GroundSolve Ltd
Consulting Geotechnical Engineers

PHASE 2 GROUND INVESTIGATION: TY HAPUS, LLANDUDNO

GSL3222/RO1

VERSION 1

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DRAFT

Prepared for:

Grŵp Cynefin
Mwy na thai • More than housing

Prepared by: Alex Ridge

GroundSolve Ltd

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This report has been prepared by GroundSolve Ltd with all reasonable care and diligence, within the best practice and guidance current at the time of issue within the proposed redline boundary and proposed Site end use as presented by the Client.

This report is confidential to the Client and GroundSolve Ltd accepts no responsibility whatsoever to third parties to whom this report is presented.

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EXECUTIVE SUMMARY

Site Location and Name:	Ty Hapus, Llandudno Ffordd Penrhyn, Llandudno LL30 1HB
Report Objective	This report presents the findings of the ground investigation, the environmental risk assessment and geotechnical assessment relating to the proposed development
Land Use History	The site was open agricultural land with railway sidings to the west of the site, until circa 1959 whereby it was utilised as a playing field and the sidings labelled as disused. A gas works was located 150m south of the site until 1955. The community centre was erected in circa 1992, and the wider site was playing fields until 2003 whereby it was used as a hard standing playing field.
Development	It is understood that the development will comprises of 23 No. 2 storey- semi-detached dwellings including accessible apartments and roadways.
Geoenvironmental Setting	**Topography:** The site is relatively flat, however no topographical information has been provided to GSL. **Geology:** The site is underlain by limited Made Ground associated with construction of the Astro turf surface, which overlies cohesive tidal flat deposits (clay), overlying granular material (TFD) above the Nant Ffrancon subgroup (Siltstone) bedrock. **Hydrogeology:** The superficial deposits are classified as a Secondary Undifferentiated aquifer and the bedrock geology is classified as a secondary B aquifer of high vulnerability. The nearest groundwater abstraction point is located 100m to the northeast of the site. **Hydrology:** The nearest surface water feature is a drainage dyke located 520m west of the site. **Flood Risk:** The site is located within an area of low risk from rivers and sea and located within a Flood Zone 2&3. **Mining & Quarrying:** On the basis of the geology of the area and the historic maps, it is considered that the site is not likely to be at risk from ground movements due to previous mines or quarrying. **Unexploded Ordnance:** A non-specialist UXO screening exercise in general accordance with CIRIA report C681 indicates a low risk.
Scope of Phase 2 Site Investigation	The scope of ground investigation works carried out at the site by GroundSolve comprised: • 10 No. window sample boreholes to a maximum depth of 5.45 mbgl; • 6 No. trial pits to a maximum depth of 2.60 mbgl; • 3 No. BRE digest 365 compliant soakaway tests. • Laboratory testing: chemical and geotechnical. • Installation of 4no. ground gas monitoring wells
Findings of the Phase 2 Ground Investigation	The ground conditions at the site (from ground level, down) comprise: • Ground surface – Topsoil and asphalt • Made Ground – Loose slightly sandy gravel (sub base) over; • Tidal flat deposits – generally comprising of very soft to firm brown clay over sandy gravel Groundwater was encountered between 1.2m bgl and 6.6m bgl and has been monitored at depths of between 0.21m bgl and 1.58m bgl. There was no visual or olfactory evidence of contamination in soils at the site. Material encountered in WS101 at a depth of 0.20m and WS108 at 1.00m elevated above the lowest GAC for speciated TPHs and material encountered at WS101 at 0.20m exceeding the lowest GAC for aliphatic TPHs No gas monitoring visits have been undertaken so far due to access restrictions. Results from the ground gas monitoring visits will be included upon completion of the monitoring period.
Phase 2 Conclusions – Geoenvironmental	**Human Health:** • Elevated pervasive contamination of hydrocarbons is present. However, subject to EHO and NHBC approval is not considered a significant risk. • However, where present, the Made Ground soils are not suitable for gardens; and **Plant growth:** No unacceptable risks. **Controlled Waters:** No unacceptable risks. **Ground Gases (Human Health / Property):** • Radon protective measures are required as the site is within an area where maximum radon potential is between 1% and 3%, therefore no radon protection measures are required • Ground gas risk assessment will be completed upon completion of the ground gas monitoring period.

