

Cardiff Parkway Development Ltd
Cardiff Parkway
Geotechnical Desk Study

Issue | 19 December 2017

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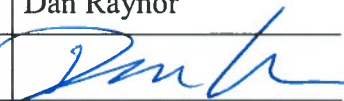
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Figure 1 Site Location

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1 Introduction

Cardiff Parkway Development Ltd intends to develop land to the south of the existing St Mellons Business Park, to the east of Cardiff into a new mixed-use business and retail park, with the possibility to include hotels. The development is proposed to include two to three storey buildings and associated car parks.

The site is located approximately 7km east of Cardiff, in an area of agricultural fields. The great western railway passes through the centre of the site, in a southwest-northeast orientation. A new train station is proposed as a key strategic aspect of the overall masterplan. The station development itself is not discussed within this report, and has been subject to a separate desk study assessment and GRIP 2 feasibility study assessing options [1]. At the time of writing a GRIP 3 assessment to assess a preferred option for the station was also in progress.

This report presents a desk-based review of available geotechnical and geo-environmental information to develop an understanding of ground conditions within the site area, and to support future outline planning applications. The report identifies potential constraints and provides outline recommendations for further investigations.

The desk study for the proposed new railway station in the centre of the Cardiff Parkway site [1] and the Ground Investigation Report for the design of OLE structures in the Great Western Route Modernisation project [2], have been reviewed and relevant information incorporated into this desk study assessment.

2 The Site

2.1 Location and Topography

The site is located approximately 7km east of Cardiff, near St Mellons, refer to **Figure 1**. The Bristol to South Wales main line railway runs northeast to southwest bisecting the site into a northern area and southern areas, as shown on **Figure 2**. Both the northern and southern site areas are currently occupied by fields with a network of drainage channels (reens).

The northern site area is bounded to the west by Faendre Reen, beyond which there is an area of rough grassland and trees before a residential area. To the north of the site is the St Mellons Business Park. Heol Las bounds the site to the east, beyond which are agricultural fields.

The southern site area is bounded to the north by the railway and by fields to the east, south and west. The topography of the site is generally flat at approximately 5mOD. The railway that bisects the site area is on an embankment at approximately 7mOD.

2.2 Site Walkover

A geotechnical site walkover was conducted on the 20 November 2017. Photographs from the site walkover are presented in Appendix A.

The fields of the northern site area are occupied by grassland, with a wet clayey topsoil. A network of drainage reens covers the site, some of these are water filled, whilst others are shallower and remain dry. Standing water was observed on parts of the fields (Photograph 9, Appendix A). The reens that border the field are between approximately 2-7m wide at the base/standing water level, and contain water approximately 1.5-2m below the field surface level. Locally the typically steep battered sides of the reens have become eroded with localised slips visible (e.g. Photograph 17, Appendix A). The three access points to the fields were identified from the road, as shown on Figure 2.

There was no evidence identified of any settlement for the buildings within the existing St Mellons Business Park to the north of proposed site, which appears to have been constructed at or close to the original ground level. Very minor settlement and cracking was identified in the pavement on the south-western corner of the southern building in the business park, which may have been caused by the pavement settling a few millimetres where the fill has been locally placed to provide ramped access to the building (Photograph 14, Appendix A).

The reconstruction of the Heol Las overbridge was underway during the visit, and the southern site area was not accessed (Photograph 8, Appendix A). From review of aerial images, the southern site area is anticipated to comprise fields of a similar nature to the fields in the northern site area.

2.3 History

The history of the site has been studied using historical Ordnance Survey (OS) plans dating from 1898 to present day. The available historical information is summarised in **Table 1** and the plans are included in **Appendix B**.

Table 1: Historical Site Development

Date	Historical Site Development
1898	The railway and the road to the east of the site, Heol Las, have been constructed. Both parts of the site are occupied by agricultural fields. The Faendre Reen stream follows a similar route to present day.
1916	No apparent significant changes
1947-48	No apparent significant changes
1963-64	No apparent significant changes
1970-1973	The electricity pylons have been constructed across the site
1981	Hendre Park Lake to the west of the site is shown on the map. The gas governor in the northern part of the site has been constructed.
1987-1992	The residential area to the west and the business park to the north have been constructed.
2002	The gas governor in the south-eastern part of the northern site area have been constructed.
2014	No apparent significant changes

In summary, the main line railway that bisects the site area has been there since at least 1898. There is no indication of significant development on the majority of the site since 1898. Industrial buildings associated with a gas governor facility were constructed in the southeast of the northern site area between 1992 and 2002. Four gas pipelines are shown to cross the site from the gas governors, as shown on Figure 2. Overhead electricity cables were constructed crossing the site area by 1970.

2.4 Potential for Unexploded Ordnance

A preliminary UXO assessment is presented below in accordance with CIRIA report C681 [3].

Evidence of previous military land-use

A search for any potential military history in the area of St Mellons has found that a number of US military bases and camps were present in St Mellons during WWII. A list of US units in the UK states that 12 units were based in the area of St Mellons [4]. Although, no information as to the exact location of the bases has been provided.

A preliminary UXO assessment was conducted by BACTEC for Section M of the railway in the Section M GIR [2]. It indicates that the site is of Low risk with regards to bombing density. However, the UXO risk has been elevated to Medium as a number of potential sources of UXO have been identified, including Bombing Decoy Sites, Defence Related Positions and positions of Anti-Aircraft Batteries, Army Decoys (A Series) and a Civil QLs and QFs (C Series) type Decoy sites.

Potential for aerially delivered ordnance

A review of historical maps has found that during WWI the site was predominantly occupied by agricultural fields. The railway that runs through the site today was already in place. No other apparent significant features. Historical maps and aerial images [5] from 1947 show no apparent significant change to the 1916 maps.

The superficial deposits are tidal flat deposits, comprising soft to firm clay. There is a possibility that ordnance could have landed in soft clay and failed to explode.

The railway line that runs through the site was a potential Luftwaffe target. Although there are no major bridges or stations on this section of the track.

Zetica regional unexploded bomb risk map shows that the site is within an area of moderate bomb risk and is not close any particular WWII targets.

Consideration of additional factors

The level of post war development is low. Therefore, it is unlikely that if there was UXO on the site after the war, it will have been dealt with.

The extent of proposed intrusive works is considered high. It is anticipated that the foundation of the proposed buildings will consist of piles extending into the underlying bedrock. The ground investigation is likely to consist of many CPT tests into the underlying bedrock. If there is UXO onsite, the risk of encountering it during the proposed GI or the construction works, which will include the installation of band drains and piles, is considered significant.

Assessment findings and recommendations for further works

Overall, it is recommended that a detailed UXO report be obtained. This is because Newport was heavily bombed during WWII, St Mellons was the site of a number of military bases and decoy sites, the ground comprises soft clay and the extent of intrusive works is considered significant.

2.5 Published Geology

The BGS 1:10,560 geological plan [6] and the BGS online viewer show that the site is overlain by tidal flat deposits of clay and silt [7].

The geological memoir [8] states that the Tidal Flat Deposits typically comprise clay and silt with beds of peat overlying sand and gravel. The memoir states that early postglacial rivers flowed along channels deeper than those of today, because sea level was at least 100ft (~30m) lower. The gradual eustatic rise in sea level resulted in the infilling of the seaward reaches of the valleys with fluvial deposits, which consist mainly of alluvial mud, silts and sands with a little gravel. The coastal flats of the Bristol Channel are thickly covered by marine alluvium, comprising mainly mud and silt, with interbedded bands of peat. The buried river channels mean that the depth of the bedrock and thickness of the superficial deposits is anticipated to vary across the site.

The bedrock in the northern site area is predominantly of the St Maughans Formation, which comprises interbedded argillaceous rocks. The southeastern corner of the northern site area and all of the southern site area are underlain by a bedrock of the Mercia Mudstone Group. The Mercia Mudstone comprises mudstone, with roughly horizontal bedding that unconformably overlies the St Maughans Formation, which dips 40° towards the northeast according to the BGS 1:50,000 scale geological map 263, dated 1986.

The memoir describes the Keuper Marl (now known as Mercia Mudstone) as “red, brownish or purplish red mudstone or silty mudstone”. The St Maughans Group is typically described as interbedded marls (mudstone) and sandstones, with subordinate conglomerate cornstones and concretionary limestones.

The BGS have a number of borehole records from nearby historical ground investigations in the scheme area, three of which are summarised in **Table 2** below. The borehole records are included in **Appendix C**.

Table 2: Materials encountered in previous GI.

BH ID (GL elevation)	Location relative to site	Materials Encountered (mbgl)
ST28SW92 (5.77m AOD)	150m north	G.L. – 0.2: Topsoil 0.2 – 0.7: Soft-firm light brown/grey very silty clay 0.7 – 3.0: Very soft grey very silty clay with wood and vegetation 3.0 – 5.5: Firm red/brown very sandy clay 5.5 – 8.5: Firm-stiff silty clay with fine gravel 8.5 – 10.0: Highly weathered red brown micaceous mudstone 10.0 – 11.0: Moderately weathered red brown mudstone with bands of purple sandstone
ST28SW158 (6.5m AOD)	150m west	G.L. – 0.3: Topsoil 0.3 – 1.0: Firm grey/brown clay 1.0 – 3.5: Stiff red/brown sandy clay with occasional gravel 3.5 – 4.1: Stiff/hard red/brown silty clay weathered marl 4.1 – 4.6: Hard red/brown marl (weak mudstone)
ST28SW153 (6.1m AOD)	100m west	G.L. – 0.3: Topsoil 0.3 – 1.0: Stiff red/brown sandy clay with occasional gravel 1.0 – 3.3: Firm becoming stiff/hard red/brown silty clay with occasional gravel 3.3 – 3.9: Stiff/hard red/brown silty clay weathered marl 3.9 – 5.0: Hard red/brown marl

In addition to the above, a ground investigation was conducted on the site of the business park to the north of the site, in 1977. The borehole records are available from the BGS, they are included in **Appendix C** and are summarised below.

