON THE GROUND CONDITIONS IN RELATION TO FOUNDATION DESIGN & CONSTRUCTION	20
Traditional Foundations	20
Bearing Capacity	23
Excavations	24
Floor Slabs	25
Sulphate Conditions	26
Hardstanding & Pavement Design	26
Drainage	27
COMMENTS ON THE CHEMICAL TEST RESULTS OF SOIL	28
Discussion of Soil Results	31
SOIL GAS MONITORING RESULTS	32
UPDATED CONCEPTUAL MODEL	33
COMMENTS ON GROUND CONTAMINATION IN RELATION TO PROPOSED DEVELOPMENT	34
Asbestos in Existing Buildings	34
Existing Drainage	34
Contaminated Soil	34
Human Health – Construction Workers	35
Human Health – Users of Completed Development	36
Water Environment	36
Effects on Building Materials & Services	36
Off-Site Disposal of Soil Arisings	37

WINDOW SAMPLE BOREHOLE & DYNAMIC PROBE RECORDS

GEOTECHNICAL LABORATORY TEST RESULTS
CHEMICAL LABORATORY TEST RESULTS

GAS MONITORING RESULTS

FIGURE 1 - SPT 'N'- value/Depth Plot
FIGURE 2 - Moisture Content/Depth Plot
FIGURE 3 - Apparent Cohesion/Depth Plot
FIGURE 4 - Soil Profile

BOREHOLE LOCATION PLAN

APPENDIX 1	Historical Map Extracts
APPENDIX 2	Environmental Database Search
APPENDIX 3	Classification of Aggressive Chemical Environment for Concrete

SOUTH HOLLAND DISTRICT COUNCIL

WILLIAM SAUNDERS PARTNERSHIP LLP

REPORT ON A SITE INVESTIGATION

AT

SMALL DROVE

WESTON

NEAR SPALDING

LINCOLNSHIRE

Report Reference No. C14022

March 2017

INTRODUCTION

South Holland District Council proposes to redevelop the site of ten detached bungalows, with a scheme of up to thirty-five houses along the east side of Small Drove, Weston. Details of the proposed residential development were not available at the time of this investigation although it was understood that the houses will have wall loads in the order of 30-40kN/m, or raft foundations with uniform distributed loads of 25-27kN/m².

A site investigation was undertaken by Ground Engineering Limited on behalf of South Holland District Council. The purpose was to provide information on the underlying ground conditions in relation to the proposed development, including a contamination assessment. In addition a desk study was conducted to detail the site history and search available information for any potential environmental issues.

LOCATION, TOPOGRAPHY AND GEOLOGY OF THE SITE

The site is located on the eastern side of Small Drove, and immediately south of its junction with Delgate Avenue, in the village of Weston, approximately 4km east of Spalding. The site lies 250m south of St. Mary's Church and is opposite Weston St. Mary Primary School. The site is centred at National Grid Reference TF 2927 2482.

The rectangular site has a 150m long frontage along the east side of Small Drove and extends for 55m to the east along Delgate Avenue, which forms the north-eastern limit of the site. The site is bounded by open arable fields to the south and east. The far south-western end of the site is defined by a drainage ditch, with Kierdan Cottage beyond.

At the time of the investigation the site was occupied by ten brick bungalows, their associated gardens and open grassed or cultivated areas. The existing properties were separated from Small Drove by a belt of grassed land, and were accessed by three concrete and asphalt paths. The southern end of the site was occupied by a gravel surfaced car parking area and a corrugated metal roofed timber garage.

At the time of the investigation, the site was largely devoid of trees and vegetation, with the exception of a row of pollarded Cypress trees in the central eastern part of the site. The northern end of the site was bordered by a Privet hedge. A row of pollarded mature Lime trees stood within the verge of the neighbouring Delgate Avenue, about 2m north of the site. Similarly mature Ash trees stood on the opposite verge of Small Drove, about 10m from the site towards the southern and northern ends of the site. Several unidentified immature trees, a Pine and Apple tree grew within the far north-eastern corner of the site.

The site is located on level ground in an area of reclaimed Fenland, standing at about 3.0mOD. The drainage ditches to the south and east of the site, drain 250m south-eastwards into the southward flowing Delgate Drain.

Foul sewers comprising 150mm diameter vitreous clay pipes, cross the central eastern and northern parts of the site, and are routed to the neighbouring pumping station to the east of the site. These sewers cross the site at invert depths between 1.3m alongside Small Drove,

deepening to an invert depth of around 2.7m at the junction of the two sewers close to the eastern site boundary, within the northern half of the site.

The geological map for the area, sheet 144 (1992) at 1:50,000 scale, shows the site and surrounding area to be covered by the extensive superficial deposits of the Terrington Beds (more recently renamed Tidal Flat Deposits). The site is shown 400m south of the limit of reclamation in 1000AD, indicating the land of the village of Weston was reclaimed by then. The Tidal Flat Deposits are indicated to rest on the solid geology of the West Walton Formation.

Previous work in the vicinity has found the soft, becoming very soft and organic, Tidal Flat Deposits to extend to about 10m depth where an interbedded succession of very loose fine sand, soft and firm organic clays was found to about 15m depth, below which was medium dense to dense Marine Sand and Gravel. The underlying solid geology was not found within 17m depth.

SITE HISTORY

Historical maps and aerial photographs dating from 1888 and including Ordnance Survey (OS) maps, aerial photographs and the internet have been reviewed as part of this desk study. Selected map and photograph extracts are reproduced in Appendix 1 as Figures A to L with relevant descriptions given below.

<i>Map Extract Studied</i>	<i>Description</i>
1888 OS Sheet: Lincs. CXXXIV.12 Scale: 1:2500 Figure A	The site occupies the western end of two fields adjacent Small Lane. A drain defines the site boundary alongside the lane, with another drainage ditch forming the south-western site boundary, and another south-east trending ditch crossing the northern half of the site. Probable farm buildings were located adjacent the south-western boundary of the site.
1904 OS Sheet: Lincs. CXXXIV.12 Scale: 1:2500 Figure B	The site layout and surrounding area were unchanged.
1932 OS Sheet: Lincs. CXXXIV.12 Scale: 1:2500 Figure C	The site layout and surrounding area were unchanged. A small outbuilding had been added to the buildings immediately south-west of the site.
1938 OS Sheet: Lincs. CXXXIV SE Scale: 1:10,560 Figure D	The site area was unchanged. A row of four blocks of semi-detached properties had been erected to the north of the site.
1958 OS Sheet: TF22 SE Scale 1:10,560 Figure E	This map shows the ten bungalows to have been constructed on the site, together with additional residential properties to the north-east, with an access road along the northern end of the site. The drainage ditch/former field boundary was still indicated crossing the site between the two northern rows of bungalows.
1967 OS Sheets: TF2924 & TF2925 Scale 1:2500 Figure F	The buildings within the site are numbered 13-22 Small Lane, and are accompanied by several outbuildings, greenhouses and hardstanding access paths. A pair of garages are shown in the south-western corner of the site. The drains adjacent Small Lane and formerly crossing the northern part of the site had been infilled (possibly culverted). St. Mary's Primary School had been established with a playing field opposite the site on the north-western side of Small Lane. The buildings to the east and north-east of the site were shown as semi-detached properties fronting Delgate Avenue. Rows of garages were shown immediately east and north of the northern end of the site.
1971-75 OS Sheet: TF22 NE & TF22 SE Scale: 1:10,000	The site and surrounding area remained unchanged. A Sewage Works was denoted 200m north-east of the site.

<i>Map Extract Studied</i>	<i>Description</i>
Figure G	
1987 OS Sheets: TF2924 & TF2925 Scale: 1:2500 Figure H	By the time of this edition, the adjacent road had become Small Drove. The site layout was unchanged, although the bungalows were now numbered 48-66. A greenhouse in the north and an outbuilding in the south, were no longer shown. An additional garage had been erected in the far south-western corner of the site. A new Pumping Station had been erected to the rear of the adjacent garages to the east, alongside the drainage ditch. Residential development of the land to the west and north-west had occurred at Park Court and Edgefield.
1995 OS Sheets: TF2524 & TF2925 Scale: 1:2500 Figure I	The site and surrounding area remained unchanged.
2002 OS Sheets: TF22 SE & TF22NE Scale: 1:10,000 Figure J	The site area remained unchanged. The residential development to the west of the site had extended southwards to the end of South Drove. A large building had been constructed at the southern end of the former school playing field to the west.
2004 Aerial Photograph Figure K	The photograph shows the bungalows and outbuildings on the site, together with a tree close to the southern path entrance at the south-western end of the site, conifers in the central eastern part of the plot and other trees and shrubs at the north-eastern edge of the site. The hedge and Lime trees are also visible around the northern edge of the site. Some intervening areas particularly in the south and south-western parts of the site appear to have been cultivated. To the east of the site, a new house is under construction on the plot formerly occupied by garages.
2015 Aerial Photograph Page 1, Appendix 2	There is little change to the site indicated on this photograph, which does indicate the former tree in the south-western part to have been felled, and the area to its south surfaced and used for car parking.
2016 OS Sheet: TF2924NW (Anglian Water Sewer Record) Scale: 1:1250 Figure L	The site appears unchanged. The property to the south (Kierdan Cottage) has been rebuilt. The building formerly occupying the school playing field is denoted as a Hall. Another pumping station is denoted about 75m south-west of the site (off plan). Two 150mm diameter sewers are illustrated crossing the site. These drain south-eastwards to the neighbouring pumping station and intercept the foul sewers beneath Small Drove.

Summary of Historical Background

The low-lying site was located within fields crossed by a drainage ditch until the ten bungalows were built sometime around the 1940s or early 1950s. The south-east trending drainage ditch crossing the northern part of the site, and the ditch along the western site boundary were both infilled in the early 1960s. The site has remained unchanged to the present day. The neighbouring semi-detached Airey houses on Delgate Avenue were erected shortly after WWII.

ENVIRONMENTAL DATABASE INFORMATION

Appendix 2 contains information derived from Environmental Databases for a radius of up to 2km 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. Historical Industrial Sites	On-Site	0 - 250m
Potentially Contaminative Uses (1:10,000 mapping)	0	3
Historical Tank Database	0	1
Historical Energy Features Database	0	1
Historical Petrol & Fuel Site Database	0	0
Historical Garage & Motor Vehicle Repair Database	0	0
Potentially Infilled Land	0	3
2. Environmental Permits, Incidents and Registers	On-Site	0 - 250m
Sites Holding Environmental Permits/Authorisations	0	1
Records of COMAH and NIHHS Sites	0	0
Environment Agency Recorded Pollution Incidents	0	0
Sites Determined as Contaminated Land under Part IIA EPA 1990	0	0
3. Landfill and Other Waste Sites	On-Site	0 - 250m
Landfill Sites	0	0
Landfill and Other Waste Sites	0	0
4. Current Land Uses	On-Site	0 - 250m
Current Industrial Sites Data	0	4
Records of Petrol and Fuel Sites	0	0
Underground High Pressure Oil and Gas Pipelines	0	0
5. Geology		
Artificial Ground or Made Ground records	No	
Superficial Ground and Drift Geology records	Yes	
6. Hydrogeology and Hydrology	On-Site	0 - 250m
Productive strata within superficial geology beneath the site	No	
Productive strata within solid geology beneath the site	No	
Groundwater Abstraction Licences	0	0
Surface Water Abstraction Licences	0	0
Potable Water Abstraction Licences	0	0
Source Protection Zones	0	0
River Quality Data	0	0
Detailed River Network Entries	0	0
Surface Water Features	Yes	Yes

7. Flooding					
Environment Agency indicative Zone 2 floodplains within 250m of site				Yes	
Environment Agency indicative Zone 3 floodplains within 250m of site				Yes	
Risk of flooding from rivers & the sea (RoFRaS) rating within 50m				Low	
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	
Maximum BGS groundwater flooding susceptibility within 50m of site				Not Prone	
BGS confidence rating for groundwater susceptibility areas				N/A	
8. Designated Environmentally Sensitive Sites				On Site	0 - 250m
Environmentally sensitive sites (Nitrate Vulnerable Zones)				0	0
9. Natural Hazards (on site)					
Hazard	Negligible	Very Low	Low	Moderate	High
Shrink Swell Clay	-	-	On-site	-	-
Landslides	-	On-site	-	-	-
Soluble Rocks	On-site	-	-	-	-
Compressible Ground	-	-	-	On-site	-
Collapsible Rocks	On-site	-	-	-	-
Running Sand	-	-	-	On-site	-
9.2. Radon					
The property is not in a Radon Affected Area, as less than 1% of properties are above the action level. Radon Protective Measures are not required for new properties or extensions.					
10. Mining					
Coal mining areas within 75m of site				No	
Non coal-mining areas within 50m of site				No	
Brine affected areas within 75m of study site				No	

Database Summary

The four (4) historical records listed are for a sewage works including a tank 140m-180m to the east; a graveyard 222m north of the site; and an electricity sub-station 217m to the north-west. In addition an infilled pond was identified 235m west of the site.

There is a single (1) discharge consent recorded within 250m of the site, issued in 2004 for sewage discharge from the pumping station 11m south-east of the site into a tributary of South Holland Main Drain. There are no pollution incidents or landfill sites listed within 250m of the site. The four (4) current industrial land uses listed within 250m of the site include; pumping stations 12m to the south-east and 80m to the south-west; an electricity sub-station 21m to the north-east; and a distribution and haulage depot (Fenland Container Services) 220m to the west.

No artificial ground or made ground is identified on the site. The site is underlain by superficial Tidal Flat Deposits and the underlying solid geology of the West Walton Formation,

both of which are designated by the EA as 'Unproductive' strata. There are no groundwater nor surface water abstraction licences within 250m of the site. There are no river network entries within 250m of the site, although the many drainage ditches in the area are identified, including the drain at the southern end of the site. The site is within a Zone 3 Floodplain and within 50m of a Zone 2 Floodplain. The site has a low Risk of Flooding from Rivers and the Sea, and is not within an area benefiting from flood defences or flood storage. The site is not within 50m of an area prone to groundwater flooding.

The site is assessed as having a 'moderate' hazard from Running Sand and Compressible Ground. The site is assessed as having a 'low' hazard for Shrink-swell and a 'very low' hazard for landslides. The site is assessed as having a 'negligible' hazard from soluble rocks and Collapsible Rocks. The site is not within an identified mining area, or brine affected area. No radon protection measures are required for new residential properties on the site.

PRELIMINARY RISK ASSESSMENT

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 below in Table 1.

Table 1: Identified Potential Contaminant Sources

<i>Contaminant Source</i>	<i>Comments</i>
Drainage & Existing Buildings	Effluent from existing sewers could provide a contaminant source. The existing buildings and structures may include asbestos containing materials (ACM).
Soil Beneath Site	Contamination may be present within made ground on the site.
Soil Gas	Potential soil gas generated from made ground or underlying geology.
Ground Contamination Outside Site Boundary	Ground contamination migrating from adjacent or neighbouring 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 *Target 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 -plants grown on contaminated soil Ingesting dust or soil on fruit or 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 site is underlain by 'Unproductive' strata of the superficial Tidal Flat Deposits and solid geology of the West Walton Formation. The site does not lie 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 The closest water features are the drainage ditches extending south-east from the southern and northern ends of the site to Delgate Drain.	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 and human or environmental receptors have been assessed based on the desk study research documented in the preceding sections of this report. A generalised preliminary conceptual model relative to the construction phase and completed development is presented below in Table 4.

Table 4: Preliminary Conceptual Model Relative to Construction & Use of Residential Development

Receptors	Pathway	Estimated Potential for Linkage with Contaminant Sources			
		Drainage & Existing Buildings	Soil Beneath Site	Soil Gas	Ground Contamination Outside Site Boundary
Human Health – groundworkers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Low likelihood	Low likelihood	Low likelihood	Low likelihood
Human Health – users of completed development	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Low likelihood	Low likelihood	Low likelihood	Low likelihood
Water Environment	Migration through ground into surface water or groundwater	Low likelihood	Low likelihood	Unlikely	Low likelihood
Flora	Vegetation on site growing on contaminated soil	Unlikely	Unlikely	Unlikely	Unlikely
Building Materials	Contact with contaminated soil	Unlikely	Low likelihood	N/A	Unlikely

Key to Table 4 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.

SITE WORK

The site work was undertaken on 13th and 14th December 2016 and comprised ten window sample boreholes (WS1 to WS10), three of which were extended by dynamic probing (WS1, WS6 and WS9). The borehole positions are shown on the exploratory hole location plan at the rear of the report.

Services information was provided and referenced in relation to the exploratory hole positions prior to boring. A service scan of the hole positions was made using a CAT (Cable Avoidance Tool) to check for the absence of buried services that may otherwise have been damaged by the investigation.

The investigation was undertaken following the protocols detailed in British Standards (BS) 'Code of Practice for Site Investigations' (BS5930:2015).

The ground levels at each borehole position have been related to Ordnance Datum (O.D.) by interpolation from a topographic survey drawing provided by the client.

Window Sample Boreholes

The window sample boreholes were undertaken using a small tracked dynamic sampling rig. Prior to boring, a starter pit was dug to 1.20m depth using hand tools in order to ensure the absence of buried services at each hole position. Small disturbed samples (D) of soil were recovered at regular intervals within the starter pits and throughout the boreholes.

The window sampling equipment consisted of drive-in sample tubes of specially constructed and strengthened steel, lined with a plastic core-liner. The barrels were initially of 87mm or 77mm internal diameter and were reduced in diameter with successive barrels with increasing depth. Upon extraction, a continuous profile of the soil was obtained within the plastic liners.

The liners were subsequently split and sub-sampled by a Geoenvironmental Engineer. An immediate assessment of the apparent soil cohesion was made using a hand shear vane meter (V) and the average of two or three tests is presented on the borehole records. These

results have been plotted together with the triaxial compression test results, against depth in Figure 2.

Standard penetration tests were undertaken at regular intervals in each hole, to give an indication of the in-situ relative density or strength of the soils. The test was made by driving a 50mm diameter open shoe and split spoon sampler (S) into the soil at the base of the borehole by means of an automatic trip hammer weighing 63.50kg falling freely through 750mm. The penetration resistance was determined as the number of blows required to drive the tool the final 300mm of a total penetration of 450mm into the soil ahead of the borehole. The SPT 'N'-values have been plotted against depth in Figure 1.

Boreholes WS2 to WS5, WS7, WS8 and WS10 were completed at 3.45m below ground level. Boreholes WS1, WS6 and WS9 were extended from 3.45m to 10.00m depth by dynamic probing. The probe was driven using the super heavy dynamic probing rig. The test comprised driving a 90° cone, 150mm² in area, on 35mm diameter rods using a 63.5kg hammer falling through 750mm. The blow count was recorded for every 100mm of penetration (N100). The results are presented as a plot of hammer blow counts against depth and accompany the borehole records.

On completion of WS1, WS6 and WS9, 50mm diameter gas and groundwater monitoring standpipes were installed to 3.00m depth. The annulus around the standpipes was backfilled with pea gravel with a bentonite seal placed around the top of the installations within 1.00m of ground level. A gas tap was installed in the top of each standpipe. A protective plastic stopcock cover was concreted into the ground flush with the surface over each installation.

The window sample borehole records give the descriptions and depths of the various strata encountered, details of all samples taken, in-situ testing, installation details and the groundwater conditions observed during boring, on completion and within the standpipe installations.

Gas & Groundwater Monitoring Visits

Three return visits were made on 20th December 2016, and 4th & 16th January 2017 in order to monitor methane, carbon dioxide and oxygen gas levels in the WS1, WS6 and WS9 standpipes. The ambient pressure and flow rate were recorded together with the depth to groundwater. The water levels have been added to the borehole records, whilst the gas and groundwater results are presented to the rear of the exploratory hole records. Samples of water (W) were retrieved from the standpipes during monitoring.

LABORATORY WORK

The samples were inspected in the laboratory and assessments of the soil characteristics have been taken into account during preparation of the borehole records. The soil descriptions have been made in accordance with BS5930:2015 and laboratory testing in accordance with BS1377:1990.

The moisture contents of selected soil samples were determined.

The 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 distributions of selected samples of sand were obtained by wet sieve analysis. The clay and silt fraction for selected samples were determined by sedimentation using a pipette. Results of these tests are given as particle size distribution curves.

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

Test specimens were prepared at full diameter from selected undisturbed samples. Immediate undrained triaxial compression tests were undertaken on the samples under three cell pressures using the 'multistage' technique. The moisture content and bulk density of each specimen was also determined. The values of apparent cohesion have been plotted against depth, together with the hand shear vane test results in Figure 2.

An indication of the settlement characteristics of a selected sample of clay was obtained from the consolidation apparatus or oedometer. The test was performed on a specimen approximately 19mm thick, contained in a steel ring. The sample was saturated and the swelling pressure balanced prior to applying a constant load with drainage allowed at both ends. When primary compression was complete, the load was increased and this repeated for three increments of load. The sample was then unloaded. The rate and total amount of consolidation were continually monitored using a computer controlled E.L.E. Datasystem 7 Unit. The results were plotted and analysed by the computer for each increment of load to obtain the coefficients of compressibility (m_v), and of consolidation (c_v), which govern the amount and rate of settlement respectively.

California Bearing Ratio (C.B.R.) tests were performed on selected recompacted near surface samples. 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 C.B.R. value is the ratio of the force required to achieve 2.5mm or 5.0mm penetration to standard forces expressed as a percentage.

Chemical analysis of nine soil samples recovered from the exploratory holes was undertaken, by an independent laboratory, primarily for characterisation purposes. The samples were tested for 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 encountered by the investigation have been plotted as a soil profile in Figure 3. The boreholes found a surface layer of made ground or topsoil resting on the anticipated superficial Tidal Flat Deposits of clays and silts, with a thick succession of very soft organic clay below about 1.80m depth. Groundwater was found from depths below about 0.70m.

Made Ground & Topsoil

A surface layer of made ground was found at positions WS1, WS5, WS6, WS7, WS8 and WS10, to depths generally between 0.40m (WS1, WS7 and WS10) and 0.90m (WS5) across most of the site, thickening locally to 1.55m (WS8) where the infilled drainage ditch was located beneath the northern part of the site.

The surface made ground layers were typically soft or firm, friable, dark brown and brown, slightly sandy, slightly gravelly, silt or clay fill and contained gravel of flint, limestone, asphalt, brick, pottery, textile, coal and ash fragments.

The thickest made ground was encountered in WS8, and was positioned on the line of the former drainage ditch beneath the northern part of the site. Below 0.90m depth, this made ground was a very soft, grey, brown, and orange brown mottled, slightly gravelly, silty, organic clay. This fill extended to 1.55m depth and contained fragments of wood, brick, ash and shell fragments.

A surface layer of topsoil was found at the remaining positions of WS2, WS3, WS4 and WS9. This was a soft, dark brown, slightly sandy, slightly gravelly, clayey silt or silty clay, and reached depths of 0.30m and 0.40m.

Tidal Flat Deposits

The Tidal Flat Deposits were encountered beneath the surface layers of made ground or topsoil at depths between 0.30m and 1.55m. Across the southern part of the site these deposits were initially a very loose or loose, brown, orange brown and grey mottled, slightly clayey, sandy

silt, representing ‘roddons’ or silt-filled creeks, and thickened southwards from 0.40m in WS7, to 2.30m in WS1. The sand within this deposit was predominantly fine grained.

Beneath the surface made ground and topsoil across the northern part of the site, and beneath the thin layer of sandy silt in WS7, an initially firm or soft, brown, orange brown and grey mottled, slightly sandy, silty clay was present. This clay contained occasional seams and layers of fine sandy silt. The clay was typically initially firm where present at shallow depths, becoming soft below about 0.80m to 1.55m depth, and very soft below 1.80m depth. This soft clay was locally present beneath the near-surface sandy silt in WS2, WS3, WS4 and WS7.

At depths of between 1.80m and 3.00m the boreholes entered a very soft, grey and dark grey, silty, organic clay. This very soft, organic clay extended to at least the base of each borehole, which was terminated at 3.45m depth. Dynamic probing indicated the very soft Tidal Flat Deposits to have a thickness of 6.80m to 8.00m, extending to depths of 9.60m and 10.00m below ground level, where firm or loose conditions were found.

Groundwater

Groundwater seepages and slow inflows were noted during withdrawal of the 1m long sampling barrels within the boreholes at depths between 0.80m and 3.00m, with levels rising to stand at between 0.80m and 2.10m within all holes on completion, except WS7, which remained dry. However, water levels may have been still rising when they were backfilled.

Groundwater stood within the monitoring installations in WS1, WS6 and WS9 at depths between 0.63m and 1.34m during the monitoring period over December 2016 and January 2017. The standpipe water levels stood between 1.61mOD and 2.52mOD.

Live Roots

Fibrous live roots were observed within the Tidal Flat Deposits in most of the holes across the site. Where present, these roots were observed to extend to depths between 0.90m (WS2), and a maximum depth of 1.40m in WS10. Borehole WS10 was positioned close to some trees in the far north-eastern corner of the site.

Evidence of Contamination

There was no olfactory or visual evidence of any hydrocarbon contamination within the soils or groundwater encountered on this site. The made ground commonly contained fragments of brick, coal and ash fragments. No asbestos containing materials (ACMs) were observed within the made ground soils.

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

The ground investigation found a surface layer of made ground or topsoil, resting on a very thick succession of Tidal Flat Deposits, which were initially firm and soft, but became very soft and organic below about 1.80m depth and extended to approximately 10.00m depth. The naturally deposited clays and silts of the Tidal Flat Deposits found across the site offer, at best, only modest bearing properties for traditional shallow strip or raft foundations. The clays and silts initially locally have a firm or soft ‘crust’ at shallow depths, which may be capable of supporting lightly loaded structures, but these soils rapidly became soft and very soft with increasing depth.

Localised deepening of traditional foundations will be required where proposed houses are located close to the existing trees, some of which will be removed. Foundations will need to penetrate the zones of root influence within the clay soils. The underlying soft and very soft clays found as shallow as 0.80m depth, are poorly consolidated, heterogeneous and unlikely to provide adequate support for deepened traditional strip foundations. Some foundations may extend into the underlying very soft, grey, organic clay soils, which offer very limited support for deepened traditional foundations.

Any proposed properties at the northern and north-western ends of the site, in areas 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 in these areas close to trees, would require a piled foundation scheme in order to transfer loads to below at least 11m depth.

Traditional 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. By contrast, made ground whose history is not completely known, must, despite any amount of investigation, present the possibility of conditions existing which could not be accepted

when considering the material as a bearing stratum. The thickness of the made ground, across the site was generally between 0.40m and 0.90m below existing ground level, and the risk associated with the use of this material as a bearing stratum is considered too great. Foundations should extend through the made ground soils. Similarly the 1.55m deep former ditch infill found in WS8 is likely to extend across the site and should be avoided, removed and replaced, or bridged by any foundations in its proximity.

The near-surface naturally deposited clays and silts of the Tidal Flat Deposits have modified plasticity indices ranging from 6% to 27% and are rated as having a low and medium volume change potential. The underlying very soft, organic clays have a modified plasticity index of 65%. Based on the National House Building Council (NHBC) Standards Chapter 4.2 'Building near trees' (2016), foundations in open ground, at least 17m from the nearest Lime tree; and at least 12m from the nearest Cypress tree; would require a minimum depth of 0.90m below either existing or finished ground level, whichever is greater, in order to penetrate the zone of seasonal influence.

The presence of isolated trees (Cypress) in the vicinity of some plots and the Lime trees beyond the northern site boundary mean that some of the proposed properties may be within their range of root influence. Fibrous live roots were found within the Tidal Flat Deposits to a maximum depth of 1.40m depth at the position of WS10, located in the north-eastern corner of the site. Foundation depths will have to consider the presence of trees, with foundations extending through any root affected clay soils.

Trees and shrubs will extend the depth affected by seasonal moisture variation and advice on this is given in the National House Building Council (NHBC) Standards Chapter 4.2 "Building near trees" (2016). Based on this document, the former high water demand Cypress trees at 5m distance, will require a minimum foundation depth of at least 1.25m in order to penetrate the zones of root influence. Similarly, a Lime tree located 10m from foundations along the northern edge of the site would require a minimum foundation depth of 1.35m below the original ground level.

Deepened foundations are required where they are to be cast within the influencing distance of trees, both in areas where trees remain or in areas where trees have been felled, in order to penetrate the zone of potential shrinkage and heave movements.

Potentially low to moderate swelling pressures could damage traditional foundations by exerting both lateral and upward heave movements over long periods following removal of trees. Such swelling pressures could be generated in areas where trees have been removed, and if the any desiccated near-surface clays are allowed to become saturated. The clay at 1.65m depth at the position of WS6, yielded a swelling pressure of only 1kPa, but greater pressures are likely closer to the trees and at shallower depths. Incorporation of some void forming or compressible material against the sides of the foundations or ground beams will be required within the zones of influence of former trees, in any root infested clay, in order to accommodate any vertical and horizontal movements caused by future heave movements of the clay.

The moisture contents plotted in Figure 3, suggest that the clays showed some evidence of slight desiccation within WS6 and WS9, extending to approximately 1.50m depth at the latter position, within the influence zone of the neighbouring Lime tree, below which moisture contents were at or in excess of their equilibrium moisture contents. This would be expected within such soils below the groundwater table.

In areas where buildings are proposed either where trees have been cleared or remain close by, it would be possible to adopt a raft foundation in accordance with NHBC Standards Chapter 4.2.9 (2016). This will require the underlying root affected clays to be removed and replaced with non-shrinkable compacted stone, with a thickness depending on the distance to trees. As an example, where an adjacent Lime tree is only 3m distant, the compacted stone should extend to the minimum foundation depth of 0.90m, increasing to 1.10m depth where foundations are 1.0m from a former Cypress tree. This solution would also avoid requirement for anti-heave precautions, such as void forming or compressible materials, which will be needed alongside strip foundations within root affected clay soils.

Bearing Capacity

Deepened traditional foundations would lose any benefit of utilising the upper firm or soft 'crust' of the Tidal Flat Deposit as a bearing stratum, since they would extend into the highly compressible, very soft, organic clay/silt which has limited bearing properties.

The soft clays of the Tidal Flat Deposit at the minimum foundation depth of 0.90m, has a net maximum safe bearing capacity for a 0.60m wide strip footing of 45kN/m² with a factor of safety of 3.0 applied against general shear failure. If a reduced factor of safety of 2.5 could be accepted, the net maximum safe bearing capacity would increase to 55kN/m².

Based on the oedometer test result and other parameters from similar deposits, the estimated consolidation settlement beneath such a 0.60m wide strip foundation at 0.90m depth and applying 45kN/m² is anticipated to be in the order of 30mm to 40mm, increasing to about 35mm to 45mm beneath a 0.90m wide strip foundation cast at the same depth and also applying 45kN/m².

Similarly the Tidal Flat Deposits beneath an 11m by 9m raft foundation would have a maximum safe bearing capacity of 30kN/m² with a factor of safety of 3.0 incorporated. Estimated consolidation settlement beneath such a raft would be in the order of 80mm to 100mm, with the potential for a further 20mm to 30mm long term secondary consolidation.

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 different soil types. Some differential settlement may occur across the building plots, due to variations in thickness and compressibility of the underlying soils and difference in depth to the organic clay. Further differential movements will occur if and where foundation pressures locally increase along foundation runs or across a raft. Movements could be further exacerbated by effects of tree roots, which could also locally generate upward heave movements. New foundations should incorporate some nominal reinforcement in order to minimise any differential movements along, across or between them.

Excavations

The soils should excavate easily by hand or with modern plant. Groundwater will be encountered below about 0.80m depth, and should coincide with the water level in the adjacent drainage ditches to the east and south. Inflows within excavations are likely to occur as seepages or slow inflows within the clay, but faster inflows could be expected within the sandy silt at the southern end of the site. Inflows from the sandy silt may be accompanied by 'running sand' conditions with ensuing side instability.

Foundations could be cast below 0.90m depth, as soon as the groundwater is encountered, preferably by taking excavations to just above the water table and completing the foundation excavations immediately prior to pouring concrete. Whilst pumping from screened sumps may achieve sufficient draw-down of the groundwater across most of the northern half of the site, it is likely that it would be more effective to control the groundwater, particularly within deep excavations for sewers, within the loose and very loose, sandy silt beneath the southern part of the site, by a dewatering scheme using well-points. Care should be taken not to allow removal of the clay or silt fraction in order to avoid loosening of this stratum. A specialist dewatering contractor should be consulted, but such a well-pointing technique is likely to enable supported excavations to be completed dry. Consideration should be given to the possibility of settlement of any neighbouring existing foundations which may be induced by dewatering.

Any old foundations and buried structures associated with the existing bungalows should be grubbed out and replaced with compacted material in order to avoid the occurrence of any 'hard spots' beneath new foundations. The building arrangement should consider the route of the sewers crossing the site.

The base of excavations should be inspected on completion to ensure that the condition of the soil complies with that assumed in design. It is possible that the ground conditions may vary across individual plots, particularly if buried silt, sand or peat-filled creeks or channels are present, which could result in variable inflows of groundwater. The stability of excavation sides within the soft and very soft clays and silt will deteriorate with increasing depth, with failure likely to occur within steeply cut faces.

Although excavation sides within dry excavations to around 1.00m depth, should remain stable, at least in the short term, the soils should not be relied upon to stand unsupported for any significant length of time. Excavation side instability is likely to occur both within the made ground and the soft, becoming very soft naturally deposited Tidal Flat Deposits, particularly where excavations approach the groundwater table. Care should be taken by personnel who enter excavations, and adequate close and interlocking side support should be provided to protect such workers.

Should pockets of inferior peaty soil, or root infested clay be present within foundation excavations, they should be removed and replaced with well graded, well compacted hardcore or lean mix concrete. This should include inspection in the areas of the sewers and historically infilled south-east aligned ditch across the northern part of the site. The excavated surface should be protected from deterioration and a blinding layer of concrete used where foundations are not completed without delay. Surface water, perched water and groundwater should not be allowed to collect in the base of excavations, since the sandy silts and silty clays are prone to rapid softening with resulting loss of their already limited bearing properties.

Floor Slabs

Ground bearing floor slabs could be adopted for properties in areas away from any existing or former trees and beyond their zones of root influence. However, ground bearing floor slabs could suffer some minor differential movements across them, or between the floor slab and building foundations. The surface layers of made ground found to 0.90m depth, and locally to 1.55m at the position of the former ditch, as well as the sewer pipe excavation backfill, are likely to have lateral variations in composition, which could result in differential movements. Incorporation of nominal reinforcement should ensure minimal movement across floor slabs applying minimal loads.

In areas of root affected clay soils locally in upper parts, ground bearing floor slabs should not be adopted for proposed buildings in the north-eastern and far northern parts of the site.

Damaging differential heave movements could occur across such slabs, particularly where they cover any clay affected by recently removed trees.

Raft foundations should avoid problems associated with shallow root affected clays, since they will require a minimum depth of 0.90m and in areas of former trees will need to be placed on a compacted stone blanket less than 1.25m thick.

Sulphate Conditions

Sulphate analysis of selected samples of soil and groundwater yielded soluble sulphate concentrations within Design Sulphate Classes DS-1 and DS-2 of the BRE Special Digest 1, Table C1 (2005), presented in Appendix 3. The pH results ranged between 7.3 and 8.3.

These results indicate an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-2 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.

Hardstanding and Pavement Design

Laboratory CBR tests on near-surface recompacted samples from WS1, WS6 and WS9 yielded CBR values between 0.1% and 2.6%.

Based on the plasticity indices for the clay sub-grade, Interim Advice Note 73/06 Revision 1 (2009) recommends an estimated design CBR value of 3.0% for a thin pavement construction on these clay soils, reducing to 1.0% for a silt soil. The clayey, sandy silts locally present at sub-grade level beneath the southern part of the site are potentially frost susceptible soils and will require a minimum construction thickness of 450mm for roads or hardstanding.

For the central and northern parts of the site, it would be prudent to adopt a conservative design CBR value of 1.5% for hardstanding design of a thin road pavement on this site.

The sub-grade should be inspected and compacted using a vibratory roller, with any soft clay, organic pockets or root infested clays removed and replaced with more suitable well-

graded coarse grained fill. 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. If proposed access roads cross the routes of the former drainage ditch or sewers, careful examination of exposed surfaces may identify the excavations, which should be assessed, since they may provide linear 'soft', 'hard' or potentially compressible features, resulting in differential movement of surface hardstanding.

Differential movement may occur across hardstanding where it crosses different strata or rests on any clay previously affected by tree roots. Ideally, any root-affected clay should be removed and replaced to a suitable depth with well compacted non-shrinkable material prior to placement of hardstanding in order to avoid future heave movements within the clay soils.

Care should be taken not to leave the sub-grade exposed to weather conditions, since in particular, the sandy silt soils are prone to rapid deterioration in the presence of surface water.

Drainage

The shallow clay and silt soils beneath this site are not likely to offer a suitable drainage medium for disposal of surface water. The shallow groundwater table is likely to impede the functioning or drainage from soakaways as well as significantly limiting the available storage potential. The efficiency of such soakaway drainage systems would also deteriorate with time, since they will be prone to silting up.

Any soakaway drainage should be kept well away from buildings, otherwise there is a potential for the removal of fines and subsequent settlement of any structures, slabs or hardstanding based upon these soils, as well as heave of any root affected clay soils. Consequently soakaway drainage would not be considered appropriate for this site, and consideration should be made to utilising the existing pumped sewer network crossing the site.

COMMENTS ON THE CHEMICAL TEST RESULTS OF SOIL

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 1.04 and 1.06 software. With the absence of a S4UL for cyanide the ATRISKsoil SSV for cyanide has been used as the soil screening criteria within this report.

In March 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 use

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 overleaf 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 for Topsoil & Made Ground Soils with SSVs

Determinand	Number of Samples	Min Value (mg/kg)	Max Value (mg/kg)	Number of Samples Exceeding SSV for:			Measured 95 th Percentile (mg/kg)	Soil Screening Values SSV (1.0% SOM)			
				Residential with home grown produce	Residential without home grown produce	Commercial / Industrial		Assessment Method	Residential with home grown produce (mg/kg)	Residential without home grown produce (mg/kg)	Commercial/ Industrial (mg/kg)
Organic matter	9	1.6%	17%	-	-	-	-	-	-	-	-
Arsenic	9	11	31	0	0	0	18.37	S4UL	37	40	640
Cadmium	9	<0.10	0.39	0	0	0	0.29	S4UL	11	85	190
Trivalent* Chromium	9	16	39	0	0	0	25.29	S4UL	910	910	8,600
Hexavalent Chromium	9	<0.50	<0.50	0	0	0	<0.50	S4UL	6	6	33
Lead	9	13	52	0	0	0	35.45	C4SL	200	310	2330
Mercury	9	<0.10	0.13	0	0	0	0.11	S4UL	11	15	320
Selenium	9	<0.20	0.35	0	0	0	0.28	S4UL	250	430	12,000
Nickel	9	17	32	0	0	0	23.94	S4UL	130	180	980
Phenols	9	<0.30	<0.30	0	0	0	<0.30	S4UL	120	440	440
Benzo[a]pyrene	9	<0.10	0.56	0	0	0	0.25	S4UL	0.79	1.2	15
Copper	9	16	100	0	0	0	47.84	S4UL	2400	7100	68,000
Zinc	9	42	230	0	0	0	138.10	S4UL	3,700	40,000	730,000
Free Cyanide	9	<0.50	<0.50	0	0	0	<0.50	ATRISK	34	34	34

Notes

*The concentration of Trivalent Chromium is assumed to be equivalent to the Total Chromium concentration. This is because most naturally occurring chromium is in the trivalent (chromic) state.

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

LQM/CIEH S4ULs 'Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3608. All rights reserved'

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

Discussion of Soil Results

The results of the laboratory analysis indicate that the made ground contains no concentrations of elements or compound contaminants, which exceed the residential soil screening criteria. All of the elements and compound contaminants tested for were also within the associated soil screening criteria for an industrial/commercial end use.

The made ground was not noted to have olfactory evidence of hydrocarbon contamination.

No asbestos containing materials (ACM) were observed within the made ground soils.

Based on these results, the encountered made ground would be considered to be suitable for reuse in the context of a residential development where the soils are exposed at the surface within garden areas.

SOIL GAS MONITORING RESULTS

The results of soil gas monitoring of the installations within WS1, WS6 and WS9, during the return visits during December 2016 and January 2017, found up to 3.9% methane and up to 1.4% carbon dioxide, with marginally depleted oxygen levels. The in-situ measurements recorded flow rates of less than 0.1l/hr. The results are tabulated following the borehole records. These in-situ measurements indicate a gas screening value (GSV) of 0.0039l/h.