Foundations	Due to the soft and variable shallow clay deposits present on the site, it is anticipated that shallow spread footings will not be suitable for the proposed developments. The foundation solution recommendations outlined below apply to the site as a whole. In response to the ground conditions that have been identified at the site, it is considered that the following foundation solutions are possible: a) Lime stabilisation / Raft Foundations; b) Piled Foundations; c) Ground Improvement by Vibro Stone Columns (VSC)
Floor Slabs	Ground floor slabs should be designed to incorporate any required gas mitigation measures which will be indicated within the final issue of the report.
Soakaways & Drainage	Soakaways are not recommended for this site due to the low permeability of the clay. Soakaway tests undertaken on the site failed to reach 25% of 75% drop of head and as such the tests failed.
Buried Concrete	It is recommended that DS-1 and AC-1 be adopted for the design of all buried concrete equating to a designated concrete class DC-1.
This summary forms part of a Tier 2 Risk Assessment (Ground Condition) report prepared by GroundSolve Ltd and contains an overview of the key findings and conclusions. The summary should not be treated as an independent document.	

1 INTRODUCTION

GroundSolve Ltd (GSL) was commissioned by Grwp Cynefin to undertake a ground investigation and contaminated land risk assessment for the construction of a new housing development comprising of semi-detached dwellings, accessible apartments and assisted living apartments on an area of land currently used as the Ty Hapus Community Centre, Llandudno referred to as Ty Hapus, Llandudno (the "Site").

This report has been devised to generally comply with the relevant principles and requirements of a range of guidance including:

- Part IIA of the Environment Protection Act, 1990;
- BS5930:2015 +A1:2020: "Code of practice for site investigations";
- BS10175: 2011 +A2:2017 "Investigation of Potentially Contaminated Sites - Code of Practice";
- The Building Regulations 2010. Part C (HM Government 2013)
- Welsh Local Government Assoc- Development of Land Affected by Contamination Guide for Developers 2017
- Welsh Land Contamination Working Group (WLGA) - Requirements for the Chemical Testing of Imported Materials for Various End Uses and Validation of Cover Systems

1.1 Proposed Development

The proposed development of the site is understood to comprise:

- the demolition of all existing buildings;
- the removal from site or the treatment of any contaminated material encountered during demolition;
- the construction of 23 No. 2 storey semi-detached dwellings including accessible apartments, access roads, parking areas, gardens and service provision.

The findings and conclusions of the risk assessments have been set out and recommendations given for the proposed residential end use. If there is a subsequent change in the proposed land the risk assessments and conclusions should be reviewed to determine whether they are still applicable for the revised end use.

Figure 1 – Extract from Proposed development plan

1.2 Objectives

The purpose of the report is to provide an assessment of the site using published information and information on conditions at the site in relation to the proposed residential development.

The findings and conclusions of the risk assessments have been set out and recommendations given for the proposed residential end use. If there is a subsequent change in the proposed land, the risk assessments and conclusions should be reviewed to determine whether they are still applicable for the revised end use.

This document is a working document and may need to be updated, in agreement with the relevant regulatory bodies, at any stage during development dependent on the conditions encountered. This version of this document is to be issued to regulators for approval (Conwy County Borough Council).

1.3 Previous Investigations

A phase one desk study report was undertaken prior to GroundSolve Ltd (GSL) undertaking a phase 2 site investigation and geotechnical report by Darty's which can be found summarised in section **3.1**

1.4 Limitations

This report has been prepared for the sole use of Grwp Cynefin. No other third party may rely upon or reproduce the contents of this report without the written approval of GroundSolve Ltd. If any unauthorised third party comes into possession of this report, they rely on it entirely at their own risk.

Access into the section of the site to the north of the community centre was restricted to the elevated and narrow nature of the path. The location proposed to be undertaken in this area was repositioned and agreed with the client, and the trial pit located to the northwest of the community centre repositioned due to services.

2 SITE DETAILS AND DESCRIPTION

Table 2.1 Current Site Overview.

Site name	Ty Happus, Llandudno
Site address	Ffordd Penrhyn, Llandudno LL30 1HB
National Grid Reference (NGR)	278487 , 381615
Approximate Site area	0.64ha
Site shape	Rectangular Northeast to Southwest - 96m East to West – 64m  **Figure 2 – Site extents and location**
General topography and ground levels	The site is relatively flat, however no topographical information has been provided to GSL.