Table 3: Materials encountered in 1977 GI

BH ID (GL elevation)	Location relative to site	Materials Encountered (mbgl)
ST28SW597 (5.2m AOD)	Immediately north of the site	GL – 0.4m bgl: Topsoil 0.4 – 2.9m bgl: Alluvium, comprising soft to firm clay/silt with peat bands 2.9 – 8.0m bgl: Glacial till, comprising firm to stiff gravelly clay/silt 8.0 – 10.5: Stiff mudstone
ST28SW635 (5.1m AOD)	Immediately north of the site	GL – 0.3m bgl: Topsoil 0.3 – 4.1m bgl: Alluvium, comprising of very soft clay. 0.3m of alluvium encountered at 1m bgl 4.1 – 7.9m bgl: Glacial till, comprising gravelly silt/sand with cobbles and boulders 7.9 – 9.1m bgl: Stiff weathered mudstone 9.1 – 11m bgl: Very weak siltstone
ST28SW636 (5.1m AOD)	Immediately north of the site	GL – 0.3m bgl: Topsoil 0.3 – 3.5m bgl: Alluvium, comprising of very soft clay. 0.3m of alluvium encountered at 1m bgl 3.5 – 9.0m bgl: Glacial till, comprising soft to stiff gravelly silt/sand/clay with cobbles and boulders 9.0 – 12.5m bgl: Firm to stiff weathered mudstone

Ground investigation has also been conducted along the railway as part of the Great Western Route Modernisation [2]. The ground investigation report says that the ground underlying this section of railway (segment 4), is expected to comprise made ground, from ground level to 1m bgl; soft tidal flat deposits, from 1m bgl to 3m bgl and mudstone/sandstone of the Mercia Mudstone Group at depths greater than 3m bgl.

A preliminary geological long section, in the Cardiff Parkway GRIP 2 Geotechnical Desk Study [1], shows that the thickness of tidal flat deposits thickens from approximately 3.2m in the west to 7m in the east. This is underlain by approximately 5m of weathered bedrock, which is shallower in the west of the scheme (5.6m bgl) and deeper in the east of the scheme (9.3m bgl). Intact weathered bedrock underlies the weathered bedrock.

In summary, topsoil is anticipated to be encountered to a depth of approximately 0.3m bgl. Soft tidal flat deposits are expected to underlie the topsoil, the thickness of which is anticipated to vary across the site from very thin (<0.5m) to approximately 7m. Glacial till deposits are anticipated to underlie the tidal flat deposits in parts of the site, with thicknesses up to approximately 5m. Whilst in other parts of the site the tidal flat deposits are anticipated to directly overlie the mudstone bedrock.

2.6 Mining

The site is located outside of a Coal Authority mining reporting area and the review of historical maps and aerial images did not identify any evidence of non-coal mining near to the site. There is not considered to be a risk posed to the project by mining.

2.7 Hydrogeology

Natural Resources Wales aquifer designation classifies the tidal flat deposits that overlie the site as unproductive.

The bedrock that underlies the northern part of the site is composed of interbedded mudstone and sandstone of the St Maughans Formation. It is classified as a secondary (A) aquifer (*permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers*)

The bedrock beneath the southern part of the site is composed of mudstone of the Mercia Mudstone Group. It is classified as a secondary (B) aquifer (*predominantly lower permeability layers, which may store/yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering*).

The nearby BGS borehole records show the level the groundwater was struck at during the ground investigation, the result of which are summarise in **Table 4**.

Table 4: Summary of groundwater strikes recorded by nearby BGS boreholes

BGS borehole reference	Location relative to site	Groundwater strikes (mbgl)	Strata
ST28SW92	150m north	6.0m bgl (seepage) 8.3m bgl	Clay with fine gravel Clay with fine gravel
ST28SW158	150m west	3.5m bgl	Boundary between clay with occasional gravel, cobbles and boulders, and the underlying mudstone
ST28SW153	100m west	3.3m bgl	Boundary between clay with occasional gravel and the underlying mudstone

In summary, it is anticipated that there could be minor water inflows from the gravel layers of the tidal flat deposits. Groundwater is also likely to be encountered at the interface between the Mercia Mudstone/St Maughans Formation and the overlying superficial deposits.

2.8 Hydrology

Many drainage channels are located within the fields of the site area. The Faendre Reen drainage channel is located along the western boundary of the scheme and flows towards the south. The general drainage direction of surface water is anticipated to be towards the Severn Channel, located approximately 1.5km south of the site.

The site is in an area indicated by Natural Resources Wales as having a low risk of flooding from rivers or sea (RoFRaS); meaning that *in a given year there is a less than 1 in 100 chance of the site flooding*.

Parts of the site, the northern end in particular, has a low risk of surface water flooding; meaning that there is *in a given year there is a less than 1 in 100 chance of the site flooding*.

2.9 Radon

The UK radon online map viewer shows that the maximum radon potential of a 1km grid that occupies the site is 5-10% and the rest of the site is within a grid with a maximum radon potential of 1-3% [8].

2.10 Environmental Information

The site comprises a series of fields that has remained relatively undeveloped. Gas governors were constructed on small areas, in the north and east of the site, as shown on **Figure 2**.

The review of the historical maps and NRW records has not identified any historical landfill sites with the site boundary. A historical landfill, Pil-Du-Lake is recorded by NRW approximately 270m west of the site; it received inert waste between 1966 and 1990. Another landfill, Swn-Y-Mor Farm No.1 is located

approximately 160m southeast of the site; it received inert, industrial, commercial and household waste. The date of last input is not provided.

The south wales mainline railway embankments, constructed in the mid 19th Century present a potential source of contaminated made ground.

3 Conceptual Site Model

Based on the information obtained about the site and reviewed in **Section 2** above, a conceptual site model has been developed, identifying potential sources, pathways and receptors of contamination. This is summarised below.

Sources

A review of the site history showed that the site has predominantly been used as agricultural fields since 1898. As a result, there could be contaminants associated with the use of fertiliser and pesticides.

There is potential that made ground could be encountered in close proximity to the railway. Contaminants typically associated with historical and operational railway lines include PCBs, PAHs, TPHs, metal, ash and sulphate. Asbestos fibres may also be present, e.g. associated with former train braking systems [9].

Made ground is also likely to be present in small discrete areas of the fields associated with buildings, sheds or tracks that are/have been on the site. There is also potential that some areas of the fields may be been previously excavated and backfilled.

There is also potential that waste associated with fly tipping may be present on parts of the site. This is anticipated to be restricted to small discrete areas.

Gas governors were constructed on small areas, in the east and the north of the site. The associated gas pipe are shown on **Figure 2**. Made ground may be encountered as pipe surround and could contain contamination.

Imported materials used in the construction of the site are a potential source of contamination, and hence any imported materials used will need to be suitably screened using an appropriate scope of testing for the proposed site end use.

There is potential for peat layers to be within the alluvium, which could be a source of ground gas. Peat layers/lenses in the nearby historical ground investigation have been recorded with a thickness of up to 1.0m.

Two historical landfills are recorded by Natural Resource Wales (NRW) near to the site. One, Swn-Y-Mor Farm No.1, is located approximately 160m southeast of the site and the other, Pil-Du-Lake, is located 270m west of the site, as shown on **Figure 2**. Swn-R-Mor Famr No.1 received inert, industrial, commercial and household waste. The first input is recorded as being 1985. Pil-Du-Lake received inert waste between 1966 and 1990.

Two on site pollution incidents are recorded by NRW. One occurred in July 2016; the pollutant was unspecified and had a minor impact. The other, occurred in April 2016, had a pollutant of soil and clay, and had a minor water impact.

Pathways

Potential pathways to human receptors include:

- Direct soil and dust ingestion;
- Dermal exposure;
- Inhalation of particulates/fibres;
- Inhalation of soil vapour;
- Gas migration.

Vertical gas migration is anticipated to be restricted by the generally cohesive nature of the surrounding material, but the gas could migrate laterally through sandier layers or within groundwater. Piling through the superficial deposits could provide a vertical flow path for the methane to reach the surface.

Should the site area be raised above existing ground levels without the existing material being excavated the likelihood of dermal exposure, ingestion and inhalation would be significantly reduced.

Pathways to Controlled Waters

- Leaching and vertical/lateral migration
- Direct discharge
- Contamination migration through preferential flow paths potentially induced by pipe network

Receptors

Potential receptors of contamination include:

- Site operatives
- General public using the business park
- Maintenance workers
- Surface waters, including the Faendre Reen and Haendre Park lake
- Groundwater, anticipated to be approximately 1m bgl

Imported materials should be screened to ensure suitability for the site end use with respect to human health and controlled waters.

If the site were to be raised by between 1-2m with suitable clean imported fill, and the existing materials not excavated, the risk posed to site end-users associated with potential contamination would be further reduced.

The identification and justification of the source-pathway-receptor linkages and the associated risk classification are presented in **Table 5**.

Table 5: PRA

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk	Comment
Onsite Made ground Fly tipped Waste Infilled land Imported materials Ground gas from peat Pollution incidents Offsite Landfills	End Site users: Public using the business park (P) & Maintenance Workers (M)	Direct dermal	Unlikely (P)	Moderate (P)	Low	Buildings and hardstanding are anticipated to occupy the majority of the site, but there will be some areas of landscaping.
			Unlikely (M)	Moderate (R)	Low	
		Ingestion	Unlikely (P)	Moderate (P)	Low	Should the level of the site be raised using imported fill (e.g. to achieve design flood levels), site end users would be even more unlikely to be exposed to any potential contaminants.
			Unlikely (M)	Moderate (R)	Low	
		Inhalation of gas or vapours	Unlikely (P)	Moderate (P)	Low	Potential pathways for the migration of ground gas could be created during the installation of piles, which could lead to the build-up of gases and create a risk of asphyxiation and explosion.
			Unlikely (M)	Moderate (R)	Low	
	Construction Workers	Direct dermal	Unlikely	Moderate	Low	Given the limited excavation likely to be required, and the limited sources of contamination identified, construction workers are unlikely to be exposed to significant levels of contamination.
		Ingestion	Unlikely	Moderate	Low	
		Inhalation of gas or vapours	Unlikely	Moderate	Low	
	Surface waters; Faendre Reen and reen along eastern boundary	Leaching, lateral migration within groundwater, contaminated surface water run off	Unlikely	Low	Low	Due to the cohesive nature of the soils anticipated at the site, the migration of groundwater through these layers is likely to be limited. Depending on the grading of the materials used, water could however migrate through the imported materials and enter controlled surface waters. For this reason, the risk to surface waters needs to be considered when selecting materials for import.