The GSV falls within the modified Wilson and Card Characteristic Situation 1 or 'Green' classification of the NHBC traffic light system, as defined by the Construction Industry Research and Information Association, CIRIA Report C665, 'Assessing risks posed by hazardous ground gasses to buildings'.

The site is not within an area where radon precautionary measures are required for new buildings.

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 intrusive ground investigation documented in the preceding sections of this report.

A generalised conceptual model, updated following the intrusive works, monitoring and testing, and targeted to provide coverage across the site, relative to the construction phase and completed development, is presented below in Table 6.

Table 6: Updated Conceptual Model Relative to Construction and Future Residential Use

Receptors	Pathway	Estimated Potential for Linkage with Contaminant Sources			
		Existing Drainage/ Buildings	Soil Beneath Site	Soil Gas	Ground Contamination Outside Site Boundary
Human Health – ground workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Moderate	Low	Moderate	Very Low
Human Health – 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	Very Low	Very Low	Very Low	Very 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
Key to Table 6 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 site with a current and end use within a residential development setting 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 works reveal materials that may appear to be contaminated.

Asbestos in Existing Buildings

It is recommended that an asbestos survey is conducted of the existing buildings or structures prior to any demolition, redevelopment or building works. Suitable precautions, in line with current best practice, should be put in place to protect workers from the effects of asbestos material, during such works.

Existing Drainage

Any redundant surface water drain runs should be removed from beneath the site and precautions should ensure that any remaining effluent is directly disposed of off-site. The integrity of existing drainage should be checked, and damaged sections replaced prior to re-use within the development. The approximately 1.3m to 2.7m deep foul sewers crossing the northern and eastern parts of the site, one of which was along the route of the former south-east drainage ditch, are likely to be encountered beneath the site. The integrity of these sewers should be checked if they are to be retained, in order to ensure that there is no leakage and that they are free-flowing. These measures should reduce the future risk to human health and the water environment to very low.

Contaminated Soil

The site is underlain by between 0.40m and locally 1.55m of made ground or topsoil, which do not contain any significantly elevated concentrations of contaminants. All

concentrations of elements and compounds detected within the near-surface soils were within the screening values for the applicable residential end use with home grown produce.

The topsoil and made ground soils would be considered to be suitable for reuse in the context of a residential development where the soils are exposed at the surface within garden areas.

Human Health - Construction Workers

No elevated levels of contaminants were identified by this investigation. There is therefore a low risk that a pathway could develop affecting groundworkers during the construction phase of development.

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 that 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) Generation of dust should be limited by damping-down.
- d) 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.
- e) Consideration should be given to gas monitoring within deep or confined spaces to ensure safety of personnel entering them, since carbon dioxide and methane gases generated from the soils could accumulate within excavations, service chambers or sub-structures.

Human Health - Users of Completed Development

The risk of ground contamination affecting the end users of the completed development, where a pathway is present, in both a residential or public open space setting, would be considered to be very low.

The results of the chemical analysis suggests that the topsoil and made ground soils could be considered suitable for re-use at the surface within new garden or landscaped areas. No scheme of remediation would be considered necessary for the proposed development.

There are no significant potential sources of ground gas and no precautions are likely to be required to protect the proposed buildings from ingress of soil gases. No precautionary measures are required to protect the properties from radon.

Water Environment

The site is underlain by Tidal Flat Deposits which are designated by the E.A. as 'Unproductive'. The neighbouring field drainage system is pumped via drainage ditches towards the south-east.

The Tidal Flat Deposits are practically impervious soils, whilst the interbedded silt filled 'roddons' may have slightly better drainage potential. The groundwater is present at around 0.80m to 1.00m below site level. The risk to groundwater from any near-surface soil contaminants is considered to be very low. It is therefore unlikely that the proposed development, including the installation of foundations, would impact the quality of the water environment.

Effects on Building Materials and Services

No precautionary measures are considered necessary for buried concrete or services, where they are to be in contact with made ground soils.

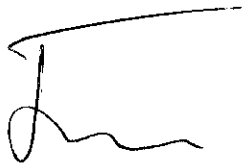
Off-Site Disposal of Soil Arisings

The results of chemical analysis are provided to the rear of this report 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 WM2 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.

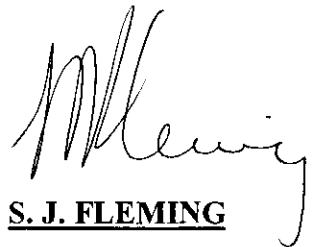
Excavated material and excess spoil should always be classified prior to removal from site as required by 'Duty of Care' (Environmental Protection Act, 1990) legislation. This means that material has to be given a proper description and waste classification prior to removal. Basic characterisation is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

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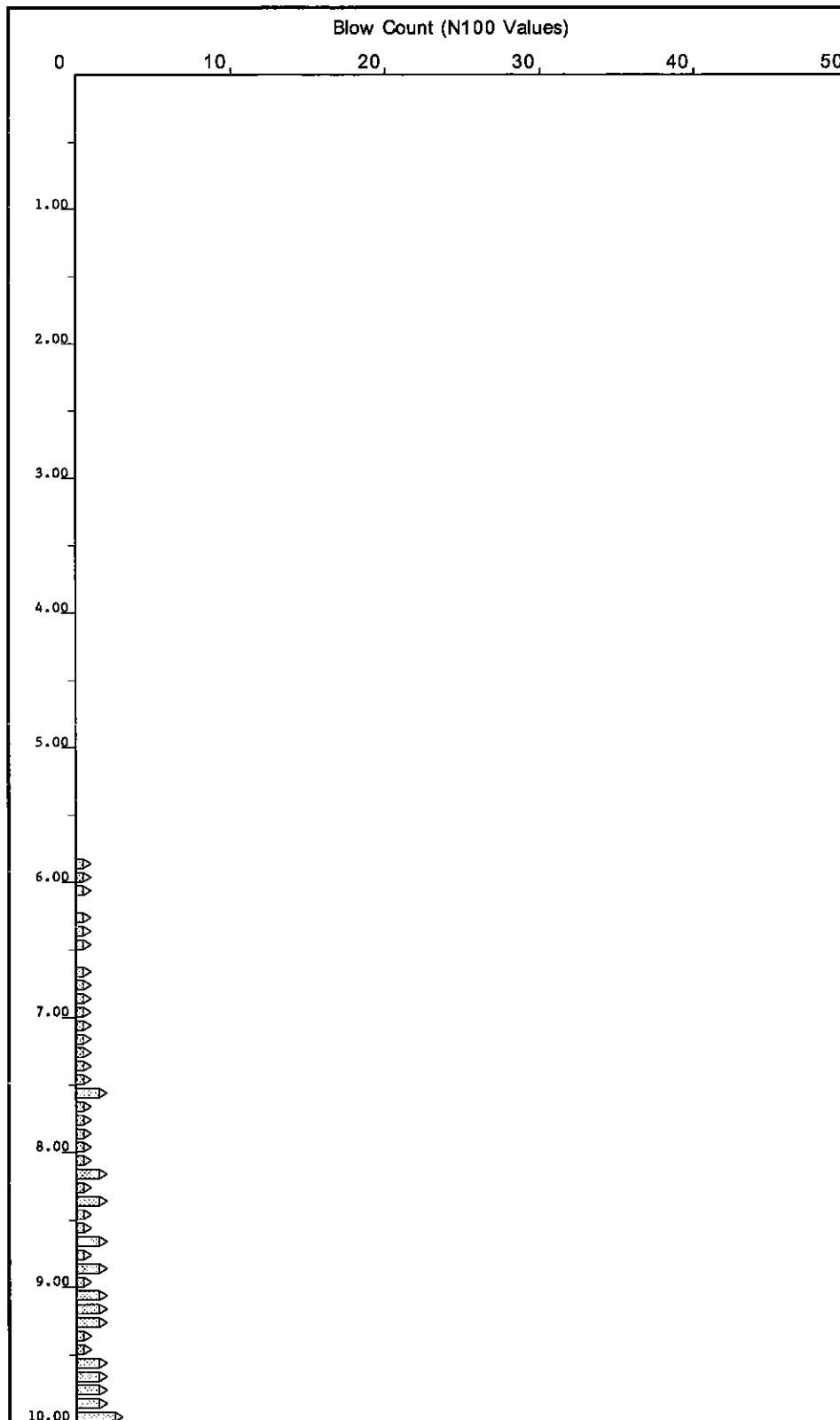


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GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: SMALL DROVE, WESTON				WINDOW SAMPLE WS1					
			Date: 14/12/16		Hole Size: 87mm dia to 2.00m 77mm dia to 3.00m 50mm dia to 10.70m		Ground Level: 3.15m. O.D.					
Samples and in-situ Tests			(Date) Water	Inst.	Description of Strata	Legend	Depth m	O.D. Level m				
Depth m	Type	Result										
0.30 0.40-0.70 0.60	D1 B1 D2				MADE GROUND - Flint GRAVEL. MADE GROUND - Firm, brown, slightly sandy, slightly gravelly, clayey SILT. Gravel is flint, asphalt, limestone and brick fragments.		0.08 0.40	3.07 2.75				
0.90 1.10 1.20-2.00 1.20 1.35-1.65	D3 D4 B2 D5 S	N8			Loose, brown/orange brown/grey mottled, slightly clayey, very sandy SILT. Sand is fine grained. (TIDAL FLAT DEPOSIT)							
2.00 2.15-2.45	D6 S	N2			Very loose, grey, slightly clayey, sandy SILT. (TIDAL FLAT DEPOSIT)							
3.00 3.15-3.45	D7 S	N1			Very soft, grey/dark grey, slightly sandy, silty, slightly organic CLAY. (TIDAL FLAT DEPOSIT)							
					Dynamic probe indicates very soft conditions. Becoming soft below 8.00m depth.							
					(TIDAL FLAT DEPOSIT)							
						10.00	-6.85					
REMARKS 1. Starter pit excavated from 0.00m to 1.20m depth 2. No live roots observed 3. No recovery in liners below 2.00m depth 4. Borehole completed at 3.45m depth and continued using dynamic probing to 10.70m depth 5. Gas monitoring standpipe installed to 3.00m depth							Project No 14022					
							Scale 1:50	Page 1/2				
KEY D - Disturbed Sample ES - Environmental Sample B - Bulk Sample M - Mackintosh Probe U - Undisturbed Sample V - Vane Shear Test W - Water Sample Cohesion () kPa ∇ Water Strike R () - Hand Penetrometer ∇ Depth to Water Cohesion () kPa on completion ∇s Standpipe Level			Groundwater Strikes				Groundwater Observations					
			Depth m						Depth m			
			No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water
			1	1.10					14/12/16	3.45		0.90
						20/12/16	3.00		0.73			
						04/01/17	3.00		0.68			
						16/01/17	3.00		0.63			

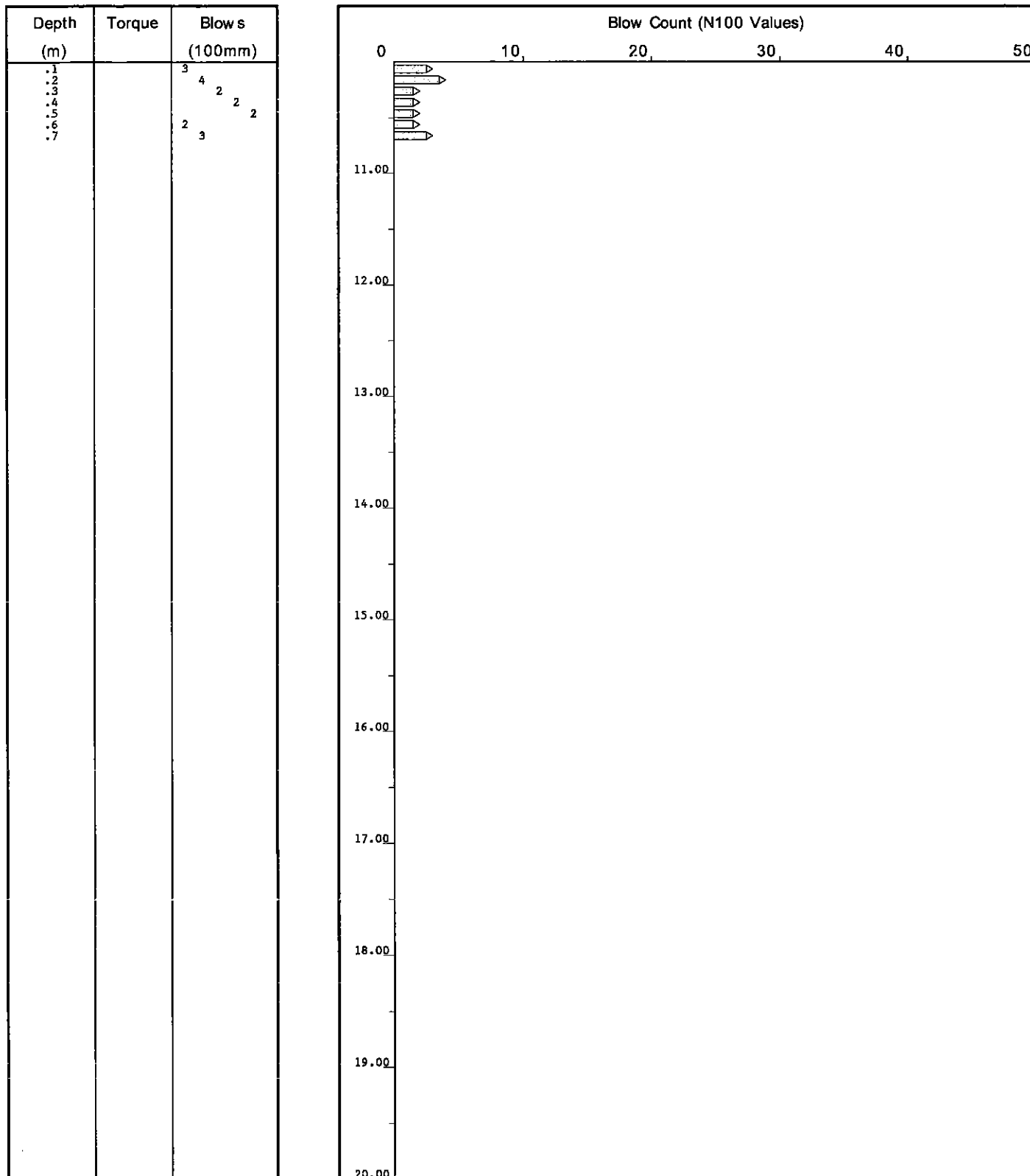
GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk	DYNAMIC PROBE PENETRATION TEST	Date 14/12/16	PROBE No WS1 Sheet 1 of 2
		Project Number 14022	
Method BS 1377 : Part 9 : Clause 3.2 (DPSH)	Client SOUTH HOLLAND DISTRICT COUNCIL	Site SMALL DROVE, WESTON	

Depth (m)	Torque	Blows (100mm)
.1		-
.2		-
.3		-
.4		-
.5		-
.6		-
.7		-
.8		-
.9		-
1.0		-
.1		-
.2		-
.3		-
.4		-
.5		-
.6		-
.7		-
.8		-
.9		-
2.0		-
.1		-
.2		-
.3		-
.4		-
.5		-
.6		-
.7		-
.8		-
.9		-
3.0		-
.1		-
.2		-
.3		-
.4		-
.5		-
.6		-
.7		-
.8		-
.9		-
4.0		-
.1		-
.2		-
.3		-
.4		-
.5		-
.6		-
.7		-
.8		-
.9		-
5.0		-
.1		-
.2		-
.3		-
.4		-
.5		-
.6		-
.7		-
.8		-
.9		-
6.0		-
.1	1	1
.2	0	1
.3	1	1
.4	1	1
.5	0	1
.6	1	1
.7	1	1
.8	1	1
.9	1	1
7.0	1	1
.1	1	1
.2	1	1
.3	1	1
.4	1	1
.5	2	1
.6	1	1
.7	2	1
.8	1	1
.9	1	1
8.0	1	1
.1	2	1
.2	1	2
.3	2	1
.4	1	2
.5	2	1
.6	1	2
.7	2	1
.8	2	1
.9	2	1
9.0	2	1
.1	2	2
.2	2	2
.3	2	1
.4	2	1
.5	2	1
.6	2	1
.7	2	2
.8	2	2
.9	2	2
10.0		3



Remarks : Probing undertaken from base of borehole. Probe rods sank 'under own weight' to 5.90m depth.	Hammer 63.5 kg	14022
	Standard Drop 750 mm	
	Cone 50 mm dia	
	Rod 8kg / 35 mm	

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk	DYNAMIC PROBE PENETRATION TEST	Date 14/12/16	PROBE No WS1 Sheet 2 of 2
		Project Number 14022	
Method BS 1377 : Part 9 : Clause 3.2 (DPSH)	Client SOUTH HOLLAND DISTRICT COUNCIL	Site SMALL DROVE, WESTON	

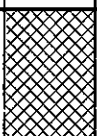
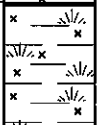


Remarks : Probing undertaken from base of borehole. Probe rods sank 'under own weight' to 5.90m depth.	Hammer 63.5 kg	14022
	Standard Drop 750 mm	
	Cone 50 mm dia	
	Rod 8kg / 35 mm	

GROUND ENGINEERING LIMITED Tel: 01733-566566 www.groundengineering.co.uk			Site: SMALL DROVE, WESTON				WINDOW SAMPLE WS2						
			Date: 13/12/16		Hole Size: 77mm dia to 2.00m 67mm dia to 3.00m 50mm dia to 3.45m		Ground Level: 3.20m. O.D.						
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m						
Depth m	Type	Result											
0.30	D1	N7	1 ▼	TOPSOIL - Soft, friable, dark brown, slightly gravelly, sandy SILT. Gravel is angular to sub-angular flint.		0.30	2.90						
0.60	D2			Firm, friable, brown, slightly sandy, clayey SILT. (TIDAL FLAT DEPOSIT)		0.70	2.50						
0.90	D3			Loose, light brown/orange brown mottled, slightly clayey, very sandy SILT with occasional fine shell fragments. Sand is predominantly fine grained.			2.00	1.20					
1.10	D4												
1.20	D5												
1.20-2.00	U1	N1	▼	(TIDAL FLAT DEPOSIT)		3.00	0.20						
1.35-1.65	S												
2.00	D6	N1	▼	Very soft, grey/dark grey/brown mottled, slightly sandy, silty CLAY.		3.45	-0.25						
2.15-2.45	S			(TIDAL FLAT DEPOSIT)									
3.00	D7	N1	▼	Very soft, grey, silty, organic CLAY with occasional peaty root traces.		Hole completed at 3.45m depth							
3.15-3.45	S			(TIDAL FLAT DEPOSIT)									
REMARKS 1. Starter pit excavated from 0.00m to 1.20m depth 2. Live roots observed to 0.90m depth 3. No recovery in liners below 2.00m depth								Project No 14022					
								Scale 1:50	Page 1/1				
KEY D - Disturbed Sample ES - Environmental Sample B - Bulk Sample M - Mackintosh Probe U - Undisturbed Sample V - Vane Shear Test W - Water Sample Cohesion () kPa ▼ Water Strike P () - Hand Penetrometer ▼s Depth to Water Cohesion () kPa on completion ▼s Standpipe Level				Groundwater Strikes			Groundwater Observations						
				Depth m						Depth m			
				No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water
1	1.10					13/12/16	3.45		1.10				

GROUND ENGINEERING L I M I T E D Tel: 01733-566565 www.groundengineering.co.uk			Site: SMALL DROVE, WESTON				WINDOW SAMPLE WS3						
			Date: 13/12/16		Hole Size: 87mm dia to 2.00m 77mm dia to 3.00m 50mm dia to 3.45m		Ground Level: 3.10m. O.D.						
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m						
Depth m	Type	Result											
0.30-0.60 0.30 0.60	B1 D1 D2		<div style="display: flex; align-items: center; justify-content: center;"> <div style="text-align: center; margin-right: 10px;">1 ▼</div> <div style="text-align: center;"> </div> </div>	TOPSOIL - Soft, dark brown, slightly gravelly, silty CLAY. Gravel is angular to sub-rounded flint.	<div style="display: flex; align-items: center; justify-content: center;"> <div style="text-align: center; margin-right: 10px;">x x x x x x x x x x</div> <div style="text-align: center;"> </div> </div>	0.40	2.70						
0.90 1.10 1.20 1.35-1.65	D3 D4 D5 S	N2		Very loose, brown/orange brown mottled, clayey, very sandy, SILT. Sand is predominantly fine grained. (TIDAL FLAT DEPOSIT)									
1.55-1.85	U1			Very soft, brown/orange brown mottled, slightly sandy, silty CLAY. (TIDAL FLAT DEPOSIT)				<div style="display: flex; align-items: center; justify-content: center;"> <div style="text-align: center; margin-right: 10px;">x x x x x x x x x x</div> <div style="text-align: center;"> </div> </div>	1.55	1.25			
2.00 2.15-2.45	D6 S	N1		Very soft, grey/dark grey mottled, silty, organic CLAY with occasional peaty root traces.									
3.00 3.15-3.45	D7 S	N1		(TIDAL FLAT DEPOSIT)									
Hole completed at 3.45m depth				<div style="display: flex; align-items: center; justify-content: center;"> <div style="text-align: center; margin-right: 10px;">x x x x x x x x x x</div> <div style="text-align: center;"> </div> </div>							3.45	-0.35	
REMARKS 1. Starter pit excavated from 0.00m to 1.20m depth 2. Live roots observed to 1.20m depth 3. No recovery in liners below 2.00m depth						Project No 14022							
						Scale 1:50	Page 1/1						
KEY D - Disturbed Sample ES - Environmental Sample B - Bulk Sample M - Mackintosh Probe U - Undisturbed Sample V - Vane Shear Test W - Water Sample Cohesion () kPa ▼ - Water Strike P () - Hand Penetrometer ▼s - Depth to Water Cohesion () kPa on completion s - Standpipe Level			Groundwater Strikes				Groundwater Observations						
			Depth m						Depth m				
			No	Struck	Rose to	Rate	Cased	Sea'ed	Date	Hole	Casing	Water	
	1	1.00					13/12/16	3.45		1.00			

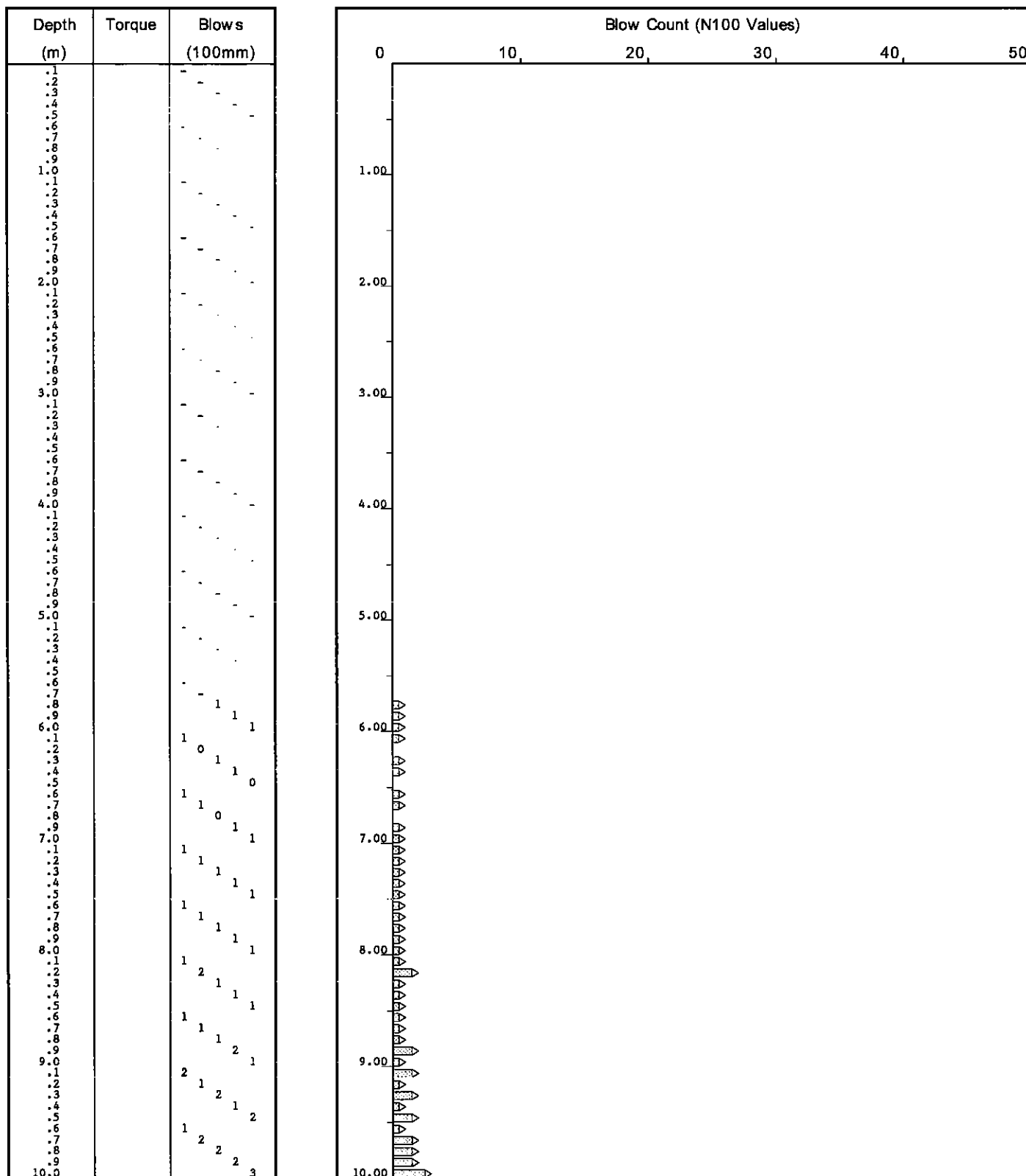
GROUND ENGINEERING LIMITED Tel: 01733-566566 www.groundengineering.co.uk			Site: SMALL DROVE, WESTON				WINDOW SAMPLE WS4					
			Date: 13/12/16		Hole Size: 87mm dia to 2.00m 77mm dia to 3.00m 50mm dia to 3.45m		Ground Level: 2.95m. O.D.					
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m					
Depth m	Type	Result										
0.20 0.30-0.60 0.60	D1 B1 D2		<div style="text-align: right; margin-right: 10px;">1 1.2</div>	TOPSOIL - Soft, dark brown, slightly sandy, clayey SILT.		0.30	2.65					
				Brown/orange brown mottled, slightly clayey, very sandy SILT. Sand is predominantly fine grained.								
0.90 1.10 1.20 1.35-1.65 1.50	D3 D4 D5 S V1	N5 (17)		(TIDAL FLAT DEPOSIT)		1.15	1.80					
				Soft, orange brown/grey mottled, slightly sandy, silty CLAY. (TIDAL FLAT DEPOSIT)		1.80	1.15					
1.80-2.00 1.95 2.00 2.15-2.45	U1 V2 D6 S	(28) N1		Very soft, grey/dark grey, silty, slightly organic CLAY with occasional peaty root traces.								
				(TIDAL FLAT DEPOSIT)		3.45	-0.50					
3.00 3.15-3.45	D7 S	N1		Hole completed at 3.45m depth								
REMARKS				Project No 14022								
								Scale 1:50 Page 1/1				
KEY D - Disturbed Sample ES - Environmental Sample B - Bulk Sample M - Mackintosh Probe U - Undisturbed Sample V - Vane Shear Test W - Water Sample Cohesion () kPa ∇ Water Strike P () Hand Penetrometer ∇ Depth to Water Cohesion () kPa on completion ∇s Standpipe Level				Groundwater Strikes				Groundwater Observations				
			Depth m			Date			Depth m			
			No	Struck	Rose to	Rate	Cased	Sealed		Hole	Casing	Water
			1	0.80					13/12/16	3.45		0.80

GROUND ENGINEERING LIMITED Tel: 01733-566566 www.groundengineering.co.uk			Site: SMALL DROVE, WESTON				WINDOW SAMPLE WS5					
			Date: 13/12/16		Hole Size: 77mm dia to 2.00m 57mm dia to 3.00m 50mm dia to 3.45m		Ground Level: 2.95m. O.D.					
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m					
Depth m	Type	Result										
0.30-0.70 0.30 0.60	B1 D1 D2			MADE GROUND - Soft, brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is pottery fragments. Occasional gastropod shells.		0.90	2.05					
0.90 1.10 1.20	D3 D4 D5			Firm, brown/orange brown mottled, silty CLAY with occasional dead root traces. (TIDAL FLAT DEPOSIT)		1.25	1.70					
1.20-2.00 1.35-1.65 1.50 1.70	U1 S V1 V2	N2 (15) (26)		Soft, becoming very soft, brown/orange brown/grey mottled, silty CLAY with occasional bivalve shell fragments. (TIDAL FLAT DEPOSIT)		1.80	1.15					
2.00 2.15-2.45	D6 S	N1		Very soft, grey/dark grey, silty, organic CLAY with occasional peaty root traces.								
3.00 3.15-3.45	D7 S	N1		(TIDAL FLAT DEPOSIT)		3.45	-0.50					
				Hole completed at 3.45m depth								
REMARKS 1. Starter pit excavated from 0.00m to 1.20m depth 2. Live roots observed to 1.10m depth 3. No recovery in liners below 2.00m depth							Project No 14022					
							Scale 1:50	Page 1/1				
KEY D - Disturbed Sample ES - Environmental Sample B - Bulk Sample M - Mackintosh Probe U - Undisturbed Sample V - Vane Shear Test W - Water Sample Cohesion () kPa  Water Strike R () - Hand Penetrometer  Depth to Water Cohesion () kPa on completion  Standpipe Level			Groundwater Strikes				Groundwater Observations					
			Depth m						Depth m			
			No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water
1	2.00					13/12/16	3.45		2.00			

GROUND ENGINEERING LIMITED Tel: 01733-566566 www.groundengineering.co.uk			Site: SMALL DROVE, WESTON		WINDOW SAMPLE WS6																																								
Date: 14/12/16			Hole Size: 87mm dia to 2.00m 67mm dia to 3.00m 50mm dia to 10.70m		Ground Level: 2.95m. O.D.																																								
Samples and in-situ Tests			(Date)	Inst.	Description of Strata	Legend	Depth m	O.D. Level m																																					
Depth m	Type	Result	Water																																										
0.30-0.60 0.30 0.60	B1 D1 D2				MADE GROUND - Soft, brown, orange brown and dark brown mottled, slightly gravelly, sandy CLAY. Gravel is flint and brick fragments.		0.75	2.20																																					
0.90 1.10 1.20 1.35-1.65 1.40 1.60-1.85	D3 D4 D5 S V1 U1	N4 (55)			Firm, brown/orange brown/grey mottled, silty, sandy CLAY with occasional light brown silt and fine sand partings. (TIDAL FLAT DEPOSIT)		1.85 2.00	1.10 0.95																																					
2.00 2.00-3.00 2.15-2.45	D6 U2 S	N1			Loose, brown/orange brown, sandy SILT. Sand is fine grained. (TIDAL FLAT DEPOSIT) Very soft, brown/orange brown/grey mottled, silty CLAY. (TIDAL FLAT DEPOSIT)		2.80	0.15																																					
3.00 3.15-3.45	D7 S	N2			Very soft, grey, silty, organic CLAY with occasional peaty root traces. (TIDAL FLAT DEPOSIT)		3.45	-0.50																																					
					Dynamic probe indicates very soft conditions.																																								
					(TIDAL FLAT DEPOSIT)																																								
					Dynamic probe indicates firm or loose conditions.		9.60	-6.65																																					
REMARKS 1. Starter pit excavated from 0.00m to 1.20m depth 2. Live roots observed to 1.10m depth 3. Borehole completed at 3.45m depth and continued using dynamic probing to 10.70m depth 4. Gas monitoring standpipe installed to 3.00m depth							Project No 14022																																						
							Scale 1:50	Page 1/2																																					
KEY D - Disturbed Sample ES - Environmental Sample B - Bulk Sample M - Mackintosh Probe U - Undisturbed Sample V - Vane Shear Test W - Water Sample Cohesion () kPa ⚡ Water Strike R () - Hand Penetrometer ⚡ Depth to Water Cohesion () kPa on completion ⚡s Standpipe Level			Groundwater Strikes <table border="1"> <thead> <tr> <th colspan="6">Depth m</th> </tr> <tr> <th>No</th> <th>Struck</th> <th>Rose to</th> <th>Rate</th> <th>Cased</th> <th>Sealed</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>2.00</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>				Depth m						No	Struck	Rose to	Rate	Cased	Sealed	1	2.00					Groundwater Observations <table border="1"> <thead> <tr> <th colspan="3">Depth m</th> </tr> <tr> <th>Date</th> <th>Hole</th> <th>Water</th> </tr> </thead> <tbody> <tr> <td>14/12/16</td> <td>3.45</td> <td>1.80</td> </tr> <tr> <td>20/12/16</td> <td>3.00</td> <td>1.34</td> </tr> <tr> <td>04/01/17</td> <td>3.00</td> <td>1.30</td> </tr> <tr> <td>16/01/17</td> <td>3.00</td> <td>1.29</td> </tr> </tbody> </table>			Depth m			Date	Hole	Water	14/12/16	3.45	1.80	20/12/16	3.00	1.34	04/01/17	3.00	1.30	16/01/17	3.00	1.29
Depth m																																													
No	Struck	Rose to	Rate	Cased	Sealed																																								
1	2.00																																												
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14/12/16	3.45	1.80																																											
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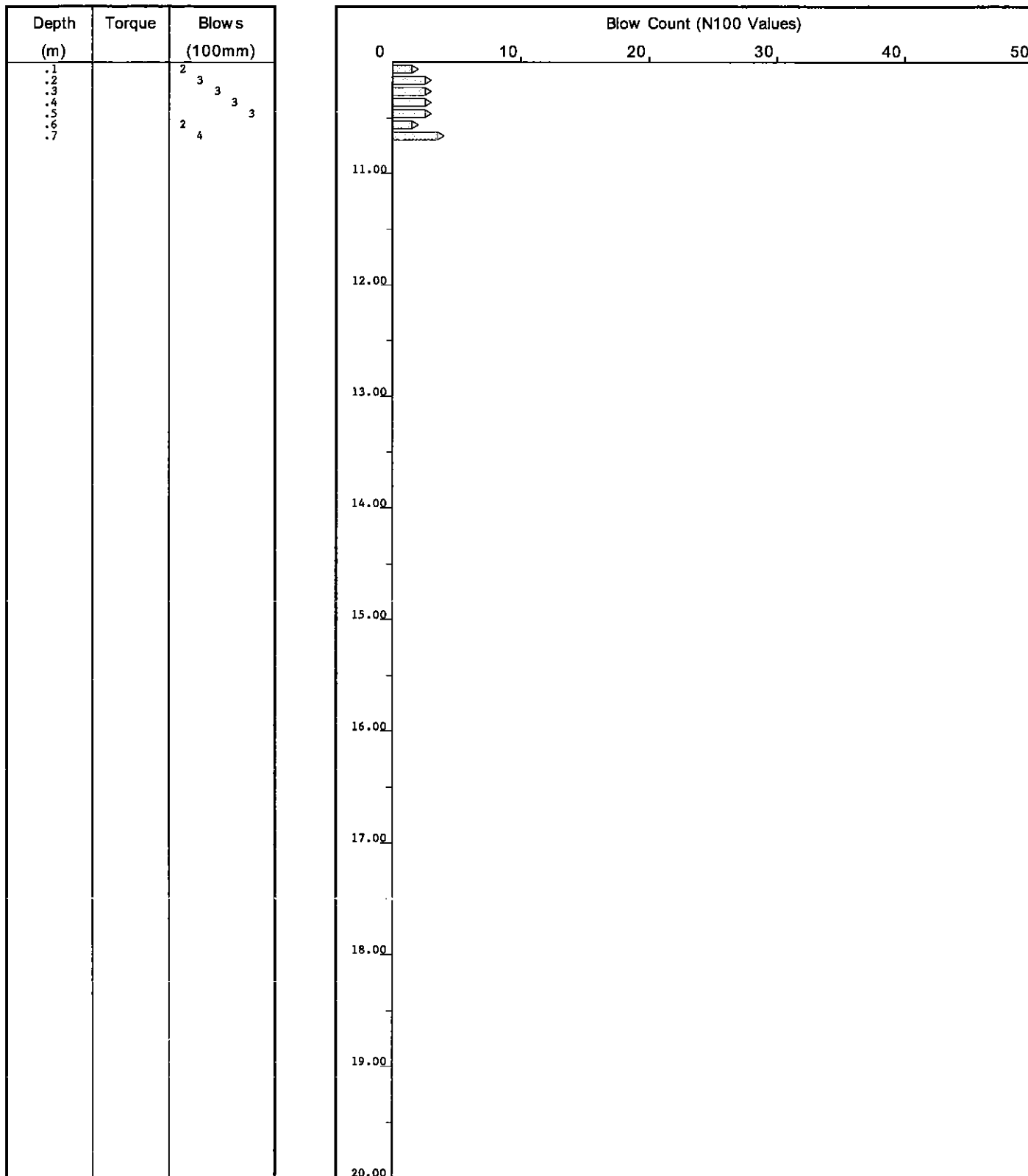
GROUND ENGINEERING LIMITED Tel: 01733-586566 www.groundengineering.co.uk			Site: SMALL DROVE, WESTON						WINDOW SAMPLE WS6						
Date: 14/12/16			Hole Size: 87mm dia to 2.00m 67mm dia to 3.00m 50mm dia to 10.70m						Ground Level: 2.95m. O.D.						
Samples and in-situ Tests			(Date)	Inst.	Description of Strata				Legend	Depth m	O.D. Level m				
Depth m	Type	Result	Water												
					Dynamic probe indicates firm or loose conditions. (Continued from previous page) (TIDAL FLAT DEPOSIT)										
					Hole completed at 10.70m depth					10.70	-7.75				
REMARKS															
										Project No 14022					
										Scale 1:50	Page 2/2				
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample W - Water Sample ⚡ Water Strike ⚡ Depth to Water on completion				ES - Environmental Sample M - Mackintosh Probe V - Vane Shear Test Cohesion () kPa P () - Hand Penetrometer Cohesion () kPa ⚡s Standpipe Level				Groundwater Strikes Depth m No Struck Rose to Rate Cased Sealed				Groundwater Observations Date Depth m Hole Casing Water			

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk	DYNAMIC PROBE PENETRATION TEST	Date 14/12/16 Project Number 14022	PROBE No WS6 Sheet 1 of 2
Method BS 1377 : Part 9 : Clause 3.2 (DPSH)	Client SOUTH HOLLAND DISTRICT COUNCIL	Site SMALL DROVE, WESTON	



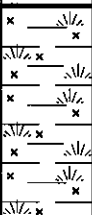
Remarks Probing undertaken from base of borehole. Probe rods sank 'under own weight' to 5.80m depth.	Hammer 63.5 kg	14022
	Standard Drop 750 mm	
	Cone 50 mm dia	
	Rod 8kg / 35 mm	

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk	DYNAMIC PROBE PENETRATION TEST	Date 14/12/16	PROBE No WS6 Sheet 2 of 2
		Project Number 14022	
Method BS 1377 : Part 9 : Clause 3.2 (DPSH)	Client SOUTH HOLLAND DISTRICT COUNCIL	Site SMALL DROVE, WESTON	



Remarks : Probing undertaken from base of borehole. Probe rods sank 'under own weight' to 5.80m depth.	Hammer 63.5 kg	14022
	Standard Drop 750 mm	
	Cone 50 mm dia	
	Rod 8kg / 35 mm	

GROUND ENGINEERING L I M I T E D Tel: 01733-568588 www.groundengineering.co.uk			Site: SMALL DROVE, WESTON				WINDOW SAMPLE WS7					
			Date: 14/12/16		Hole Size: 87mm dia to 2.00m 77mm dia to 3.00m 50mm dia to 3.45m		Ground Level: 2.90m. O.D.					
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m					
Depth m	Type	Result										
0.30	D1			MADE GROUND - Soft, friable, brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is angular coal and ash fragments.		0.40	2.50					
0.60	D2			Brown/orange brown/grey mottled, clayey, sandy SILT with occasional shell fragments. (TIDAL FLAT DEPOSIT)		0.80	2.10					
0.90	D3			Firm, brown/orange brown/grey mottled, slightly sandy, silty CLAY with occasional silt partings. (TIDAL FLAT DEPOSIT)		1.30	1.60					
1.10	D4											
1.20	D5											
1.20-2.00	U1											
1.35-1.65	S	N4		Soft, brown/orange brown/grey mottled, silty CLAY. Becoming very soft below 2.00m depth.								
1.50	V1	(23)										
1.95	V2	(24)										
2.00	D6											
2.15-2.45	S	N1		(TIDAL FLAT DEPOSIT)		2.80	0.10					
3.00	D7			Very soft, grey/dark grey, silty, slightly organic CLAY with occasional peaty root traces. (TIDAL FLAT DEPOSIT)		3.45	-0.55					
3.15-3.45	S	N1		Hole completed at 3.45m depth								
REMARKS 1. Starter pit excavated from 0.00m to 1.20m depth 2. Live roots observed to 0.90m depth 3. No recovery in liners below 2.00m depth							Project No 14022					
							Scale 1:50	Page 1/1				
KEY D - Disturbed Sample ES - Environmental Sample B - Bulk Sample M - Mackintosh Probe U - Undisturbed Sample V - Vane Shear Test W - Water Sample Cohesion () kPa Water Strike P () - Hand Penetrometer Depth to Water Cohesion () kPa on completion Standpipe Level			Groundwater Strikes				Groundwater Observations					
			Depth m						Depth m			
			No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water
						14/12/16	3.45		dry			

GROUND ENGINEERING L I M I T E D Tel: 01733-586566 www.groundengineering.co.uk			Site: SMALL DROVE, WESTON				WINDOW SAMPLE WS8					
			Date: 13/12/16		Hole Size: 87mm dia to 2.00m 77mm dia to 3.00m 50mm dia to 3.45m		Ground Level: 2.90m. O.D.					
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m					
Depth m	Type	Result										
0.30-0.70 0.30 0.60	B1 D1 D2			MADE GROUND - Soft, brown, slightly sandy, slightly gravelly, silty CLAY with rare shell fragments. Gravel is brick, ash and textile fragments.		0.90	2.00					
0.90 1.10 1.20 1.35-1.65 1.45	D3 D4 D5 S V1	N2 (17)		MADE GROUND - Very soft, grey, brown and occasionally orange brown mottled, slightly gravelly, silty, organic CLAY with occasional shell fragments. Gravel is brick, wood and ash fragments.		1.55	1.35					
1.65-1.90	U1			Soft, brown/orange brown/grey mottled, silty CLAY. (TIDAL FLAT DEPOSIT)		2.00	0.90					
1.95 2.00 2.15-2.45	V2 D6 S	(27) N1	▼ c	Very soft, grey, silty, organic CLAY with occasional peaty root traces.								
3.00 3.15-3.45	D7 S	N1	1 X	(TIDAL FLAT DEPOSIT)		3.45	-0.55					
				Hole completed at 3.45m depth								
REMARKS 1. Starter pit excavated from 0.00m to 1.20m depth 2. Live roots observed to 1.20m depth 3. No recovery in liners below 2.00m depth							Project No 14022					
							Scale 1:50	Page 1/1				
KEY D - Disturbed Sample ES - Environmental Sample B - Bulk Sample M - Mackintosh Probe U - Undisturbed Sample V - Vane Shear Test W - Water Sample Cohesion () kPa ▽ Water Strike R () - Hand Penetrometer ▽ Depth to Water Cohesion () kPa on completion ▽s Standpipe Level			Groundwater Strikes				Groundwater Observations					
			Depth m						Depth m			
			No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water
1	3.00					13/12/16	3.45		2.10			

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WINDOW SAMPLE
WS9

Date: 14/12/16

Hole Size:	87mm dia to 2.00m
	77mm dia to 3.00m
	50mm dia to 10.70m

Ground Level: 3.00m. O.D.