The ground investigation was undertaken between 17th December 2024 and the 19th December 2024. Exploratory location plans and drawings are found in **Appendix A**, with photographs of the site presented in **Appendix B**.

Table 2.2 – Summary of Description of the Site and its Environs

Current Use:	The site is currently used as a community centre with a multi-use games area (MUGA) to the rear which has been out of use for some time.
Access	Via asphalt roadway direct from Ffordd Penrhyn to a car park area to the front of the community centre. The MUGA is access over a grassed area which features a wooden play area.
Existing Buildings& Structures	Existing buildings on the site include the community building and a storage building to the north.
Site Surface	Partly asphalt/concrete slabs to the front of the community centre, with asphalt surfacing within the MUGA area and access path to the MUGA. Some grassed areas to the rear of the community centre building and along the northern boundary of the building.
Vegetation	Generally grass with bushes noted on site boundaries.
Storage Tanks	Below Ground Tanks: No evidence/none suspected. Above Ground Tanks: None present.
Services	A number of foul service covers were noted.
Asbestos	No potential Asbestos Containing Materials (ACMs) noted in the buildings or on the ground surface. However, a refurbishment / demolition asbestos survey will be required Prior to demolition of the storage building.
Waste Disposal/ Materials Storage	No site storage of waste materials was identified.
Surrounding Area	Residential to the north, west and southeast, a school to the south, and a retail park to the east.
Local / Background Knowledge	The site has largely remained the same since 2003.

3 PREVIOUS INVESTIGATIONS

3.1 Review

A summary of the findings from previous reports is given in **Table 3.1** below:

Table 3.1: Summary of Previous Investigations.

Site History	The site was open agricultural land with railway sidings to the west of the site, until circa 1959 whereby it was utilised as a playing field and the sidings labelled as disused. A gas works was located 150m south of the site until 1955. The community centre was erected in circa 1992, and the wider site was playing fields until 2003 whereby it was used as a hard standing playing field.
Geological Setting	Published information indicates superficial deposits of Tidal Flat deposits (Clay, silt, sand and gravel) Bedrock geology comprises of the Nant Ffrancon subgroup (Siltstone) No BGS borehole records are available for the site or proximal area.
Mining	No past underground mining recorded.
Hydrogeology	The superficial deposits are classified as Secondary Undifferentiated The bedrock geology is classified as Secondary B
Waste	The site is surrounded by historical and licenced waste sites, with the nearest historical landfill site located 224m SW of the site, with a licenced located 170m W and 215m W. Further detail is available within the Phase 1 Risk assessment undertaken by Darty's (24168-DAT-SI-XX-RP-S-001)
Contamination Sources	**Onsite sources:** Car parking – Limited potential for fuel from parked vehicles Made ground – Localised with the construction of the community building and MUGA **Offsite sources:** Historical Gas works – Lateral migration of contaminants from historical gas works (TPHs, PAHs, Heavy metals) Historical landfill – Migration of ground gas

4 FIELDWORK

4.1 Introduction

The fieldwork was carried out between the 17th and 19th December 2024. GroundSolve personnel were present to supervise all work, describe the ground encountered, and take samples. Fieldwork procedures were undertaken in accordance with the relevant sections of:

- BS5930:2015 + A1:2020 "Code of Practice for Site Investigations;"
- BS10175:2011 + A2:2017 “Investigation of Potentially Contaminated Sites – Code of Practice.”

The investigation included:

- 10 No. windowless sample boreholes to a maximum depth of 5.45mBGL,
- 6 No. machine excavated trial pits to maximum depth of 2.60mBGL,
- 3 No. soakaway tests conducted across 3 No. of the trial pits,
- Sampling for chemical and geotechnical testing of soils,
- 6 No. ground gas and groundwater monitoring visits
- Description of the ground encountered in accordance with BS5930:2015 + A1:2020, Code of Practice for Site Investigations.

4.2 Dynamic (Window) Sample Boreholes

10 No. windowless sampling boreholes (WS) were completed using a tracked windowless sample rig. The exploratory hole logs are presented in **Appendix C**.