4 Site Summary

The site is currently occupied by agricultural fields, with a network of interconnected drainage channels or reens. In the south eastern corner of the northern site area is small area of industrial buildings.

The recorded ground conditions based on available ground investigation are summarised in **Table 6** below. The surface of the bedrock is anticipated to vary in depth due to buried river channels identified, which are in-filled with the superficial soils including glacial till locally and to the north of the site and more generally with the soft tidal flat deposits. The bedrock is anticipated to be shallower in areas close to where the overlying deposits are of glacial till, such as in the north and western areas of the site, but this will need to be confirmed with intrusive ground investigation.

Table 6: Recorded ground conditions – based on available GI

Material	Top depth range (m bgl)	Bottom depth range (m bgl)	Thickness range (m)
Topsoil	GL	0.3	0.3
Alluvium	0.3	0.8 – 7.3	0.5 – 7.0
Glacial till	absent to 4.0	absent to 9m	absent to 5.5
Weathered mudstone	3 - 7	8 - 12	4 - 5
Intact bedrock	8 – 12	-	-

5 Proposed Development

The proposed development involves the construction of a business park, which will comprises two to three-storey offices and associated roads, car parking and landscaping.

6 Preliminary Geotechnical Considerations

6.1 General

From the available desk study information, an assessment has been undertaken to identify potential geotechnical constraints. Preliminary geotechnical recommendations are provided and a preliminary scope of further ground investigation is proposed.

6.2 Additional Information Required

In order to prepare the site for the construction of the business park the following work and considerations are recommended.

- All utilities information should be obtained and identified utilities, such as those associated with the, current St Mellons Business Park, Great Western Main Line railway, overhead electrification lines, and gas governors in the east and north of the site should be surveyed.
- The site area itself, including the full channel geometry of the drainage reens and railway embankment and any structures present on the site should be accurately surveyed.
- Access points to the field and locations of reen crossings to be identified. (Locations identified using aerial photography/satellite mapping and site walkover surveys and are indicated on **Figure 2**).
- A suitable scope of ground investigation is required.

6.3 Earthworks

Pending the conclusions of the flood risk modelling currently underway, it is anticipated that the development of the areas to the north of the railway will require the raising of the ground surface by approximately 1m.

Any earthworks required would need to be undertaken in accordance with an appropriate earthworks specification. This would also need to define the physical and chemical requirements for any imported materials to ensure their acceptability both in terms of engineering properties and chemical acceptable reuse criteria.

The site is underlain by soft alluvium with recorded thicknesses ranging from less than 0.5m to 7m. Any up-filling of the site required to achieve necessary site levels would apply additional loading to these soft tidal flat deposits, resulting in

consolidation and potentially significant magnitudes of settlement, e.g. up to or greater than 200mm of settlement could potentially occur should the site be raised by 2m.

Any structures located within areas with significant thickness of soft ground are likely to require piled foundations, and differential settlements between these relatively stiff foundations and adjacent areas of raised ground could be a particular concern, e.g. at the interfaces with the piled buildings and tie ins with existing infrastructure (site access for adjacent roads). The assessment of potential settlements would also need to be considered when designing and constructing drainage runs and service connections.

Particular measures will be required to ensure that any total and differential settlements are within acceptable limits. Such measures may include ground improvement to strengthen the soft soils and limit the magnitude of settlements, surcharging using additional height of fill to consolidate the soft alluvium deposits prior to removal and construction, or use of piled embankments to prevent transfer of loading of the soft ground. For surcharging solutions, the time taken for the settlement to occur and potential for ongoing creep settlements during the lifetime of the development associated with the peat deposits will need to be understood. If surcharging is employed, the use of band drains could be considered to speed up the process of consolidation. The impact of potentially large settlements on both buried and overhead services and utilities crossing the site, and the adjacent existing assets such as the railway, culverts and access roads, will need to be considered.

Groundwater is anticipated to be encountered at shallow depth. Based on visual inspection, the water level in the reens was approximately 1-1.5m below the ground level of the fields during the site walkover.

Four gas pipes cross the site from the gas governors, as shown on **Figure 2**. The gas pipes are likely to be sensitive to ground movements that could be caused by the proposed works, which require raising of site levels. The masterplan should take into consideration the location of the gas pipes and consideration will need to be given to potential effects on the pipes by the proposed works and any mitigation measures needed.

6.4 Foundations

Given that the site is largely underlain by variable thicknesses of soft tidal flat deposits, traditional shallow foundations are unlikely to be generally suitable to support the proposed buildings. The two to three story buildings proposed for the development are typically expected to require piled foundations extending to the underlying St Maughans and Mercia Mudstone Formation bedrock. The road and car parks around the offices are anticipated to be founded on raised platforms on top of the superficial deposits. Potential issues associated with differential and total settlement are discussed in Section 6.3.

Suitable foundation options should be reviewed once the ground conditions and anticipated structural loadings are better understood, including the variations in these. Pending this, it may be possible to utilise other foundation types in some areas, such as raft foundations.

6.5 Road Pavement

Given the anticipated requirement to raise the site levels, the road pavement formations can be readily defined as part of the earthworks specification. Should any roads be required at existing ground level, an appropriate thickness of capping material will need to be considered, potentially in conjunction with some form of geotextile reinforcement.

In any areas where ground levels are raised to create development plateaus, the fill materials used can be controlled to provide a suitable pavement formation.

As discussed in Section 6.3, the potential for ongoing settlement of pavements in any areas of raised fill will be a key issue that will need to be addressed as part of the further site investigation, design and construction programme.

6.6 Drainage

The site currently has an inconnecting network of reens to control surface water levels within the site. Review of the available exploratory holes suggests that the superficial deposits are predominantly of cohesive material, underlain by a mudstone bedrock, therefore unsuitable for effective soakaways.

It is understood that the existing network of reens will either need to be maintained or replacement reens provided as part of the development. The area of the site to the south of the railway is understood to be an area of potential such reen replacement.

Attenuation measures such as buried tanks may also potentially be required as part of the overall development.

The potential for large total and differential settlements has been identified as a result of the need to raise the site levels. Both pre-earthworks drainage and permanent drainage systems will need to be designed to accommodate anticipated ground movements, and the works will need to be phased to ensure that the drainage systems remain serviceable.

7 Preliminary Geoenvironmental Considerations

Key geoenvironmental constraints have been identified in Section 3 above. There is potential to encounter contamination associated with the site's agricultural land use, but this is considered unlikely to be a significant constraint to the proposed development. It has been identified that the superficial deposits are likely to contain layers of organic material, such as peat, which could be a source of ground gas. The piles for the proposed buildings may provide a migration pathway for ground gas to reach the surface and if it were to concentrate within a confined area, it poses a risk of explosion or asphyxiation.

An investigation will be required to characterise the site. This should include soil and groundwater sampling and testing, as well as gas and groundwater monitoring. The results of the investigation should be assessed in accordance with development proposals and proposed site end uses. Following this, mitigation and/or remediation measures may be recommended in order to ensure the site is suitable for its intended end use, with no unacceptable risks posed to human health or controlled water receptors.

8 Site Investigation Proposals

8.1 Geotechnical

Intrusive ground investigations will be required to inform:

- Ground conditions for foundation design and consideration of settlement due to filling of the site;
- Existing groundwater levels in the various strata;
- Concrete classification requirements.

8.2 Geo-environmental

Investigations and assessment will be required to satisfy likely planning conditions related to contamination. It is envisaged that the following will be required to investigate the presence of any contamination associated with the identified sources:

- Sampling and testing to identify any leaks / contamination migration from the gas governors in the north and east of the site;
- Sampling and testing to identify any potential contamination associated with made ground;
- Gas monitoring to assess the risk posed by potential ground gas.

8.3 Proposed preliminary investigations

In order to investigate the above considerations, the ground investigation is anticipated to comprise of the following:

Cable percussion boreholes

- confirm the thickness of superficial deposits and the nature of the bedrock;
- correlate with CPT results;
- in-situ testing to obtain parameters for design (including shear vane testing and SPT in soils and weathered rock);
- sampling for geotechnical and chemical testing (including recovery of Class 1 samples using thin walled sampling tubes and piston samples to allow strength, stiffness and permeability testing at various depths within the alluvium);
- splitting of piston samples to allow logging of high quality undisturbed samples – to establish the potential presence of any structure within the soft ground, such as fine sand laminations which may have a significant impact on settlement durations for a surcharging solution;
- Installation of groundwater and gas monitoring standpipes.

Cone Penetration Tests (CPT) - with piezocone

- confirm the thickness of superficial deposits;
- obtain strength and stiffness parameters;
- undertake dissipation tests at various depths to provide information on consolidation characteristics throughout the soft ground.

Trial pits

- confirm stratigraphy and groundwater conditions;
- Obtain samples for geotechnical and chemical testing.

References

- [1] Ove Arup & Partners Ltd (2017). Cardiff Parkway GRIP 2 Options Report – Geotechnical Desk Study.
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- [5] Welsh Government Historic Aerial Photography WMTS.
<http://lle.gov.wales/catalogue/item/WelshGovernmentAerialPhotographyUnitWMTS/?lang=en>
- [6] Geological Survey of England and Wales (1969), Newport Sheet 149, Scale 1:50,000, Southampton.
- [7] British Geological Survey, Geoindex Onshore, Accessed November 2017 [<http://mapapps2.bgs.ac.uk/geoindex/home.html>]
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- [9] Department of the Environment (1995). Industry profile, railway land.