10.00	-7.00
-------	-------

Project No
14022

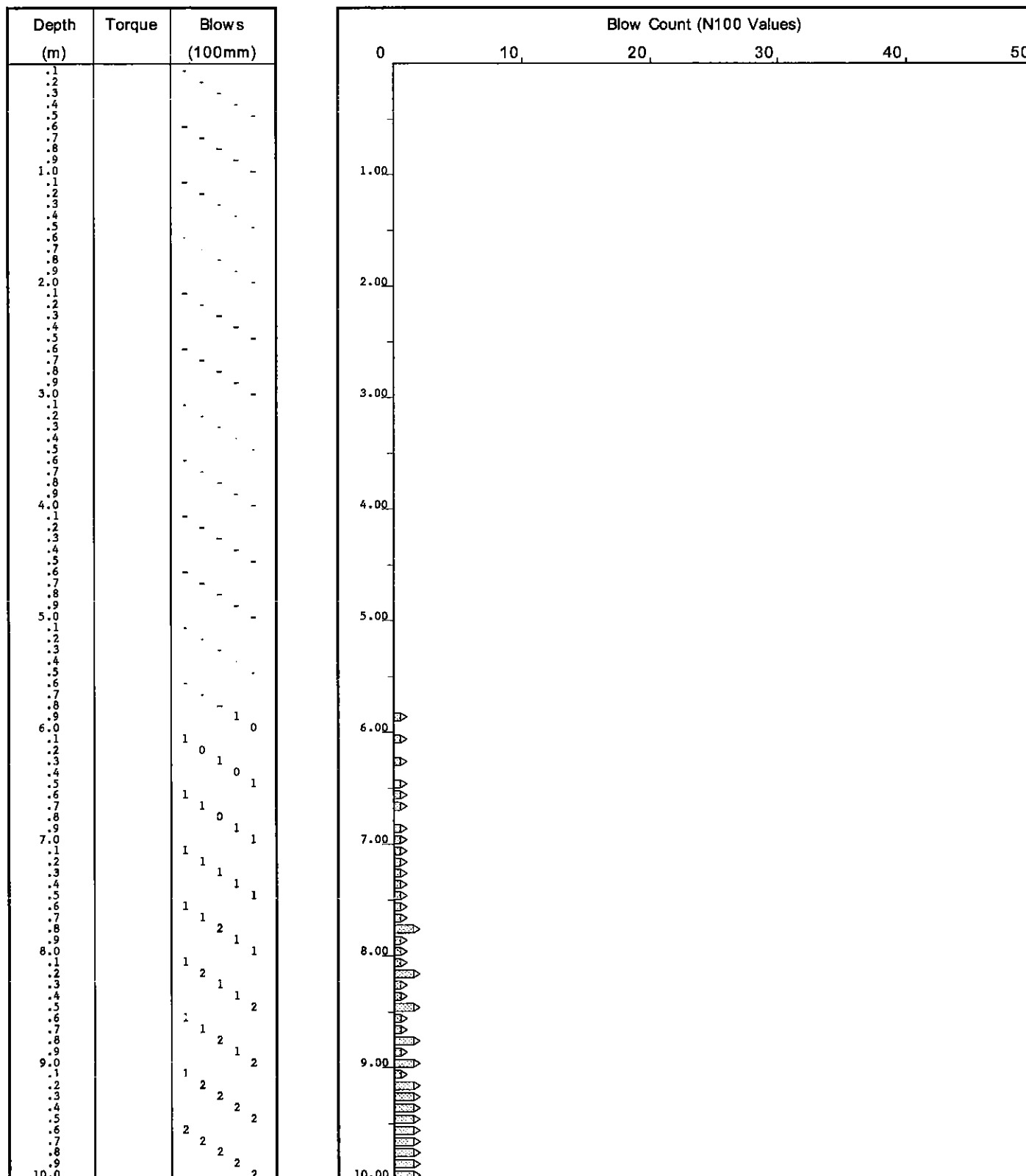
KEY

D - Disturbed Sample	ES - Environmental Sample
B - Bulk Sample	M - Macintosh Probe
U - Undisturbed Sample	V - Vane Shear Test
W - Water Sample	Cohesion () kPa
⚡ Water Strike	P () - Hand Penetrometer
⚡ Depth to Water on completion	Cohesion () kPa
	⚡s Standpipe Level

Groundwater Strikes						Groundwater Observations			
Depth m						Date	Depth m		
No.	Struck	Rose to	Rate	Cased	Sealed		Hole	Casing	Water
1	1.00					14/12/16	3.45		1.00
						20/12/16	3.00		0.90
						04/01/17	3.00		0.87
						16/01/17	3.00		0.87

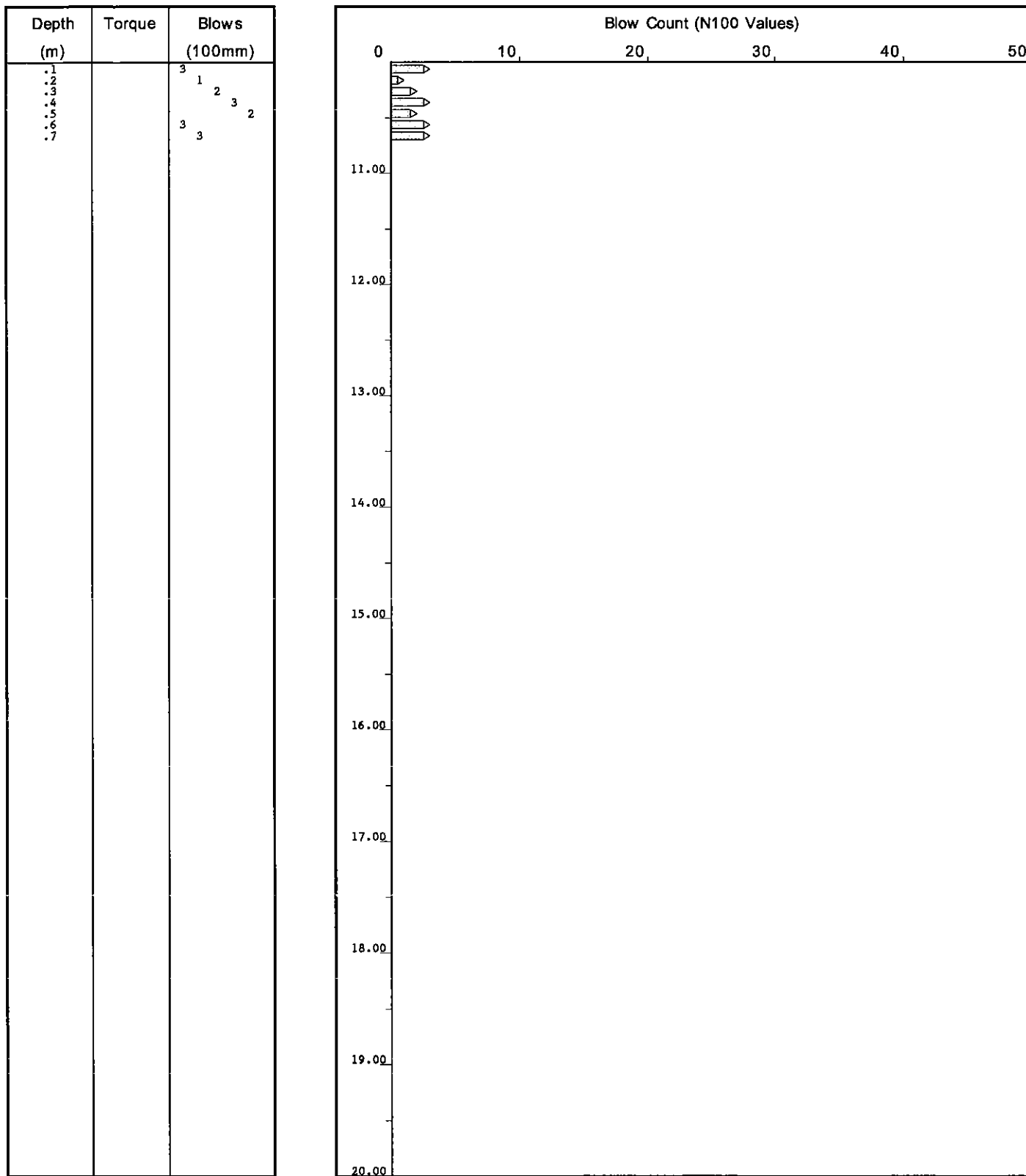
GROUND ENGINEERING LIMITED Tel: 01733-668566 www.groundengineering.co.uk			Site: SMALL DROVE, WESTON					WINDOW SAMPLE WS9				
Date: 14/12/16			Hole Size: 87mm dia to 2.00m 77mm dia to 3.00m 50mm dia to 10.70m					Ground Level: 3.00m. O.D.				
Samples and in-situ Tests			(Date)	Inst.	Description of Strata				Legend	Depth m	O.D. Level m	
Depth m	Type	Result	Water									
					Dynamic probe indicates firm or loose conditions.					10.00	-7.00	
					Hole completed at 10.70m depth					10.70	-7.70	
REMARKS												
										Project No 14022		
										Scale 1:50	Page 2/2	
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample W - Water Sample ▽ Water Strike ▽ Depth to Water on completion ES - Environmental Sample M - Mackintosh Probe V - Vane Shear Test Cohesion () kPa P () - Hand Penetrometer Cohesion () kPa ▽s Standpipe Level					Groundwater Strikes Depth m No Struck Rose to Rate Cased Sealed				Groundwater Observations Date Hole Casing Water			

GROUND ENGINEERING L I M I T E D Tel: 01733-568688 www.groundengineering.co.uk	DYNAMIC PROBE PENETRATION TEST	Date 14/12/16	PROBE No WS9 Sheet 1 of 2
		Project Number 14022	
Method BS 1377 : Part 9 : Clause 3.2 (DPSH)	Client SOUTH HOLLAND DISTRICT COUNCIL	Site SMALL DROVE, WESTON	



Remarks : Probing undertaken from base of borehole. Probe rods sank 'under own weight' to 5.90m depth.	Hammer 63.5 kg	14022
	Standard Drop 750 mm	
	Cone 50 mm dia	
	Rod 8kg / 35 mm	

GROUND ENGINEERING LIMITED Tel: 01733-566566 www.groundengineering.co.uk	DYNAMIC PROBE PENETRATION TEST	Date 14/12/16	PROBE No WS9 Sheet 2 of 2
		Project Number 14022	
Method BS 1377 : Part 9 : Clause 3.2 (DPSH)	Client SOUTH HOLLAND DISTRICT COUNCIL	Site SMALL DROVE, WESTON	



Remarks : Probing undertaken from base of borehole. Probe rods sank 'under own weight' to 5.90m depth.	Hammer 63.5 kg	14022
	Standard Drop 750 mm	
	Cone 50 mm dia	
	Rod 8kg / 35 mm	

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Date: 13/12/16

Hole Size:	77mm dia to 2.00m
	57mm dia to 3.00m
	50mm dia to 3.45m

Ground Level: 3.00m. O.D.

REMARKS 1. Starter pit excavated from 0.00m to 1.20m depth
2. Live roots observed to 1.40m depth
3. No recovery in liners below 2.00m depth

Project No
14022

Scale	Page
1:50	1/1

KEY		Groundwater Strikes						Groundwater Observations			
		Depth m						Date	Depth m		
		No Struck	Rose to	Rate	Cased	Sealed	Hole		Casing	Water	
D - Disturbed Sample	ES - Environmental Sample	1	0.80					13/12/16	3.45		0.80
B - Bulk Sample	M - Mackintosh Probe										
U - Undisturbed Sample	V - Vane Shear Test										
W - Water Sample	Cohesion () kPa										
☒ Water Strike	P () - Hand Penetrometer										
☒ Depth to Water on completion	Cohesion () kPa										
	Standpipe Level										

LABORATORY TEST RESULTS

CONTRACT SMALL DROVE, WESTON

Bore-hole	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.	Aqueous Extract mg/l	Water mg/l	pH	Top %	Base %	
WS1	B1	0.40 - 0.70	36	30	6	28	1.84	1.44										0.1	0.2	SOIL CLASSIFICATION = MI 0% retained on 425µm sieve 0% retained on 20mm sieve
	M1	0.73																		
	D3	0.90												49		214	7.3			
	D6	2.00	35	27	8	32											7.9			
WS3	U1	1.55 - 1.85				44	1.80	1.25	QM	26 29 33	50 110 200	14	0							SOIL CLASSIFICATION = ML/ MI 0% retained on 425µm sieve
	D7	3.00																		
	D5	1.20	39	19	20	31									659		7.5			
WS4	U1	1.80 - 2.00				40	1.74	1.24	QM	28 31 35	50 110 200	15	0							SOIL CLASSIFICATION = CI 0% retained on 425µm sieve
	D6	2.00				56														
	D7	3.00				69														

U - UNDISTURBED SAMPLE
D - DISTURBED SAMPLE
B - BULK SAMPLE
W - WATER SAMPLE

C.U. - CONSOLIDATED UNDRAINED
C.D. - CONSOLIDATED DRAINED
Q. - IMMEDIATE UNDRAINED
Q.M. - IMMEDIATE UNDRAINED MULTISTAGE

Aqueous Extract 2:1 Water:Soil

C.B.R. - CALIFORNIA BEARING RATIO

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14022

LABORATORY TEST RESULTS

CONTRACT SMALL DROVE, WESTON

Bore-hole	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.	Aqueous Extract mg/l	Water mg/l	pH	Top %	Base %		
WS5	D3	0.90	48	23	25	36														SOIL CLASSIFICATION = CI 0% retained on 425µm sieve	
	B1	0.30 0.60			24	1.98	1.58											2.3	2.6		
	D3	0.90																			
	M1	1.34											25				7.7				
	D7	3.00				59											7.4				
WS7	D3	0.90	46	19	27	26														SOIL CLASSIFICATION = CI 0% retained on 425µm sieve	
	U1	1.65 - 1.80																			
	D6	2.00			45																
	D7	3.00			54																
	U1	1.65 - 1.80			45	1.80	1.24	QM	49 51 55	50 100 200	25	0									
WS8	U1	1.65 - 1.80																		SOIL CLASSIFICATION = CI 0% retained on 425µm sieve	
	B1	0.30 - 0.60			27	1.91	1.50											1.4	1.7		
WS9	B1	0.30 - 0.60																			

14022

LABORATORY TEST RESULTS

CONTRACT SMALL DROVE, WESTON

Bore-hole	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	Soil Total % Dry Wt.	Aqueous Extract mg/l	Water mg/l	pH	Top %	Base %	
WS9	M1	0.90													519		7.3			SOIL CLASSIFICATION = CL 0% retained on 425µm sieve
	D4	1.10	33	19	14	26														
	U1	1.65 - 1.80				31	1.90	1.45	QM	51	50	28	0							
	D6	2.00				35				55	100									
	D7	3.00	97	32	65	73				61	200									
WS10																				SOIL CLASSIFICATION = CE 0% retained on 425µm sieve
	U1	1.65 - 1.85				34	1.97	1.47	QM	45	50	26	0							
	D6	2.00								50	100				245		7.9			

U - UNDISTURBED SAMPLE
D - DISTURBED SAMPLE
B - BULK SAMPLE
W - WATER SAMPLE

C.U. - CONSOLIDATED UNDRAINED
C.D. - CONSOLIDATED DRAINED
Q. - IMMEDIATE UNDRAINED
Q.M. - IMMEDIATE UNDRAINED MULTISTAGE

Aqueous Extract 2:1 Water:Soil

C.B.R. - CALIFORNIA BEARING RATIO

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8180

GROUND ENGINEERING**TEST CERTIFICATE**

Newark Road Peterborough
t: 01733 566566 f: 01733 315280
e: admin@groundengineering.co.uk

Determination of Particle Size Distribution

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Sieved Grading and Sedimentation by Pipette

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

Certificate Number: PL5724-1/3/710-2
Client Reference: C14022
Lab Job Number: PL5724-1
Date Sampled: Unknown
Date Received: 01.02.2017
Date Tested: 14.02.2017

Contact: Steve Fleming

Certificate of Sampling: N/A
Sampling Certificate No.: N/A
Sampled By: Client

Site Name: Small Drove
Site Address: Weston

TEST RESULTS

Laboratory Reference: PL5724-1/3

Pre-treatment for organic material: No

Client Reference: U1

Sample Description: Brown slightly clayey SILT/SAND with occasional fine subangular limestone siltstone and shell fragments

Material Specification: Not Required

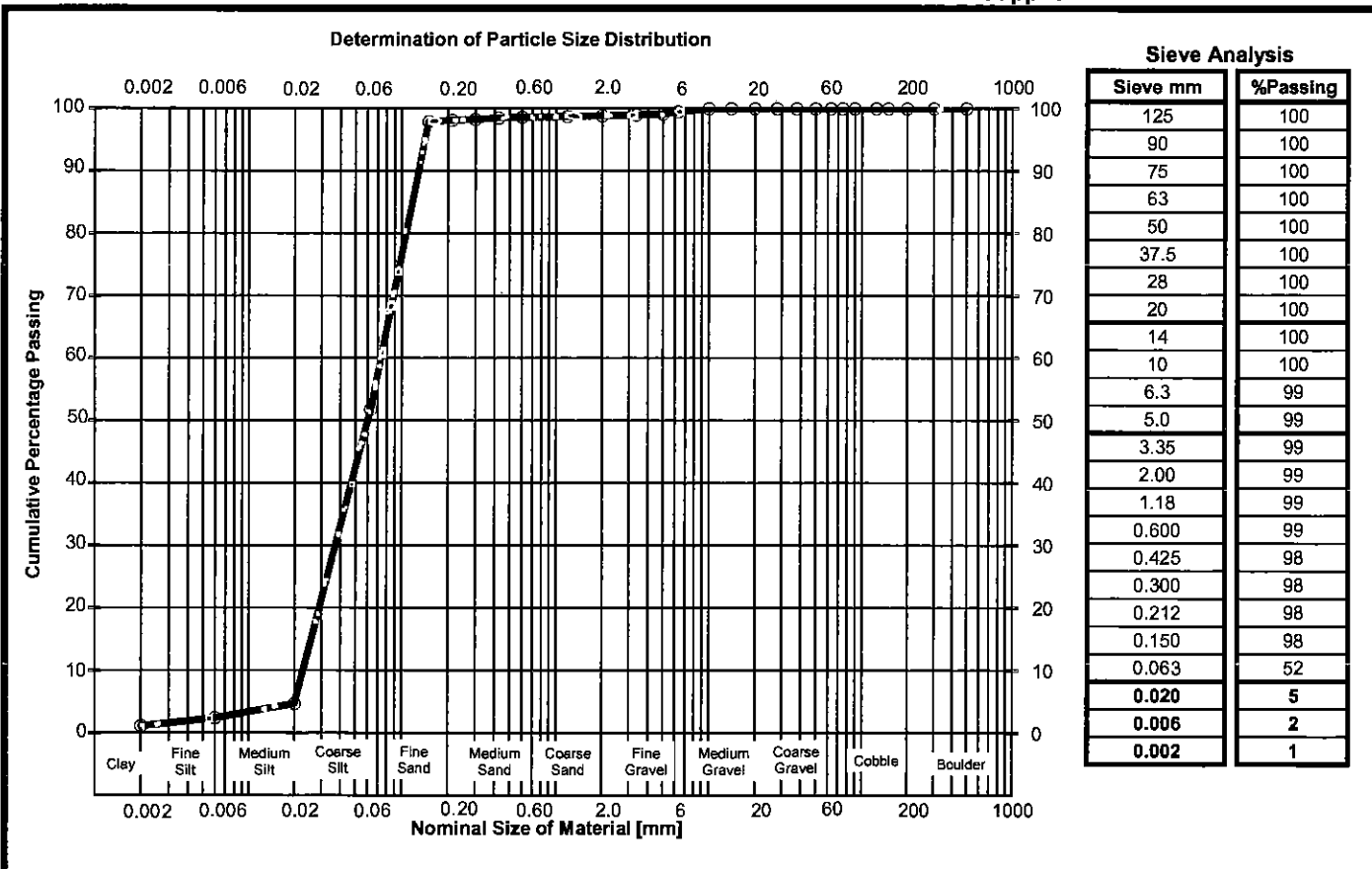
Depth Top: 1.20m

Location: WS1

Depth Base: 2.00m

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: 21.02.2017 Page 1 of 1

Form Number: GELab/C/709-2 Version 46

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e: admin@groundengineering.co.uk

Determination of Particle Size Distribution

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Sieved Grading and Sedimentation by Pipette

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

Certificate Number: PL5724-1/6/710-2
Client Reference: C14022
Lab Job Number: PL5724-1
Date Sampled: Unknown
Date Received: 01.02.2017
Date Tested: 14.02.2017

Contact: Steve Fleming

Site Name: Small Drove
Site Address: Weston

Certificate of Sampling: N/A
Sampling Certificate No.: N/A
Sampled By: Client

TEST RESULTS

Laboratory Reference: PL5724-1/6

Pre-treatment for
organic material: No

Client Reference: U1

Sample Description: Brown slightly clayey SILT/SAND with occasional firm subangular siltstone and shell fragments

Material Specification: Not Required

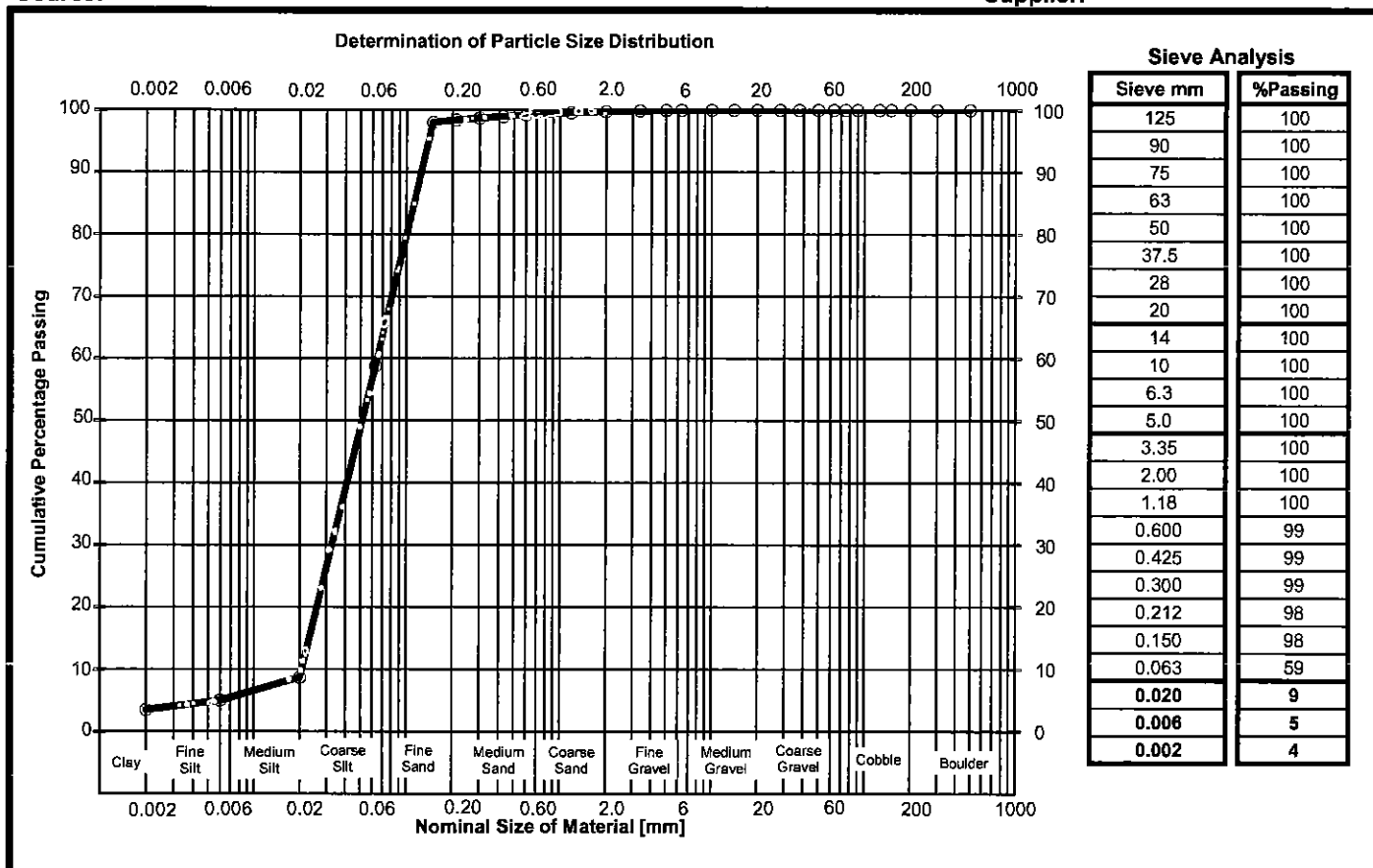
Depth Top: 1.20m

Location: WS2

Depth Base: 2.00m

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:

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e: admin@groundengineering.co.uk

Determination of Particle Size Distribution

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Sieved Grading and Sedimentation by Pipette

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

Certificate Number: PL5724-1/7/710-2
Client Reference: C14022
Lab Job Number: PL5724-1
Date Sampled: Unknown
Date Received: 01.02.2017
Date Tested: 14.02.2017

Contact: Steve Fleming

Site Name: Small Drove
Site Address: Weston

Certificate of Sampling: N/A
Sampling Certificate No.: N/A
Sampled By: Client

TEST RESULTS

Laboratory Reference: PL5724-1/7
Client Reference: D5

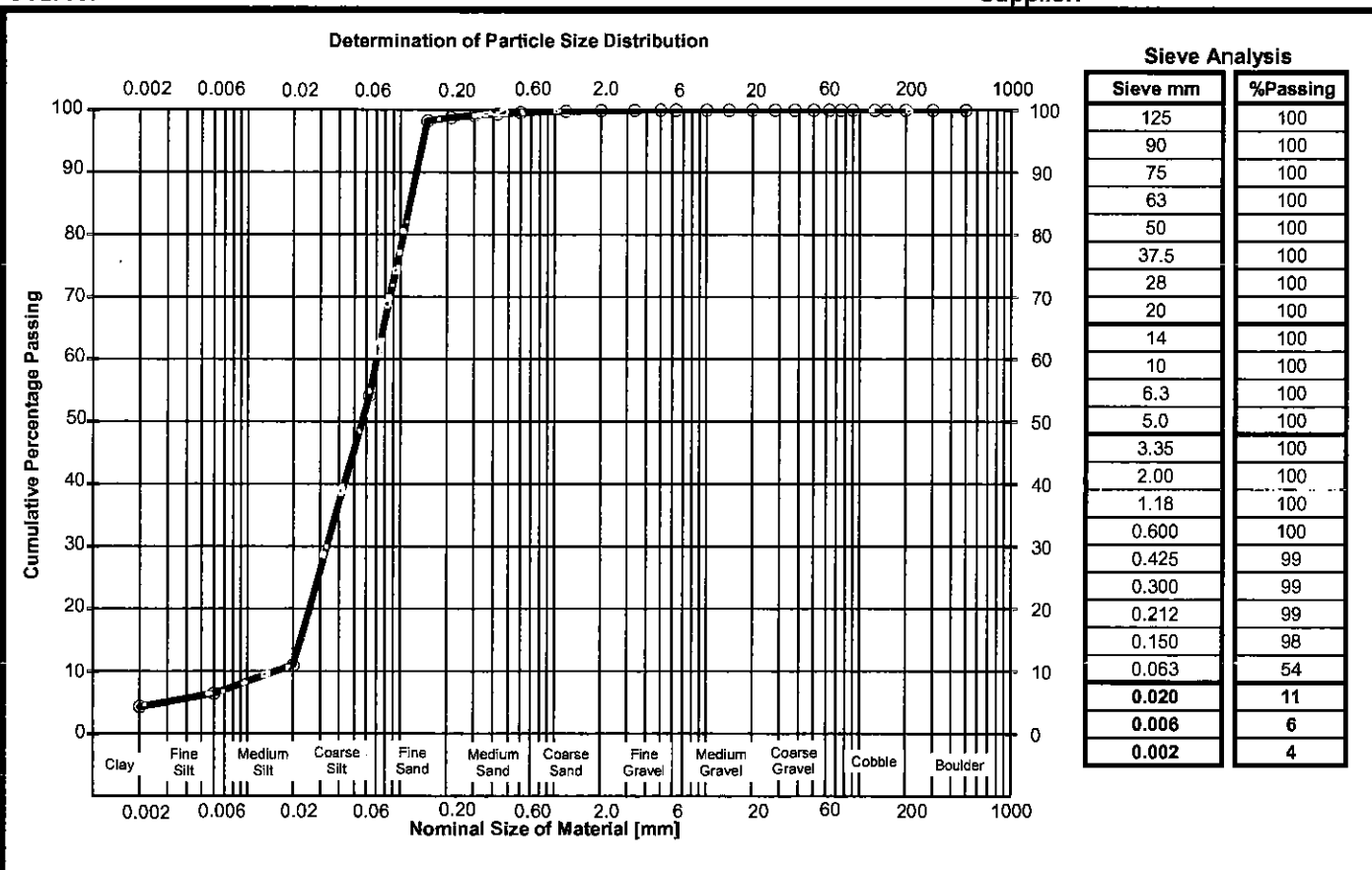
Pre-treatment for organic material: No

Sample Description: Brown grey slightly clayey SILT/SAND

Material Specification: Not Required
Location: WS3
Source:

Depth: 1.20m

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: 21.02.2017 Page 1 of 1
Form Number: GELab/C/709-2 Version 46

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TEST CERTIFICATE**One-Dimensional Consolidation****Properties**

(Tested in accordance with BS1377 : Part 5 1990)

Client: Ground Engineering Ltd
Client Address: Newark Road
Peterborough
Cambridgeshire
Postcode: PE1 5UA
Contact: Steve Fleming
Site Name: Small Drove
Site Address: Weston

Newark Road Peterborough

t:01733 566566 f:01733 315280

e: admin@groundengineering.co.uk

Certificate Number: PL5724-1-16/731

Client Reference Number: C14022

Date Sampled: Unknown

Date Received: 01.02.2017

Date Tested: 08.02.2017

Sampling Certificate No: N/A

Certificate of Sampling: N/A

Sampled By: Client

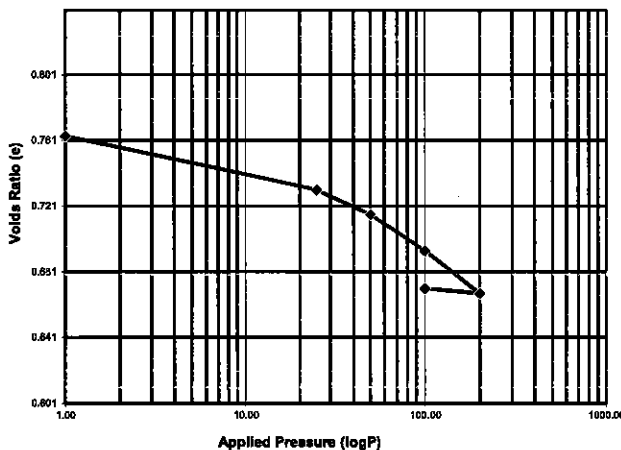
Test Details

Location: WS6
Sample Ref: U1
Sample Description: Firm brown orange brown dark grey silty sandy CLAY
Particle Density (Mg/m³): 2.7 Assumed
Mean Lab Temp. (°C): 22
Variations from Standard: None
Lab Reference: PL5724-1-16
Depth: 1.65 m

Specimen Details

	INITIAL	FINAL
Height (mm):	18.94	17.94
Bulk Density (Mg/m ³):	1.99	2.07
Moisture Content (%):	30	28
Dry Density (Mg/m ³):	1.53	1.62
Voids Ratio:	0.764	0.671
Degree of Saturation (%):	100.0	100.0
Diameter (mm):	74.96	N/A
Swelling Pressure (kPa):	1	N/A
Method of time fitting used:	Log Time	N/A

Voids Ratio against logarithm of Applied Pressure



Applied Pressure (kPa)	Coefficient of Compressibility m_v (m ² /MN)	Coefficient of Consolidation c_v (m ² /year)
1	0.79	7.16
25	0.35	7.26
50	0.26	9.61
100	0.15	12.24
200	0.02	---
100		

Comments:

Approved [x] M.Hartnup - Laboratory Manager
Signatory: [] L.Petch - Team Leader

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 22/02/2017

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Peterborough PE1 5UA



Final Report

Report No.: 16-31062-1

Initial Date of Issue: 22-Dec-2016

Client Ground Engineering Limited

Client Address: Newark Road
Peterborough
Cambridgeshire
PE1 5UA

Contact(s): Steve Fleming

Project C14022 Small Drove, Weston

Quotation No.: **Date Received:** 19-Dec-2016

Order No.: C14022 **Date Instructed:** 19-Dec-2016

No. of Samples: 9

Turnaround (Wkdays): 4 **Results Due:** 22-Dec-2016

Date Approved: 22-Dec-2016

Approved By:


Details: Glynn Harvey, Laboratory Manager

Results - Soil

Client: Ground Engineering Limited		Chemtest Job No.: 16-31062				Chemtest Sample ID.: 392826				16-31062				16-31062				16-31062				16-31062				16-31062			
Quotation No.:		Client Sample Ref.: WS1		16-31062		392826		392827		16-31062		392828		392829		16-31062		392830		392831		16-31062		392832		16-31062		392833	
Order No.: C14022		Client Sample ID.: D1		16-31062		D1		SOIL		16-31062		D1		SOIL		16-31062		D1		SOIL		16-31062		D3		SOIL		D1	
		Sample Type: SOIL		16-31062		SOIL		SOIL		16-31062		SOIL		SOIL		16-31062		SOIL		SOIL		16-31062		SOIL		SOIL		SOIL	
		Top Depth (m): 0.30		16-31062		0.30		0.30		16-31062		0.20		0.30		16-31062		0.30		0.30		16-31062		0.90		0.30		0.30	
		Date Sampled: 14-Dec-2016		16-31062		13-Dec-2016		13-Dec-2016		16-31062		13-Dec-2016		13-Dec-2016		16-31062		14-Dec-2016		13-Dec-2016		13-Dec-2016		13-Dec-2016		14-Dec-2016		14-Dec-2016	
Determinand		Accred.		SOP		Units		LOD																					
pH		U	2010		N/A	8.3	8.1	8.2	8.1			8.2	19	8.1		7.9		8.0		8.1			8.1					8.1	
Moisture		N	2030	%	0.020	18	20	19	19			19		19		18		19		22			22					18	
Boron (Hot Water Soluble)		U	2120	mg/kg	0.40	0.43	1.0	< 0.40	0.66			< 0.40		0.66		0.51		0.63		1.2			1.2					0.49	
Sulphate (2:1 Water Soluble) as SO4		U	2120	g/l	0.010	< 0.010	< 0.010	< 0.010	< 0.010			< 0.010		< 0.010		< 0.010		< 0.010		< 0.010			< 0.010				< 0.010		
Cyanide (Free)		U	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50			< 0.50		< 0.50		< 0.50		< 0.50		< 0.50			< 0.50				< 0.50		
Cyanide (Total)		U	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50			< 0.50		< 0.50		< 0.50		< 0.50		< 0.50			< 0.50				< 0.50		
Sulphide (Easily Liberatable)		U	2325	mg/kg	0.50	1.4	1.2	0.95	1.6			0.95		1.6		0.92		1.5		1.0			1.0				1.2		
Arsenic		U	2450	mg/kg	1.0	31	11	11	13			11		13		14		13		11			11				12		
Cadmium		U	2450	mg/kg	0.10	0.39	0.10	< 0.10	0.36			< 0.10		0.36		0.28		0.17		< 0.10			< 0.10				0.16		
Chromium		U	2450	mg/kg	1.0	18	17	16	39			16		39		21		19		20			20				20		
Copper		U	2450	mg/kg	0.50	100	18	16	38			16		38		26		17		20			20				26		
Mercury		U	2450	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		0.13		0.11		0.10			0.10				0.11		
Nickel		U	2450	mg/kg	0.50	32	20	17	20			17		20		21		19		21			21				21		
Lead		U	2450	mg/kg	0.50	52	14	13	42			13		42		25		35		16			16				27		
Selenium		U	2450	mg/kg	0.20	0.35	< 0.20	< 0.20	< 0.20			< 0.20		< 0.20		0.27		0.22		< 0.20			< 0.20				0.23		
Zinc		U	2450	mg/kg	0.50	150	51	42	230			42		230		110		79		58			58				84		
Chromium (Hexavalent)		N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50			< 0.50		< 0.50		< 0.50		< 0.50		< 0.50			< 0.50				< 0.50		
Organic Matter		U	2625	%	0.40	17	1.6	1.6	1.7			1.6		1.7		1.9		1.9		3.1			3.1				2.9		
Acenaphthene		U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		< 0.10		< 0.10			< 0.10				< 0.10		
Acenaphthylene		U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		< 0.10		< 0.10			< 0.10				< 0.10		
Anthracene		U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		< 0.10		< 0.10			< 0.10				< 0.10		
Benzofluoranthene		U	2700	mg/kg	0.10	0.21	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		0.32		< 0.10			< 0.10				< 0.10		
Benzofluoranthene		U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		0.56		< 0.10			< 0.10				< 0.10		
Benzofluoranthene		U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		0.70		< 0.10			< 0.10				< 0.10		
Benzofluoranthene		U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		0.48		< 0.10			< 0.10				< 0.10		
Benzofluoranthene		U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		0.34		< 0.10			< 0.10				< 0.10		
Chrysene		U	2700	mg/kg	0.10	0.20	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		0.22		< 0.10			< 0.10				< 0.10		
Dibenz(a,h)Anthracene		U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		< 0.10		< 0.10			< 0.10				< 0.10		
Fluoranthene		U	2700	mg/kg	0.10	0.78	< 0.10	< 0.10	0.22			< 0.10		0.22		< 0.10		0.85		< 0.10			< 0.10				0.14		
Fluorene		U	2700	mg/kg	0.10	< 0.10	< 0.10	< 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		U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		0.30		< 0.10			< 0.10				< 0.10		
Naphthalene		U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		< 0.10		< 0.10			< 0.10				< 0.10		
Phenanthrene		U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10			< 0.10		< 0.10		< 0.10		< 0.10		< 0.10			< 0.10				< 0.10		
Pyrene		U	2700	mg/kg	0.10	0.77	< 0.10	< 0.10	0.23			< 0.10		0.23		< 0.10		0.99		< 0.10			< 0.10				0.13		
Total Of 16 PAH's		U	2700	mg/kg	2.0	< 2.0	< 2.0	< 2.0	< 2.0			< 2.0		< 2.0		< 2.0		4.8		< 2.0			< 2.0				< 2.0		
Total Phenols		U	2920	mg/kg	0.30	< 0.30	< 0.30	< 0.30	< 0.30			< 0.30		< 0.30		< 0.30		< 0.30		< 0.30			< 0.30				< 0.30		