4.3 Trial Pits

6 No. trial pits (TP101 – TP103, SA101 – SA103) were dug using an ECR580 excavator. The exploratory hole logs are presented in **Appendix C**.

4.4 Soakaway Tests

Soakaway tests were conducted in 3 No. of the pits, using a towable water bowser. All 3 No. tests failed to obtain a permeability value due to low permeability of the clay strata. A summary of results can be found below in **Table 4-1**.

The results are presented in **Appendix D**.

Table 4-1 – Summary of falling head permeability results

Location ID	Number of tests	Result
SA101	1	Test failed to reach 25% and 75% head
SA102	1	Test failed to reach 25% and 75% head
SA103	1	Test failed to reach 25% and 75% head

4.5 Samples and Sample Containers

Soil samples for chemical analysis each comprised a pair of samples: a plastic tub for metals and inorganics and an amber glass jar for organics.

Soil samples were stored in cool boxes with ice packs and dispatched directly to the testing laboratory, for all phases of the investigation.

Samples for physical testing comprised of bulk samples disturbed samples, and small disturbed samples and were dispatched to The Testing Laboratory (TTL).

5 LABORATORY TESTING

5.1 Chemical Laboratory Testing

Chemical samples were submitted to a UKAS accredited laboratory in accordance with ISO17025 and are also MCERTS accredited for soil analysis in accordance with the Environment Agency's scheme. The laboratory carries out Quality Assurance and Quality Control in accordance with BS ISO 17025 and participate in external laboratory comparison and quality control schemes. Details of the accreditation and the methods of analysis are provided on the relevant test reports.

The selection of samples for laboratory testing and analytes to be determined were made based on the preliminary CSM from the Phase 1 desk study, and relevant observations during the investigations. As highlighted within the Phase 1 desk study and subsequent CSM the area of historical railway sidings was an area of potential contaminated impact, however access to this area was restricted due to no traffic management being requested by the client.

The sample selection rationale is as follows:

- To gain a good coverage across the Site of the various material types and strata encountered;
- To fully characterise the potential made ground materials within the identified higher-risk areas.

The selected soil samples were tested for a range of typical contamination indicators including specific tests for contaminants suspected as being present from the desk study, CSM, and observations made on-site. Tests were also performed which were used to support the modelling of contaminant transport and impacts (e.g. TOC) and for waste classification purposes.

Each of the soil samples were analysed for the 'total' concentration of a suite of potential contaminants.

The results of the laboratory analysis are presented in **Appendix E**. The various suites of analysis for the soil are presented in **Table 5.1** below:

Table 5.1: Suites of Analysis for Environmental Soil Samples

Determinand	Soil Suite 1
Number of Samples	5
Index Tests	
Asbestos Screen / Quantification	✓
pH	✓
Metals	
As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn (all totals)	✓
Inorganics	
Acid Soluble Sulphate	✓

Determinand	Soil Suite 1
Cyanide - Total	✓
Sulphate (2:1 extract on soil samples)	✓
Organics	
Phenols - Total (monohydric)	✓
Total Organic Carbon (TOC)	✓
PAH (Speciated USEPA 16)	✓
TPH (C10-C40), DRO, Mineral Oil	✓
Benzene, Toluene, Ethyl Benzene, Xylenes (BTEX);	✓

5.2 Physical Laboratory Testing

Samples were submitted to Professional Soils Laboratory (PSL) who are UKAS accredited in accordance with ISO17025. The following geotechnical testing was undertaken with the results of this testing presented in are presented in **Appendix F**. The various suites of analysis for the soil are presented in **Table 5.1**:

Table 5.2: Summary of Physical Testing

Determinant	Samples Used in Testing
Index Tests	
pH	**5**
Sulphate (2:1 extract on soil samples)	**5**
Atterberg	**15**
Moisture Content	**12**
PSD (Particle Size Distribution	**7**
BRE SD-1 Suite	**8**
Lime stabilisation (1.25, 2.50, 5.0)	**1**

6 GROUND CONDITIONS

6.1 General

The site investigations have allowed the site-specific ground conditions to be described and this information was used to provide an improved conceptual ground model. The geology encountered during the site investigations was generally consistent with existing publicly available information online on the British Geological Survey (BGS) GeoIndex (onshore) viewer. A summary of the general strata encountered across the site is provided in the following sub sections.