Figures



SZ	15/12/2017	EB	TW	DR
Issue	Date	By	Drawn	Appr

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4 North Street
Cardiff CF10 1AF
Tel: +44 (0)300 304 3047 Fax: +44 (0)300 304 3048
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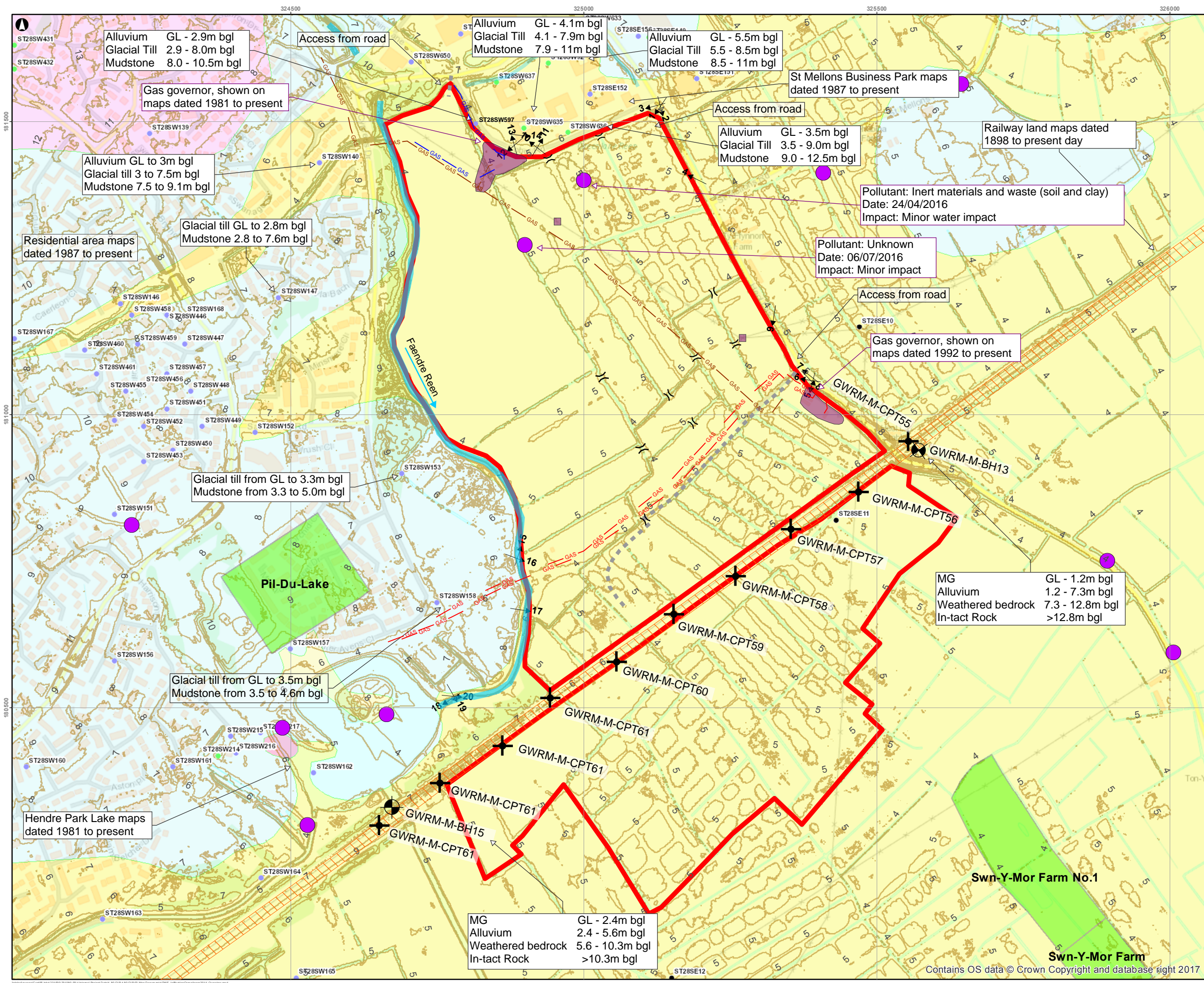
Client
Cardiff Parkway Development Ltd

Job Title

Cardiff Parkway Business Park

1:50,000	
Job No 252199	Drawing Status Issue
Drawing No 1	Issue S2

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LEGEND

Site area

BGS superficial deposits

- Tidal flat deposits - clay, silt and sand
- Glacial till deposits
- Glaicofluvial deposits

Other

- NRW recorded historic landfill site
- BGS borehole record
- Railway land
- GWRM CPT
- GWRM borehole
- Site photographs (Appendix H)
- Reen crossing point
- Electricity pylon
- Post 2013 NRW recorded pollution incident

— GAS — High pressure gas pipe
— GAS — Intermediate pressure gas pipe
— GAS — Medium pressure gas pipe
— GAS — Low pressure gas pipe

S2	15/12/2017	EB	TW	DR
Issue	Date	By	Chkd	Appd

Metres

0 75 150 300

ARUP

4 Pierhead Street
Cardiff CF10 4QP
Tel: +44 29 2047 3727 Fax: +44 29 2047 2277
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Client

Cardiff Parkway Development Ltd

Job Title

Cardiff Parkway Business Park

Scale at A3

1:6,000

Job No	Drawing Status
252199	Issue

Drawing No	Issue
2	S2

Appendix A

Site walkover photographs

Appendix A – Site Photographs 20/11/2017



Photograph 1 – Northeastern corner of the field looking southwest



Photograph 2 – Northeastern corner of field looking south



Photograph 3 – North-eastern corner of field looking west



Photograph 4 – Heol Las looking northwest



Photograph 5 – The gas governor from Heol Las, looking south



Photograph 6 – The gas governor from Heol Las, looking west



Photograph 7 – Looking northwest from next to the gas governor on Heol Las



Photograph 8 – Looking southeast from next to the gas governor on Heol Las



Photograph 9 – Looking south from Heol Las



Photograph 10 – Looking northwest from Cobol Road



Photograph 11 - Looking northeast from Cobol Road



Photograph 12 - Looking southwest from Cobol Road at the gas governor



Photograph 13 - Looking north from Cobol Road at the existing business park



Photograph 14 – Looking at the southern corner of a building in the existing business park. Sign of possible slight settlement in pavement.



Photograph 15 – Looking north from the bank of the Faendre Reen



Photograph 16 – Looking east from the bank of the Faendre Reen



Photograph 17 - Looking east from the bank of the Faendre Reen



Photograph 18 – Looking West at Haendre Park Lake



Photograph 19 – Looking south across the Faendre Reen



Photograph 20 – Looking east along the Faendre Reen

Appendix B

Groundsure historical maps

Site Details:

GWRM Section M

Client Ref: PO-141218-026243
Report Ref: GS-1822262_SS_3_3
Grid Ref: 324545, 180745

Map Name: County Series

Map date: 1898-1902

Scale: 1:10,560

Printed at: 1:10,560



Surveyed 1874
 Revised 1888
 Edition N/A
 Copyright N/A
 Levelled N/A

Surveyed 1881
 Revised 1902
 Edition N/A
 Copyright N/A
 Levelled N/A



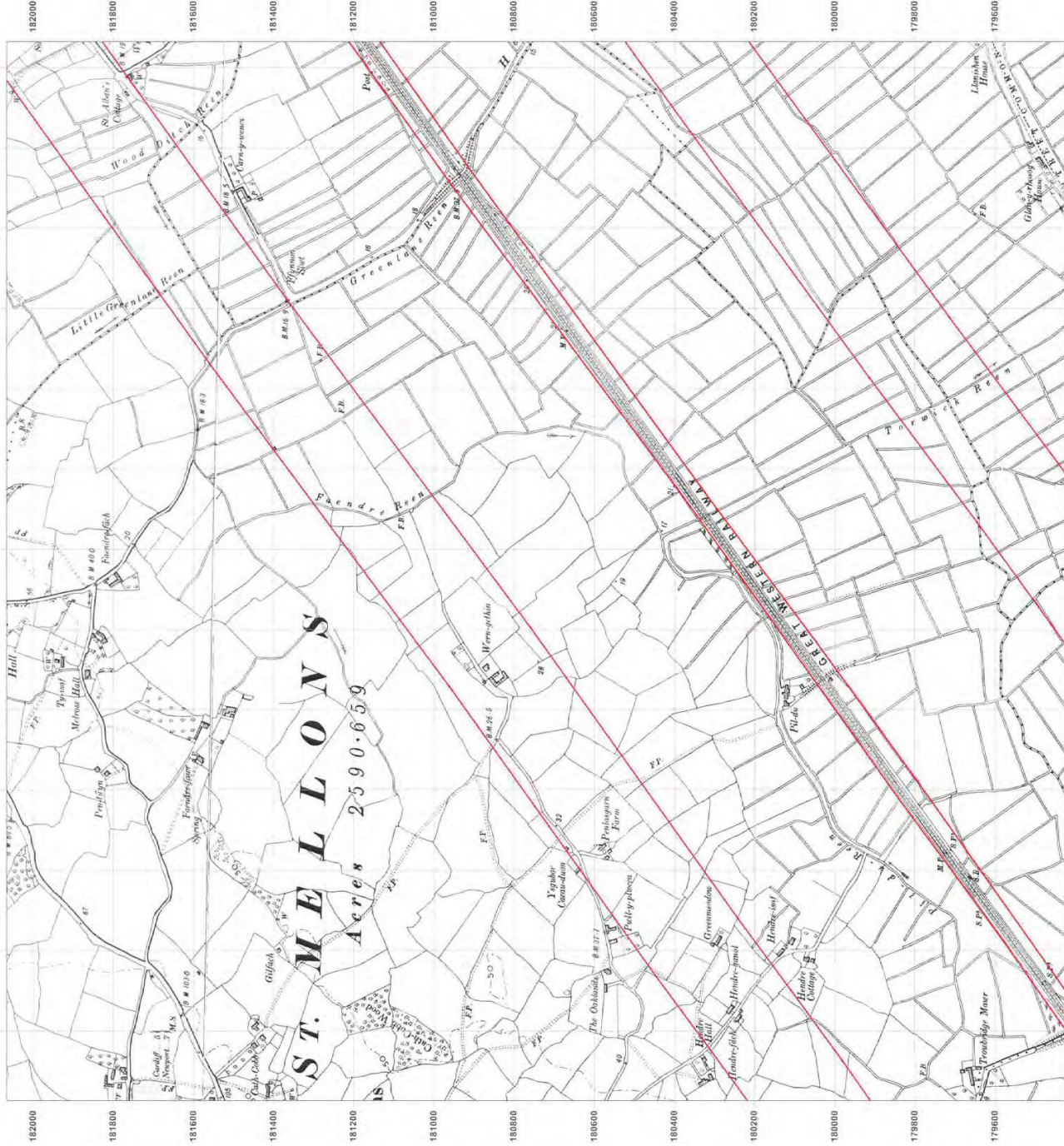
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Site Details:

GWRM Section M

Client Ref: PO-141218-026243

Report Ref: GS-1822262_SS_3_3


Grid Ref: 324545, 180745

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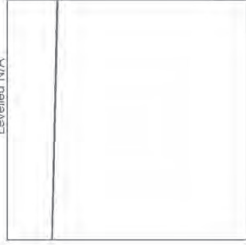
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Revised N/A

Edition N/A

Copyright N/A

Levelled N/A




Surveyed 1878

Revised 1916

Edition N/A

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Levelled N/A

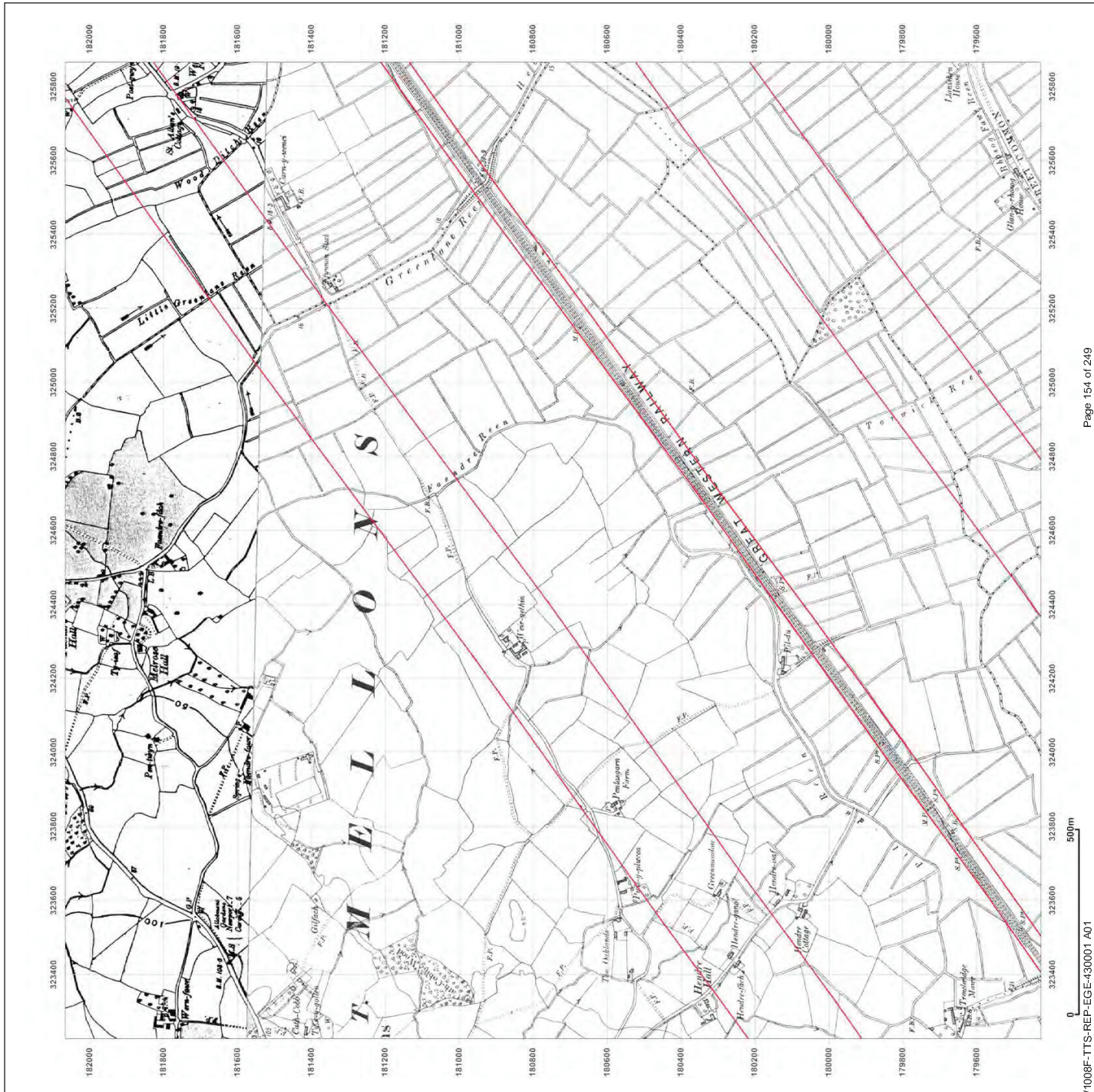


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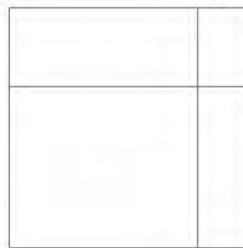
Map date: 1963-1964

Printed at: 1:10,560



Surveyed 1949	Surveyed N/A
Revised 1949	Revised 1963
Edition N/A	Edition N/A
Copyright N/A	Copyright N/A
Levelled N/A	Levelled N/A

Surveyed 1964	Surveyed 1949
Revised 1964	Revised 1953
Edition N/A	Edition N/A
Copyright N/A	Copyright N/A
Published N/A	Published N/A



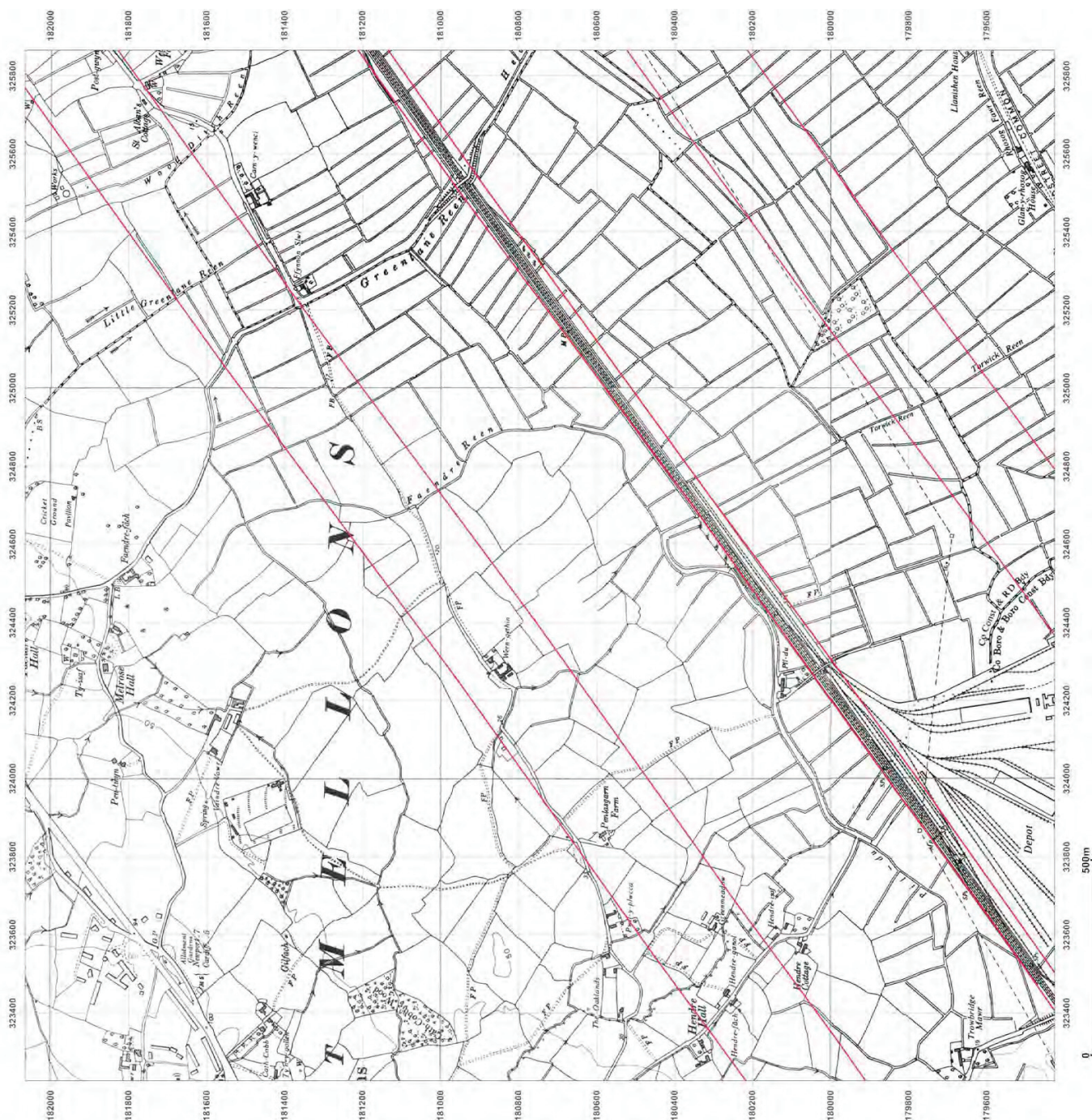
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Report Ref: GS-1822262_SS_3_3
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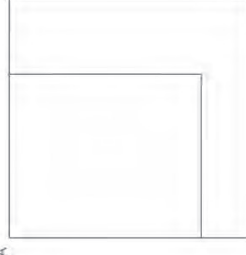
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Surveyed 1981
Revised 1981
Edition N/A
Copyright N/A
Levelled N/A