Client: Ground Engineering Limited		Chemtest Job No.:			
Quotation No.:		Chemtest Sample ID.:			
Order No.: C14022		Client Sample Ref.:			
		Client Sample ID.:			
		Sample Type:			
		Top Depth (m):			
		Date Sampled:			
Determinand	Accred.	SOP	Units	LOD	
pH	U	2010		N/A	7.7
Moisture	N	2030	%	0.020	18
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	1.5
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010
Cyanide (Free)	U	2300	mg/kg	0.50	< 0.50
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50
Sulphide (Easily Liberatable)	U	2325	mg/kg	0.50	0.94
Arsenic	U	2450	mg/kg	1.0	14
Cadmium	U	2450	mg/kg	0.10	0.29
Chromium	U	2450	mg/kg	1.0	19
Copper	U	2450	mg/kg	0.50	21
Mercury	U	2450	mg/kg	0.10	0.12
Nickel	U	2450	mg/kg	0.50	21
Lead	U	2450	mg/kg	0.50	36
Selenium	U	2450	mg/kg	0.20	0.32
Zinc	U	2450	mg/kg	0.50	110
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50
Organic Matter	U	2625	%	0.40	3.5
Acenaphthene	U	2700	mg/kg	0.10	< 0.10
Acenaphthylene	U	2700	mg/kg	0.10	< 0.10
Anthracene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]anthracene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]pyrene	U	2700	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Chrysene	U	2700	mg/kg	0.10	< 0.10
Dibenz[a,h]Anthracene	U	2700	mg/kg	0.10	< 0.10
Fluoranthene	U	2700	mg/kg	0.10	0.45
Fluorene	U	2700	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	< 0.10
Naphthalene	U	2700	mg/kg	0.10	< 0.10
Phenanthrene	U	2700	mg/kg	0.10	< 0.10
Pyrene	U	2700	mg/kg	0.10	0.36
Total Of 16 PAH's	U	2700	mg/kg	2.0	< 2.0
Total Phenols	U	2920	mg/kg	0.30	< 0.30

SOP	Title	Parametera 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.
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; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID
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"

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

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.co.uk

Gas and Groundwater Monitoring Record

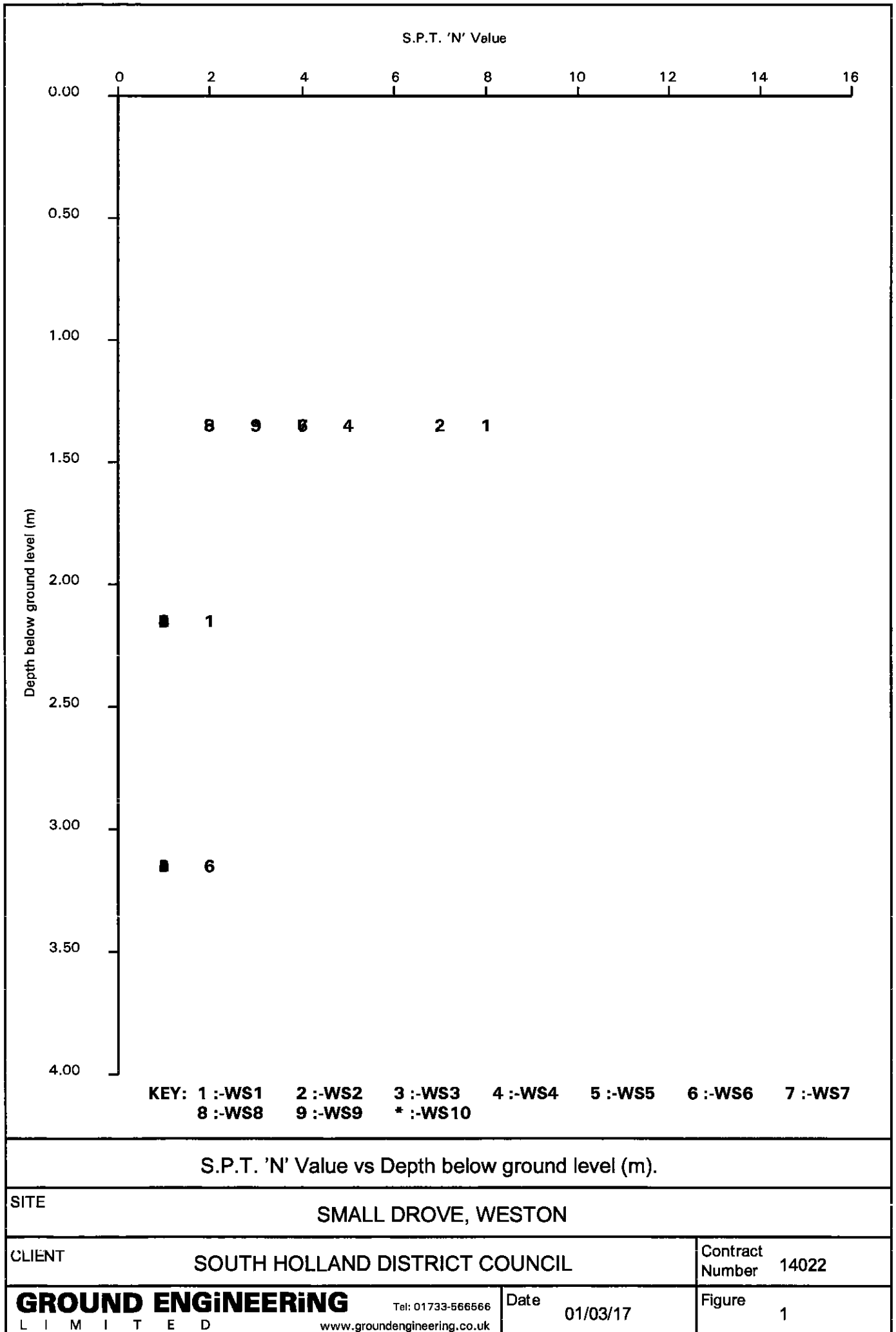
Site: Small Drove, Weston, Spalding

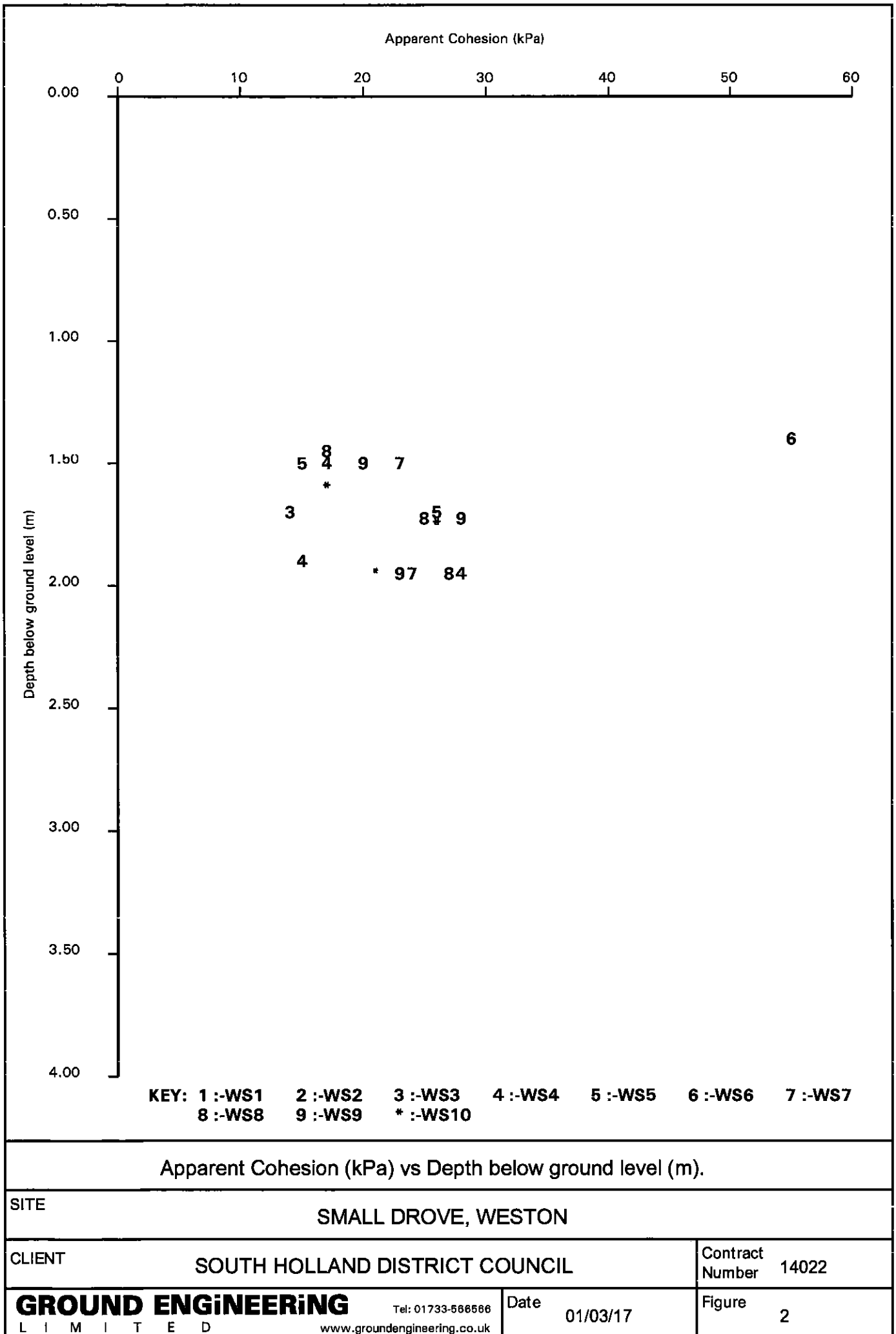
Report Ref: C14022

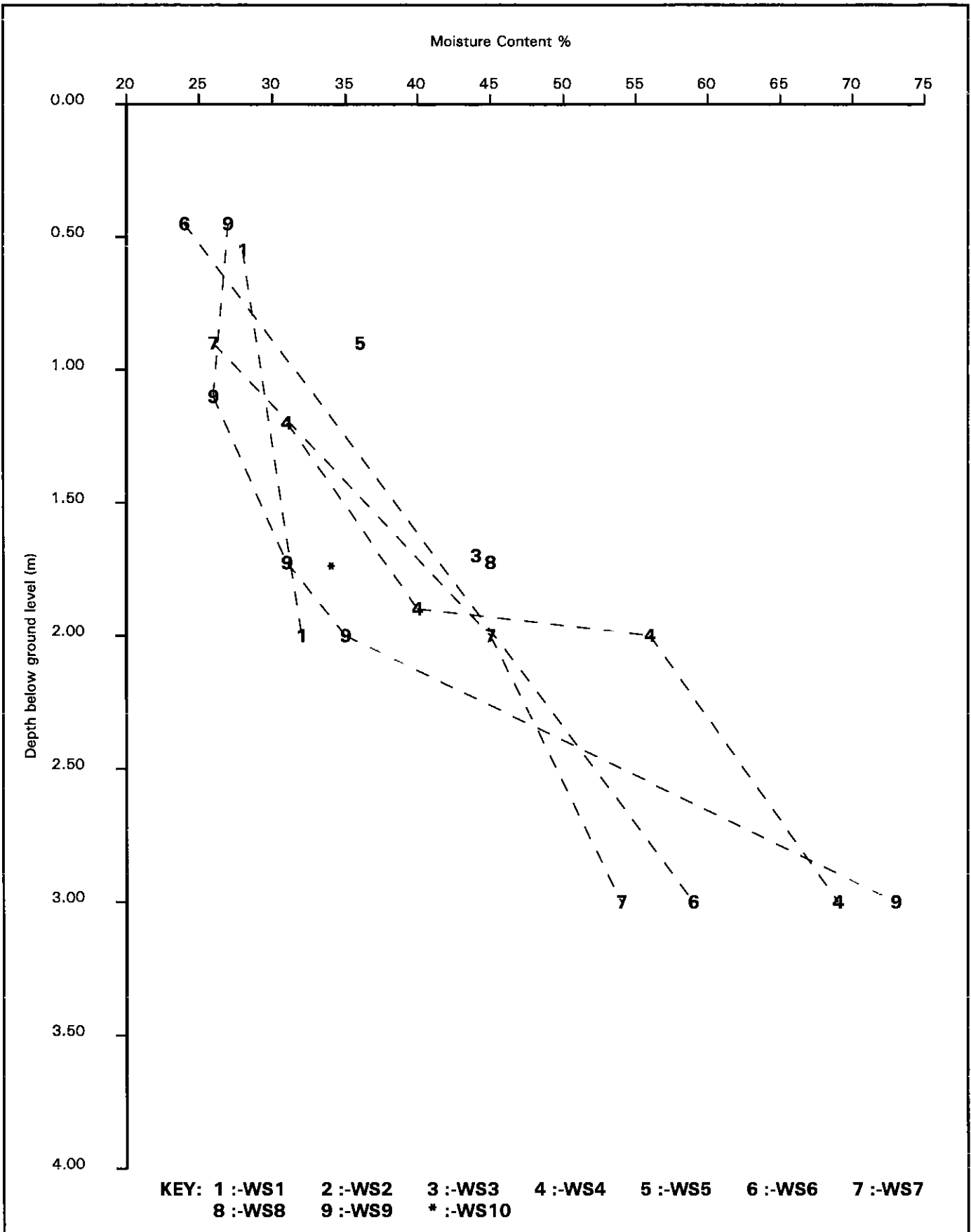
Date	Borehole No.	Methane (% v/v)		Carbon Dioxide (% v/v)			Oxygen (% v/v)		Flow Rate (l/hr)	Atmosph. Pressure (mb)	Dp (mb)	Depth of Well (mbgl)	Depth to Groundwater (mbgl)	Comments
		Peak	Steady	Peak	Steady	Max.	Min.	Max.						
20-12-16	WS1	<0.1	<0.1	0.7	0.7	20.0	20.0	20.0	<0.1	1018	<1	3.00	0.73	
20-12-16	WS6	<0.1	<0.1	1.4	1.4	19.4	19.4	19.4	<0.1	1018	<1	3.00	1.34	
20-12-16	WS9	<0.1	<0.1	0.9	0.9	19.9	19.9	19.9	<0.1	1018	<1	3.00	0.90	
04-01-17	WS1	<0.1	<0.1	0.8	0.8	19.5	19.5	19.5	<0.1	1021	<1	3.00	0.68	
04-01-17	WS6	<0.1	<0.1	1.1	1.1	19.2	19.2	19.2	<0.1	1021	<1	3.00	1.30	
04-01-17	WS9	<0.1	<0.1	1.3	1.3	19.8	19.8	19.8	<0.1	1021	<1	3.00	0.87	
16-01-17	WS1	<0.1	<0.1	<0.1	<0.1	20.1	20.1	20.1	<0.1	1025	<1	3.00	0.63	
16-01-17	WS6	3.9	3.9	0.5	0.5	18.1	18.1	18.1	<0.1	1025	<1	3.00	1.29	
16-01-17	WS6	2.8	2.8	0.3	0.3	18.7	18.7	18.7	<0.1	1025	<1	3.00	1.29	WS6 purged and re-monitored after 1 hour
16-01-17	WS9	<0.1	<0.1	<0.1	<0.1	20.3	20.3	20.3	<0.1	1024	<1	3.00	0.87	

LEL – Lower Explosive Limit

GROUND ENGINEERING LIMITED, NEWARK ROAD, PETERBOROUGH, PE1 5UA







Moisture Content % vs Depth below ground level (m).

SITE

SMALL DROVE, WESTON

CLIENT

SOUTH HOLLAND DISTRICT COUNCIL

Contract

Number 14022

GROUND ENGINEERING

Tel: 01733-566566

Date

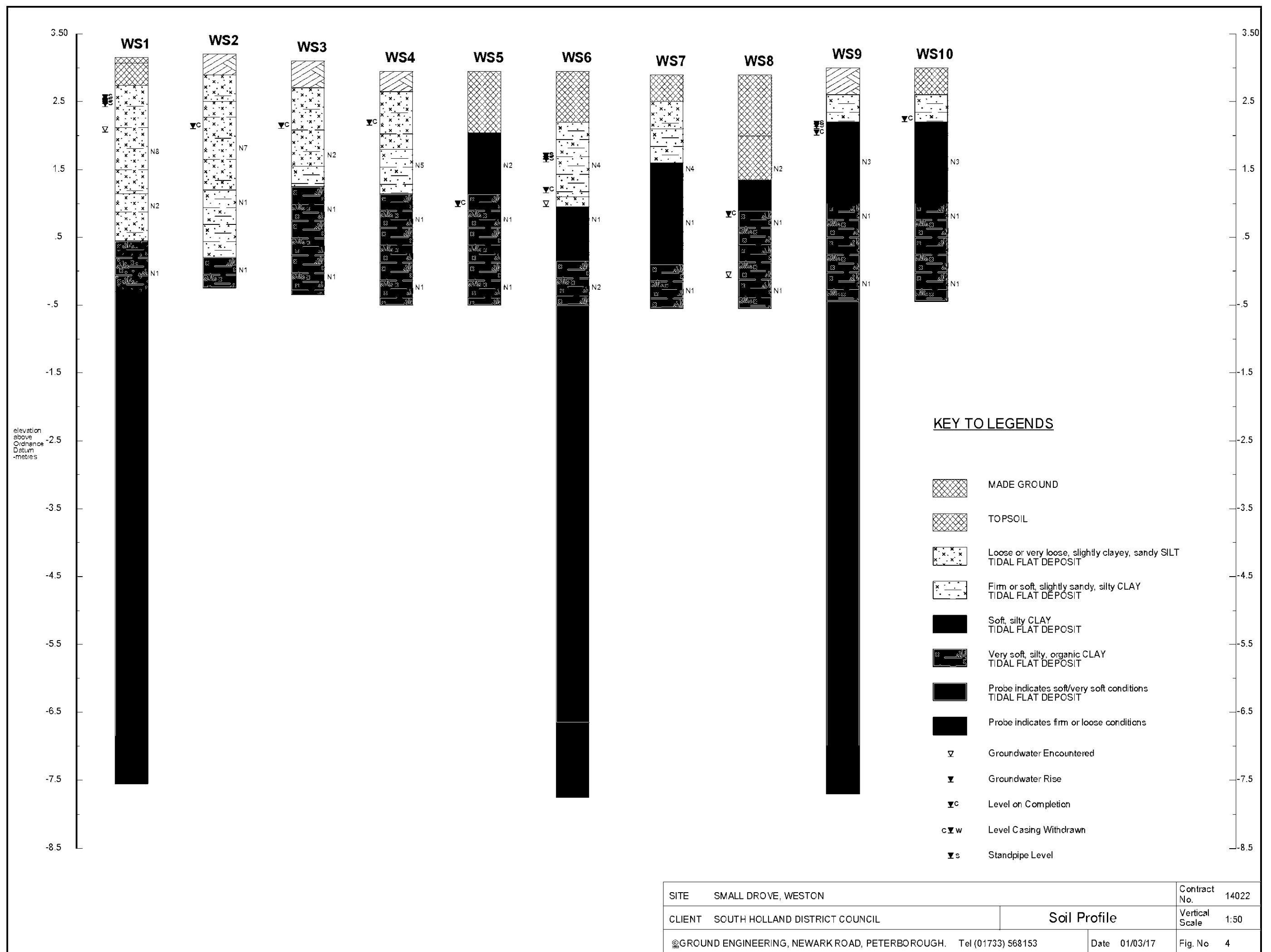
01/03/17

Figure

3

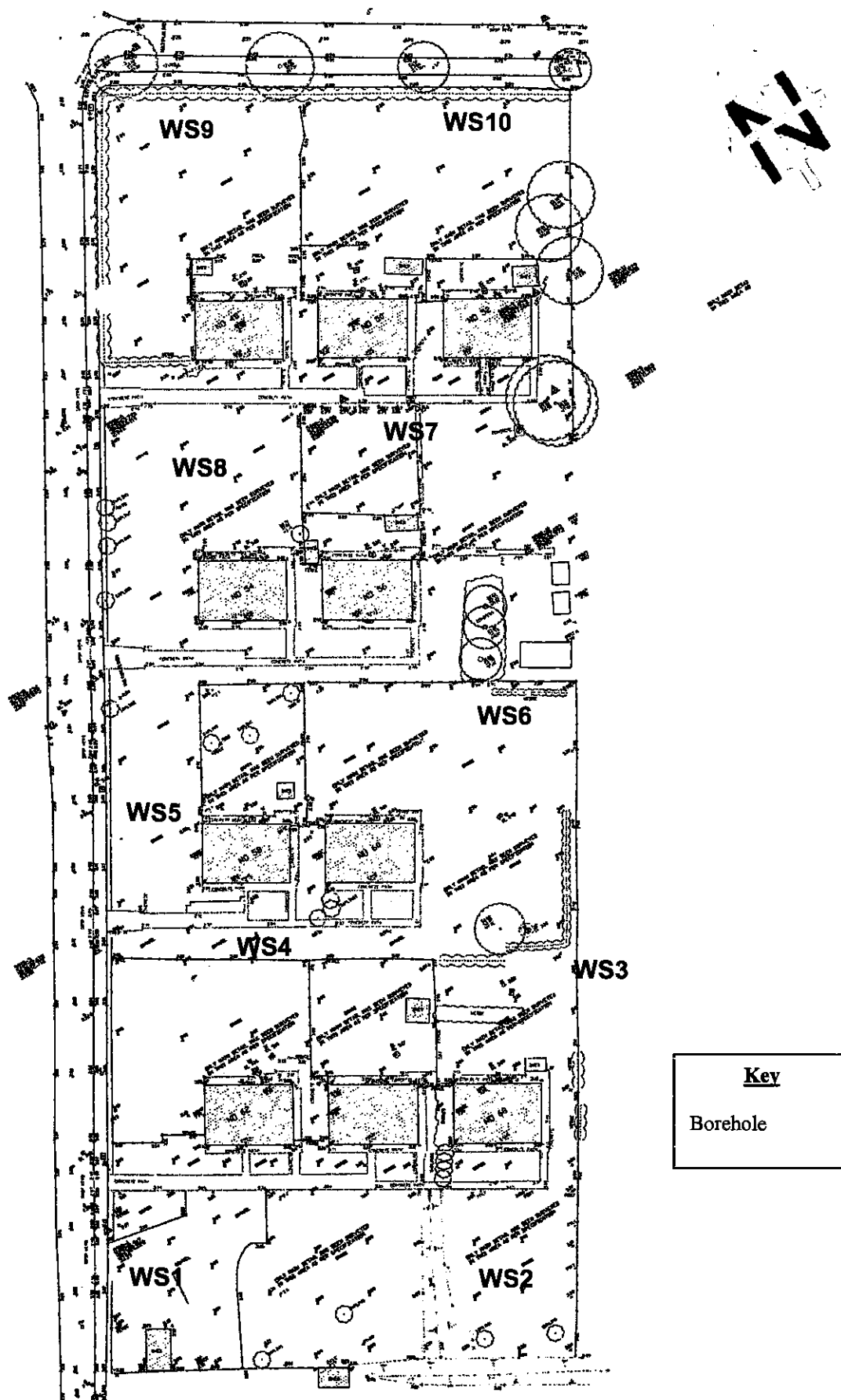
L I M I T E D

www.groundengineering.co.uk



Borehole Location Plan

Based on a topographic survey plan provided by the client. Not to Scale



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Client : South Holland District Council

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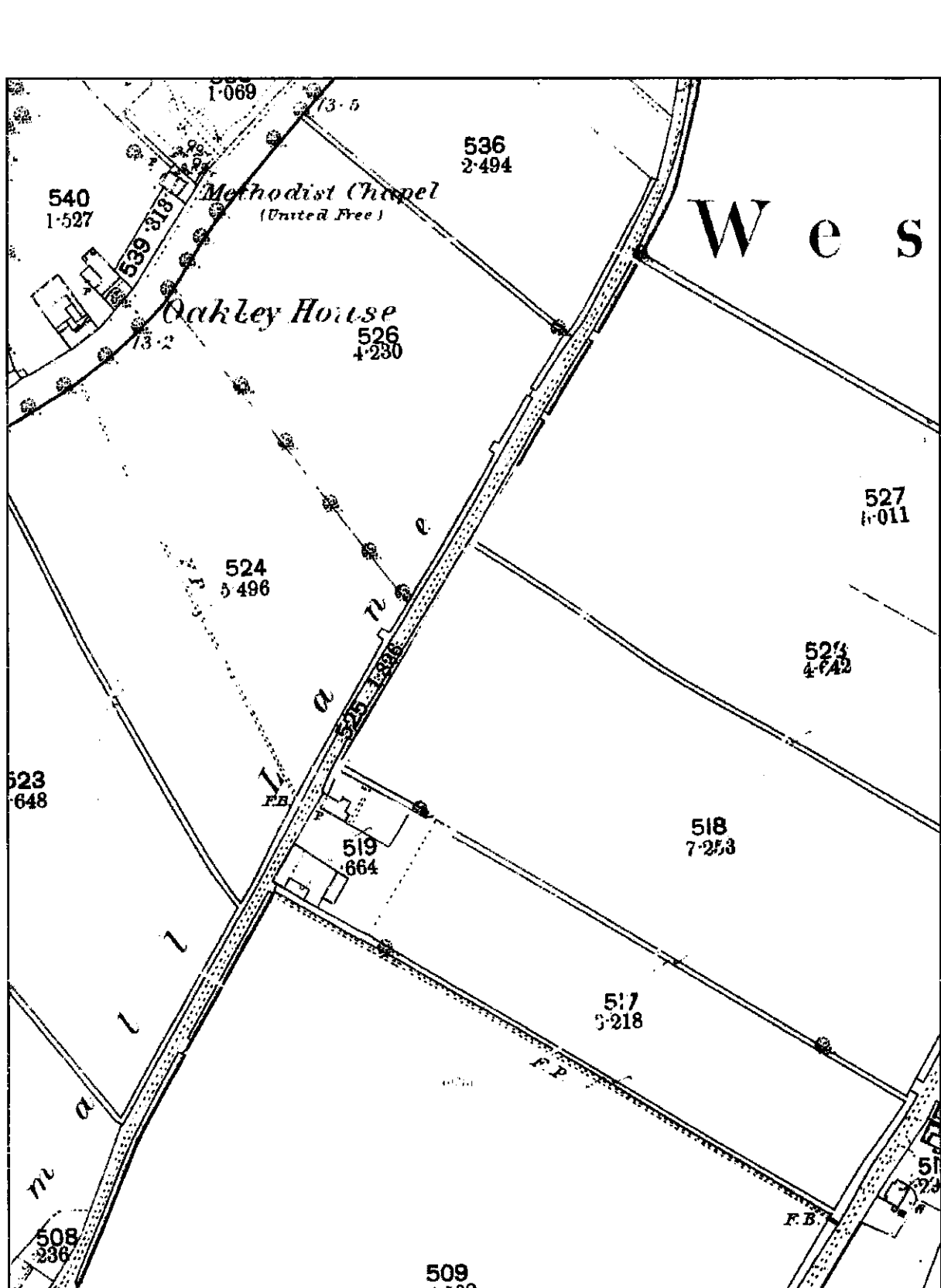
APPENDIX 1

HISTORICAL MAP & PHOTOGRAPH EXTRACTS

Site History

Figure A

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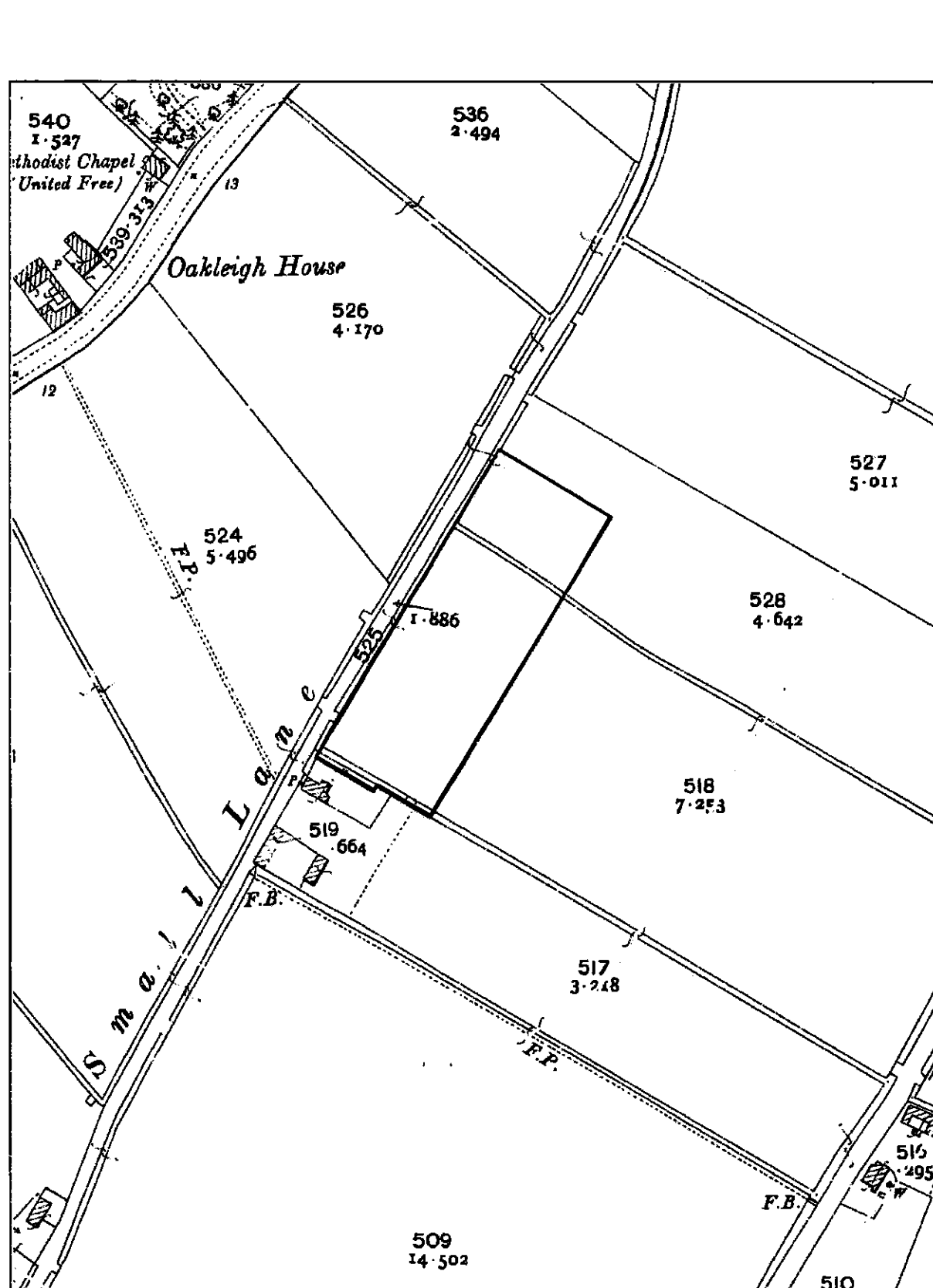
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Site History

Figure B

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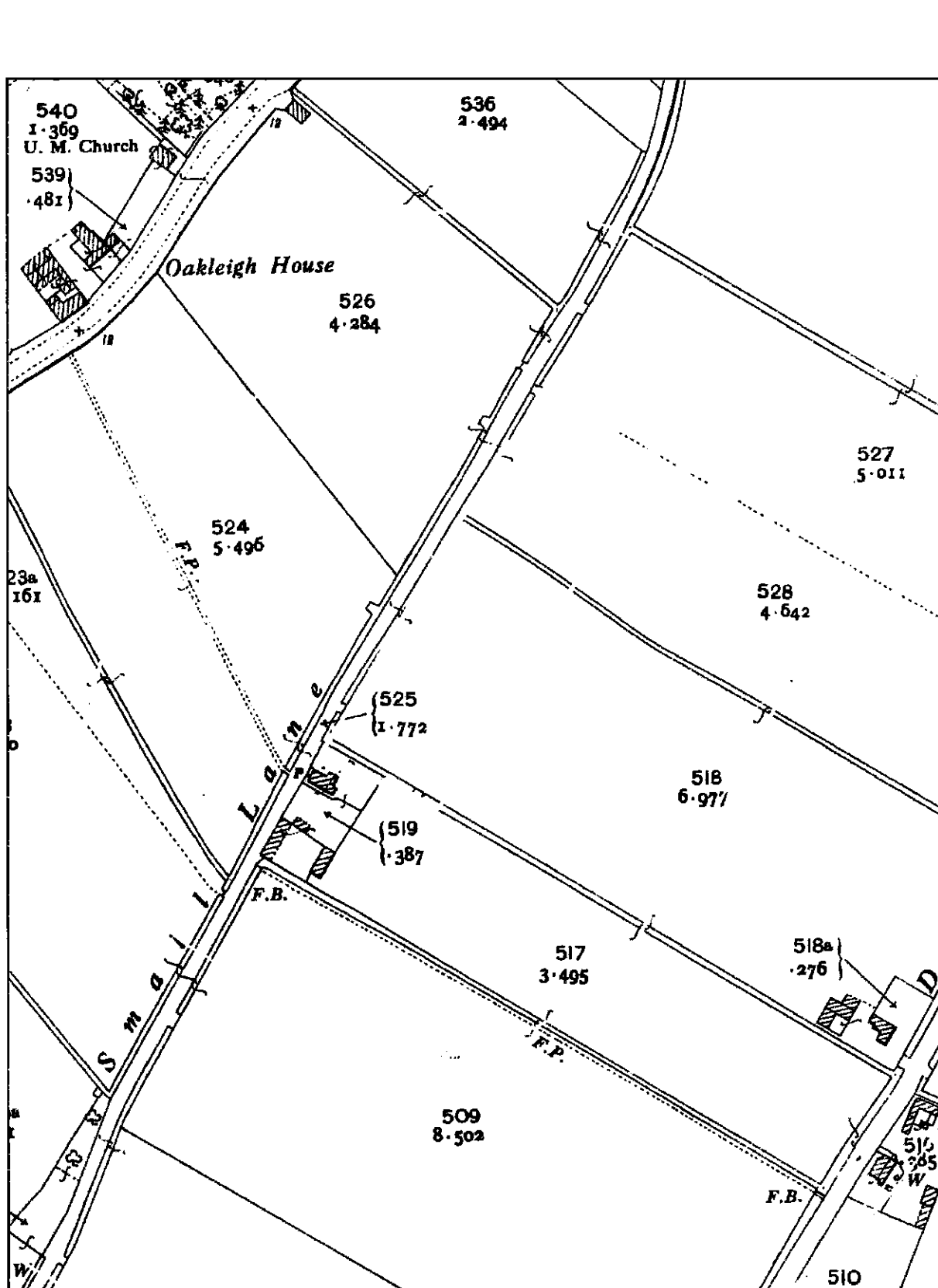
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Site History

Figure C

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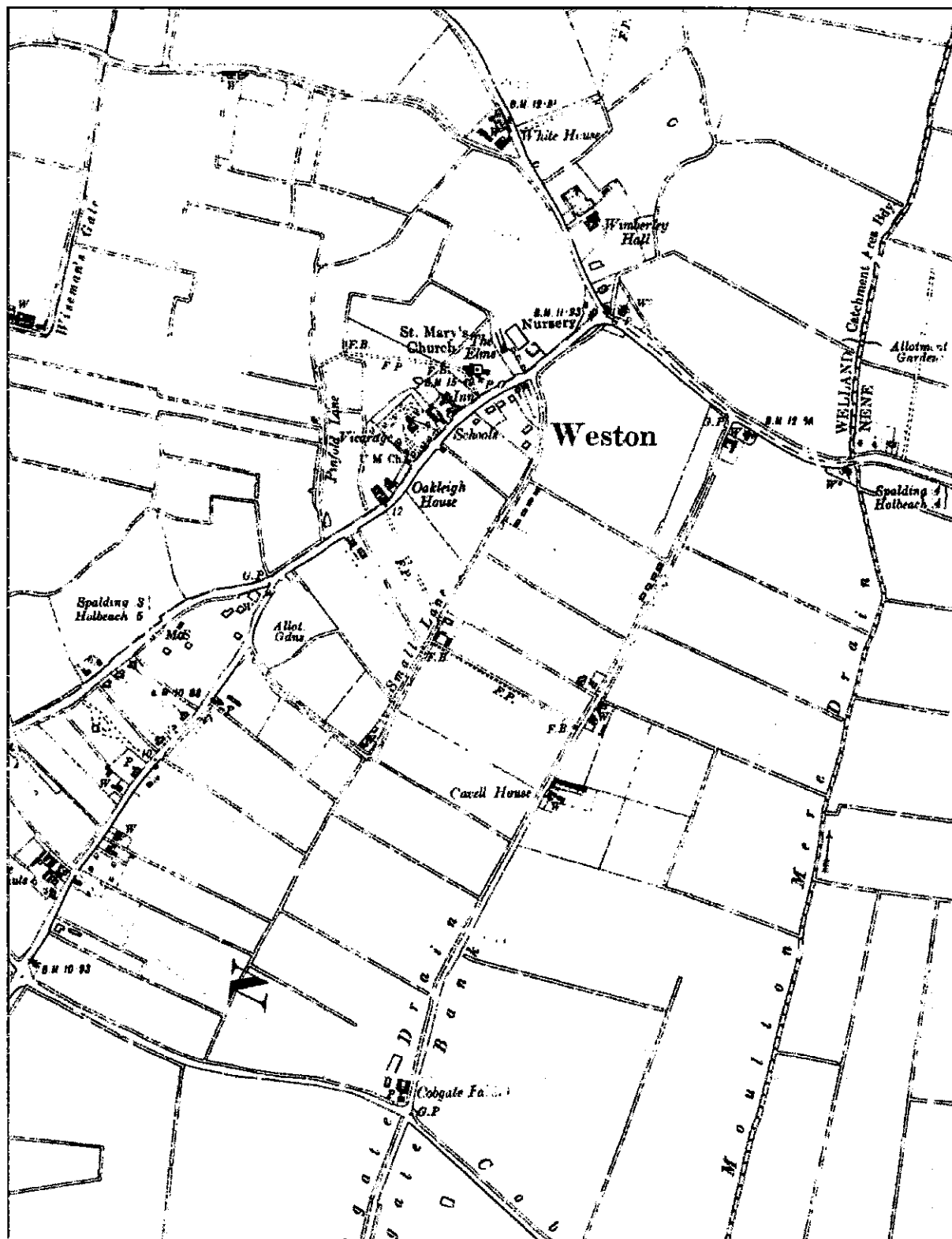
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Site History