6.2 Ground Surface

Ground surface varied across the site with areas of topsoil, concrete, flag stone and Coloured Asphalt. Coloured Asphalt formed the majority of the investigation area being present in both the MUGA area as well as the MUGA path. TP103 and WS107 were excavated within a grassed area comprising of topsoil, while WS108 was excavated in an area comprising of flag stones, forming a pathway to the rear of the storage building. All other locations were excavated through astro turf.

6.3 Anthropogenic Materials

Made ground was encountered in all exploratory holes and was described variously as loose brown gravel of mixed lithologies which formed a subbase below the concrete underlaying the astroturf surface with a maximum thickness of 0.25m. Made ground was encountered below topsoil within TP103 and was described as a loose reddish brown sandy gravel of slate, granite, schist and sandstone with mudstone, granite and siltstone cobbles of 0.15m thickness.

No visual or olfactory evidence of contamination was noted during the fieldwork.

6.4 Natural Deposits

Underlying the Made Ground/ topsoil (WS107 & TP103), very soft to firm clay (Tidal flat deposits) was recorded throughout the site and generally comprised of grey mottled brown sandy gravelly clay varying in thicknesses between 1.35m to 2.25m becoming softer toward the horizon change to underlying granular strata.

Very loose becoming very dense gravelly fine to coarse sand with calcitic shells (tidal flat deposits) was identified from 2.30m – 2.90m bgl and proven to a depth of 5.45m in all window sample locations and TP103.

6.5 Bedrock

Bedrock was not encountered during this investigation.

6.6 Groundwater

Groundwater strikes were encountered in 10 No. of the exploratory hole locations, summarised below in **Table 6-1**.

Table 6-1 – Groundwater Conditions

Location ID	Depth of Strike (mbgl)	Depth after 20 minutes	Strata
WS101	2.25	NC	Gravelly sand
WS102	2.20	NC	Laminated clay
WS103	2.80	NC	Gravelly sand
WS104	2.70	NC	Gravelly sand
WS105	2.80	NC	Gravelly sand
WS106	2.55	NC	Gravelly sand
WS107	2.50	NC	Gravelly sand
WS108	2.30	NC	Gravelly sand
WS109	2.90	NC	Gravelly sand
WS110	2.30	NC	Gravelly sand

NC – No change

7 GENERIC QUANTITATIVE RISK ASSESSMENT

7.1 Assessment for the Protection of Human Health

The results of the soil analyses are presented below, where they have been compared to suitable generic assessment criteria (GACs), in order to allow a generic quantitative risk assessment (GQRA) to be carried out for the site and the proposed development. In the absence of GACs, the risk from total concentrations have been assessed by comparing total concentrations with the lowest applicable GAC for a speciated compound within the banding.

The Category 4 Screening Levels (C4SLs) published by DEFRA (2014) have been adopted in the first instance, which have been published for six substances to date. Where a C4SL is unavailable, the "Suitable 4 Use Levels" (S4ULs) published by LQM/CIEH (2015) have been adopted.

These criteria have been derived using the CLEA model for a range of standard end-use scenarios and a range of soil organic matter (SOM) contents. It should be noted that the C4SL values are derived on the basis of a "low level of toxicological concern", while the S4UL values are based on a "tolerable" or "minimal" level of risk. As such, the S4ULs describe a lower level of risk than the C4SLs, and are equivalent to the former Soil Guideline Values (SGVs, published by the Environment Agency) and the previous editions of the LQM/CIEH GAC values.

The GQRA is based on a soil with a Soil Organic Matter of 2.5%, for a residential with gardens end use.

A full summary of the chemical test results is presented in **Appendix G**.

7.2 Results

Metals

The results from the metal analysis have recorded very low concentrations with no exceedances of the applicable GACs.