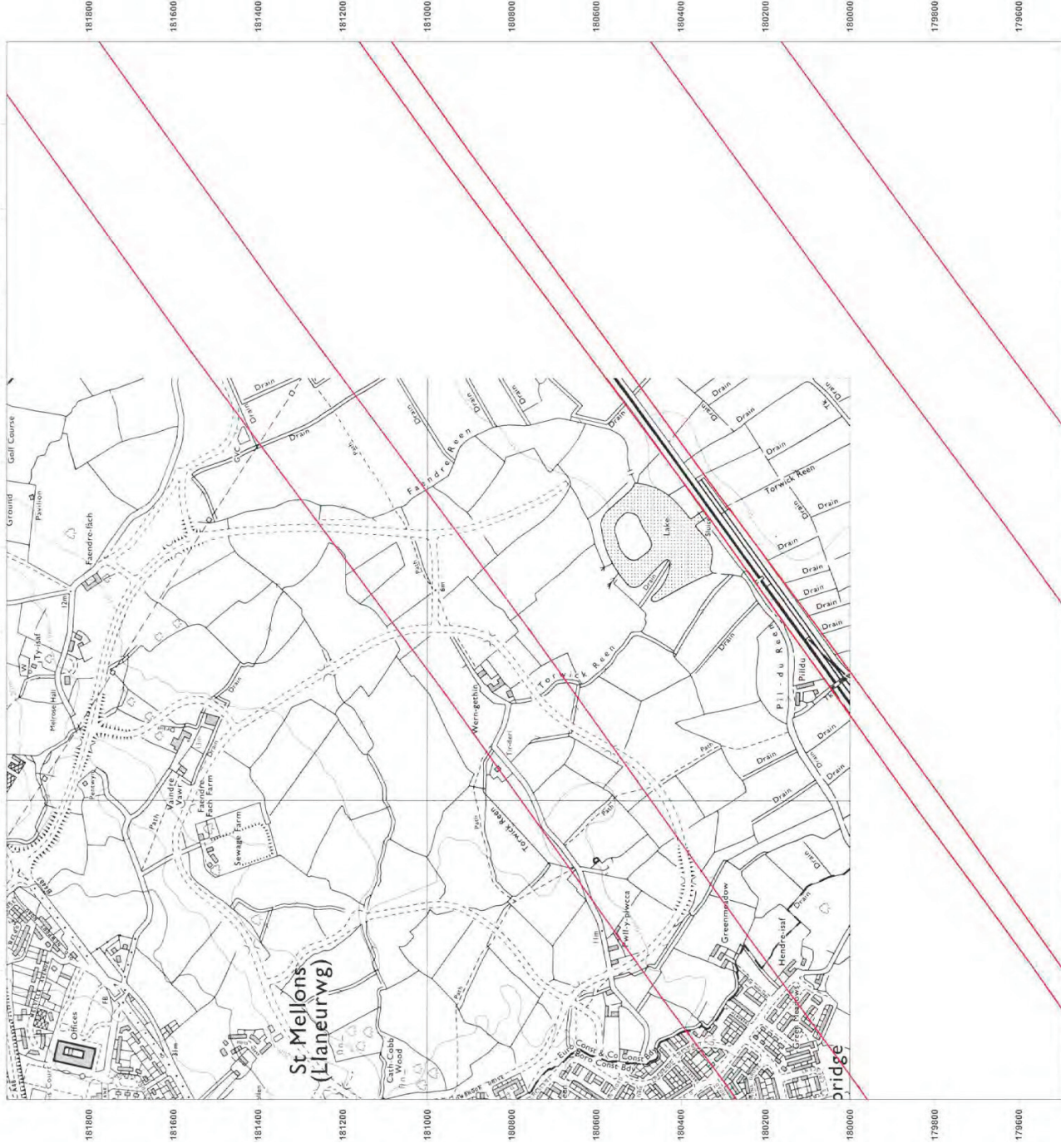
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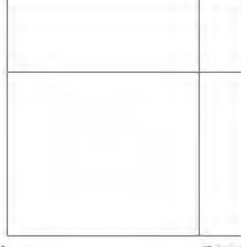
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Surveyed 1981
 Revised 1992
 Edition N/A
 Copyright N/A
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Surveyed 1979
 Revised 1987
 Edition N/A
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Surveyed 1966
 Revised 1988
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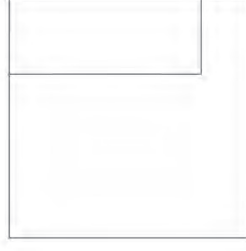
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Report Ref: GS-1822262_SS_3_3
Grid Ref: 324545, 180745

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Map date: 2002

Scale: 1:10,000

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Grid Ref: 324545, 180745

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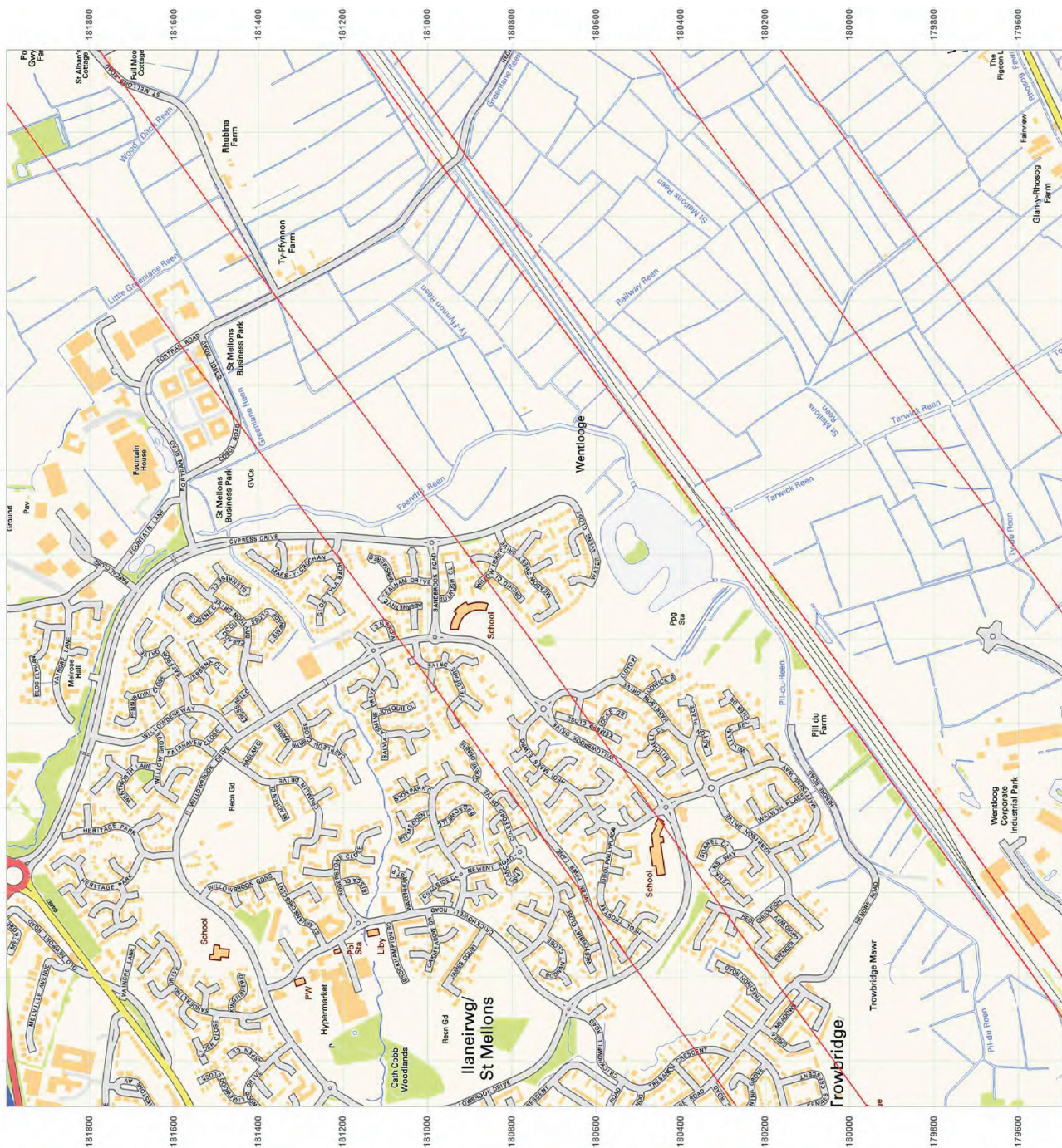


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Report Ref: GS-1822262_SS_3_3
Grid Ref: 324545, 180745