Figure D

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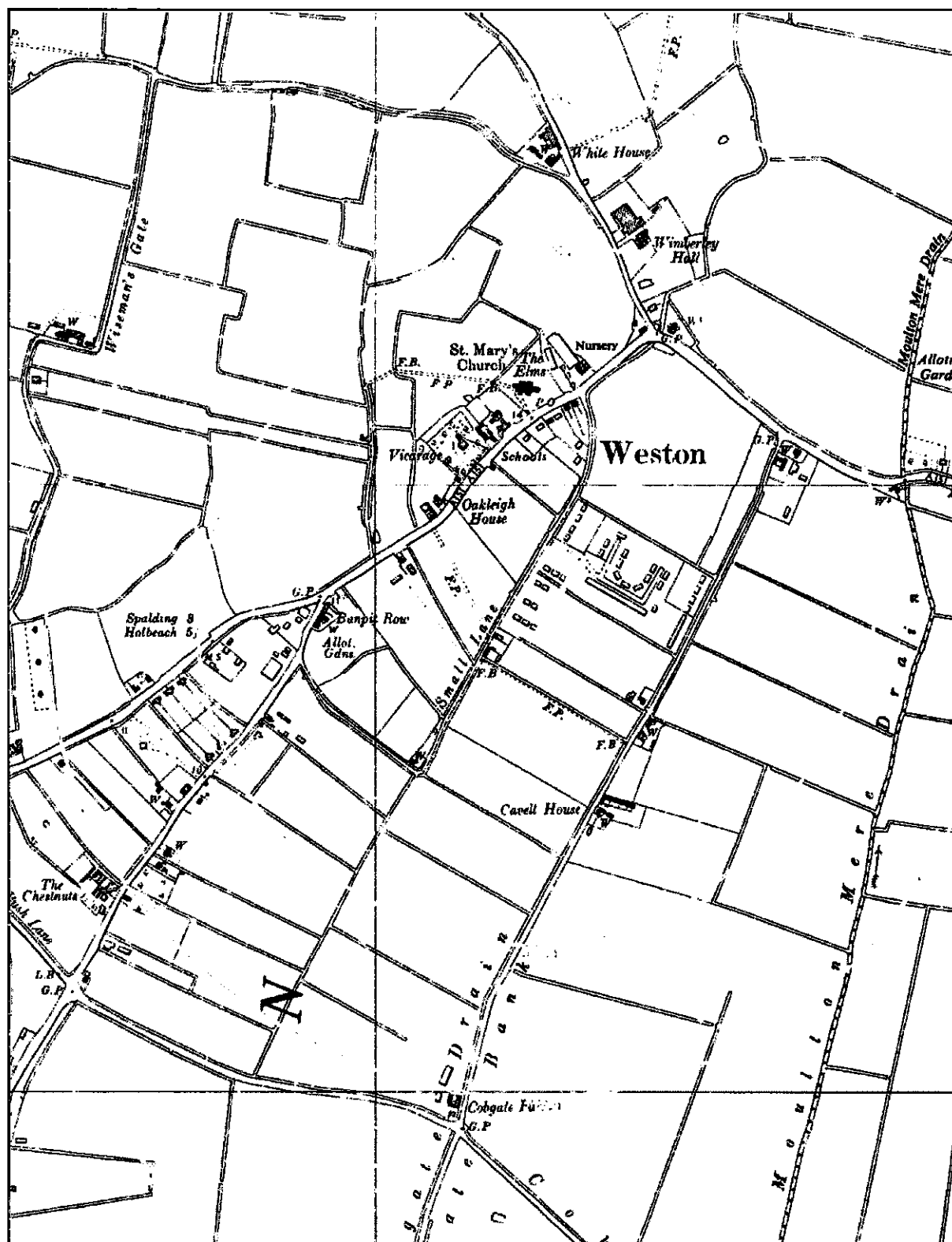
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Site History

Figure E

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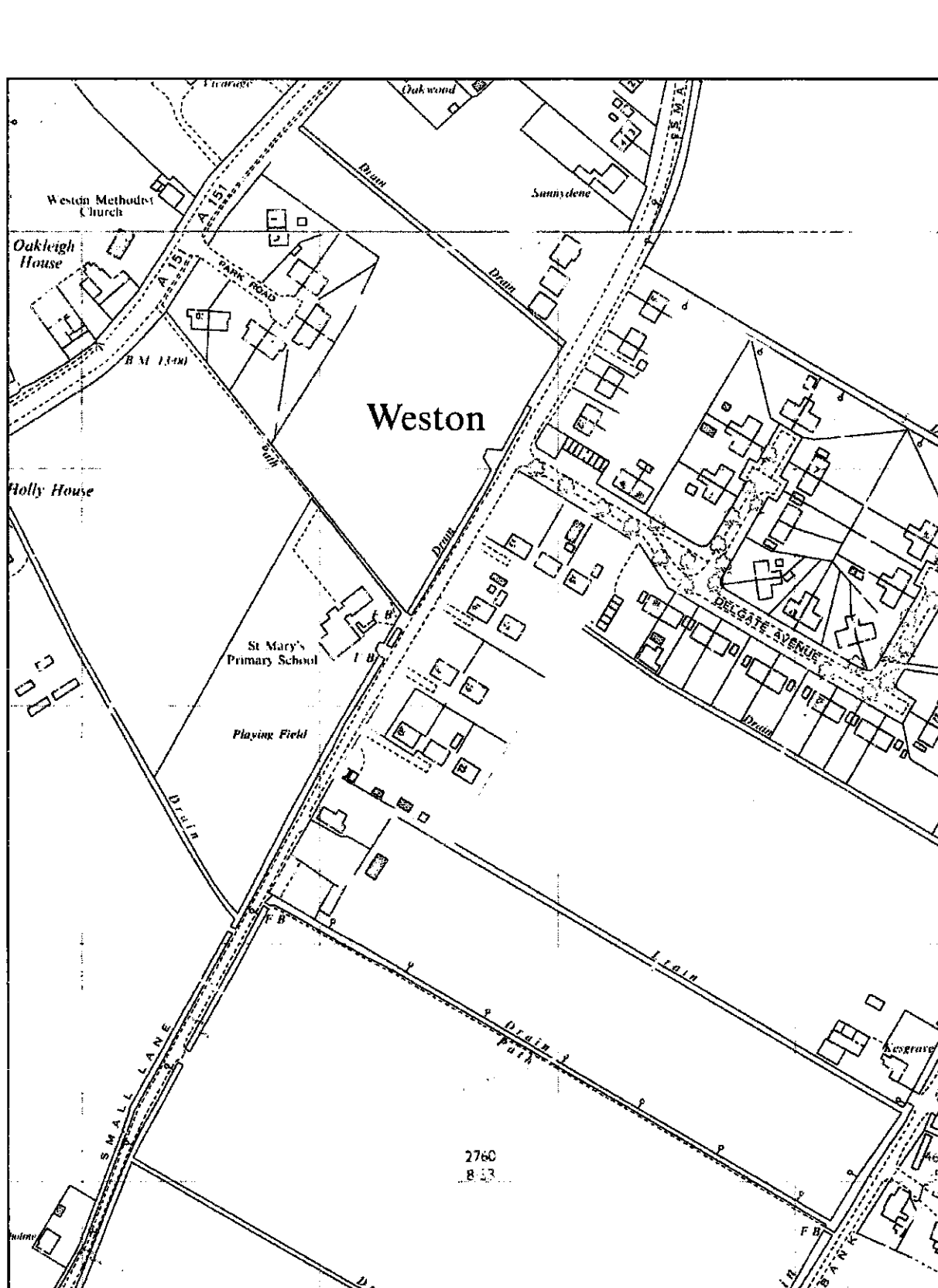
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Site History

Figure F

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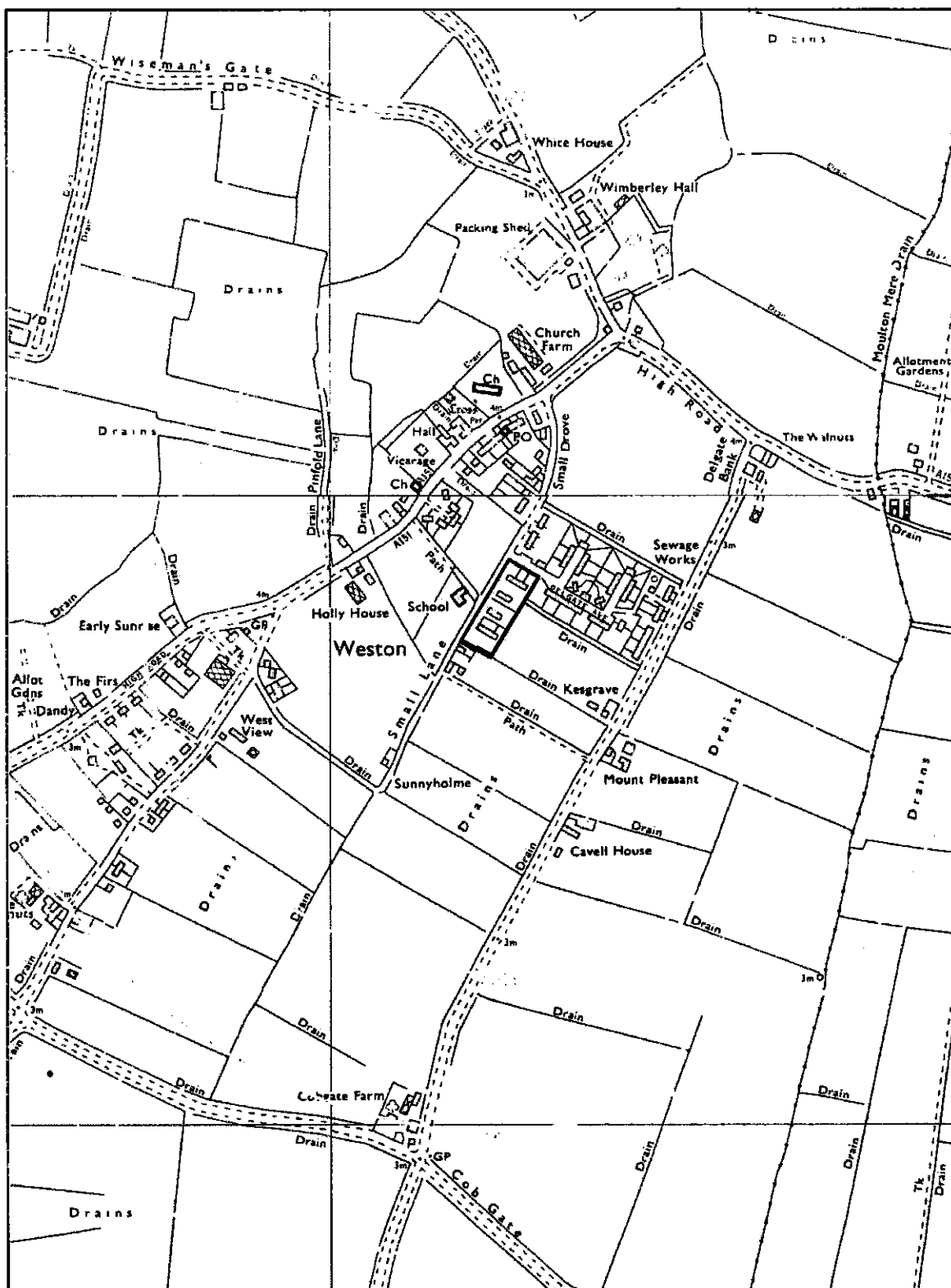
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Site History

Figure G

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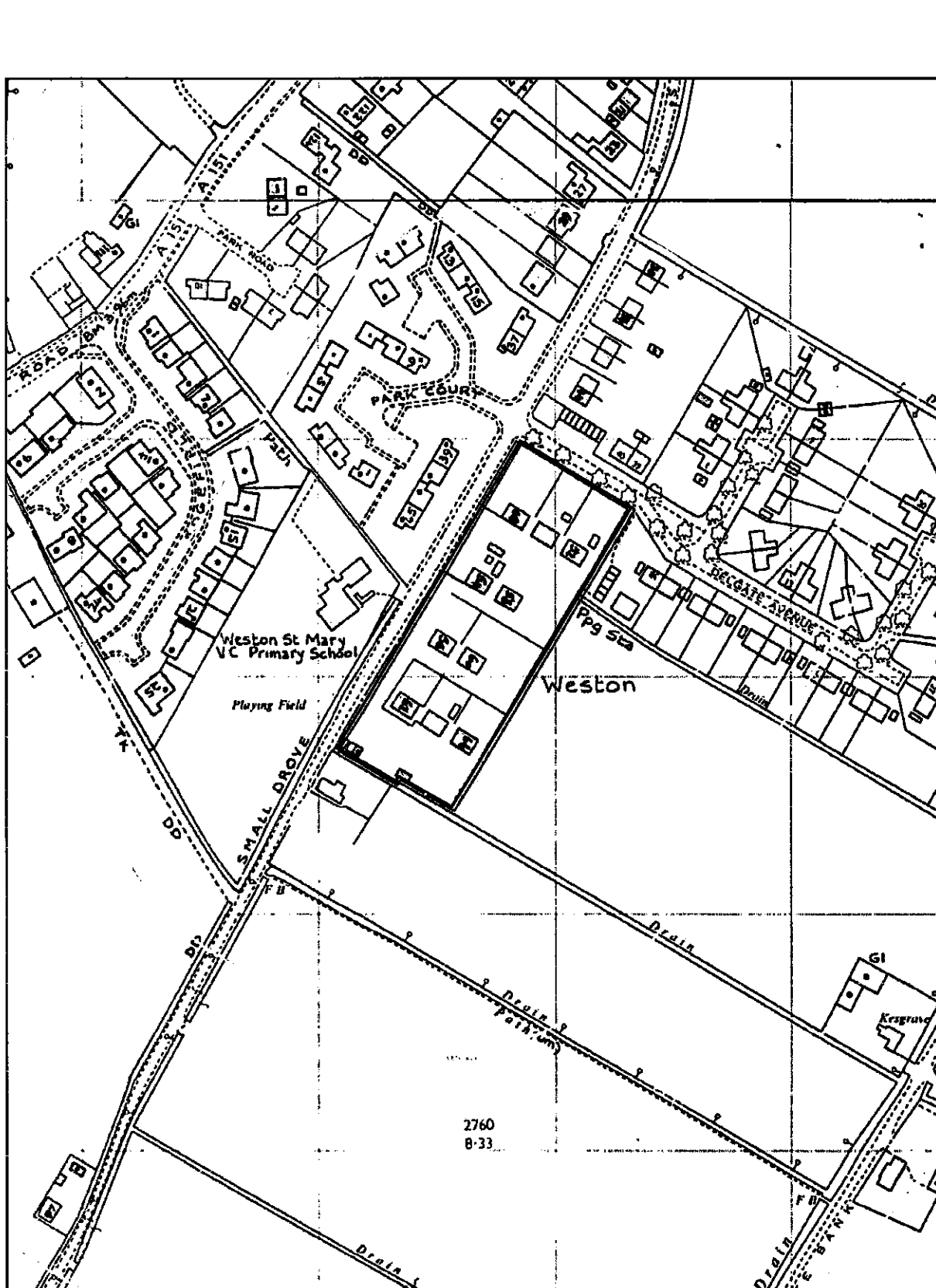
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Site History

Figure H

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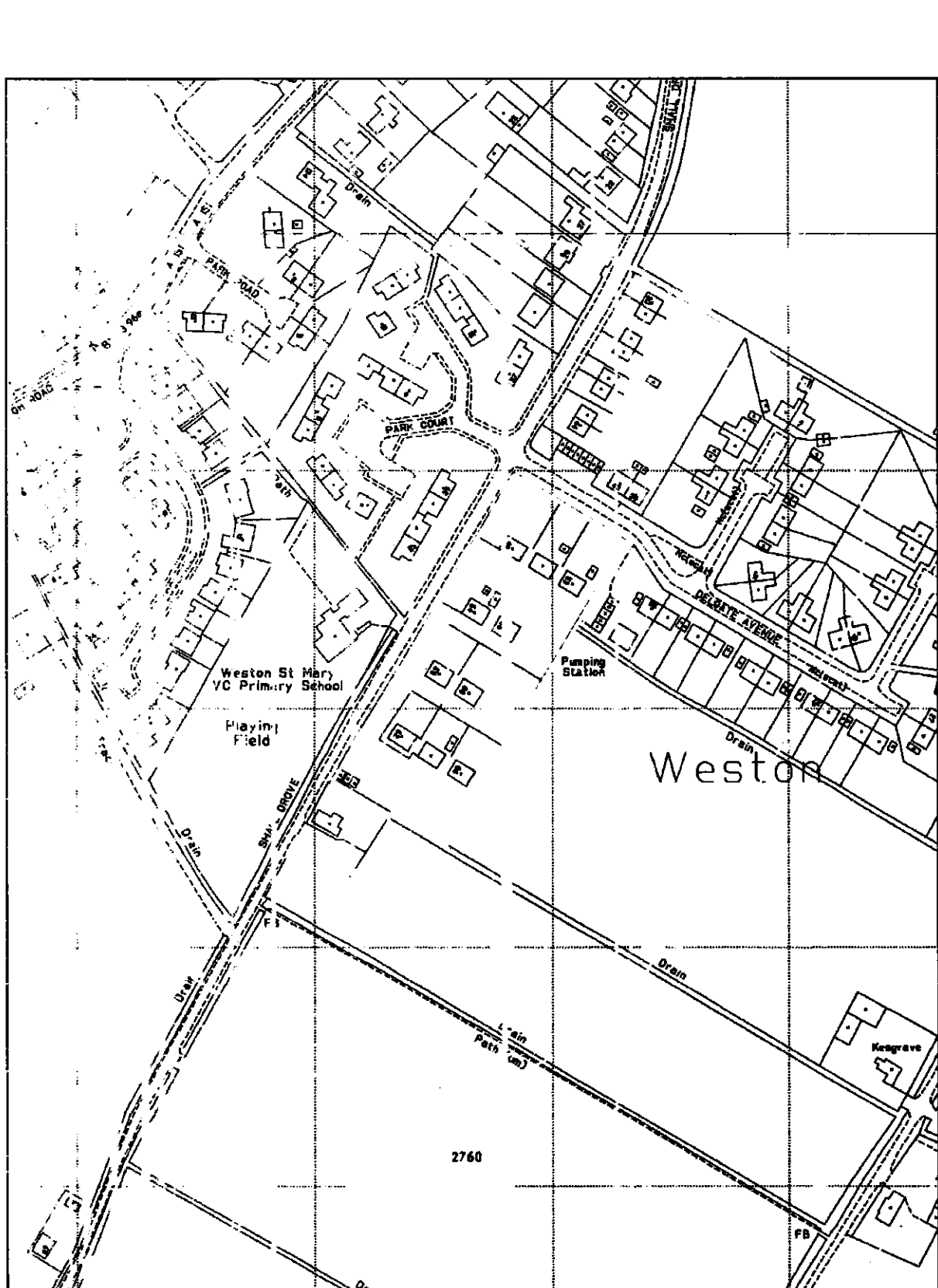
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C14022

Site History

Figure I

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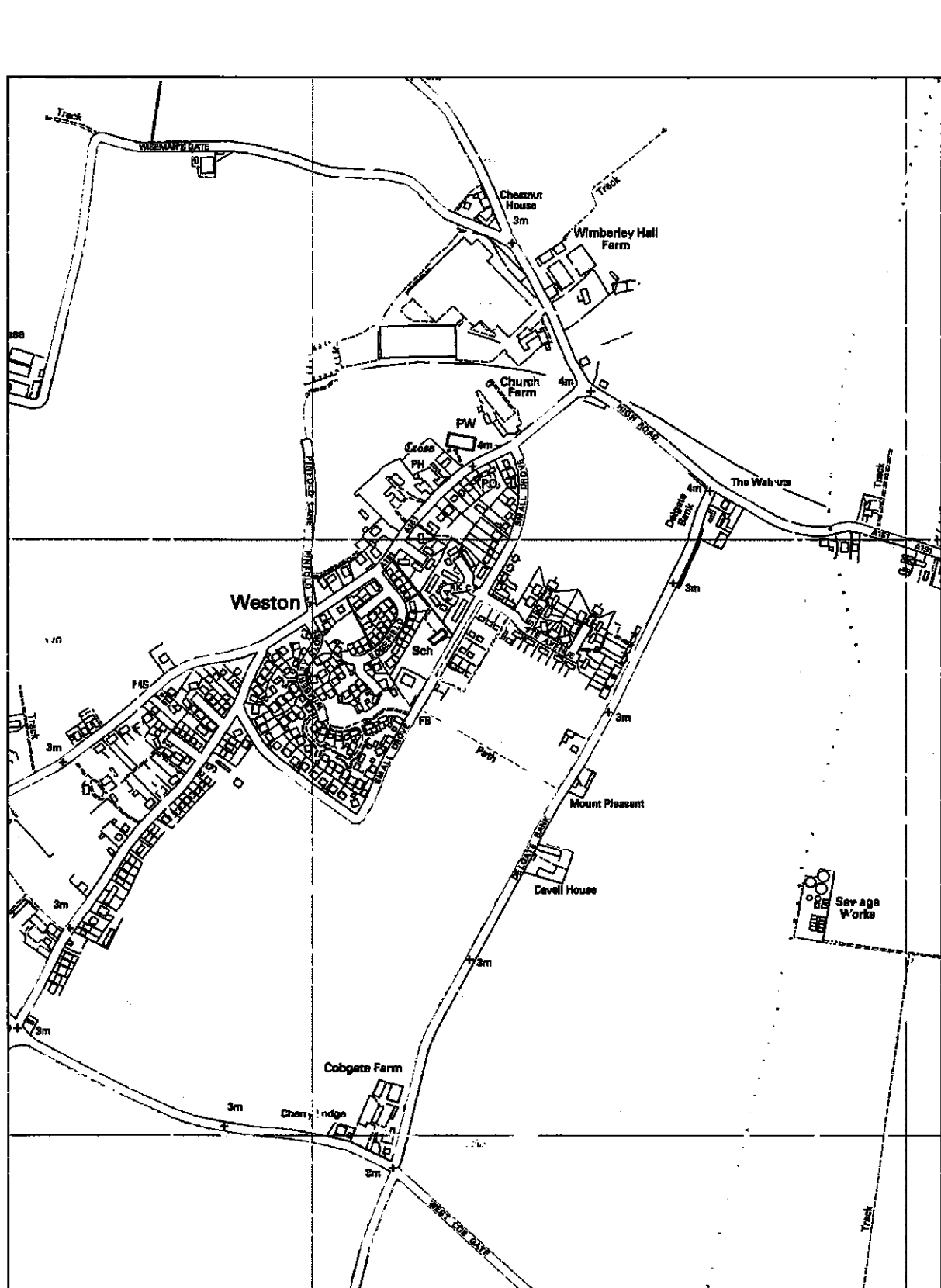
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Site History

Figure J

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Site History

Figure K

Reproduced from the 2004 Aerial Photograph Not to scale



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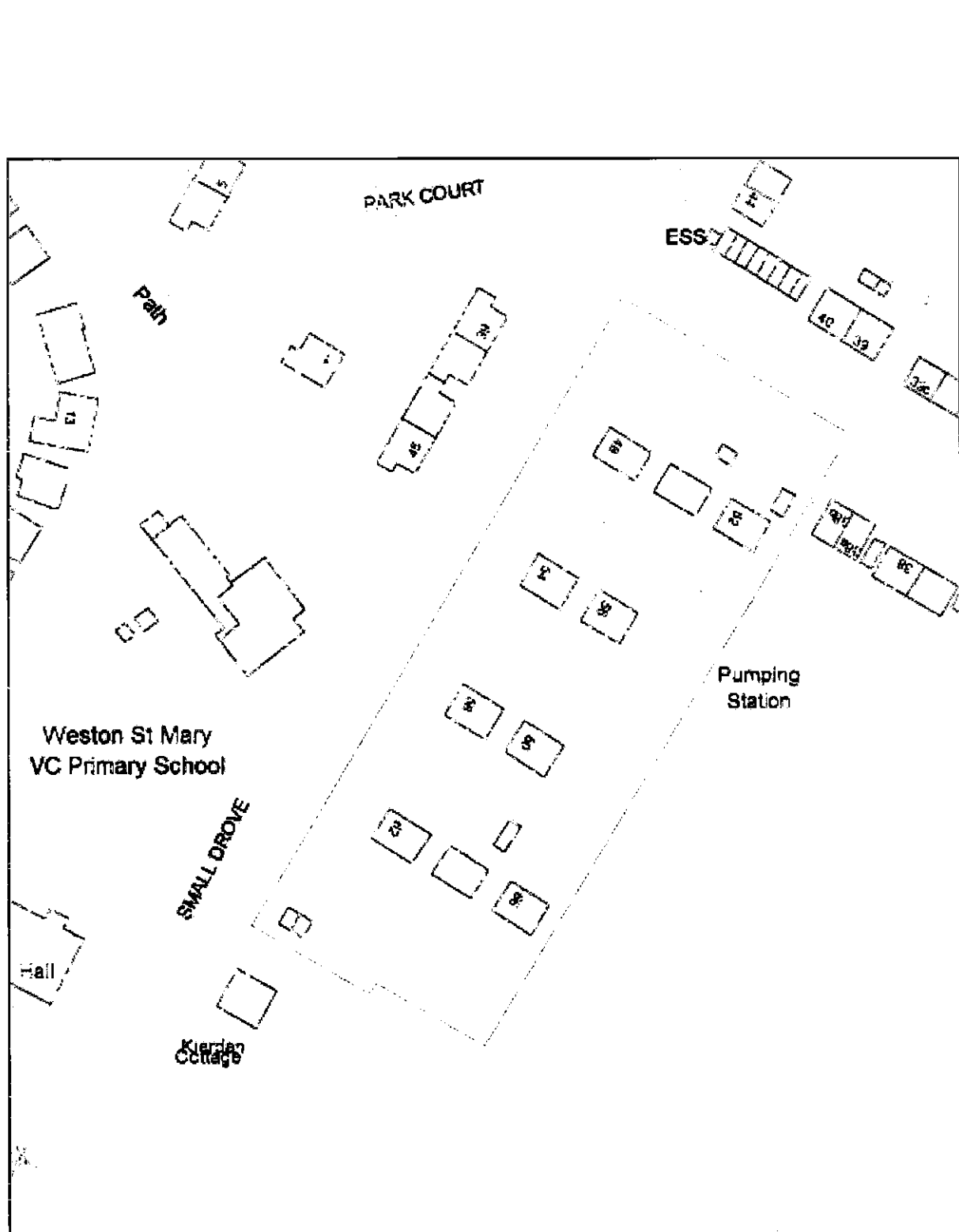
Project No.

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Site History

Figure L

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APPENDIX 2

ENVIRONMENTAL DATABASE SEARCH

Address: SMALL DROVE, WESTON, PE12 6HU

Date: 20 Dec 2016

Reference: GS-3535098

Client: Ground Engineering Limited

NW

NE

W

E



SW

S

SE

Aerial Photograph Capture date: 06-Apr-2015

Grid Reference: 529274,324819

Site Size: 0.82ha

Report Reference: GS-3535098

Client Reference: C14022

Contents Page

Contents Page	3
Overview of Findings	6
Using this report	10
1. Historical Land Use	11
1. Historical Industrial Sites	12
1.1 Potentially Contaminative Uses identified from 1:10,000 scale Mapping	12
1.2 Additional Information – Historical Tank Database	12
1.3 Additional Information – Historical Energy Features Database	12
1.4 Additional Information – Historical Petrol and Fuel Site Database	13
1.5 Additional Information – Historical Garage and Motor Vehicle Repair Database	13
1.6 Potentially Infilled Land	13
2. Environmental Permits, Incidents and Registers Map	14
2. Environmental Permits, Incidents and Registers	15
2.1 Industrial Sites Holding Licences and/or Authorisations	15
2.1.1 Records of historic IPC Authorisations within 500m of the study site	15
2.1.2 Records of Part A(1) and IPPC Authorised Activities within 500m of the study site	15
2.1.3 Records of Red List Discharge Consents (potentially harmful discharges to controlled waters) within 500m of the study site	15
2.1.4 Records of List 1 Dangerous Substances Inventory Sites within 500m of the study site	15
2.1.5 Records of List 2 Dangerous Substance Inventory Sites within 500m of the study site	15
2.1.6 Records of Part A(2) and Part B Activities and Enforcements within 500m of the study site	16
2.1.7 Records of Category 3 or 4 Radioactive Substances Authorisations	16
2.1.8 Records of Licensed Discharge Consents within 500m of the study site	16
2.1.9 Records of Water Industry Referrals (potentially harmful discharges to the public sewer) within 500m of the study site	16
2.1.10 Records of Planning Hazardous Substance Consents and Enforcements within 500m of the study site	16
2.2 Dangerous or Hazardous Sites	17
2.3 Environment Agency/Natural Resources Wales Recorded Pollution Incidents	17
2.3.1 Records of National Incidents Recording System, List 2 within 500m of the study site	17
2.3.2 Records of National Incidents Recording System, List 1 within 500m of the study site	17
2.4 Sites Determined as Contaminated Land under Part 2A EPA 1990	17
3. Landfill and Other Waste Sites Map	18
3. Landfill and Other Waste Sites	19
3.1 Landfill Sites	19
3.1.1 Records from Environment Agency/Natural Resources Wales landfill data within 1000m of the study site	19
3.1.2 Records of Environment Agency/Natural Resources Wales historic landfill sites within 1500m of the study site	19
3.1.3 Records of BGS/DoE non-operational landfill sites within 1500m of the study site	19
3.1.4 Records of Landfills from Local Authority and Historical Mapping Records within 1500m of the study site	19
3.2 Other Waste Sites	19
3.2.1 Records of waste treatment, transfer or disposal sites within 500m of the study site	19
3.2.2 Records of Environment Agency/Natural Resources Wales licensed waste sites within 1500m of the study site	20
4. Current Land Use Map	21
4. Current Land Uses	22
4.1 Current Industrial Data	22
4.2 Petrol and Fuel Sites	22
4.3 National Grid High Voltage Underground Electricity Transmission Cables	22
4.4 National Grid High Pressure Gas Transmission Pipelines	23

5. Geology	24
5.1 Artificial Ground and Made Ground.....	24
5.2 Superficial Ground and Drift Geology	24
5.3 Bedrock and Solid Geology	24
6 Hydrogeology and Hydrology	25
6a. Aquifer Within Superficial Geology	25
6b. Aquifer Within Bedrock Geology and Abstraction Licenses	26
6c. Hydrogeology – Source Protection Zones and Potable Water Abstraction Licenses	27
6d. Hydrogeology – Source Protection Zones within confined aquifer	28
6e. Hydrology – Detailed River Network and River Quality	29
6. Hydrogeology and Hydrology	30
6.1 Aquifer within Superficial Deposits.....	30
6.2 Aquifer within Bedrock Deposits.....	30
6.3 Groundwater Abstraction Licences.....	30
6.4 Surface Water Abstraction Licences.....	31
6.5 Potable Water Abstraction Licences.....	31
6.6 Source Protection Zones.....	31
6.7 Source Protection Zones within Confined Aquifer.....	31
6.8 Groundwater Vulnerability and Soil Leaching Potential.....	31
6.9 River Quality.....	32
6.9.1 Biological Quality.....	32
6.9.2 Chemical Quality.....	32
6.10 Detailed River Network.....	32
6.11 Surface Water Features.....	33
7a. Environment Agency/Natural Resources Wales Flood Map for Planning (from rivers and the sea)	34
7b. Environment Agency/Natural Resources Wales Risk of Flooding from Rivers and the Sea (RoFRaS) Map	35
7 Flooding	36
7.1 River and Coastal Zone 2 Flooding.....	36
7.2 River and Coastal Zone 3 Flooding.....	38
7.3 Risk of Flooding from Rivers and the Sea (RoFRaS) Flood Rating.....	39
7.4 Flood Defences.....	39
7.5 Areas benefiting from Flood Defences.....	39
7.6 Areas benefiting from Flood Storage.....	39
7.7 Groundwater Flooding Susceptibility Areas.....	39
7.7.1 Are there any British Geological Survey groundwater flooding susceptibility areas within 50m of the boundary of the study site? No.....	39
7.7.2 What is the highest susceptibility to groundwater flooding in the search area based on the underlying geological conditions?.....	39
7.8 Groundwater Flooding Confidence Areas.....	40
8. Designated Environmentally Sensitive Sites Map	41
8. Designated Environmentally Sensitive Sites	42
8.1 Records of Sites of Special Scientific Interest (SSSI) within 2000m of the study site:.....	42
8.2 Records of National Nature Reserves (NNR) within 2000m of the study site:.....	42
8.3 Records of Special Areas of Conservation (SAC) within 2000m of the study site:.....	42
8.4 Records of Special Protection Areas (SPA) within 2000m of the study site:.....	42
8.5 Records of Ramsar sites within 2000m of the study site:.....	42
8.6 Records of Ancient Woodland within 2000m of the study site:	43
8.7 Records of Local Nature Reserves (LNR) within 2000m of the study site:.....	43
8.8 Records of World Heritage Sites within 2000m of the study site:.....	43
8.9 Records of Environmentally Sensitive Areas within 2000m of the study site:	43

8.10 Records of Areas of Outstanding Natural Beauty (AONB) within 2000m of the study site:	43
8.11 Records of National Parks (NP) within 2000m of the study site:	43
8.12 Records of Nitrate Sensitive Areas within 2000m of the study site:.....	43
8.13 Records of Nitrate Vulnerable Zones within 2000m of the study site:.....	44
8.14 Records of Green Belt land within 2000m of the study site:.....	44
9. Natural Hazards Findings	45
9.1 Detailed BGS GeoSure Data.....	45
9.1.1 Shrink Swell.....	45
9.1.2 Landslides.....	45
9.1.3 Soluble Rocks.....	45
9.1.4 Compressible Ground.....	46
9.1.5 Collapsible Rocks.....	46
9.1.6 Running Sand.....	46
9.2 Radon.....	46
9.2.1 Radon Affected Areas.....	46
9.2.2 Radon Protection.....	47
10. Mining	48
10.1 Coal Mining.....	48
10.2 Non-Coal Mining.....	48
10.3 Brine Affected Areas	48
Contact Details	49
Standard Terms and Conditions	51

Overview of Findings

For further details on each dataset, please refer to each individual section in the main report as listed. Where the database has been searched a numerical result will be recorded. Where the database has not been searched '-' will be recorded.

Section 1: Historical Industrial Sites	On-site	0-50	51-250	251-500
1.1 Potentially Contaminative Uses Identified from 1:10,000 scale mapping	0	0	3	4
1.2 Additional Information – Historical Tank Database	0	0	1	1
1.3 Additional Information – Historical Energy Features Database	0	0	1	-
1.4 Additional Information – Historical Petrol and Fuel Site Database	0	0	0	0
1.5 Additional Information – Historical Garage and Motor Vehicle Repair Database	0	0	0	0
1.6 Potentially Infilled Land	0	0	3	0
Section 2: Environmental Permits, Incidents and Registers	On-site	0-50m	51-250	251-500
2.1 Industrial Sites Holding Environmental Permits and/or Authorisations				
2.1.1 Records of historic IPC Authorisations	0	0	0	0
2.1.2 Records of Part A(1) and IPPC Authorised Activities	0	0	0	0
2.1.3 Records of Red List Discharge Consents	0	0	0	0
2.1.4 Records of List 1 Dangerous Substances Inventory sites	0	0	0	0
2.1.5 Records of List 2 Dangerous Substances Inventory sites	0	0	0	0
2.1.6 Records of Part A(2) and Part B Activities and Enforcements	0	0	0	0
2.1.7 Records of Category 3 or 4 Radioactive Substances Authorisations	0	0	0	0
2.1.8 Records of Licensed Discharge Consents	0	1	0	0
2.1.9 Records of Water Industry Referrals	0	0	0	0
2.1.10 Records of Planning Hazardous Substance Consents and Enforcements within 500m of the study site	0	0	0	0
2.2 Records of COMAH and NIHS sites	0	0	0	0
2.3 Environment Agency/Natural Resources Wales Recorded Pollution Incidents				
2.3.1 National Incidents Recording System, List 2	0	0	0	0
2.3.2 National Incidents Recording System, List 1	0	0	0	0
2.4 Sites Determined as Contaminated Land under Part 2A EPA 1990	0	0	0	0

Section 3: Landfill and Other Waste Sites	On-site	0-50m	51-250	251-500	501-1000	1000-1500
3.1 Landfill Sites						
3.1.1 Environment Agency/Natural Resources Wales Registered Landfill Sites	0	0	0	0	0	Not searched
3.1.2 Environment Agency/Natural Resources Wales Historic Landfill Sites	0	0	0	0	0	0
3.1.3 BGS/DoE Landfill Site Survey	0	0	0	0	0	0
3.1.4 Records of Landfills in Local Authority and Historical Mapping Records	0	0	0	0	0	0
3.2 Landfill and Other Waste Sites Findings						
3.2.1 Operational and Non-Operational Waste Treatment, Transfer and Disposal Sites	0	0	0	0	Not searched	Not searched
3.2.2 Environment Agency/Natural Resources Wales Licensed Waste Sites	0	0	0	0	0	0

Section 4: Current Land Use	On-site	0-50m	51-250	251-500
4.1 Current Industrial Sites Data	0	2	2	Not searched
4.2 Records of Petrol and Fuel Sites	0	0	0	0
4.3 National Grid Underground Electricity Cables	0	0	0	0
4.4 National Grid Gas Transmission Pipelines	0	0	0	0

Section 5: Geology	
5.1 Are there any records of Artificial Ground and Made Ground present beneath the study site?	No
5.2 Are there any records of Superficial Ground and Drift Geology present beneath the study site?	Yes
5.3 For records of Bedrock and Solid Geology beneath the study site see the detailed findings section.	

Section 6: Hydrogeology and Hydrology

0-500m

6.1 Are there any records of Strata Classification in the Superficial Geology within 500m of the study site?

Yes

6.2 Are there any records of Strata Classification in the Bedrock Geology within 500m of the study site?

Yes

	On-site	0-50m	51-250	251-500	501-1000	1000-2000
6.3 Groundwater Abstraction Licences (within 2000m of the study site)	0	0	0	0	0	0
6.4 Surface Water Abstraction Licences (within 2000m of the study site)	0	0	0	0	0	0
6.5 Potable Water Abstraction Licences (within 2000m of the study site)	0	0	0	0	0	0
6.6 Source Protection Zones (within 500m of the study site)	0	0	0	0	Not searched	Not searched
6.7 Source Protection Zones within Confined Aquifer	0	0	0	0	Not searched	Not searched
6.8 Groundwater Vulnerability and Soil Leaching Potential (within 500m of the study site)	0	0	0	0	Not searched	Not searched

Section 6: Hydrogeology and Hydrology

0-500m

	On-site	0-50m	51-250	251-500	501-1000	1000-1500
6.9 Is there any Environment Agency/Natural Resources Wales information on river quality within 1500m of the study site?	No	No	No	No	No	No
6.10 Detailed River Network entries within 500m of the site	0	0	0	0	Not searched	Not searched
6.11 Surface water features within 250m of the study site	Yes	No	Yes	Not searched	Not searched	Not searched

Section 7: Flooding

7.1 Are there any Environment Agency Zone 2 floodplains within 250m of the study site?	Yes
7.2 Are there any Environment Agency/Natural Resources Wales Zone 3 floodplains within 250m of the study site?	Yes
7.3 What is the Risk of flooding from Rivers and the Sea (RoFRaS) rating for the study site?	Low
7.4 Are there any Flood Defences within 250m of the study site?	No
7.5 Are there any areas benefiting from Flood Defences within 250m of the study site?	No
7.6 Are there any areas used for Flood Storage within 250m of the study site?	No
7.7 What is the maximum BGS Groundwater Flooding susceptibility within 50m of the study site?	Not Prone
7.8 What is the BGS confidence rating for the Groundwater Flooding susceptibility areas?	Not Applicable

Section 8: Designated Environmentally Sensitive Sites

	On-site	0-50m	51-250	251-500	501-1000	1000-2000
8.1 Records of Sites of Special Scientific Interest (SSSI)	0	0	0	0	0	0
8.2 Records of National Nature Reserves (NNR)	0	0	0	0	0	0
8.3 Records of Special Areas of Conservation (SAC)	0	0	0	0	0	0
8.4 Records of Special Protection Areas (SPA)	0	0	0	0	0	0
8.5 Records of Ramsar sites	0	0	0	0	0	0
8.6 Records of Ancient Woodlands	0	0	0	0	0	0
8.7 Records of Local Nature Reserves (LNR)	0	0	0	0	0	0
8.8 Records of World Heritage Sites	0	0	0	0	0	0
8.9 Records of Environmentally Sensitive Areas	0	0	0	0	0	0

Section 8: Designated Environmentally Sensitive Sites

	On-site	0-50m	51-250	251-500	501-1000	1000-2000
8.10 Records of Areas of Outstanding Natural Beauty (AONB)	0	0	0	0	0	0
8.11 Records of National Parks	0	0	0	0	0	0
8.12 Records of Nitrate Sensitive Areas	0	0	0	0	0	0
8.13 Records of Nitrate Vulnerable Zones	0	0	0	0	0	0
8.14 Records of Green Belt land	0	0	0	0	0	0

Section 9: Natural Hazards

9.1 What is the maximum risk of natural ground subsidence?

Moderate

9.1.1 What is the maximum Shrink-Swell hazard rating identified on the study site?

Low

9.1.2 What is the maximum Landslides hazard rating identified on the study site?

Very Low

9.1.3 What is the maximum Soluble Rocks hazard rating identified on the study site?

Negligible

9.1.4 What is the maximum Compressible Ground hazard rating identified on the study site?

Moderate

9.1.5 What is the maximum Collapsible Rocks hazard rating identified on the study site?

Negligible

9.1.6 What is the maximum Running Sand hazard rating identified on the study site?

Moderate

9.2 Radon

9.2.1 Is the property in a Radon Affected Area as defined by the Health Protection Agency (HPA) and if so what percentage of homes are above the Action Level?