Table 7.1: Metals Suite

Metals	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Arsenic	2.4	9.6	5.55	5	37	C4SL	0
Cadmium	< 1.6	< 1.6	< 1.6	5	22	C4SL	0
Chromium	12.4	42.2	25.68	5	910	S4UL	0
Copper	7.9	20	10.3	5	2400	C4SL	0
Lead	15.6	99	27.83	5	200	S4UL	0

Metals	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Mercury	0.9	0.9	0.62	5	1.2	S4UL	0
Nickel	5.2	27.5	15.07	5	130	S4UL	0
Phenol - Monohydric	< 0.50	< 0.50	< 0.50	5	380	S4UL	0
Selenium	< 3.0	< 3.0	< 3.0	5	250	S4UL	0
Zinc	44.5	104	56.65	5	3700	C4SL	0

GroundSolve conclude that the risk from metal concentrations to the proposed development is considered low with no exceedances of relevant GACs for residential with gardens (2.50% OM content).

PAHs

All samples selected for analysis have generally recorded low PAHs.

Table 7.2: Polyaromatic Hydrocarbons

Polyaromatic Hydrocarbons (PAH)	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Acenaphthene	< 0.013	0.023	0.01	5	510	S4UL	0
Acenaphthylene	< 0.015	0.019	0.01	5	420	S4UL	0
Anthracene	< 0.017	0.032	0.02	5	5400	S4UL	0
Benzo(a)anthracene	< 0.012	0.187	0.04	5	11	S4UL	0
Benzo(a)pyrene	< 0.019	0.246	0.05	5	5	C4SL	0
Benzo(b)fluoranthene	< 0.020	0.273	0.07	5	3.3	S4UL	0
Benzo(g,h,i)perylene	< 0.019	0.191	0.05	5	340	S4UL	0
Benzo(k)fluoranthene	< 0.025	0.103	0.03	5	93	S4UL	0
Chrysene	< 0.028	0.207	0.05	5	22	S4UL	0
Dibenzo(a,h)anthracene	< 0.017	0.046	0.02	5	0.28	S4UL	0
Fluoranthene	< 0.017	0.332	0.07	5	560	S4UL	0
Fluorene	< 0.013	0.021	0.01	5	400	S4UL	0
Indeno(1,2,3-c,d)pyrene	< 0.019	0.212	0.05	5	36	S4UL	0
Naphthalene	< 0.016	0.022	0.01	5	5.6	S4UL	0
Phenanthrene	< 0.014	0.106	0.03	5	220	S4UL	0
Pyrene	< 0.016	0.294	0.08	5	1200	S4UL	0

Petroleum Hydrocarbons (PHC)

No hydrocarbon impacted material was encountered during the fieldwork. No speciated hydrocarbon testing was undertaken, however BTEX, DRO, Mineral oil and TPH C10-C40 were carried out on 5 selected samples.

Table 7.3: Total Petroleum Hydrocarbons

Petroleum Hydrocarbons	WS101	WS101	WS105	WS108	WS108
	0.20	1.00	1.00	0.20	1.00
Benzene	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Toluene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Ethylbenzene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
xylenes	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Diesel Range Organics (>C10-C25)	1020	< 12	< 12	29	< 12
>C10-C40 Soil	6680	19.3	23.2	118	24.7
Mineral Oil (>C10-C40 Total)	6330	< 19	< 19	72	< 19

The results have shown no concentrations above the detection limit within any of the BTEX analysis. Four of the five samples have shown low concentrations of DRO, Mineral oil and TPH C10-C40 and indicate no potential human health risk.

WS101 at 0.20m has recorded elevated DRO, Mineral oil and TPH C10-C40. The sample is from granular made ground underlying the macadam surfacing. It is anticipated that the elevated concentration is from the macadam fragment present within the granular made ground and the surface materials. it would be recommended that these materials are not reused within soft landscaped areas as part of the proposed development.

Asbestos

Asbestos can be present in soil as fragments of bulk Asbestos Containing Materials (ACMs) (e.g., asbestos cement sheeting) and also as discrete asbestos fibres within the soil matrix. This investigation has carried out assessments to determine whether both bulk fragments of asbestos and discrete fibres are present in the soil at the site. The asbestos assessment commenced on site with inspection of the Made Ground by our site staff for the presence of bulk ACMs. During the fieldwork no suspected ACMs were identified.

Laboratory assessments were carried out in order to confirm the site assessment that ACMs were absent, and no asbestos was detected in any of the samples retrieved from site.