Map Name: National Grid

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Appendix C

Existing nearby GI logs



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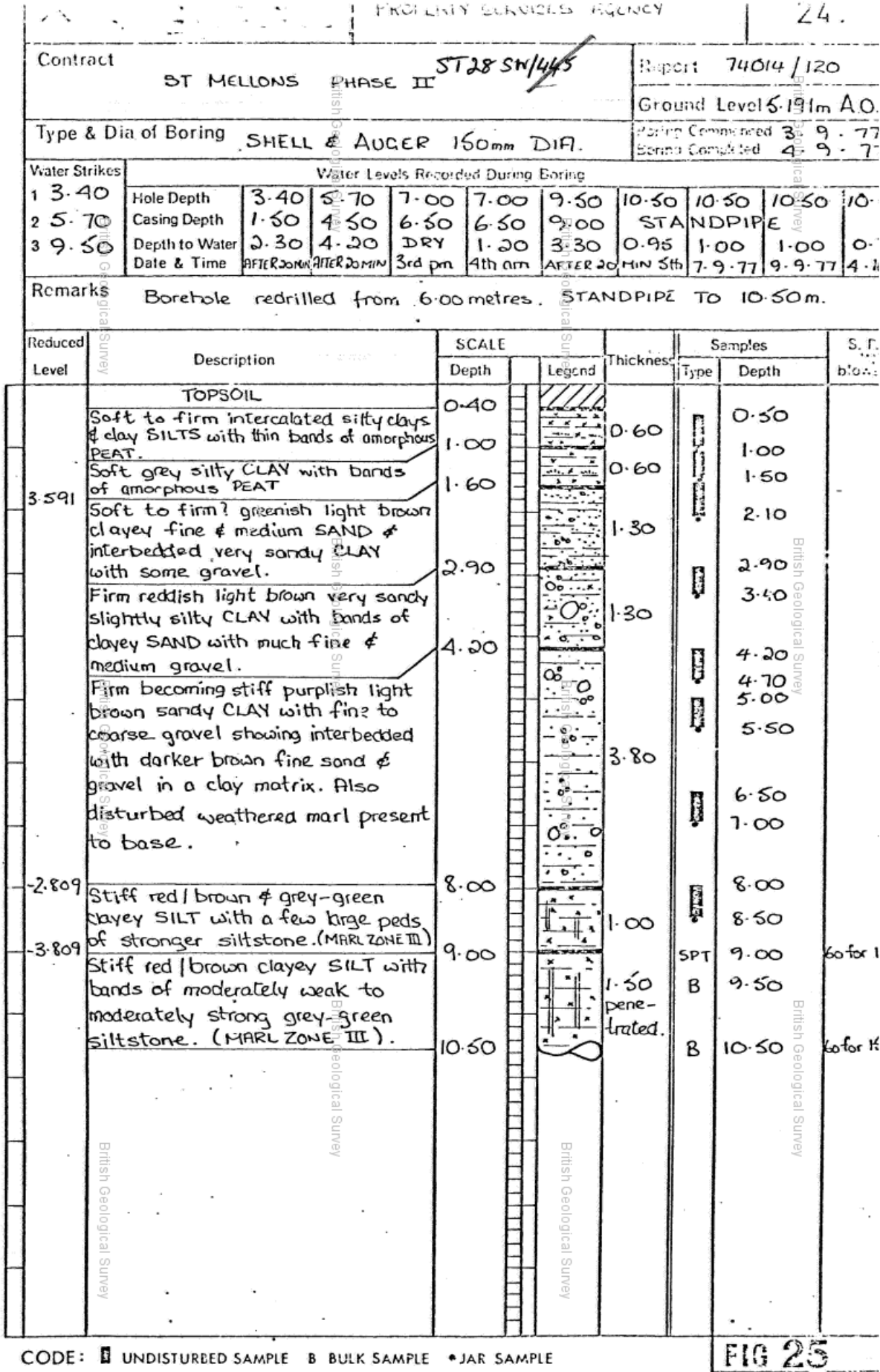
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CODE: ☒ UNDISTURBED SAMPLE ☐ R. RIHK SAMPLE ☐ AD SAMPLE



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Contract		ST28 SW/45		Report 74014/120	
ST. MELLONS				Ground Level 6.056m A.O	
Type & Dia of Boring		SHELL & AUGER 150mm Ø		Boring Commenced 2. 9. 77 Boring Completed 2. 9. 77	
Water Strikes		Water Levels Recorded During Boring			
1 3.00	Hole Depth	3.00	4.50	5.60	10.00
2 4.50	Casing Depth	1.50	3.60	5.00	6.00
3 5.60	Depth to Water	1.45	3.30	2.65	2.00
4 10.00	Date & Time	LEVELS AFTER 20 MINS			
Remarks		STANDPIPE TO 12.00m.			
Reduced Level	Description	SCALE	Legend	Thickness	Samples
		Depth		Type	Depth
	TOPSOIL	0.30			0.50
	Firm to stiff grey brown mottled silty CLAY.	1.00			1.00
	Firm brown amorphous PEAT.	1.30			1.50
	Soft to very soft light brown very silty CLAY with bands & pockets of PEAT some thin bands of light grey silty clay. (ALLUVIUM).	3.50			1.95
1.556	Soft becoming stiff light reddish brown mottled green, yellow sandy CLAY with weathered fine to coarse gravel. Some cobbles & seams of sand. (WEATHERED GLACIAL DRIFT.).	5.60			2.50
	Dense fine to coarse, sub-rounded to sub-angular GRAVEL & some sand in a bind of chocolate brown silty clay.	7.20			3.00
	Stiff purplish brown silty sandy CLAY with fine to coarse gravel. GLACIAL DRIFT	9.00			3.50
3.944	Firm to stiff red/brown silty CLAY to clayey SILT with small mudstone peds. Occasional rounded siltstone/sandstone. (MARL ZONE IV).	10.50			4.00
5.444	Stiff red/brown silty CLAY with bands of red/brown purplish muddy siltstones. MARL ZONE III to II	12.50			5.00
					5.50
					6.50
					6.50
					7.20
					7.70
					9.00
					9.50
					10.50
					10.50
					12.00
					12.50

CODE: ☒ UNDISTURBED SAMPLE ☐ BULK SAMPLE ☐ JAR SAMPLE

FIG 27

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Contract		ST28 SW/445		Report 74014/120			
ST. MELLONS		Ground Level 5.078m AOD					
Type & Dia of Boring		SHELL & AUGER. 150mm Ø		Boring Commenced 4.9.77 Boring Completed 4.9.77			
Water Strikes		Water Levels Recorded During Boring					
1 4.00	Hole Depth	4.00	5.30	9.00	13.00		
2 5.30	Casing Depth	4.00	5.30	7.50	13.00		
3 9.00	Depth to Water	3.30	3.40	7.50	1.00		
	Date & Time	AFTER 20 MINS		5.9.77	7.9.77		
Remarks		STANDPIPE TO 13.00m.					
Reduced Level	Description	SCALE		Thickness	Samples		S. P. blow
		Depth	Legend		Type	Depth	
3.078	TOPSOIL	0.40		0.40			
	Firm light brown & grey silty CLAY many roots peaty traces.	1.30		0.90		0.50	
	Firm brown amorphous PEAT.	1.60		0.30		1.00	
	Soft grey silty CLAY.	2.00		0.40		1.30	
0.078	Firm to stiff with softer pockets light brown mottled grey very silty CLAY (showing grey streaks on root fibres & possible fissures)			3.00	B SPT	2.00	3
					W	2.50	
						3.50	
						4.00	
-2.722	Dense fine to coarse SAND & fine GRAVEL with some coarse gravel bands with light brown silty matrix some thin seams of light grey silty clay.	5.00		2.80	SPT W B	5.00	30
						5.30	
						5.50	
						6.50	
-3.022	Stiff red brown sandy silty CLAY. (GLACIAL DRIFT).	7.80		0.30	B SPT	6.50	41
		8.10				8.30	
				1.40		8.50	
						9.00	
-4.422	Firm to stiff red (brown silty CLAY with small beds of mudstone (MARL ZONE 'Vb.')	9.60		3.60			
	Variable interbedded purple & brown mudstone, siltstone & fine micaceous sandstone generally moderately weak to weak. Showing some weathered clay matrix.			pene-trated	SPT.	11.00	54
						11.50	
					SPT	12.50	74
	MARL ZONE II.	13.00				13.00	

CODE: ■ UNDISTURBED SAMPLE B BULK SAMPLE • JAR SAMPLE

FIG 20

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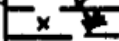









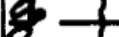


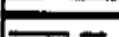
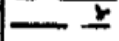
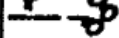

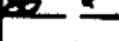



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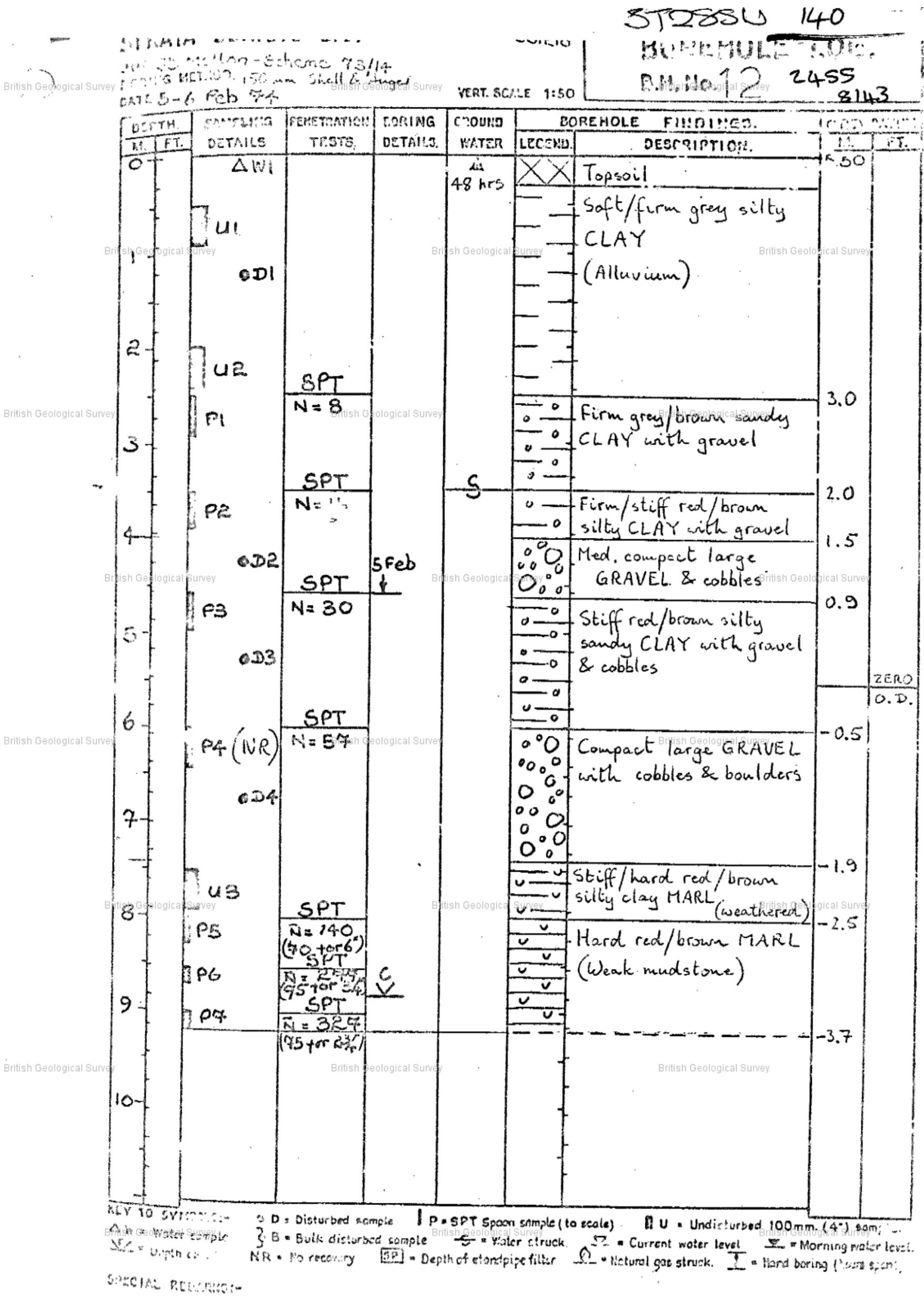
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Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