The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.

9.2.2 Is the property in an area where Radon Protection are required for new properties or extensions to existing ones as described in publication BR211 by the Building Research Establishment?

No radon protective measures are necessary.

Section 10: Mining

10.1 Are there any coal mining areas within 75m of the study site?

No

10.2 Are there any Non-Coal Mining areas within 50m of the study site boundary?

No

10.3 Are there any brine affected areas within 75m of the study site?

No

Using this report

The following report is designed by Environmental Consultants for Environmental Professionals bringing together the most up-to-date market leading environmental data. This report is provided under and subject to the Terms & Conditions agreed between Groundsure and the Client. The document contains the following sections:

1. Historical Industrial Sites

Provides information on past land uses that may pose a risk to the study site in terms of potential contamination from activities or processes. Potentially Infilled Land features are also included. This search is conducted using radii of up to 500m.

2. Environmental Permits, Incidents and Registers

Provides information on Regulated Industrial Activities and Pollution Incidents as recorded by Regulatory Authorities, and sites determined as Contaminated Land. This search is conducted using radii up to 500m.

3. Landfills and Other Waste Sites

Provides information on landfills and other waste sites that may pose a risk to the study site. This search is conducted using radii up to 1500m.

4. Current Land Uses

Provides information on current land uses that may pose a risk to the study site in terms of potential contamination from activities or processes. These searches are conducted using radii of up to 500m. This includes information on potentially contaminative industrial sites, petrol stations and fuel sites as well as high pressure gas pipelines and underground electricity transmission lines.

5. Geology

Provides information on artificial and superficial deposits and bedrock beneath the study site.

6. Hydrogeology and Hydrology

Provides information on productive strata within the bedrock and superficial geological layers, abstraction licenses, Source Protection Zones (SPZs) and river quality. These searches are conducted using radii of up to 2000m.

7. Flooding

Provides information on river and coastal flooding, flood defences, flood storage areas and groundwater flood areas. This search is conducted using radii of up to 250m.

8. Designated Environmentally Sensitive Sites

Provides information on the Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR), Special Areas of Conservation (SAC), Special Protection Areas (SPA), Ramsar sites, Local Nature Reserves (LNR), Areas of Outstanding Natural Beauty (AONB), National Parks (NP), Environmentally Sensitive Areas, Nitrate Sensitive Areas, Nitrate Vulnerable Zones and World Heritage Sites and Scheduled Ancient Woodland. These searches are conducted using radii of up to 2000m.

9. Natural Hazards

Provides information on a range of natural hazards that may pose a risk to the study site. These factors include natural ground subsidence and radon.

10. Mining

Provides information on areas of coal and non-coal mining and brine affected areas.

11. Contacts

This section of the report provides contact points for statutory bodies and data providers that may be able to provide further information on issues raised within this report. Alternatively, Groundsure provide a free Technical Helpline (08444 159000) for further information and guidance.

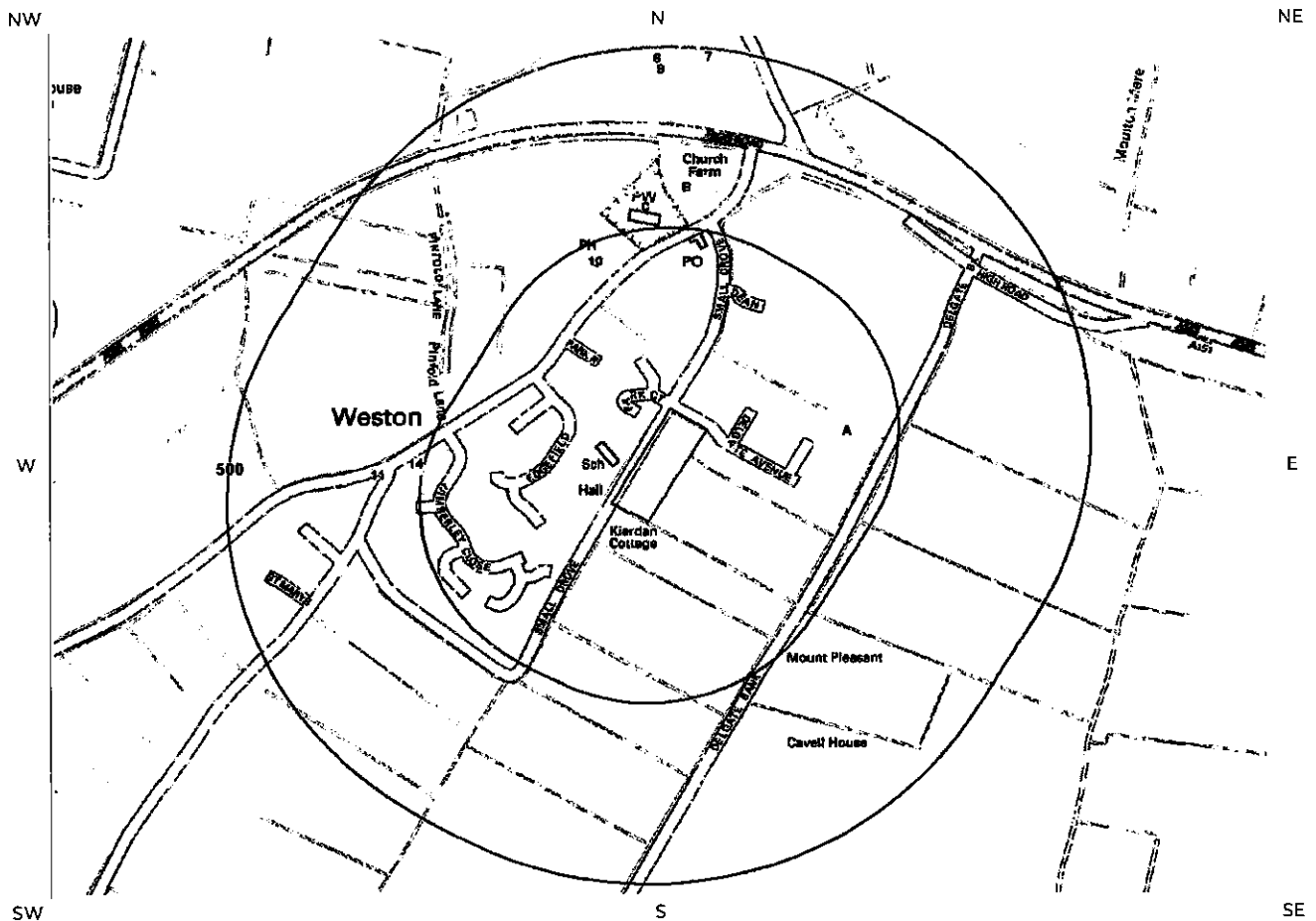
Note: Maps

Only certain features are placed on the maps within the report. All features represented on maps found within this search are given an identification number. This number identifies the feature on the mapping and correlates it to the additional information provided below. This identification number precedes all other information and takes the following format -Id: 1, Id: 2, etc. Where numerous features on the same map are in such close proximity that the numbers would obscure each other a letter identifier is used instead to represent the features. (e.g. Three features which overlap may be given the identifier "A" on the map and would be identified separately as features 1A, 3A, 10A on the data tables provided).

Where a feature is reported in the data tables to a distance greater than the map area, it is noted in the data table as "Not Shown".

All distances given in this report are in Metres (m). Directions are given as compass headings such as N: North, E: East, NE: North East from the nearest point of the study site boundary.

1. Historical Land Use



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Historical 1:10,000 and 1:10,560 scale mapping

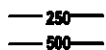


Site Outline

Industrial Land Use

Potentially Infilled Land

Historical 1:2,500, 1:1,250 and 1:500 scale mapping



Search Buffers (m)

Energy Features

Petrol Stations

Tanks

Garages

1. Historical Industrial Sites

1.1 Potentially Contaminative Uses identified from 1:10,000 scale Mapping

The systematic analysis of data extracted from standard 1:10,560 and 1:10,000 scale historical maps provides the following information:

Records of sites with a potentially contaminative past land use within 500m of the search boundary: 7

ID	Distance [m]	Direction	Use	Date
1A	140	E	Sewage Works	1971
2A	180	E		1971
3C	222	N	Grave Yard	1887
4B	252	N		1955
5B	264	N	Nursery	1938
6	417	N	Unspecified Commercial/Industrial	1989
7	429	N	Packing Shed	1973

1.2 Additional Information – Historical Tank Database

The systematic analysis of data extracted from High Detailed 1:1,250 and 1:2,500 scale historical maps provides the following information.

Records of historical tanks within 500m of the search boundary: 2

ID	Distance (m)	Direction	Use	Date
8A	180	E	Tanks	1967
9	461	N		1987

1.3 Additional Information – Historical Energy Features Database

The systematic analysis of data extracted from High Detailed 1:1,250 and 1:2,500 scale historical maps provides the following information.

Records of historical energy features within 500m of the search boundary: 2

ID	Distance (m)	Direction	Use	Date
10	217	NW		1987
11	304	W	Gas Governor	1987

1.4 Additional Information – Historical Petrol and Fuel Site Database

The systematic analysis of data extracted from High Detailed 1:1,250 and 1:2,500 scale historical maps provides the following information.

Records of historical petrol stations and fuel sites within 500m of the search boundary: 0

Database searched and no data found.

1.5 Additional Information – Historical Garage and Motor Vehicle Repair Database

The systematic analysis of data extracted from High Detailed 1:1,250 and 1:2,500 scale historical maps provides the following information.

Records of historical garage and motor vehicle repair sites within 500m of the search boundary: 0

Database searched and no data found.

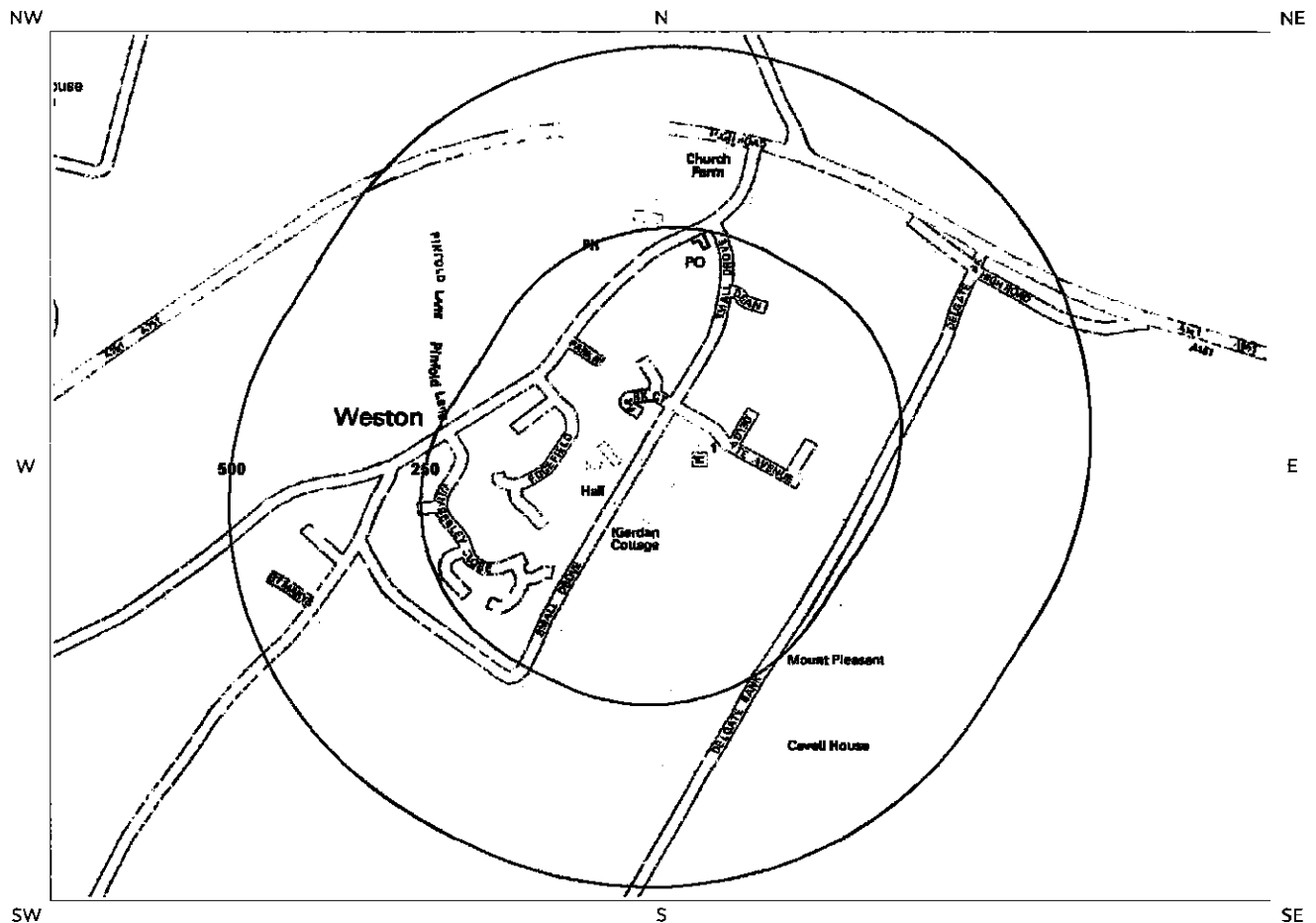
1.6 Potentially Infilled Land

Records of Potentially Infilled Features from 1:10,000 scale mapping within 500m of the study site: 3

The following Historical Potentially Infilled Features derived from the Historical Mapping information is provided by Groundsure:

ID	Distance(m)	Direction	Use	Date
12A	140	E	Sewage Works	1971
13C	222	N	Grave Yard	1887
14	235	W	Pond	1903

2. Environmental Permits, Incidents and Registers Map



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- | | |
|---------------------------------|--|
| ☆ Recorded Pollution Incident | ▼ RAS 3 & 4 Authorisations |
| ◆ Dangerous Substances (List 1) | ▲ Part A(1) Authorised Processes and Historic IPC Authorisations |
| ◇ Dangerous Substances (List 2) | ⚠ Part A(2) and Part B Authorised Processes |
| Site Outline | COMAH / NIHHS Sites |
| — 250 — Search Buffers (m) | ■ Water Industry Referrals |
| — 500 — | ⚡ Licenced Discharge Consents |
| | □ Red List Discharge Consents |
| | ⚠ Sites Determined as Contaminated Land |
| | ⚡ Hazardous Substance Consents and Enforcements |

2. Environmental Permits, Incidents and Registers

2.1 Industrial Sites Holding Licences and/or Authorisations

Searches of information provided by the Environment Agency/Natural Resources Wales and Local Authorities reveal the following information:

2.1.1 Records of historic IPC Authorisations within 500m of the study site:

0

Database searched and no data found.

2.1.2 Records of Part A(1) and IPPC Authorised Activities within 500m of the study site:

0

Database searched and no data found.

2.1.3 Records of Red List Discharge Consents (potentially harmful discharges to controlled waters) within 500m of the study site:

0

Database searched and no data found.

2.1.4 Records of List 1 Dangerous Substances Inventory Sites within 500m of the study site:

0

Database searched and no data found.

2.1.5 Records of List 2 Dangerous Substance Inventory Sites within 500m of the study site:

0

Database searched and no data found.

2.1.6 Records of Part A(2) and Part B Activities and Enforcements within 500m of the study site:

0

Database searched and no data found.

2.1.7 Records of Category 3 or 4 Radioactive Substances Authorisations:

0

Database searched and no data found.

2.1.8 Records of Licensed Discharge Consents within 500m of the study site:

1

The following Licensed Discharge Consents records are represented as points on the Environmental Permits, Incidents and Registers Map:

ID	Distance (m)	Direction	NGR	Details
1	11	SE	529320 324830	<p>Address: WESTON DELGATE TPS, WESTON, LINCOLNSHIRE, . . .</p> <p>Effluent Type: SEWAGE DISCHARGES - PUMPING STATION - WATER COMPANY</p> <p>Permit Number: ANNNF13677</p> <p>Permit Version: 1</p> <p>Receiving Water: TRIB OF S HOLLAND MAIN DRAIN</p> <p>Status: NEW CONSENT (WRA 91, S88 & SCHED 10 AS AMENDED BY ENV ACT 1995)</p> <p>Issue date: 14/05/2004</p> <p>Effective Date: 14-May-2004</p> <p>Revocation Date: -</p>

2.1.9 Records of Water Industry Referrals (potentially harmful discharges to the public sewer) within 500m of the study site:

0

Database searched and no data found.

2.1.10 Records of Planning Hazardous Substance Consents and Enforcements within 500m of the study site:

0

Database searched and no data found.

2.2 Dangerous or Hazardous Sites

Records of COMAH & NIHHS sites within 500m of the study site:

0

Database searched and no data found.

2.3 Environment Agency/Natural Resources Wales Recorded Pollution Incidents

2.3.1 Records of National Incidents Recording System, List 2 within 500m of the study site:

0

Database searched and no data found.

2.3.2 Records of National Incidents Recording System, List 1 within 500m of the study site:

0

Database searched and no data found.

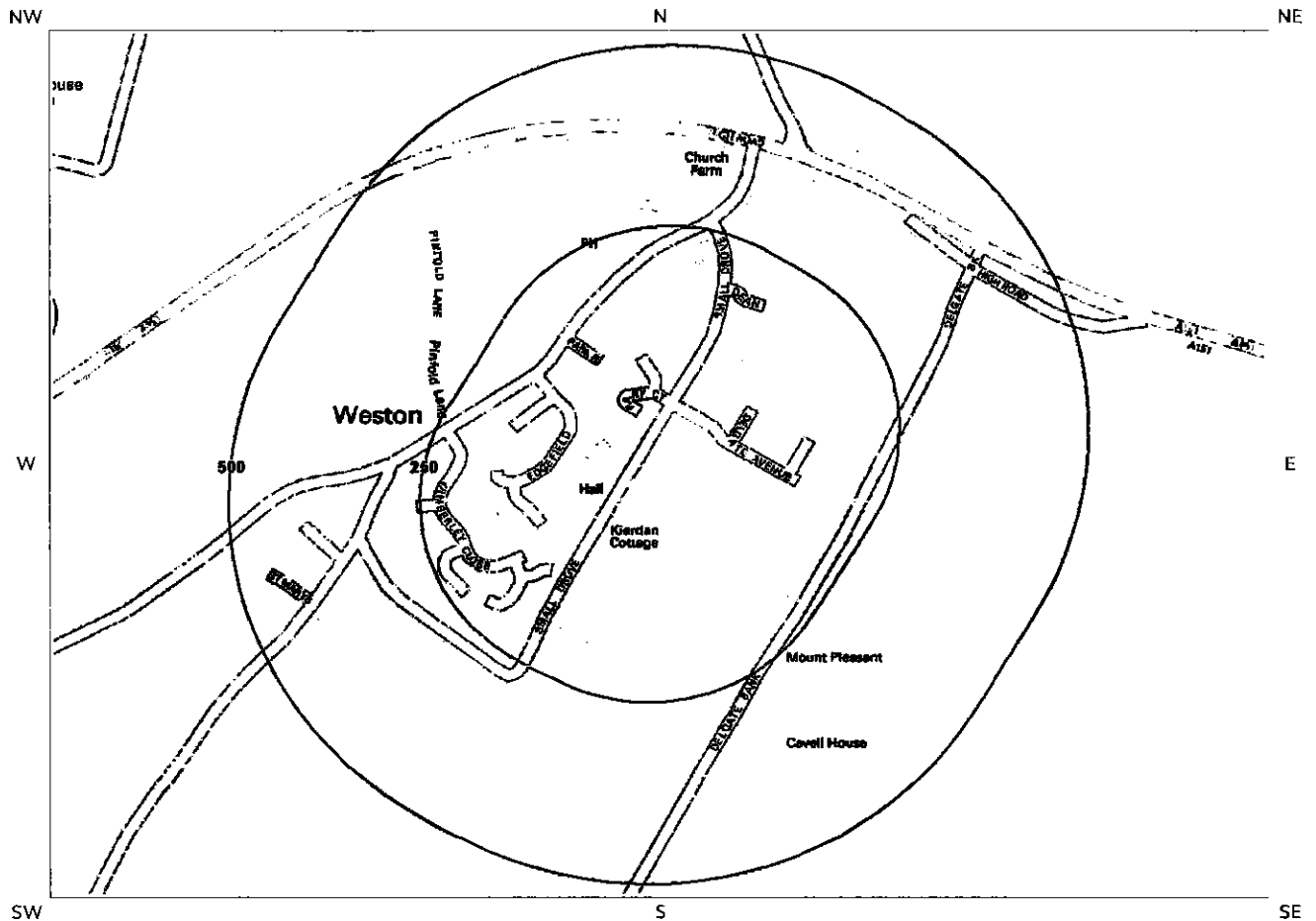
2.4 Sites Determined as Contaminated Land under Part 2A EPA 1990

How many records of sites determined as contaminated land under Section 78R of the Environmental Protection Act 1990 are there within 500m of the study site?

0

Database searched and no data found.

3. Landfill and Other Waste Sites Map



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<p>Site Outline</p> <p>— 250 — Search Buffers (m)</p> <p>— 500 —</p>	<p>EA/NRW Active Landfill</p> <p>EA/NRW Historic Landfill</p> <p>⊙ BGS / DoE Survey Landfill</p>	<p>Historic and Planned Waste Sites</p> <p>☑ EA/NRW Licensed Waste Site</p> <p>Local Authority/Historical Mapping Landfill Records</p>
--	--	--

3. Landfill and Other Waste Sites

3.1 Landfill Sites

3.1.1 Records from Environment Agency/Natural Resources Wales landfill data within 1000m of the study site:

0

Database searched and no data found.

3.1.2 Records of Environment Agency/Natural Resources Wales historic landfill sites within 1500m of the study site:

0

Database searched and no data found.

3.1.3 Records of BGS/DoE non-operational landfill sites within 1500m of the study site:

0

Database searched and no data found.

3.1.4 Records of Landfills from Local Authority and Historical Mapping Records within 1500m of the study site:

0

Database searched and no data found.

3.2 Other Waste Sites

3.2.1 Records of waste treatment, transfer or disposal sites within 500m of the study site:

0

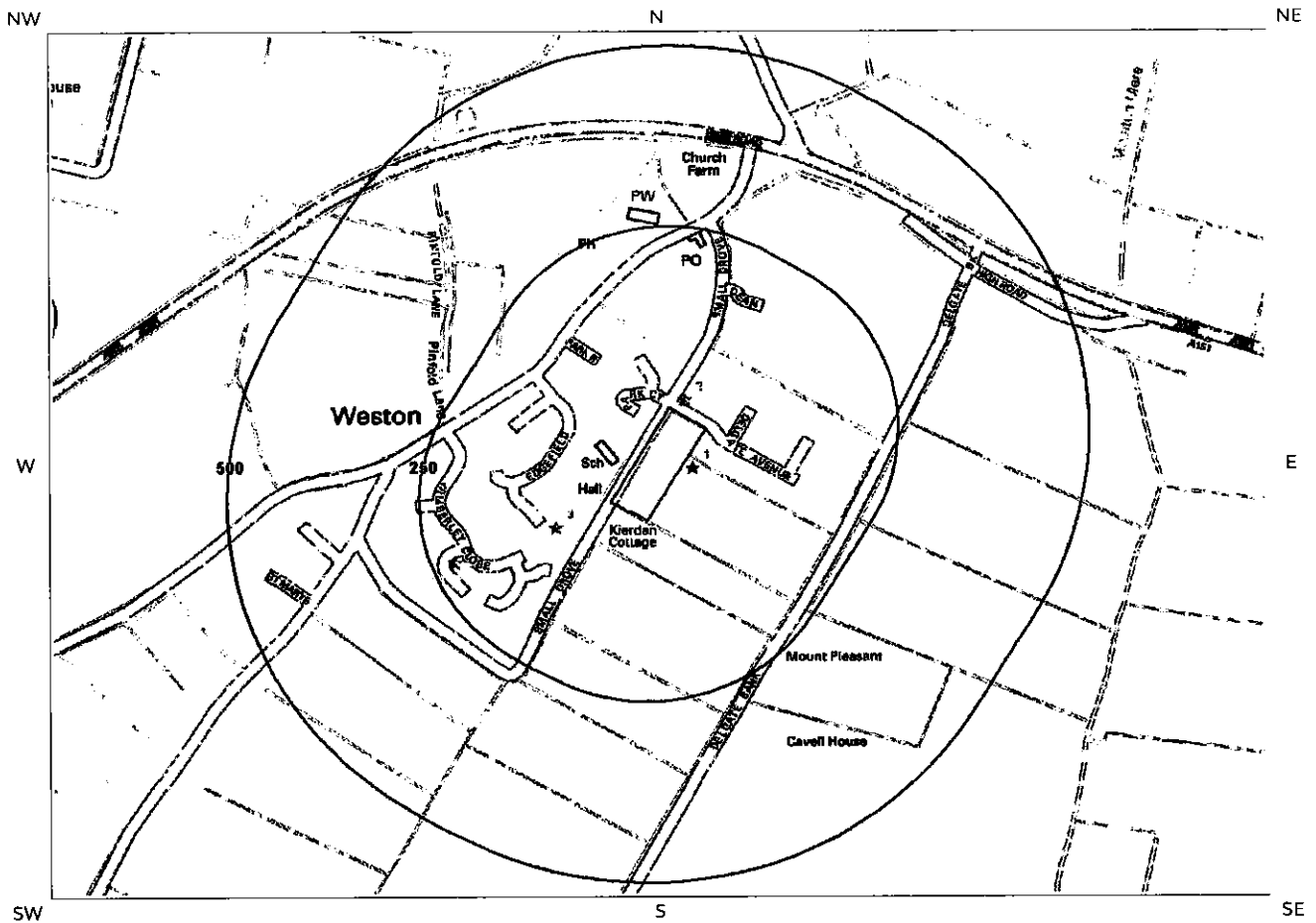
Database searched and no data found.

3.2.2 Records of Environment Agency/Natural Resources Wales licensed waste sites within 1500m of the study site:

0

Database searched and no data found.

4. Current Land Use Map



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4. Current Land Uses

4.1 Current Industrial Data

Records of potentially contaminative industrial sites within 250m of the study site:

4

The following records are represented as points on the Current Land Uses map.

ID	Distance (m)	Direction	Company	NGR	Address	Activity	Category
1	12	SE	Pumping Station	529314 324817	PE12	Water Pumping Stations	Industrial Features
2	21	NE	Electricity Sub Station	529304 324911	PE12	Electrical Features	Infrastructure and Facilities
3	80	SW	Pumping Station	529135 324734	PE12	Water Pumping Stations	Industrial Features
4	220	W	Ferland Container Services	529003 324686	1, St. Lamberts Grove, Weston, Spalding, PE12 6WD	Distribution and Haulage	Transport, Storage and Delivery

4.2 Petrol and Fuel Sites

Records of petrol or fuel sites within 500m of the study site:

0

Database searched and no data found.

4.3 National Grid High Voltage Underground Electricity Transmission Cables

This dataset identifies the high voltage electricity transmission lines running between generating power plants and electricity substations. The dataset does not include the electricity distribution network (smaller, lower voltage cables distributing power from substations to the local user network). This information has been extracted from databases held by National Grid and is provided for information only with no guarantee as to its completeness or accuracy. National Grid do not offer any warranty as to the accuracy of the available data and are excluded from any liability for any such inaccuracies or errors.

Records of National Grid high voltage underground electricity transmission cables within 500m of the study site:

0

Database searched and no data found.

4.4 National Grid High Pressure Gas Transmission Pipelines

This dataset identifies high-pressure, large diameter pipelines which carry gas between gas terminals, power stations, compressors and storage facilities. The dataset does not include the Local Transmission System (LTS) which supplies gas directly into homes and businesses. This information has been extracted from databases held by National Grid and is provided for information only with no guarantee as to its completeness or accuracy. National Grid do not offer any warranty as to the accuracy of the available data and are excluded from any liability for any such inaccuracies or errors.

Records of National Grid high pressure gas transmission pipelines within 500m of the study site: 0

Database searched and no data found.

5. Geology

5.1 Artificial Ground and Made Ground

Database searched and no data found.

The database has been searched on site, including a 50m buffer.

5.2 Superficial Ground and Drift Geology

The database has been searched on site, including a 50m buffer.

Lex Code	Description	Rock Type
TFD	TIDAL FLAT DEPOSITS	CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]

5.3 Bedrock and Solid Geology

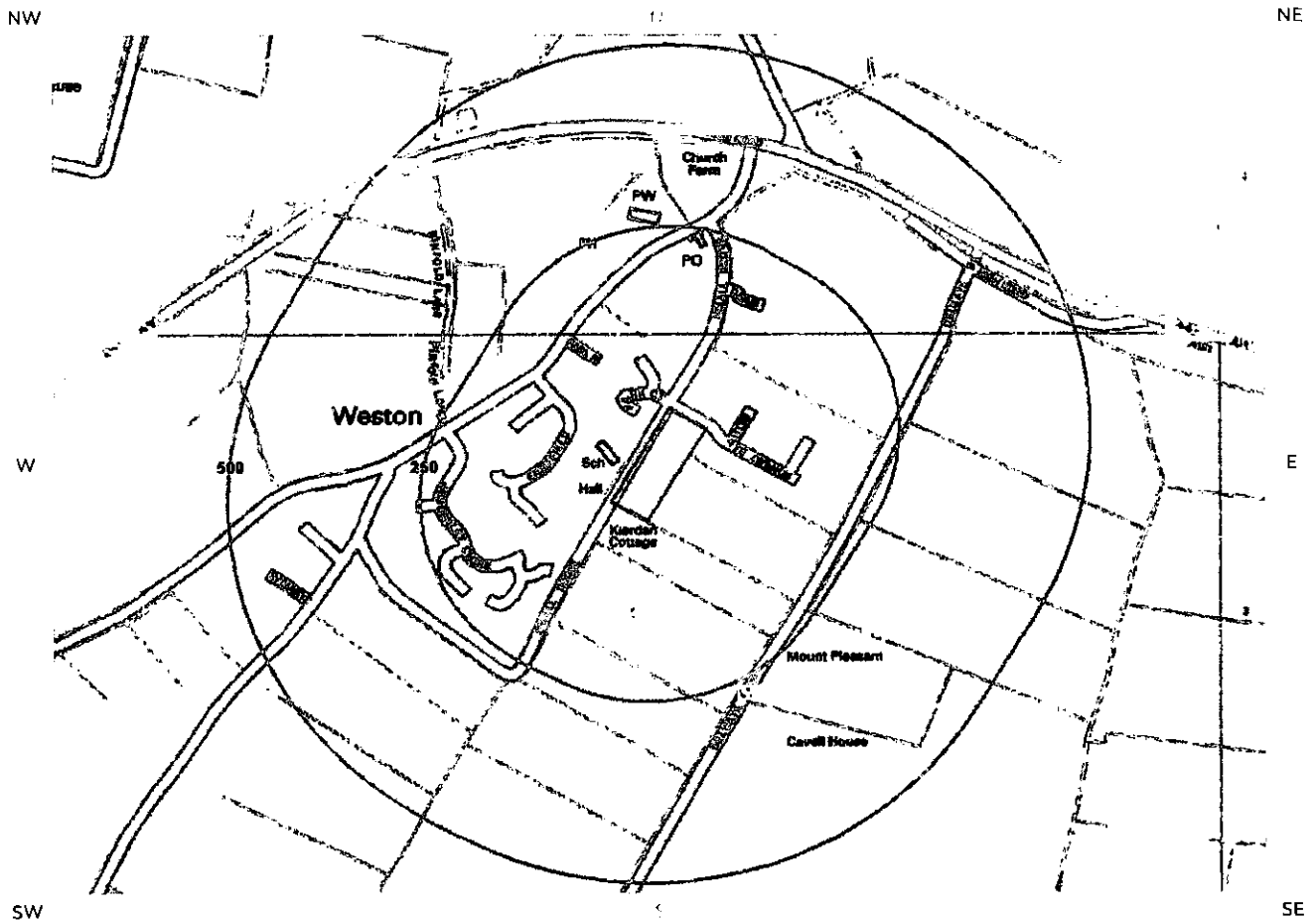
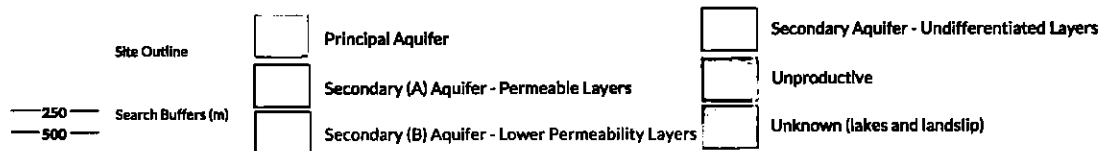
The database has been searched on site, including a 50m buffer.

Lex Code		
WWB-MDSI	WEST WALTON FORMATION	MUDSTONE AND SILTSTONE

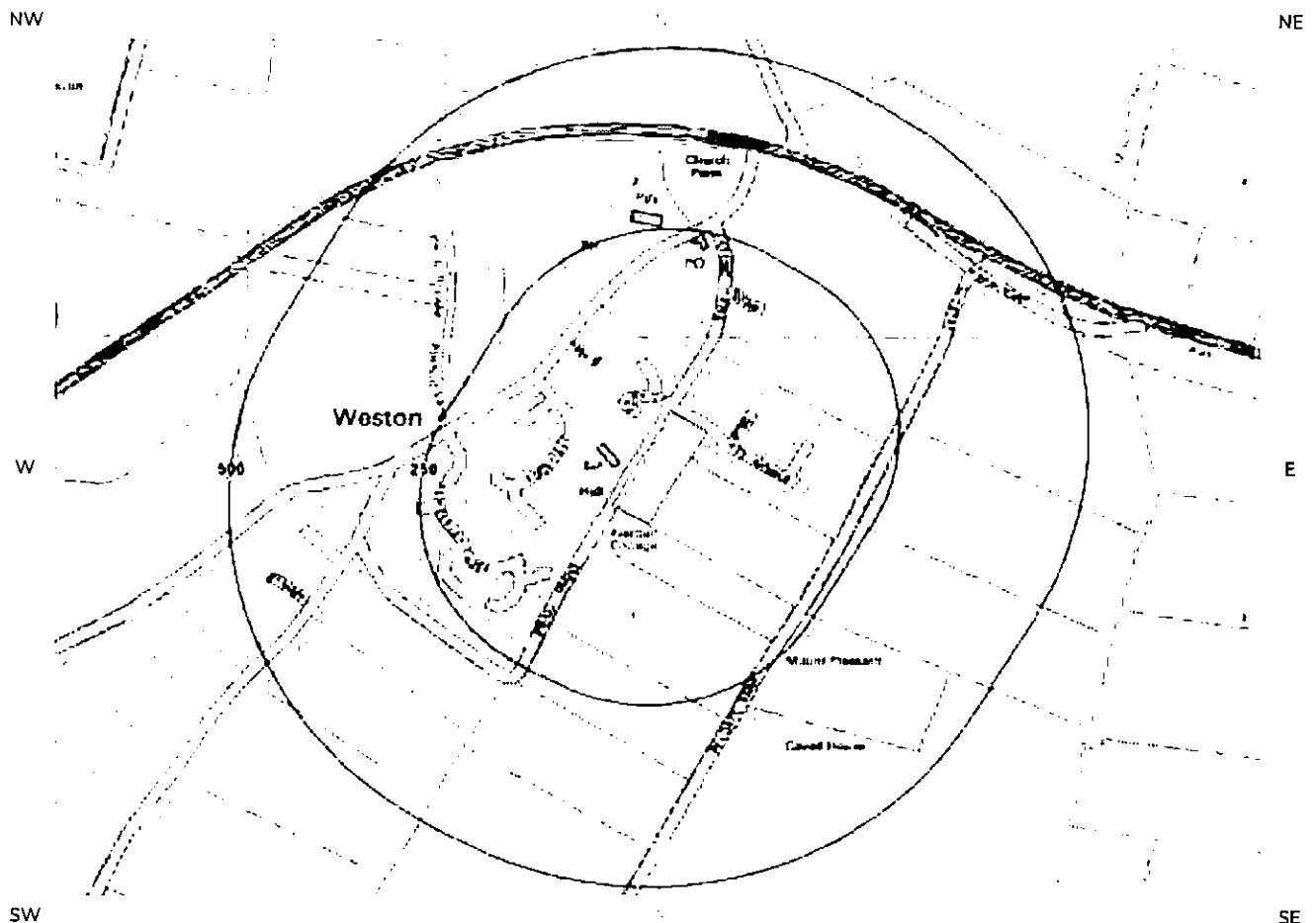
(Derived from the BGS 1:50,000 Digital Geological Map of Great Britain)