7.3 Assessment for the Protection of Controlled Waters

Made Ground is relatively thin, typically less than 1.0m in thickness overlying tidal flat deposits comprising soft clay to 2.5m overlying loose fine to coarse sand proven to 5.0m.

The total concentrations detected within soil samples are predominantly relatively marginal in human health terms and do not indicate particularly high concentrations. As discussed above, the made ground is underlain by clay deposits which will limit any potential vertical migration.

Overall, it is assessed that there is a low possibility of a contaminant linkage between and the underlying groundwater in the secondary undifferentiated aquifer and the underlying Secondary B aquifer.

GroundSolve believes that the site does not pose a significant risk to Controlled Water because:

- No contamination sources present on site.
- The whole site is underlain by Clay deposits from the tidal flat deposits, which would not act as a preferential pathway due to the inherent low permeability of the material.
- The shallow groundwaters at and in the vicinity of the site are not abstracted for human consumption;

7.4 Permanent Ground Gases

The Phase 1 desk study identified a historical landfill located close to the western boundary.

The site remained undeveloped land until 2003 when an all weather sports pitch was constructed over the majority of the site. No grossly contaminated soil was identified within the field work.

The fieldwork has shown thin Made Ground (sandy gravel) typically <1.0m thick. TOC carried out from the Made Ground material are relatively low ranging from 0.79% to 2.79%. The Made Ground is not considered a ground gas risk.

Underlying the Made Ground, the fieldwork has shown a typical sequence of soft locally very soft and firm sandy clay to 2.5m overlying slightly gravelly fine to coarse Sand with varying amount of shells proven to 5m. No significant organic material has been encountered.

As detailed in the Groundsure Report GS-R5C-LVU-Z2Y-P9J, the Site is located within an area where the radon risk is low, with between 1.0% and 3.0% of properties are affected by radon, therefore no radon protective measures are required.

Measured Gas Concentrations

Three rounds of gas monitoring have been carried out to date in the 4 No. gas monitoring wells. A summary of the air pressure trends during the monitoring period has been provided in Appendix E. The highest flow rates, methane, and carbon dioxide concentrations, together with the lowest oxygen levels (i.e., a combination of the worst-case temporal conditions recorded) from the monitoring visits are summarised in the table below:

Table 7.4: Summary of Ground Gas Monitoring

Borehole	Response Zone mbgl	No. of monitoring occasions	Steady State Flow (l/hr)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (% v/v)	Water Level mbgl	Atmospheric pressure readings mb
WS101	1.0m - 3.0m	3	0.5	<0.1	1.4 – 2.0	14.9 – 18.0	1.75-1.80	1006-1041
WS103	1.5m - 3.0m	3	0.1	<0.1	0.1 – 0.4	19.7 – 20.7	1.83-1.92	1005-1043
WS107	1.0m - 3.0m	3	0.3	<0.1	0.9 – 1.2	18.0 – 20.5	1.83-1.94	1007-1041
WS110	1.0m - 3.0m	3	0.5	<0.1	0.5 – 0.7	19.5 – 20.9	1.74-1.84	1006-1039

Ground Gas Assessment

The graph in Appendix F show that 2 of the 3 visits to date were carried out during falling air pressure conditions.

Background information relating to the origin and production of landfill and ground gases are presented in **Appendix H**, together with current guidance on the assessment of ground gases. In accordance with this approach and the above measured ground gas levels, it is considered that the worst-case temporal conditions may not have been measured during the monitoring period. However, it is anticipated that the worst-case temporal conditions will not be significantly worse than those presented in **Table 7.4** above. The gas flow rates have typically remained low ranging between <0.1l/hr and 0.5l/hr.

Groundwater has been recorded relatively consistent ranging between 1.74m and 1.94m and typically resting just above the tidal flat sand deposits. The water levels were generally below the top of each response zone, therefore were not flooded.

From Table 8.5 of CIRIA C665 the worst-case Characteristic Situation for the site are as follows:

Table 7.5: Characteristic Gas Situations

Borehole Number	Steady State Flow	CH_4			CO_2		
	l/h	% v/v	GSV (l/hr)	Characteristic Situation	% v/v	GSV (l/hr)	Characteristic Situation
WS101	0.5	0.1	0.0005	1	2.0	0.0100	1
WS103	0.1	0.1	0.0001	1	0.4	0.0040	1
WS107	0.3	0.1	0.0003	1	1.2	0.0036	1
WS110	0.5	0.1	0.0005	1	0.7	0.0035	1

Based on the ground investigation and gas monitoring to date, the site can be classified as a CS1, therefore no protections potentially required. **However, 3No. further gas monitoring visits will be carried out to complete the risk assessment**.