		Bored for <i>P.S.A</i> <i>ST28SW / 92</i>		Borehole <i>8</i>			
		<i>CROYDON</i>		<i>2494 8160</i>			
Contract <i>MO.D DISPERSAL</i>				Report <i>74014 / 48</i>			
<i>ST MELLONS</i>				Ground Level <i>5.77m</i>			
Type & Dia of Boring <i>SHELL & AUGER 150mm Ø</i>				Boring Commenced <i>5.9.75</i> Boring Completed <i>6.9.75</i>			
Water Strikes		Water Levels Recorded During Boring					
<i>1 6.00</i>		Hole Depth <i>11.00</i>					
<i>2 8.50</i>		Casing Depth <i>11.00</i>		<i>standpipe</i>			
<i>3</i>		Depth to Water <i>1.30</i>		<i>1.30 0.25 0.75</i>			
		Date & Time <i>6th am</i>		<i>6th pm 7th am 8.10.75 23.10.75</i>			
Remarks <i>standpipe installed to 11.00m</i> <i>Seepage at 6.00m Flow at 8.50m</i>							
Reduced Level	Description	SCALE		Thickness	Samples		S. P. T. 'N' blows / ft
		Depth	Legend		Type	Depth	
	<i>TOP SOIL</i>	<i>0.00</i>					
	<i>Soft-firm light brown / grey very silty CLAY</i>	<i>0.70</i>		<i>0.50</i>		<i>0.50 0.75</i>	
	<i>Very soft grey very silty CLAY with wood & vegetation</i>					<i>1.20</i>	
				<i>2.30</i>		<i>2.05</i>	
	<i>Firm red / brown very sandy CLAY with fine gravel (some medium coarse) & some roots showing weathered</i>	<i>3.00</i>			<i>CPT</i>	<i>3.50</i>	<i>24</i>
						<i>4.00</i>	
	<i>Firm-stiff silty CLAY with fine gravel some medium & coarse & odd cobbles</i>	<i>5.50</i>		<i>0.50</i>	<i>CPT</i>	<i>5.00</i>	<i>20</i>
						<i>5.50</i>	
				<i>3.00</i>	<i>CPT</i>	<i>6.50</i>	<i>32</i>
						<i>7.00</i>	
	<i>Highly weathered red brown micaceous MUDSTONE (MARL zone III)</i>	<i>8.50</i>			<i>CPT</i>	<i>8.00</i>	<i>53</i>
				<i>1.50</i>	<i>SPT</i>	<i>9.00</i>	<i>49</i>
						<i>9.45</i>	
	<i>Moderately weathered red brown MUDSTONE with bands of purple sandstone (MARL zone II)</i>	<i>10.00</i>		<i>1.00</i>	<i>SPT</i>	<i>10.50</i>	<i>81</i>
		<i>11.00</i>				<i>11.00</i>	
				<i>penetrated</i>			

CODE: ☐ UNDISTURBED SAMPLE ☐ BULK SAMPLE ☐ JAR SAMPLE

FIG 8





ST28SW 147

BOREHOLE LOG

B.N. No. 19 2448 8120

BRITISH GEOLOGICAL SURVEY LTD.

JOB NO. 83/210

VERT. SCALE 1:50

100 mm Shell & ragger

20 Jan 94

DEPTH m ft	SAMPLING DETAILS	PENETRATION TESTS	CORING DETAILS	GROUND WATER	BOREHOLE FINDINGS		LOAD DATA	
					LOG NO.	DESCRIPTION	IN	OUT
0					XX	Topsoil	2.10	
1	P1	SPT N= 47		48 hr level		Stiff red/brown silty sandy CLAY with occasional gravel, cobbles & boulders		
2	P2	SPT N= 35	20 Jan					
3	UI CD3							
4								
5	UR CD4			S		Hard friable silty clay MARL . Red brown & grey with calcareous bands. (Weathered)	2.8	
6	P3	SPT N= 240 (35, or 3 3/4")		Sealed		Hard red/brown & grey MARL (Weak mudstone/siltstone)	1.3	
7	P4	SPT						ZERO O.D.
8		N= 332 (33, or 3")					-0.5	

SYMBOLS:-

○ D = Disturbed sample

□ P = SPT spoon sample (to scale)

□ U = Undisturbed 100mm. (4") sample

□ B = Bulk disturbed sample

— S = Water struck

— W = Current water level

— M = Morning water

NR = No recovery

— D = Depth of standpipe filter

— G = Natural gas struck

— I = Yard boring (1000 spm)

SPECIAL REMARKS:-



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

BGS ID: 383421 : BGS Reference: ST28SW153

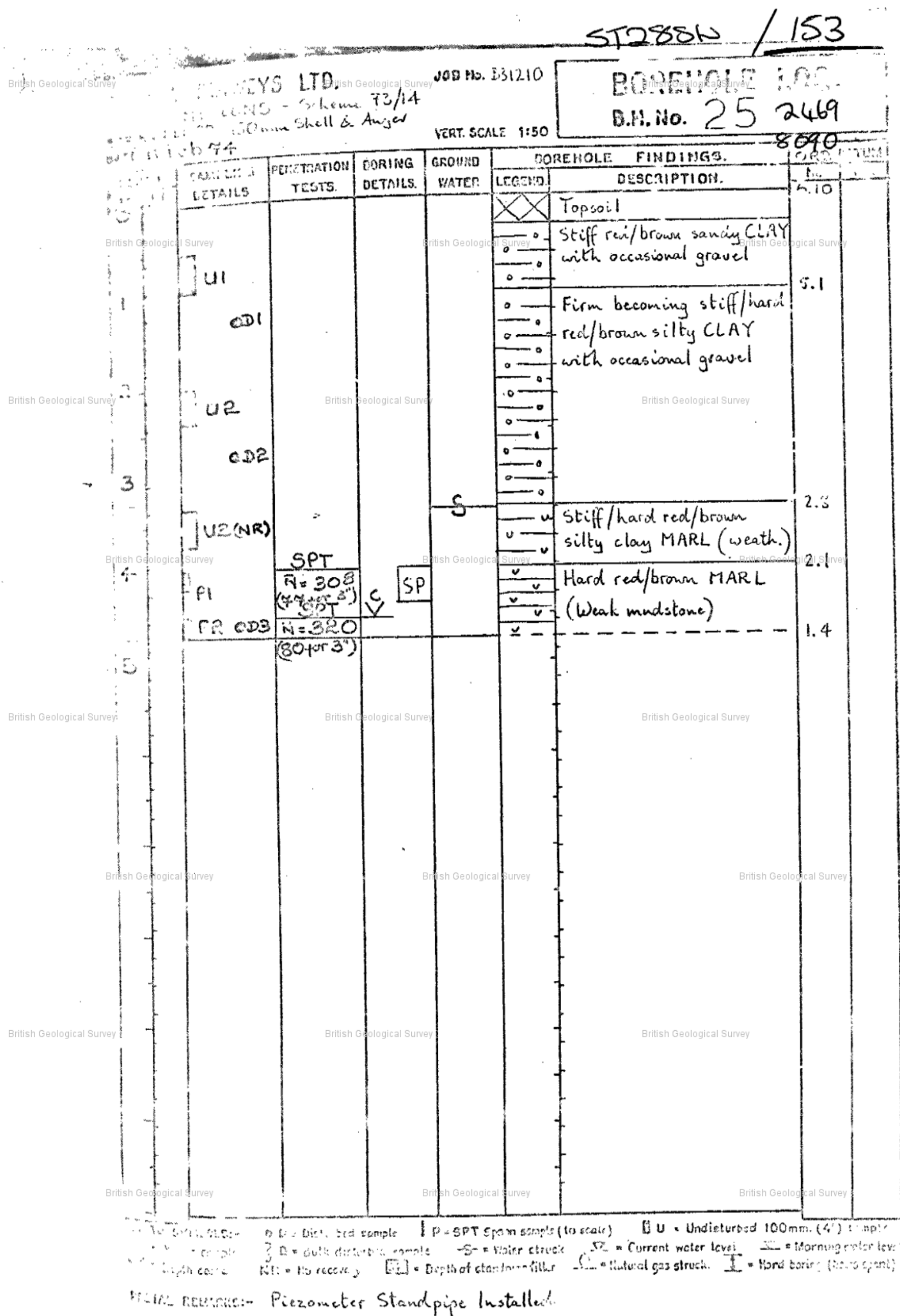
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