6 Hydrogeology and Hydrology

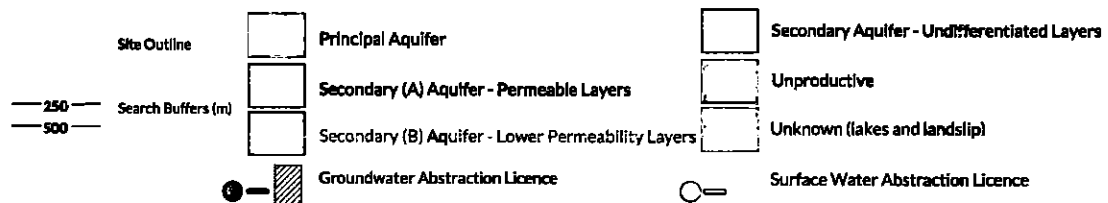
6a. Aquifer Within Superficial Geology



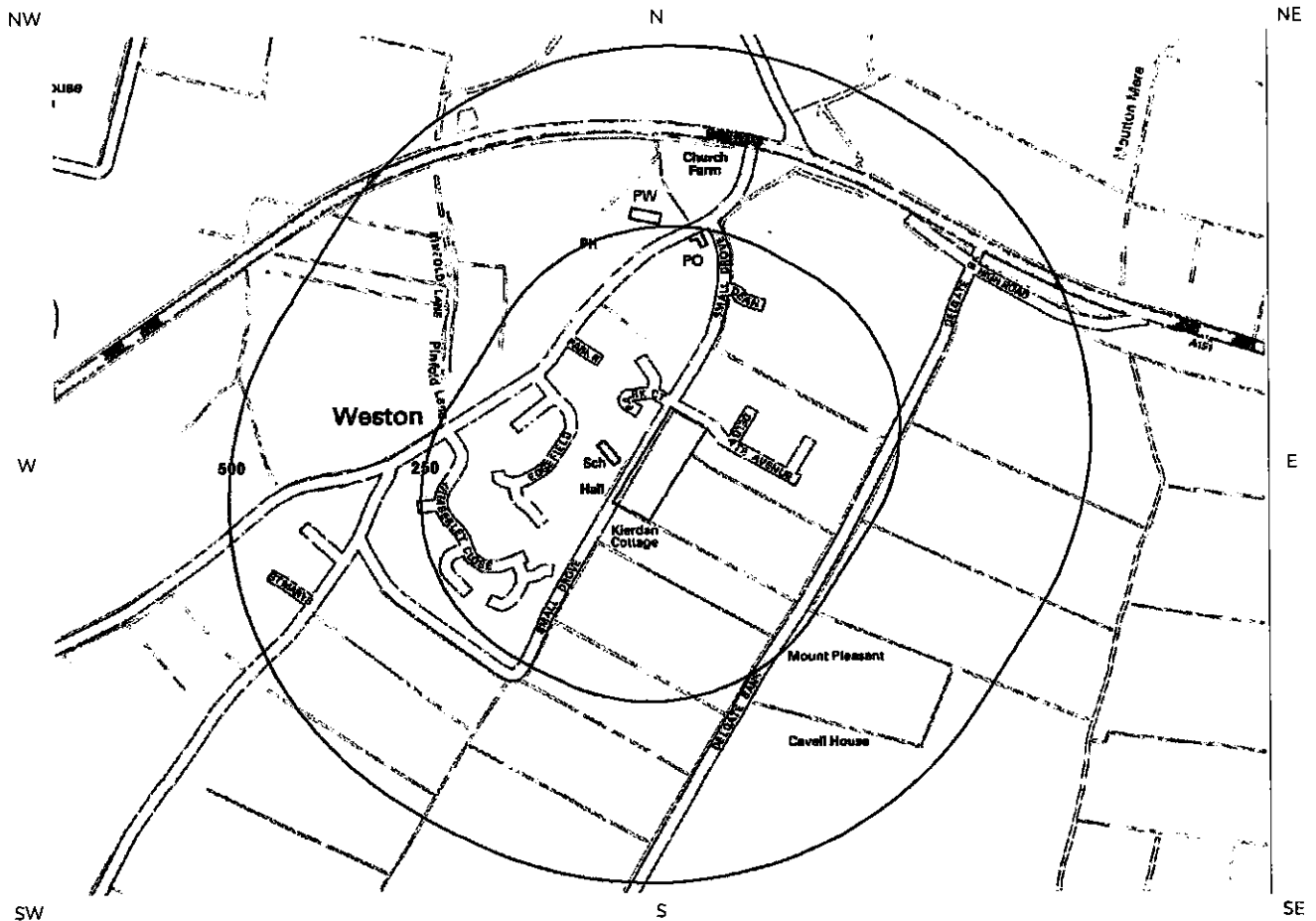
6b. Aquifer Within Bedrock Geology and Abstraction Licenses



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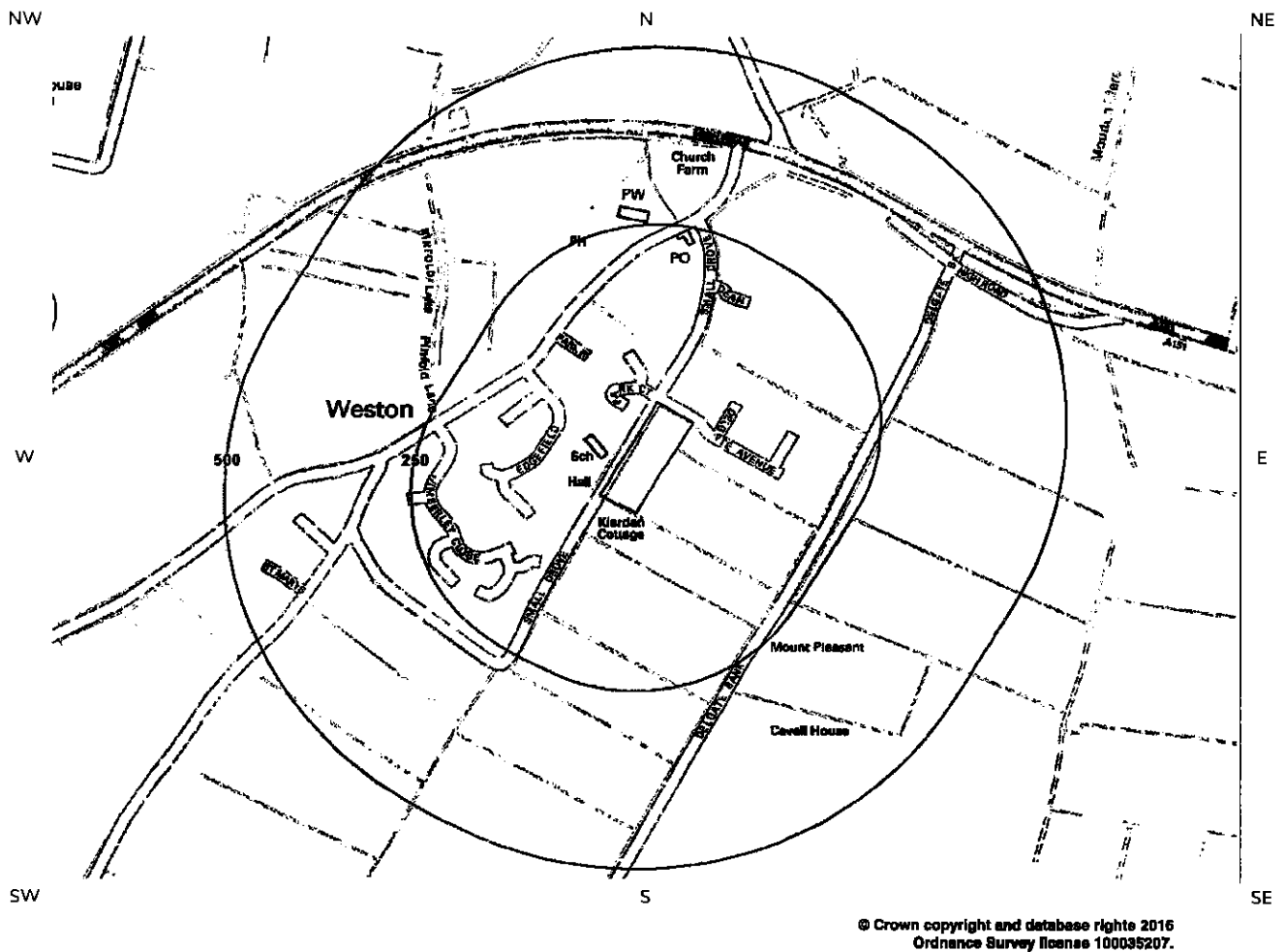
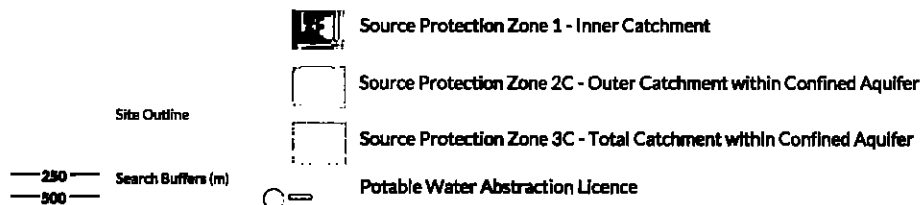
6c. Hydrogeology – Source Protection Zones and Potable Water Abstraction Licenses



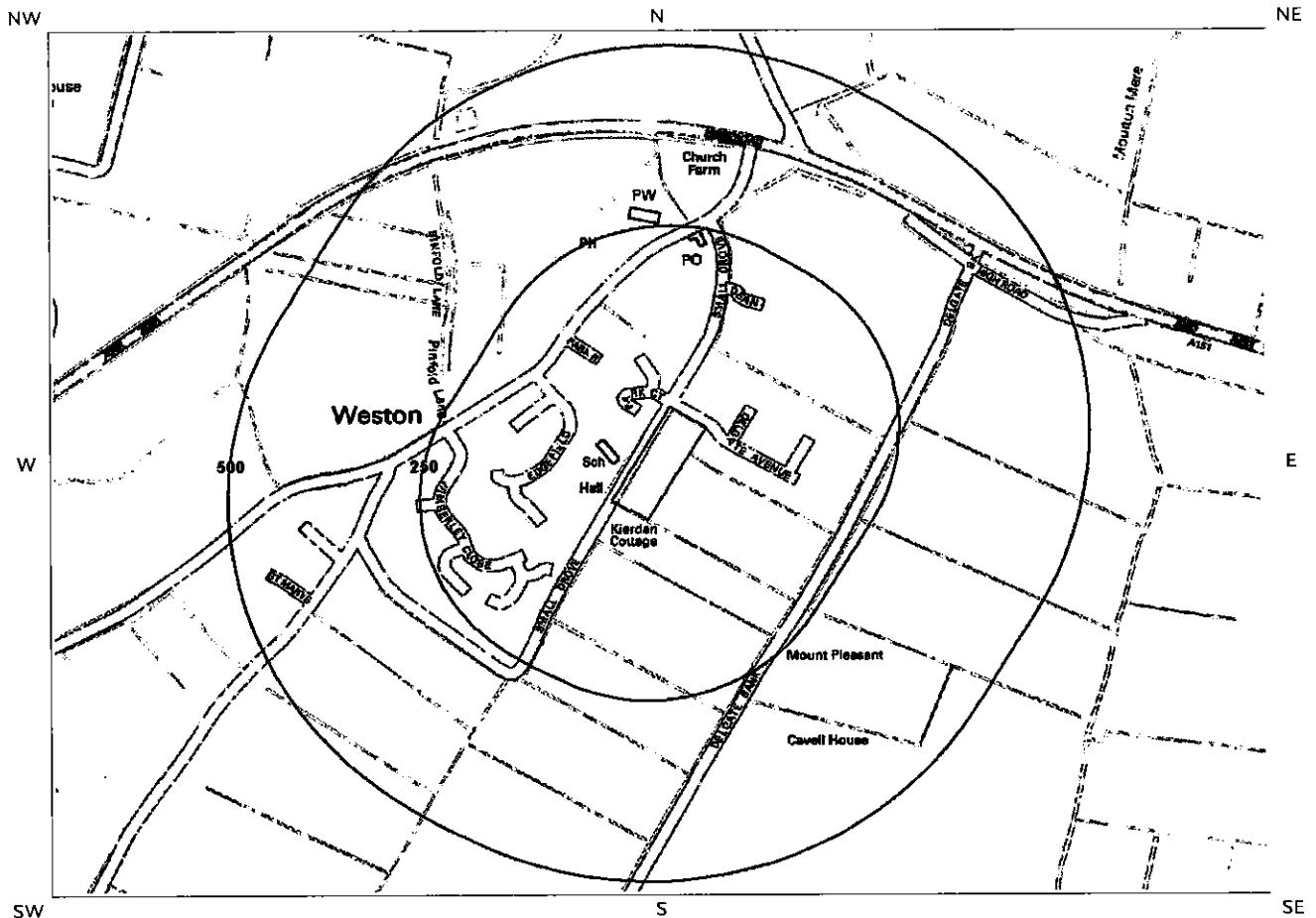
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- Site Outline
- 250 Search Buffers (m)
- 500 Search Buffers (m)
- Source Protection Zone 1 - Inner Catchment
- Source Protection Zone 2 - Outer Catchment
- Source Protection Zone 3 - Total Catchment
- Source Protection Zone 4 - Zone of Special Interest
- Potable Water Abstraction Licence

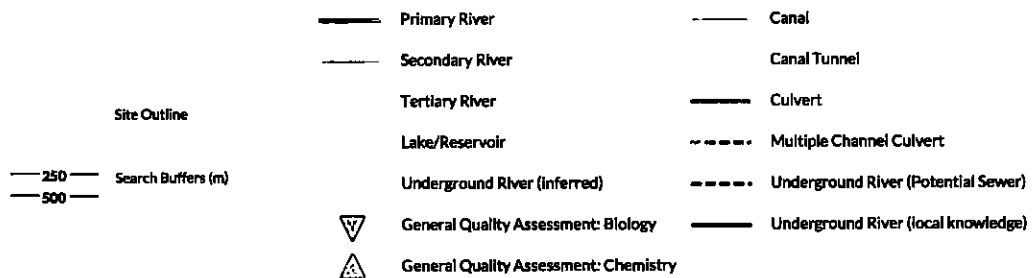
6d. Hydrogeology – Source Protection Zones within confined aquifer



6e. Hydrology – Detailed River Network and River Quality



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6. Hydrogeology and Hydrology

6.1 Aquifer within Superficial Deposits

Are there records of strata classification within the superficial geology at or in proximity to the property? Yes

From 1 April 2010, the Environment Agency/Natural Resources Wales's Groundwater Protection Policy has been using aquifer designations consistent with the Water Framework Directive. For further details on the designation and interpretation of this information, please refer to the Groundsure Enviro Insight User Guide.

The following aquifer records are shown on the Aquifer within Superficial Geology Map (6a):

ID	Distance (m)	Direction	Designation	Description
1	0	On Site	Unproductive	These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow
2	101	N	Unproductive	These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow

6.2 Aquifer within Bedrock Deposits

Are there records of strata classification within the bedrock geology at or in proximity to the property? Yes

From 1 April 2010, the Environment Agency/Natural Resources Wales's Groundwater Protection Policy has been using aquifer designations consistent with the Water Framework Directive. For further details on the designation and interpretation of this information, please refer to the Groundsure Enviro Insight User Guide.

The following aquifer records are shown on the Aquifer within Bedrock Geology Map (6b):

ID	Distance (m)	Direction	Designation	Description
1	0	On Site	Unproductive	These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow
2	101	N	Unproductive	These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow

6.3 Groundwater Abstraction Licences

Are there any Groundwater Abstraction Licences within 2000m of the study site? No

Database searched and no data found.

6.4 Surface Water Abstraction Licences

Are there any Surface Water Abstraction Licences within 2000m of the study site?

No

Database searched and no data found.

6.5 Potable Water Abstraction Licences

Are there any Potable Water Abstraction Licences within 2000m of the study site?

No

Database searched and no data found.

6.6 Source Protection Zones

Are there any Source Protection Zones within 500m of the study site?

No

Database searched and no data found.

6.7 Source Protection Zones within Confined Aquifer

Are there any Source Protection Zones within the Confined Aquifer within 500m of the study site?

No

Historically, Source Protection Zone maps have been focused on regulation of activities which occur at or near the ground surface, such as prevention of point source pollution and bacterial contamination of water supplies. Sources in confined aquifers were often considered to be protected from these surface pressures due to the presence of a low permeability confining layer (e.g. glacial till, clay). The increased interest in subsurface activities such as onshore oil and gas exploration, ground source heating and cooling requires protection zones for confined sources to be marked on SPZ maps where this has not already been done.

Database searched and no data found.

6.8 Groundwater Vulnerability and Soil Leaching Potential

Is there any Environment Agency/Natural Resources Wales information on groundwater vulnerability and soil leaching potential within 500m of the study site?

No

Database searched and no data found.

6.9 River Quality

Is there any Environment Agency/Natural Resources Wales information on river quality within 1500m of the study site? No

6.9. Biological Quality:

Database searched and no data found.

6.9.2 Chemical Quality:

Database searched and no data found.

6.10 Detailed River Network

Are there any Detailed River Network entries within 500m of the study site? No

Database searched and no data found.

6.11 Surface Water Features

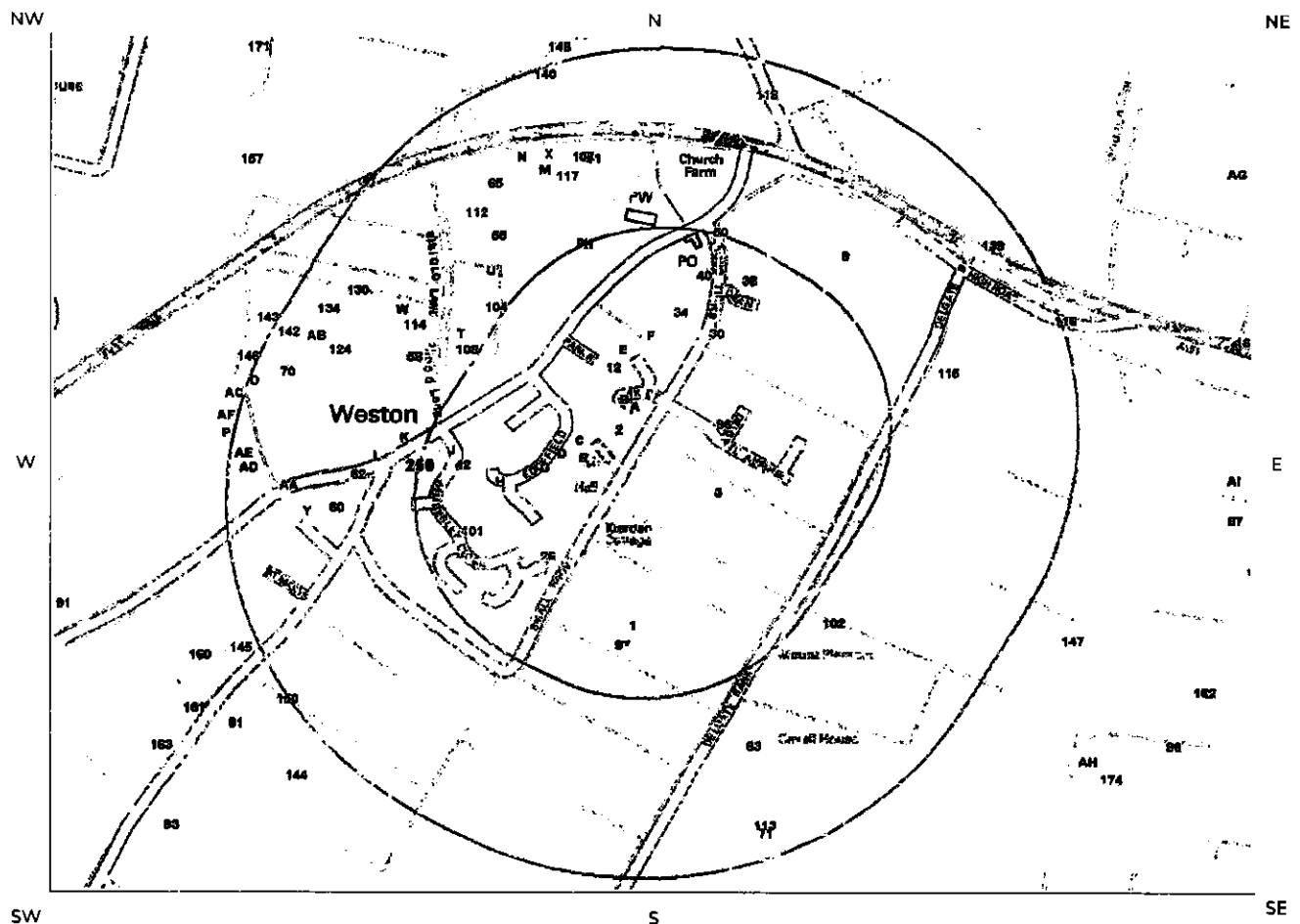
Are there any surface water features within 250m of the study site?

Yes

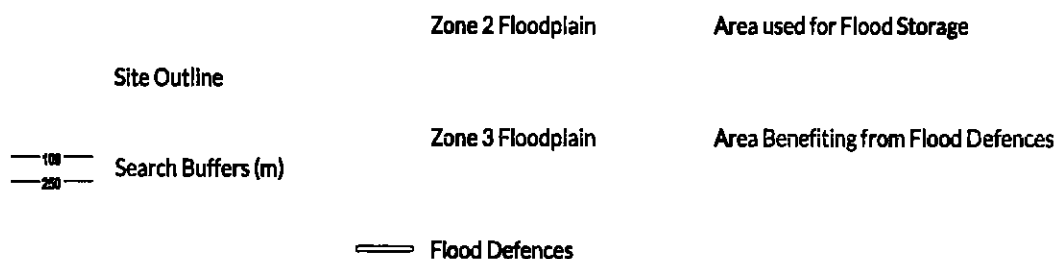
The following surface water records are not represented on mapping:

	Direction
0	On Site
0	On Site
55	SW
98	NE
136	SW
185	SW
194	N
218	SE
222	SE
226	SE
230	NW
233	SE
233	SE
240	NW
244	E

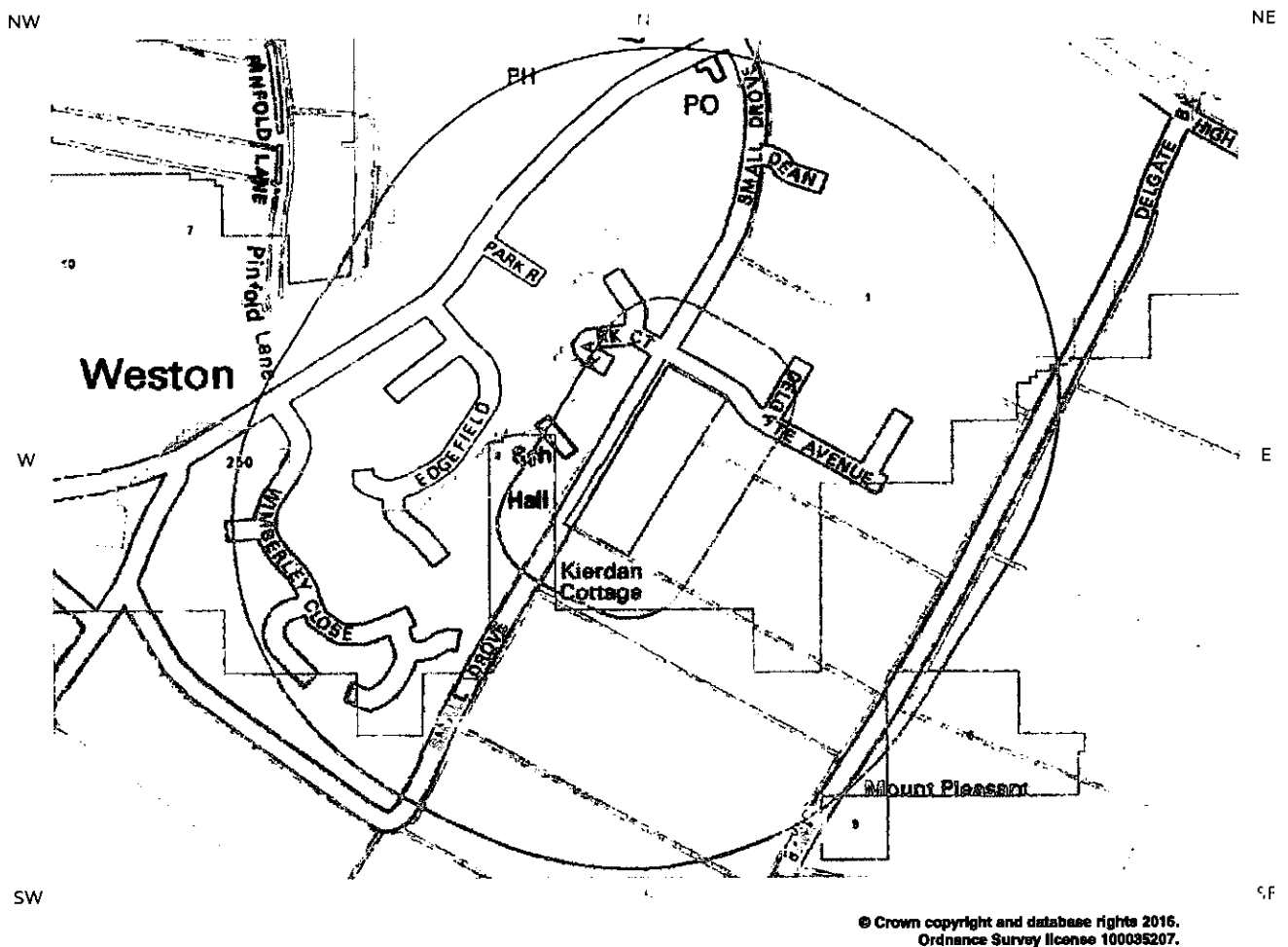
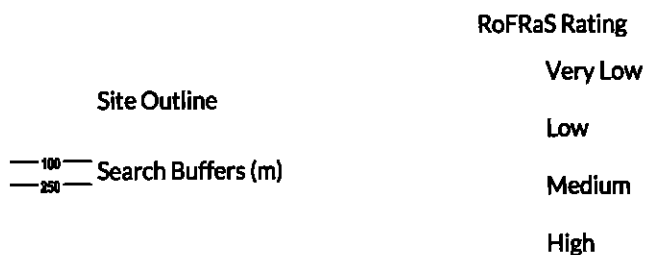
7a. Environment Agency/Natural Resources Wales Flood Map for Planning (from rivers and the sea)



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7b. Environment Agency/Natural Resources Wales Risk of Flooding from Rivers and the Sea (RoFRaS) Map



7 Flooding

7.1 River and Coastal Zone 2 Flooding

Is the site within 250m of an Environment Agency/Natural Resources Wales Zone 2 floodplain? **Yes**

Environment Agency/Natural Resources Wales Zone 2 floodplains estimate the annual probability of flooding as between 1 in 1000 (0.1%) and 1 in 100 (1%) from rivers and between 1 in 1000 (0.1%) and 1 in 200 (0.5%) from the sea. Any relevant data is represented on Map 7a – Flood Map for Planning:

ID	Distance (m)	Direction	Update	Type
1	0	On Site	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
2	13	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
3	31	SE	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
4A	32	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
5A	38	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
6A	39	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
7A	44	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
8B	47	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
9	50	E	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
10B	56	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
11C	69	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
12	69	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
13C	75	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
14C	81	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
15F	82	N	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
16C	82	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
17D	84	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
18C	84	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
19D	84	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)

20D	85	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
21D	85	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
22D	86	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
23D	87	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
24E	89	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
25E	89	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
26	89	SW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
27D	90	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
28D	90	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
29F	90	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
30	91	NE	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
31G	92	W	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
32G	96	W	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
33G	96	W	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
34	98	N	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
35G	98	W	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
36G	99	W	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
37	100	W	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
38	103	N	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
39H	137	W	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
40	140	N	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
41H	153	W	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
42	185	W	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
43J	213	W	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
44I	216	N	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
45I	218	N	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
46I	220	N	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
47J	224	W	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)

48S	231	NW	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
49I	235	N	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)
50	238	N	09-Sep-2016	Zone 2 - (Fluvial/Tidal Models)

7.2 River and Coastal Zone 3 Flooding

Is the site within 250m of an Environment Agency/Natural Resources Wales Zone 3 floodplain? **Yes**

Zone 3 shows the extent of a river flood with a 1 in 100 (1%) or greater chance of occurring in any year or a sea flood with a 1 in 200 (0.5%) or greater chance of occurring in any year. Any relevant data is represented on Map 7a – Flood Map for Planning.

ID	Distance (m)	Direction	Update	Type
1	0	On Site	09-Sep-2016	Zone 3 - (Fluvial Models)
2	0	On Site	09-Sep-2016	Zone 3 - (Fluvial Models)
3	51	NW	09-Sep-2016	Zone 3 - (Fluvial Models)
4A	57	NW	09-Sep-2016	Zone 3 - (Fluvial Models)
5A	65	W	09-Sep-2016	Zone 3 - (Fluvial Models)
6A	68	W	09-Sep-2016	Zone 3 - (Fluvial Models)
7A	236	SE	09-Sep-2016	Zone 3 - (Fluvial Models)
8B	240	NW	09-Sep-2016	Zone 3 - (Fluvial Models)
9	248	NW	09-Sep-2016	Zone 3 - (Fluvial Models)
10B	250	NW	09-Sep-2016	Zone 3 - (Fluvial Models)

7.3 Risk of Flooding from Rivers and the Sea (RoFRaS) Flood Rating

What is the highest risk of flooding onsite?

Low

The Environment Agency/Natural Resources Wales RoFRaS database provides an indication of river and coastal flood risk at a national level on a 50m grid with the flood rating at the centre of the grid calculated and given above. The data considers the probability that the flood defences will overtop or breach by considering their location, type, condition and standard of protection.

RoFRaS data for the study site indicates the property is in an area with a Low (greater than 1 in 1000 but less than 1 in 100) chance of flooding in any given year.

Any relevant data within 250m is represented on the RoFRaS Flood map. Data to 50m is reported in the table below.

ID	Distance (m)	Direction	RoFRaS flood Risk
1	0.0	On Site	Low
2	7.0	W	Medium

7.4 Flood Defences

Are there any Flood Defences within 250m of the study site?

No

Database searched and no data found.

7.5 Areas benefiting from Flood Defences

Are there any areas benefiting from Flood Defences within 250m of the study site?

No

7.6 Areas benefiting from Flood Storage

Are there any areas used for Flood Storage within 250m of the study site?

No

7.7 Groundwater Flooding Susceptibility Areas

7.7.1 Are there any British Geological Survey groundwater flooding susceptibility areas within 50m of the boundary of the study site? No

Notes: Groundwater flooding may either be associated with shallow unconsolidated sedimentary aquifers which overlie unproductive aquifers (Superficial Deposits Flooding), or with unconfined aquifers (Clearwater Flooding).

7.7.2 What is the highest susceptibility to groundwater flooding in the search area based on the underlying geological conditions?

Not Prone

The area is not considered to be prone to groundwater flooding based on rock type.

7.8 Groundwater Flooding Confidence Areas

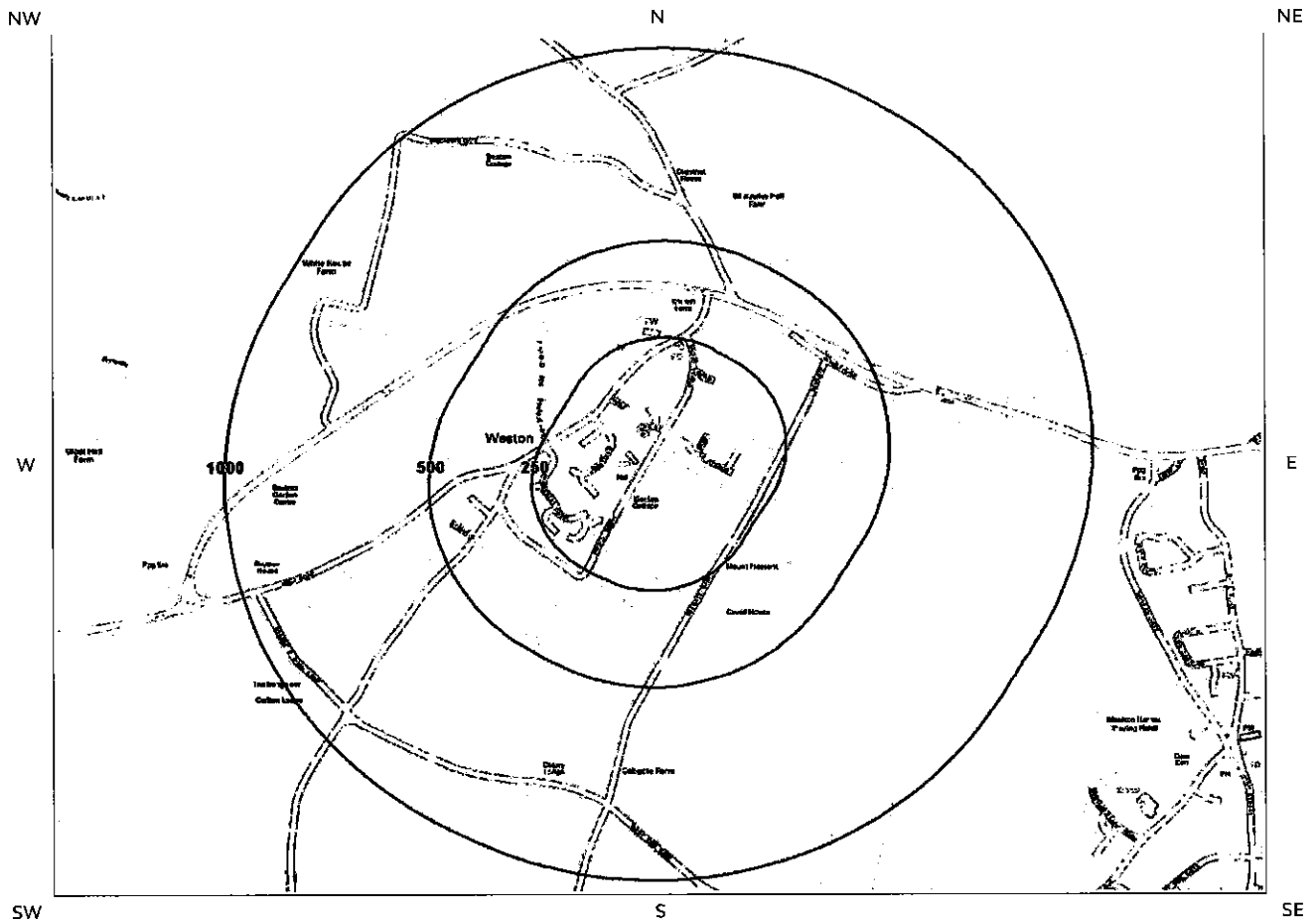
What is the British Geological Survey confidence rating in this result?

Not Applicable

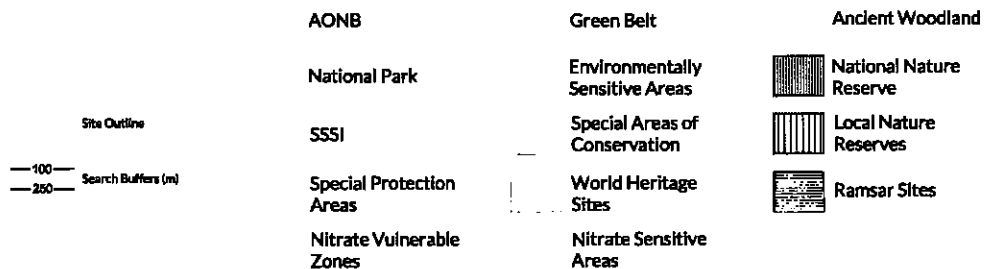
Notes: Groundwater flooding is defined as the emergence of groundwater at the ground surface or the rising of groundwater into man-made ground under conditions where the normal range of groundwater levels is exceeded.

The confidence rating is on a threefold scale - Low, Moderate and High. This provides a relative indication of the BGS confidence in the accuracy of the susceptibility result for groundwater flooding. This is based on the amount and precision of the information used in the assessment. In areas with a relatively lower level of confidence the susceptibility result should be treated with more caution. In other areas with higher levels of confidence the susceptibility result can be used with more confidence.

8. Designated Environmentally Sensitive Sites Map



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8. Designated Environmentally Sensitive Sites

Presence of Designated Environmentally Sensitive Sites within 2000m of the study site? No

8.1 Records of Sites of Special Scientific Interest (SSSI) within 2000m of the study site:

0

Database searched and no data found.

8.2 Records of National Nature Reserves (NNR) within 2000m of the study site:

0

Database searched and no data found.

8.3 Records of Special Areas of Conservation (SAC) within 2000m of the study site:

0

Database searched and no data found.

8.4 Records of Special Protection Areas (SPA) within 2000m of the study site:

0

Database searched and no data found.

8.5 Records of Ramsar sites within 2000m of the study site:

0

Database searched and no data found.

8.6 Records of Ancient Woodland within 2000m of the study site:

0

Database searched and no data found.

8.7 Records of Local Nature Reserves (LNR) within 2000m of the study site:

0

Database searched and no data found.

8.8 Records of World Heritage Sites within 2000m of the study site:

0

Database searched and no data found.

8.9 Records of Environmentally Sensitive Areas within 2000m of the study site:

0

Database searched and no data found.

8.10 Records of Areas of Outstanding Natural Beauty (AONB) within 2000m of the study site:

0

Database searched and no data found.

8.11 Records of National Parks (NP) within 2000m of the study site:

0

Database searched and no data found.

8.12 Records of Nitrate Sensitive Areas within 2000m of the study site:

0

Database searched and no data found.

8.13 Records of Nitrate Vulnerable Zones within 2000m of the study site:

0

Database searched and no data found.

8.14 Records of Green Belt land within 2000m of the study site:

0

Database searched and no data found.

9. Natural Hazards Findings

9.1 Detailed BGS GeoSure Data

BGS GeoSure Data has been searched to 50m. The data is included in tabular format. If you require further information on geology and ground stability, please obtain a Groundsure Geo Insight, available from our website. The following information has been found:

9.1.1 Shrink Swell

What is the maximum Shrink-Swell** hazard rating identified on the study site? Low

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard

Ground conditions predominantly medium plasticity. Do not plant trees with high soil moisture demands near to buildings. For new build, consideration should be given to advice published by the National House Building Council (NHBC) and the Building Research Establishment (BRE). There is a possible increase in construction cost to reduce potential shrink-swell problems. For existing property, there is a possible increase in insurance risk, especially during droughts or where vegetation with high moisture demands is present.

9.1.2 Landslides

What is the maximum Landslide* hazard rating identified on the study site? Very Low

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard

Slope instability problems are unlikely to be present. No special actions required to avoid problems due to landslides. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with landslides.

9.1.3 Soluble Rocks

What is the maximum Soluble Rocks* hazard rating identified on the study site? Negligible

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard

Soluble rocks are present, but unlikely to cause problems except under exceptional conditions. No special actions required to avoid problems due to soluble rocks. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with soluble rocks.

* This indicates an automatically generated 50m buffer and site.

9.1.4 Compressible Ground

What is the maximum Compressible Ground* hazard rating identified on the study site? Moderate

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard

Significant potential for compressibility problems. Avoid large differential loadings of ground. Do not drain or de-water ground near the property without technical advice. For new build consider possibility of compressible ground in ground investigation, construction and building design. Consider effects of groundwater changes. Extra construction costs are likely. For existing property possible increase in insurance risk from compressibility, especially if water conditions or loading of the ground change significantly.

9.1.5 Collapsible Rocks

What is the maximum Collapsible Rocks* hazard rating identified on the study site? Negligible

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard

No indicators for collapsible deposits identified. No actions required to avoid problems due to collapsible deposits. No special ground investigation required, or increased construction costs or increased financial risk due to potential problems with collapsible deposits.

9.1.6 Running Sand

What is the maximum Running Sand** hazard rating identified on the study site? Moderate

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard

Significant potential for running sand problems with relatively small changes in ground conditions. Avoid large amounts of water entering the ground (for example through pipe leakage or soak-aways). Do not dig (deep) holes into saturated ground near the property without technical advice. For new build consider the consequences of soil and groundwater conditions during and after construction. For existing property possible increase in insurance risk from running sand, for example, due to water leakage, high rainfall events or flooding.

9.2 Radon

9.2.1 Radon Affected Areas

Is the property in a Radon Affected Area as defined by the Health Protection Agency (HPA) and if so what percentage of homes are above the Action Level? The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.

* This indicates an automatically generated 50m buffer and site.

9.2.2 Radon Protection

Is the property in an area where Radon Protection are required for new properties or extensions to existing

ones as described in publication BR211 by the Building Research Establishment?

No radon protective measures are necessary.

10. Mining

10.1 Coal Mining

Are there any coal mining areas within 75m of the study site? No

Database searched and no data found.

10.2 Non-Coal Mining

Are there any Non-Coal Mining areas within 50m of the study site boundary? No

Database searched and no data found.

10.3 Brine Affected Areas

Are there any brine affected areas within 75m of the study site? No

Guidance: No Guidance Required.

Contact Details

Groundsure Helpline
Telephone: 08444 159 000
info@groundsure.com



British Geological Survey Enquiries
Kingsley Dunham Centre
Keyworth, Nottingham NG12 5GG
Tel: 0115 936 3143.
Fax: 0115 936 3276.
Email:

Web: www.bgs.ac.uk

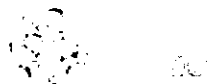
BGS Geological Hazards Reports and general geological enquiries:
enquiries@bgs.ac.uk



Environment Agency
National Customer Contact Centre, PO Box 544
Rotherham, S60 1BY
Tel: 03708 506 506

Web: www.environment-agency.gov.uk

Email: enquiries@environment-agency.gov.uk



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133-155 Waterloo Road, London, SE1 8UG
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Ordnance Survey
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Local Authority
Authority: South Holland District Council
Phone: 01775 761 161
Web: <http://www.sholland.gov.uk/>
Address: Council Offices, Priory Road, Spalding, Lincolnshire, PE11

Gemapping PLC
Virginia Villas, High Street, Hartley Witney,
Hampshire RG27 8NW
Tel: 01252 845444



APPENDIX 3

CLASSIFICATION OF AGGRESSIVE CHEMICAL ENVIRONMENT FOR BURIED CONCRETE

TABLE C1 – AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE
(ACEC) CLASSIFICATION FOR NATURAL GROUND LOCATIONS^a

Table C1 Aggressive Chemical Environment for Concrete (ACEC) classification for natural ground locations^a						
Sulfate				Groundwater		ACEC
Design Sulfate	2:1 water/soil	Groundwater	Total potential	Static	Mobile	Class for
Class for location	extract^b		sulfate^c	water	water	location
1	2	3	4	5	6	7
	(SO₄ mg/l)	(SO₄ mg/l)	(SO₄ %)	(pH)	(pH)	
DS-1	< 500	< 400	< 0.24	≥ 2.5		AC-1s
					> 5.5 ^d	AC-1 ^d
					2.5–5.5	AC-2z
DS-2	500–1500	400–1400	0.24–0.6	> 3.5		AC-1s
					> 5.5	AC-2
				2.5–3.5		AC-2s
					2.5–5.5	AC-3z
DS-3	1600–3000	1500–3000	0.7–1.2	> 3.5		AC-2s
					> 5.5	AC-3
				2.5–3.5		AC-3s
					2.5–5.5	AC-4
DS-4	3100–6000	3100–6000	1.3–2.4	> 3.5		AC-3s
					> 5.5	AC-4
				2.5–3.5		AC-4s
					2.5–5.5	AC-5
DS-5	> 6000	> 6000	> 2.4	> 3.5		AC-4s
				2.5–3.5	≥ 2.5	AC-5

Notes

- a** Applies to locations on sites that comprise either undisturbed ground that is in its natural state (ie is not brownfield – Table C2) or clean fill derived from such ground.
- b** The limits of Design Sulfate Classes based on 2:1 water/soil extracts have been lowered relative to previous Digests (Box C7).
- c** Applies only to locations where concrete will be exposed to sulfate ions (SO₄) which may result from the oxidation of sulfides (eg pyrite) following ground disturbance (Appendix A1 and Box C8).
- d** For flowing water that is potentially aggressive to concrete owing to high purity or an aggressive carbon dioxide level greater than 15 mg/l (Section C2.2.3), increase the ACEC Class to AC-2z.

Explanation of suffix symbols to ACEC Class

- Suffix 's' indicates that the water has been classified as static.
- Concrete placed in ACEC Classes that include the suffix 'z' primarily have to resist acid conditions and may be made with any of the cements or combinations listed in Table D2 on page 42.

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Site Investigations



Geologists



Environmental &
Geotechnical
Engineers



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Date: 16th January 2019

GROUND GAS RISK ASSESSMENT SMALL DROVE, WESTON S181221/GAS

INTRODUCTION

Authorisation

The ground gas monitoring carried out by Solmek was to the instructions of William Saunders, on a parcel of land to the east of Small Drove, Weston.

Sources of information provided by William Saunders, including previous work undertaken at the site, are detailed below:

- *Ground Engineering Ltd Phase 2 Site Investigation (Project No C14022A).*

Reference should be made to the above report for details of the site's underlying geological conditions.

Scope of Works

The proposed development is outlined to be residential housing with gardens, soft landscaping and areas of hardstanding. A drawing showing the previous borehole locations are shown in Figure 1 attached.

The information provided in this Ground Gas Assessment is based on the investigation fieldwork, and is subject to the comments and approval of the various Regulatory Authorities.

There may be other conditions prevailing on the site which have not been disclosed by this investigation and which have not been taken into account by this report. Solmek reserve the right to alter conclusions and recommendations should further information be available or provided. Any schematic representation or opinion of the possible configuration of ground conditions between exploratory holes is conjectural and given for guidance only and confirmation of intermediate ground conditions should be considered if deemed necessary.

GROUND GAS ASSESSMENT

The proposed development of the site involves residential housing. Therefore, ground gas results have been compared to the NHBC Traffic Light System, shown in Table 1.

Ground gases such as carbon dioxide (CO₂) and methane (CH₄) can be classed as a form of contamination where there is a potential risk to human health. Previous ground gas monitoring carried out by others has proven raised methane levels locally. As a result, three additional visits have been carried out between December 2018 and January 2019 to assess the potential risks posed by ground gases.

The gas was monitored by measuring emissions from monitoring points installed into boreholes WS1, WS6 and WS9 during the fieldwork. The results are appended to this report. The monitoring was generally carried out in accordance with current guidance provided within CIRIA C665:2007.

Ground Gas Results

The atmospheric pressure has an impact on the concentrations of gas released. The atmospheric pressure was between 1008 and 1025 millibars during the surveys. Times of rising and falling atmospheric pressure regional trends were noted during each survey. Boreholes were purged of groundwater after measuring the water levels. Gas monitoring was then undertaken after a suitable time period.

Carbon dioxide concentrations were recorded between 0.1 and 4.4% volume, and oxygen levels were between 0.1 and 20.4%. There was evidence of oxygen depletion, (recorded at <19%), within WS1 and WS9 on all three occasions, and in WS6 on the second and third visit.

Methane was not detected in boreholes WS6 and WS9 during the survey and no flow rates were recorded. However within WS1, methane was detected on all three occasions at levels of 87.4%, 36.2% and 70.5% respectively with related flows ranging between 4.0l/hr and 11.0l/hr.

Ground Gas Analysis

The results obtained have been compared with relevant guidance that includes the following:

- BRE/Environment Agency BR414 (2001) - Protective Measures for housing on gas-contaminated land
- Wilson & Card (1999) - Reliability and Risk in Gas Protection Design
- CIRIA 149 (1995) - Protecting Development from Methane
- CIRIA C665 (2007) – Assessing risks posed by hazardous ground gases to buildings.

The Building Regulations set action levels for both methane and carbon dioxide from which an initial assessment can be made. The action threshold for methane is 1% while for carbon dioxide an initial consideration should be undertaken if gas concentrations exceed 1.5%. Action might be required if carbon dioxide concentrations exceed 5%. If these thresholds are exceeded, reference should be made to specific documentation to determine the nature and extent of the gas control measures required.

TABLE 1: NHBC TRAFFIC LIGHT SYSTEM (FROM CIRIA C665)

Traffic light classification	Methane		Carbon dioxide	
	Typical max concentration (% v/v)	Gas screening value (litres/hr)	Typical max concentration (% v/v)	Gas screening value (litres/hr)
Green	1	0.16	5	0.78
Amber 1				
Amber 2	5	0.63	10	1.56
Red	20	1.56	30	3.13

The gas concentrations from the monitoring visits would place the site in **NHBC Red**. A list of gas protection required are given in the table below.

TABLE 2: NHBC PROTECTION MEASURES

Traffic light classification	Protection measures required
Green	Gas protection measures not considered necessary.
Amber 1	Gas resistant membrane & ventilated sub-floor void to create permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as per BRE Report 414.
Amber 2	As Amber 1 but membrane should be installed by a specialist contractor; certification of correct installation is also required. Installation & certification 'package' is the ideal way to do this.
Red	Standard residential housing would be unacceptable without further risk assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

Yours sincerely,



Deryck Simpson
On behalf of Solmek Ltd.



Title
Borehole Location Plan
Project
Small Drove, Weston
Client
William Saunders
Date
January 2019
Fig No.
Figure 1
Scale
NTS
Key
 N
<p style="text-align: right;">Solmek Ltd. 12 Yarm Road Stockton-on-Tees TS18 3NA</p> <p style="text-align: right;">Tel: +44 (0) 1642 607083 Fax: +44 (0) 1642 612355 e-mail: south@solmek.com www.solmek.com</p> <p style="text-align: right;">  </p>



GAS MONITORING RESULTS

Project number	S181221
Project name	SMALL DROVE, WESTON
Client	William Saunders
Visit no	1
Date	18/12/2018
Equipment	GFM 435 Gas Analyser
Operator	KM

Weather Conditions	CLOUDY
Ground Conditions	DAMP
Ambient Atmospheric Pressure	1008
Regional Pressure Trend	Rising

Position	Flow	Pressure	CH ₄		CO ₂		O ₂ (% v/v)	CO (ppm)	H ₂ S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
WS1	4.0	1008	87.4	3.4960	4.4	0.1760	0.1			0.78	3.00	
WS6	0.1	1008	0.0	0.0000	0.1	0.0001	20.4			1.41	3.00	
WS9	0.1	1008	0.0	0.0000	2.4	0.0024	17.9			1.12	3.00	

KEY

CH₄ = Methane, **CO₂** = Carbon Dioxide, **O₂** = Oxygen, **CO** = Carbon Monoxide, **H₂S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.



GAS MONITORING RESULTS

Project number	S181221
Project name	SMALL DROVE, WESTON
Client	William Saunders
Visit no	2
Date	08/01/2019
Equipment	GFM 435 Gas Analyser
Operator	KM

Weather Conditions	SUNNY
Ground Conditions	DRY
Ambient Atmospheric Pressure	1025
Regional Pressure Trend	Falling

Position	Flow	Pressure	CH ₄		CO ₂		O ₂ (% v/v)	CO (ppm)	H ₂ S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
WS1	11.0	1025	36.2	3.9856	1.7	0.1872	11.1			0.78	3.00	
WS6	0.1	1025	0.0	0.0000	1.7	0.0017	18.4			1.39	3.00	
WS9	0.1	1025	0.0	0.0000	2.8	0.0028	16.7			1.10	3.00	

KEY

CH₄ = Methane, **CO₂** = Carbon Dioxide, **O₂** = Oxygen, **CO** = Carbon Monoxide, **H₂S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.



GAS MONITORING RESULTS

Project number	S181221
Project name	SMALL DROVE, WESTON
Client	William Saunders
Visit no	3
Date	15/01/2019
Equipment	GFM 435 Gas Analyser
Operator	KM

Weather Conditions	SUNNY
Ground Conditions	DAMP
Ambient Atmospheric Pressure	1013
Regional Pressure Trend	Falling

Position	Flow	Pressure	CH ₄		CO ₂		O ₂ (% v/v)	CO (ppm)	H ₂ S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
WS1	5.0	1013	70.5	3.5250	2.6	0.1300	5.7			1.00	3.00	
WS6	0.1	1013	0.0	0.0000	1.8	0.0018	17.1			1.41	3.00	
WS9	0.1	1013	0.0	0.0000	0.6	0.0006	18.3			1.10	3.00	

KEY

CH₄ = Methane, **CO₂** = Carbon Dioxide, **O₂** = Oxygen, **CO** = Carbon Monoxide, **H₂S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

These conditions accompany our tender and supercede any previous conditions issued. Solmek will prepare a report solely for the use of the Client (the party invoiced) and its agent(s). No reliance should be placed on the contents of this report, in whole or in part by 3rd parties. The report, its content and format and associated data are copyright, and the property of Solmek. Photocopying of part or all of the contents, transfer or reproduction of any kind is forbidden without written permission from Solmek. A charge may be levied against such approval, the same to be made at the discretion of Solmek. Solmek was a trading name of Hymas Geoenvironmental Ltd.

Solmek cannot be held liable and do not warrant, or otherwise guarantee the validity of information provided by third parties and subsequently used in our reports. Solmek are not responsible for the action negligent of otherwise of subcontractors or third parties.

Site investigation is a process of sampling. The scope and size of an investigation may be considered proportional to levels of confidence regarding the ground and groundwater conditions. The exploratory holes undertaken investigate only a small volume of the ground in relation to the overall size of the site, and can only provide a general indication of site conditions. The opinions provided and recommendations given in this report are based on the ground conditions as encountered within each of the exploratory holes. There may be different ground conditions elsewhere on the site which have not been identified by this investigation and which therefore have not been taken into account in this report. Reports are generally subject to the comments of the local authority and Environment Agency. The comments made on groundwater conditions are based on observations made at the time that site work was carried out. It should be noted that mobile contamination, ground gas levels and groundwater levels may vary owing to seasonal, tidal and/or weather related effects. Solmek cannot be held liable for any unrecorded or unforeseen obstructions between exploratory boreholes and trial pits. This includes instances where previous structures on the site (buried man made structures) or the presence of boulder clay (cobbles and/or boulder obstructions) have been anticipated. All types of piling operations should make allowance for obstructions within the construction budget to accommodate this. Unrecorded ancient mining may occur anywhere where seams that have been worked and influence the rock and soil above. Dissolution cavities can occur where gypsum or chalk is present. Rotary drilling is the recommended technique to prove the integrity of the rock.

Where the scope of the investigation is limited via access to information, time constraints, equipment limitations, testing, interpretation or by the client or his agents budgetary constraints, elements not set out in the proposal and excluded from the report are deemed to be omitted from the scope of the investigation.

Desk studies are generally prepared in accordance with RICS guidelines. Environmental site investigations are generally undertaken as 'exploratory investigations' in accordance with the definitions provided in paragraph 5.4 of BS 10175:2001 in order to confirm the conceptual assumptions. You are advised to familiarize yourself with the typical scope of such an investigation. No pumping of water will be undertaken unless a licence or facilities/equipment have been arranged by others.

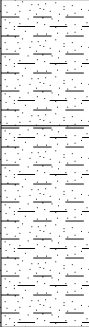
Where the type, number or/and depth of exploratory hole is specified by others, Solmek cannot and will not be responsible for any subsequent shortfall or inadequacy in data, and any consequent shortfall in interpretation of environmental and geotechnical aspects which may be required at a later date in order to facilitate the design of permanent or temporary works.

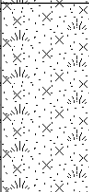
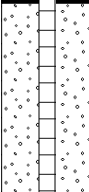
All information acquired by Solmek in the course of investigation is the property of Solmek, and, only also becomes the joint property of the Client only on the complete settlement of all invoices relating to the project. Solmek reserve the right to use the information in commercial tendering and marketing, unless the Client expressly wishes otherwise in writing. The quoted rates do not include VAT, and payment terms are 30 days from dispatch of invoice from our offices. Quotes are subject to a site visit.

We have allowed for 1 mobilisation and normal working hours unless otherwise stated. The scope of the investigation may be reviewed following the desk study and/or fieldwork. The presence or otherwise of Japanese Knotweed or other invasive plants can be difficult to identify especially during winter months. If Japanese Knotweed or other invasive species are suspect, it should be confirmed by an ecologist. We have not allowed for acquiring services information, and cannot be responsible for damage to underground services or pipes not shown to us or not clearly shown on plans. Costs incurred will be passed on to you, and in commissioning Solmek you understand and accept that you/your agent have a contractual relationship with Solmek & you accept this. Our rates assume unobstructed, reasonably level and firm access to the exploratory positions and adequate clear working areas and headroom. We have priced on the basis that you or your client have the necessary permissions, wayleaves and approvals to access land. All boreholes and pits are backfilled with arisings except where gas monitoring pipes are installed with stopcock covers. Solmek are not responsible for any uneven surfaces as a result of siteworks and rutting and backfilled excavations may require re-levelling and/or making good by others after fieldwork is complete, and Solmek has not allowed for this. No price has been provided or requested for a return visit to remove pipework and covers. Hourly rates apply to consultancy only and do not include expenses unless otherwise shown. If warranties are required, legal costs incurred will be passed on to you assuming Solmek agree to complete such warranties, modified or otherwise and you understand and agree to pay all costs.

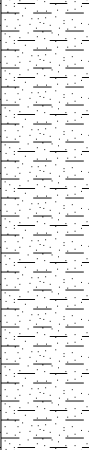
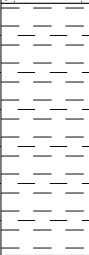
We reserve the right to pursue full payment of the invoice prior to release of any information including reports. We advise you/your client that we may elect to pursue our statutory rights under late payment legislation, and will apply 8% to the base rate for unreasonably late payments. Solmek are exempt from the CIS Scheme. Solmek offer to undertake work only in strict accordance with conditions covered by our current insurances, which are available for inspection. Solmek are not responsible for acts, negligent or otherwise of subcontractors and as a matter of policy cannot indemnify any other parties. Professional indemnity Insurance is limited to ten times the invoice net total except where stated otherwise by Solmek. Solmek give notice that consequential loss as a direct or indirect result of Solmek's activities or omission of the same are excluded.

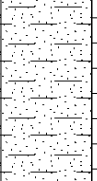
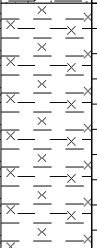
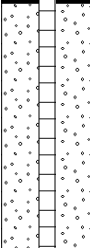
Appendix C – Borehole Logs

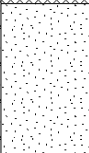
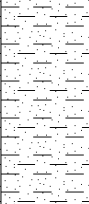
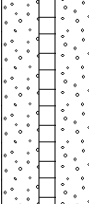
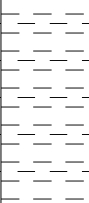
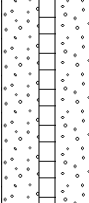
<div><div>Environment - Health & Safety - Sustainability</div></div> <div><div>Head Office</div><div>3 Henley Way, Doddington Road Lincoln, LN6 3QR Tel: +44 (0) 1522 882555 Email: info@deltasimons.com</div></div>					Project No: 19-0423.01		Hole ID: DS101		Page: 1 of 1			
					Project: Small Drove, Weston							
Dynamic Sampler Log					Date: 29/03/2019		Client: D.Brown Building Contractors Ltd					
Description of Strata	Legend	Strata Depth (m bgl)	Strata Thickness (m)	Reduced Level (mAOD)	Casing Diameter (mm)	Water	Sample Details			Test Details		Backfill
							Depth (m)	Type	Ref	Depth (m)	Results	
MADE GROUND: Brown fine to medium SAND with frequent rootlets.		0.20	(0.20)	2.93		2.00						
MADE GROUND: Brown slightly clayey fine to medium SAND.			(0.50)									
Soft brown sandy CLAY with occasional rootlets. (TIDAL FLAT DEPOSITS)		0.70	(0.50)	2.43								
Soft greyish brown slightly sandy CLAY. Sand is fine. (TIDAL FLAT DEPOSITS)		1.20	(0.50)	1.93			1.50	ES	1			
Very soft grey SILT. (TIDAL FLAT DEPOSITS)		2.00	(0.80)	1.13								
			(1.00)				2.50	ES	2			
		3.00		0.13								
Borehole complete at 3.00 m bgl.												
Remarks: 1. Engineer verified logged in general accordance to BS 5930:2015.2. Area CAT scanned prior to excavation.3. Groundwater encountered at 2.00 m bgl.4. Installed with a 63 mm HDPE standpipe to 3.00 m bgl.					Water Strike			Water Level		Borehole Diameter		
					Date	Time	Depth Strike	Duration	Depth Water	Depth Base	Diameter	
							2.00 m					
Coordinates: E529225.32 N324791.36		Elevation (mAOD): 3.13		Drilled By: Delta Drilling		Plant Used: Premier 110		Logged: BB	Checked: PH	Approved: PH	Scale: 1:30	

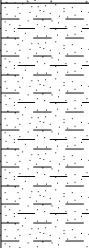
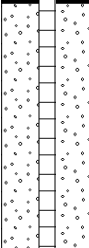
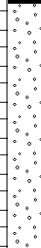
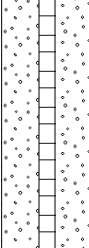
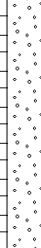
 <div> Head Office 3 Henley Way, Doddington Road Lincoln, LN6 3QR Tel: +44 (0) 1522 882555 Email: info@deltasimons.com </div>					Project No: 19-0423.01		Hole ID: DS102		Page: 1 of 1			
					Project: Small Drove, Weston							
Dynamic Sampler Log					Date: 29/03/2019		Client: D.Brown Building Contractors Ltd					
Description of Strata	Legend	Strata Depth (m bgl)	Strata Thickness (m)	Reduced Level (mAOD)	Casing Diameter (mm)	Water	Sample Details			Test Details		Backfill
							Depth (m)	Type	Ref	Depth (m)	Results	
MADE GROUND: Brown fine to medium SAND with occasional rootlets.		0.20	(0.20)	2.69								
Brown slightly silty fine SAND. (TIDAL FLAT DEPOSITS)		1.00	(0.80)	1.89								
Brownish grey silty fine SAND. (TIDAL FLAT DEPOSITS)		1.80	(0.80)	1.09			1.40	ES	1			
Very soft blueish grey SILT. (TIDAL FLAT DEPOSITS)		2.00	(0.20)	0.89			1.90	ES	2			
Borehole complete at 2.00 m bgl.												
Remarks: 1. Engineer verified logged in general accordance to BS 5930:2015.2. Area CAT scanned prior to excavation.3. Borehole remained dry upon completion. 4. Installed with a 63 mm HDPE standpipe to 2.00 m bgl.					Water Strike			Water Level		Borehole Diameter		
					Date	Time	Depth Strike	Duration	Depth Water	Depth Base	Diameter	
Coordinates: E529238.77 N324778.94		Elevation (mAOD): 2.89		Drilled By: Delta Drilling		Plant Used: Premier 110		Logged: BB	Checked: PH	Approved: PH	Scale: 1:30	

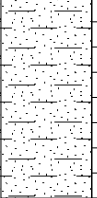
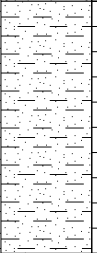
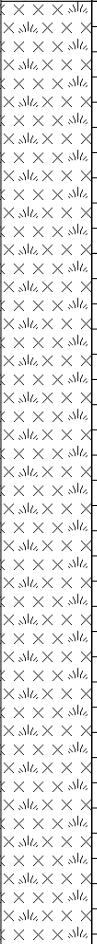
<div><div>Head Office 3 Henley Way, Doddington Road Lincoln, LN6 3QR Tel: +44 (0) 1522 882555 Email: info@deltasimons.com</div></div>					Project No: 19-0423.01		Hole ID: DS103		Page: 1 of 1						
					Project: Small Drove, Weston										
Dynamic Sampler Log					Date: 29/03/2019		Client: D.Brown Building Contractors Ltd								
Description of Strata	Legend	Strata Depth (m bgl)	Strata Thickness (m)	Reduced Level (mAOD)	Casing Diameter (mm)	Water	Sample Details			Test Details		Backfill			
							Depth (m)	Type	Ref	Depth (m)	Results				
MADE GROUND: Brown fine to medium SAND with frequent rootlets. Soft greyish mottled brown slightly sandy CLAY. Sand is fine. (TIDAL FLAT DEPOSITS)		0.10	(0.10)	2.99			1.50	ES	1						
			(0.70)												
		0.80		2.29											
Brown fine to medium SAND. (TIDAL FLAT DEPOSITS)		0.90	(0.10)	2.19											
Soft brown slightly sandy CLAY. Sand is fine. (TIDAL FLAT DEPOSITS)			(1.10)												
		2.00		1.09											
Very soft grey slightly silty CLAY. (TIDAL FLAT DEPOSITS)			(1.00)				2.50	ES	2						
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
															
Remarks: 1. Engineer verified logged in general accordance to BS 5930:2015.2. Area CAT scanned prior to excavation.3. Groundwater encountered at 2.00 m bgl.4. Installed with a 63 mm HDPE standpipe to 3.00 m bgl.					Water Strike			Water Level		Borehole Diameter					
					Date	Time	Depth Strike	Duration	Depth Water	Depth Base	Diameter				
							2.00 m								
Coordinates: E529245.14 N324767.28					Elevation (mAOD): 3.09			Drilled By: Delta Drilling		Plant Used: Premier 110		Logged: BB	Checked: PH	Approved: PH	Scale: 1:30

 <div> Head Office 3 Henley Way, Doddington Road Lincoln, LN6 3QR Tel: +44 (0) 1522 882555 Email: info@deltasimons.com </div>					Project No: 19-0423.01		Hole ID: DS104		Page: 1 of 1			
					Project: Small Drove, Weston							
Dynamic Sampler Log					Date: 29/03/2019		Client: D.Brown Building Contractors Ltd					
Description of Strata	Legend	Strata Depth (m bgl)	Strata Thickness (m)	Reduced Level (mAOD)	Casing Diameter (mm)	Water	Sample Details			Test Details		Backfill
							Depth (m)	Type	Ref	Depth (m)	Results	
MADE GROUND: Crushed concrete overlying soft brown sandy CLAY. Sand is fine. (REWORKED MATERIAL) Soft brown sandy CLAY. Sand is fine. (TIDAL FLAT DEPOSITS)		0.20	(0.20)	3.10		1.00 	1.00	ES	1			
		2.00	(1.80)	1.30								
		3.00	(1.00)	0.30								
Borehole complete at 3.00 m bgl.												
Remarks: 1. Engineer verified logged in general accordance to BS 5930:2015.2. Area CAT scanned prior to excavation.3. Groundwater encountered at 1.00 m bgl.4. Installed with a 63 mm HDPE standpipe to 3.00 m bgl.						Water Strike			Water Level		Borehole Diameter	
						Date	Time	Depth Strike	Duration	Depth Water	Depth Base	Diameter
								1.00 m				
Coordinates: E529255.84 N324747.22		Elevation (mAOD): 3.30		Drilled By: Delta Drilling		Plant Used: Premier 110		Logged: BB	Checked: PH	Approved: PH	Scale: 1:30	

 <div> Head Office 3 Henley Way, Doddington Road Lincoln, LN6 3QR Tel: +44 (0) 1522 882555 Email: info@deltasimons.com </div>					Project No: 19-0423.01		Hole ID: DS105		Page: 1 of 1			
					Project: Small Drove, Weston							
Dynamic Sampler Log					Date: 29/03/2019		Client: D.Brown Building Contractors Ltd					
Description of Strata	Legend	Strata Depth (m bgl)	Strata Thickness (m)	Reduced Level (mAOD)	Casing Diameter (mm)	Water	Sample Details			Test Details		Backfill
							Depth (m)	Type	Ref	Depth (m)	Results	
MADE GROUND: Brown fine to medium SAND with frequent rootlets.		0.20	(0.20)	2.77								
Brown slightly clayey fine to medium SAND with frequent rootlets. (TIDAL FLAT DEPOSITS)		1.00	(0.80)	1.97								
Soft greyish brown CLAY with frequent lenses of silt (1.50 m bgl & 1.70 m bgl). (TIDAL FLAT DEPOSITS)		2.00	(1.00)	0.97			1.50	ES	1			
Borehole complete at 2.00 m bgl.												
Remarks: 1. Engineer verified logged in general accordance to BS 5930:2015.2. Area CAT scanned prior to excavation.3. Borehole remained dry upon completion. 4. Installed with a 63 mm HDPE standpipe to 2.00 m bgl.					Water Strike			Water Level		Borehole Diameter		
					Date	Time	Depth Strike	Duration	Depth Water	Depth Base	Diameter	
Coordinates: E529282.73 N324791.33		Elevation (mAOD): 2.97		Drilled By: Delta Drilling		Plant Used: Premier 110		Logged: BB	Checked: PH	Approved: PH	Scale: 1:30	

<div><div>Head Office 3 Henley Way, Doddington Road Lincoln, LN6 3QR Tel: +44 (0) 1522 882555 Email: info@deltasimons.com</div></div>					Project No: 19-0423.01		Hole ID: DS106		Page: 1 of 1				
					Project: Small Drove, Weston								
Dynamic Sampler Log					Date: 29/03/2019		Client: D.Brown Building Contractors Ltd						
Description of Strata	Legend	Strata Depth (m bgl)	Strata Thickness (m)	Reduced Level (mAOD)	Casing Diameter (mm)	Water	Sample Details			Test Details		Backfill	
							Depth (m)	Type	Ref	Depth (m)	Results		
MADE GROUND: Brown fine to medium SAND with frequent rootlets.		0.20	(0.20)	2.75									
Brown fine to medium SAND. (TIDAL FLAT DEPOSITS)			(0.60)										
		0.80		2.15									
Soft brown sandy CLAY. Sand is fine. (TIDAL FLAT DEPOSITS)		1.00	(0.20)	1.95									
Soft blueish grey sandy CLAY. Sand is fine. (TIDAL FLAT DEPOSITS)			(1.00)				1.50	ES	1				
		2.00		0.95									
Very soft blueish grey CLAY. (TIDAL FLAT DEPOSITS)			(1.00)				2.50	ES	2				
		3.00		-0.05									
Borehole complete at 3.00 m bgl.													
Remarks: 1. Engineer verified logged in general accordance to BS 5930:2015.2. Area CAT scanned prior to excavation.3. Borehole remained dry upon completion. 4. Installed with a 63 mm HDPE standpipe to 3.00 m bgl.					Water Strike			Water Level		Borehole Diameter			
					Date	Time	Depth Strike	Duration	Depth Water	Depth Base	Diameter		
Coordinates: E529287.59 N324828.19		Elevation (mAOD): 2.95		Drilled By: Delta Drilling		Plant Used: Premier 110		Logged: BB	Checked: PH	Approved: PH	Scale: 1:30		

<div><div>Head Office 3 Henley Way, Doddington Road Lincoln, LN6 3QR Tel: +44 (0) 1522 882555 Email: info@deltasimons.com</div></div>					Project No: 19-0423.01		Hole ID: DS107		Page: 1 of 1				
					Project: Small Drove, Weston								
Dynamic Sampler Log					Date: 29/03/2019		Client: D.Brown Building Contractors Ltd						
Description of Strata	Legend	Strata Depth (m bgl)	Strata Thickness (m)	Reduced Level (mAOD)	Casing Diameter (mm)	Water	Sample Details			Test Details		Backfill	
							Depth (m)	Type	Ref	Depth (m)	Results		
MADE GROUND: Brown fine to medium SAND with frequent rootlets.		0.20	(0.20)	2.40									
Brown fine to medium SAND with frequent rootlets. (TIDAL FLAT DEPOSITS)			(0.80)										
Soft greyish mottled brown sandy CLAY. Sand is fine. (TIDAL FLAT DEPOSITS)		1.00	(1.00)	1.60									
Very soft blueish mottled brown CLAY. (TIDAL FLAT DEPOSITS)		2.00	(1.00)	0.60									
Borehole complete at 3.00 m bgl.		3.00	(1.00)	-0.40									
Remarks: 1. Engineer verified logged in general accordance to BS 5930:2015.2. Area CAT scanned prior to excavation.3. Groundwater encountered at 2.00 m bgl.4. Installed with a 63 mm HDPE standpipe to 3.00 m bgl.					Water Strike			Water Level		Borehole Diameter			
					Date	Time	Depth Strike	Duration	Depth Water	Depth Base	Diameter		
							2.00 m						
Coordinates: E529268.99 N324837.99		Elevation (mAOD): 2.60		Drilled By: Delta Drilling		Plant Used: Premier 110		Logged: BB	Checked: PH	Approved: PH	Scale: 1:30		

<div><div>Head Office 3 Henley Way, Doddington Road Lincoln, LN6 3QR Tel: +44 (0) 1522 882555 Email: info@deltasimons.com</div></div>					Project No: 19-0423.01		Hole ID: DS108		Page: 1 of 2				
					Project: Small Drove, Weston								
Dynamic Sampler Log					Date: 29/03/2019		Client: D.Brown Building Contractors Ltd						
Description of Strata	Legend	Strata Depth (m bgl)	Strata Thickness (m)	Reduced Level (mAOD)	Casing Diameter (mm)	Water	Sample Details			Test Details		Backfill	
							Depth (m)	Type	Ref	Depth (m)	Results		
MADE GROUND: Brownish black fine to medium SAND with frequent rootlets. (TOPSOIL)		0.20	(0.20)	2.73									
Brown slightly clayey fine to medium SAND. (TIDAL FLAT DEPOSITS)		1.00	(0.80)	1.93									
Soft brown slightly sandy CLAY. Sand is fine. (TIDAL FLAT DEPOSITS)		2.00	(1.00)				1.50	ES	1				
Soft blueish grey organic SILT. (TIDAL FLAT DEPOSITS)			(4.00)	0.93		<div>2.00</div>							
						<div>4.60</div>		4.00	ES	2			
						<div>5.00</div>							
Remarks: 1. Engineer verified logged in general accordance to BS 5930:2015.2. Area CAT scanned prior to excavation.3. Groundwater encountered at 5.00 m bgl.4. Installed with a 63 mm HDPE standpipe to 6.00 m bgl.					Water Strike			Water Level		Borehole Diameter			
					Date	Time	Depth Strike	Duration	Depth Water	Depth Base	Diameter		
							2.00 m 5.00 m	10 min	4.60 m				
Coordinates: E529315.84 N324857.92		Elevation (mAOD): 2.93		Drilled By: Delta Drilling		Plant Used: Premier 110		Logged: BB	Checked: PH	Approved: PH	Scale: 1:30		

<div><div>Head Office 3 Henley Way, Doddington Road Lincoln, LN6 3QR Tel: +44 (0) 1522 882555 Email: info@deltasimons.com</div></div>					Project No: 19-0423.01		Hole ID: DS108		Page: 2 of 2			
					Project: Small Drove, Weston							
Dynamic Sampler Log					Date: 29/03/2019		Client: D.Brown Building Contractors Ltd					
Description of Strata	Legend	Strata Depth (m bgl)	Strata Thickness (m)	Reduced Level (mAOD)	Casing Diameter (mm)	Water	Sample Details			Test Details		Backfill
							Depth (m)	Type	Ref	Depth (m)	Results	
Soft blueish grey organic SILT. (TIDAL FLAT DEPOSITS)		6.00		-3.07								
Borehole complete at 6.00 m bgl.												
Remarks: 1. Engineer verified logged in general accordance to BS 5930:2015.2. Area CAT scanned prior to excavation.3. Groundwater encountered at 5.00 m bgl.4. Installed with a 63 mm HDPE standpipe to 6.00 m bgl.					Water Strike			Water Level		Borehole Diameter		
					Date	Time	Depth Strike	Duration	Depth Water	Depth Base	Diameter	
							2.00 m 5.00 m	10 min	4.60 m			
Coordinates: E529315.84 N324857.92		Elevation (mAOD): 2.93		Drilled By: Delta Drilling		Plant Used: Premier 110		Logged: BB	Checked: PH	Approved: PH	Scale: 1:30	

Appendix D – Monitoring Data













[illegible]



[illegible]

Appendix E – Chemical Analysis



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Analytical Report Number : 19-35621

Project / Site name:	Weston	Samples received on:	01/04/2019
Your job number:	19-0423.01	Samples instructed on:	01/04/2019
Your order number:	DS45595	Analysis completed by:	08/04/2019
Report Issue Number:	1	Report issued on:	08/04/2019
Samples Analysed:	15 soil samples		

Signed:

Dr Claire Stone
Quality Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Analytical Report Number: 19-35621

Project / Site name: Weston

Your Order No: DS45595

Lab Sample Number				1191314	1191315	1191316	1191317	1191318
Sample Reference				DS101	DS101	DS102	DS102	DS103
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.50	2.50	1.40	1.90	1.50
Date Sampled				29/03/2019	29/03/2019	29/03/2019	29/03/2019	29/03/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)				Units	Limit of detection	Accreditation Status		
Stone Content				%	0.1	NONE	< 0.1	< 0.1
Moisture Content				%	N/A	NONE	23	22
Total mass of sample received				kg	0.001	NONE	0.87	1.0
							0.85	1.1
							1.1	1.0
General Inorganics								
Total Organic Carbon (TOC)				%	0.1	MCERTS	0.7	0.5
							0.4	0.7
							0.5	



Analytical Report Number: 19-35621

Project / Site name: Weston

Your Order No: DS45595

Lab Sample Number				1191319	1191320	1191321	1191322	1191323
Sample Reference				DS103	DS104	DS104	DS105	DS106
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.50	1.00	2.50	1.50	1.50
Date Sampled				29/03/2019	29/03/2019	29/03/2019	29/03/2019	29/03/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)				Units	Limit of detection	Accreditation Status		
Stone Content				%	0.1	NONE	< 0.1	< 0.1
Moisture Content				%	N/A	NONE	23	21
Total mass of sample received				kg	0.001	NONE	1.0	0.77
							0.85	0.96
							0.96	0.98
General Inorganics								
Total Organic Carbon (TOC)				%	0.1	MCERTS	4.6	0.8
							1.7	0.4
							0.4	0.7



Analytical Report Number: 19-35621

Project / Site name: Weston

Your Order No: DS45595

Lab Sample Number				1191324	1191325	1191326	1191327	1191328
Sample Reference				DS106	DS107	DS107	DS108	DS108
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.50	1.50	2.50	1.50	4.00
Date Sampled				29/03/2019	29/03/2019	29/03/2019	29/03/2019	29/03/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)				Units	Limit of detection	Accreditation Status		
Stone Content				%	0.1	NONE	< 0.1	< 0.1
Moisture Content				%	N/A	NONE	33	20
Total mass of sample received				kg	0.001	NONE	0.75	1.0
General Inorganics								
Total Organic Carbon (TOC)				%	0.1	MCERTS	1.3	0.7
							1.0	0.7
								1.4



Analytical Report Number : 19-35621

Project / Site name: Weston

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1191314	DS101	None Supplied	1.50	Brown clay.
1191315	DS101	None Supplied	2.50	Brown clay.
1191316	DS102	None Supplied	1.40	Brown sandy clay with gravel.
1191317	DS102	None Supplied	1.90	Brown sandy clay.
1191318	DS103	None Supplied	1.50	Brown clay and sand.
1191319	DS103	None Supplied	2.50	Brown clay and sand.
1191320	DS104	None Supplied	1.00	Brown clay and sand.
1191321	DS104	None Supplied	2.50	Grey clay.
1191322	DS105	None Supplied	1.50	Brown sandy clay.
1191323	DS106	None Supplied	1.50	Brown clay and sand.
1191324	DS106	None Supplied	2.50	Brown clay.
1191325	DS107	None Supplied	1.50	Brown sandy clay.
1191326	DS107	None Supplied	2.50	Brown clay.
1191327	DS108	None Supplied	1.50	Brown sandy clay.
1191328	DS108	None Supplied	4.00	Brown clay and sand.

Analytical Report Number : 19-35621

Project / Site name: Weston

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests [™]	L009-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Analytical Report Number : 19-37858

Project / Site name:	Weston	Samples received on:	05/04/2019
Your job number:	19-0423.02	Samples instructed on:	16/04/2019
Your order number:	DS45595	Analysis completed by:	25/04/2019
Report Issue Number:	1	Report issued on:	25/04/2019
Samples Analysed:	3 silt samples		

Signed: 

Dr Claire Stone
Quality Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

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Analytical Report Number: 19-37858

Project / Site name: Weston

Your Order No: DS45595

Lab Sample Number				1203128	1203129	1203130		
Sample Reference				WS1	WS6	WS9		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				None Supplied	None Supplied	None Supplied		
Date Sampled				04/04/2019	04/04/2019	04/04/2019		
Time Taken				None Supplied	None Supplied	None Supplied		
Analytical Parameter (Soil Analysis)				Units	Limit of detection	Accreditation Status		
Stone Content				%	0.1	NONE	< 0.1	< 0.1
Moisture Content				%	N/A	NONE	0.01	0.01
Total mass of sample received				kg	0.001	NONE	0.50	0.50
General Inorganics								
Total Organic Carbon (TOC)				%	0.1	NONE	2.8	4.5

Analytical Report Number : 19-37858

Project / Site name: Weston

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1203128	WS1	None Supplied	None Supplied	Brown silt.
1203129	WS6	None Supplied	None Supplied	Brown silt.
1203130	WS9	None Supplied	None Supplied	Brown silt.

Analytical Report Number : 19-37858

Project / Site name: Weston

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests [™]	L009-PL	D	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Analytical Report Number : 19-38131

Project / Site name:	Small Drove, Weston	Samples received on:	18/04/2019
Your job number:	19-0423.01	Samples instructed on:	18/04/2019
Your order number:	DS45595	Analysis completed by:	26/04/2019
Report Issue Number:	1	Report issued on:	29/04/2019
Samples Analysed:	3 water samples		

Signed:



Rexona Rahman
Head of Customer Services
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.



Analytical Report Number: 19-38131

Project / Site name: Small Drove, Weston

Your Order No: DS45595

Lab Sample Number	1204923	1204924	1204925		
Sample Reference	WS1	WS6	WS9		
Sample Number	None Supplied	None Supplied	None Supplied		
Depth (m)	None Supplied	None Supplied	None Supplied		
Date Sampled	17/04/2019	17/04/2019	17/04/2019		
Time Taken	None Supplied	None Supplied	None Supplied		
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status		

Environmental Forensics

Gases

Methane	mg/l	0.1	NONE	2.0	2.6	< 0.1		
---------	------	-----	------	-----	-----	-------	--	--

U/S = Unsuitable Sample I/S = Insufficient Sample



Analytical Report Number : 19-38131

Project / Site name: Small Drove, Weston

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
TO - Gases C1-C4	Determination of volatile hydrocarbons by GC-MS Headspace.	In-house method		W	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30°C.