The Site is located within an area where the radon risk is low, with estimated 1.0% and 3% of properties affected by radon; therefore, no radon protective measures are required.

7.5 Risks to Human Health (Construction Phase)

During the construction works there will be a risk from dust to on-site workers and people occupying adjacent properties. Appropriate risk assessments should be carried out by the contractor to allow appropriate controls for the mitigation of risk to health of construction workers to be put in place. This risk can be controlled to within acceptable limits by:

- Method statement for site activities including control of dust generation;
- Having adequate site hygiene facilities allowing staff to keep a good level of personal hygiene;
- The method statement shall have a contingency plan which should be implemented if the presence of significantly elevated levels of lead is suspected in groundworks; and
- Only permitting smoking or eating on site in appropriate pre-designated areas.

Given proximity of residential receptors in the environs of the site and construction workers, control of fugitive dust will be a priority. As a minimum it is anticipated the works will be undertaken in accordance with BRE best practise guidance, and that the following measures will be introduced to assist with control of dust generation during the groundworks phase of the works:

- Access roads and any stockpiles created during groundworks should be regularly damped down with water;
- Vehicles used to transport materials/wastes and aggregates should be enclosed or tarpaulined;
- Vehicle movements and speed should be kept to a minimum within the site ;
- Dust generating equipment (e.g., mobile crushing and screening equipment) should be located to minimise potential nuisance impacts to receptors as far as practicable; and
- Minimising drop heights of all loading and unloading activities that involve the transfer of soils and demolition materials.

7.6 Conceptual Site Model

The proposed development comprises of semi-detached dwellings, accessible apartments and assisted living apartments with access roads and landscaped areas, measuring 94m in length and 64m in width.

The findings of the Phase 2 site investigation revealed the following general downward succession:

- Site surface: AstroTurf, concrete flag stones and topsoil;
- Made Ground (present across the site with the exception of WS107);
- Tidal flat deposits: Encountered in all areas, comprising a layer of very soft to firm sandy clay to 2.5m over loose becoming medium dense gravelly fine to coarse sand proven to 5.45m

The potential contamination at the site has been assessed using the contaminant-pathway-receptor linkage approach. Following the site investigation, the plausible contaminant sources have been updated. The results of site investigation and laboratory analysis generally record very low to zero concentrations of potential contaminants.

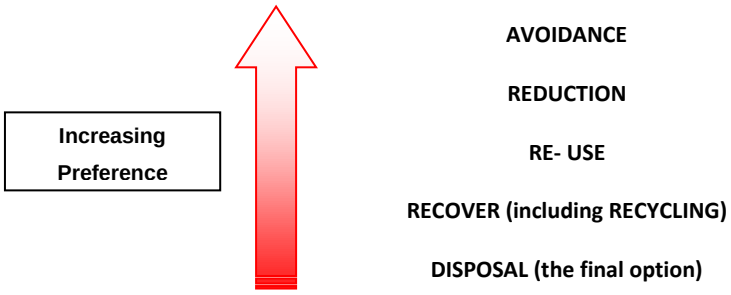
However, one sample (WS101@0.2m) has indicated that the asphalt surface material has elevated TPH concentrations. The asphalt surface material and potentially the underlying granular fill are not recommended to be reused within sensitive areas of the new development i.e. private gardens and soft landscaped areas. The hydrocarbon impacted material within these locations will need to be taken off site and will not be suitable for re use as engineered fill.

While unexpected contamination is not anticipated, the proposed development could encounter previously unrecorded hotspots of contaminants. These will be assessed and mitigated in accordance with current good practice.

8 WASTE ASSESSMENT

8.1 Waste Hierarchy

In accordance with government guidance, it is required that the production and disposal of waste is managed in accordance with the following hierarchy of preference:



8.2 Waste Characterisation and Classification

If there is a portion of excess soil this will then have to be sent to a suitable landfill site. A two-phase approach is required comprising:

- Waste Characterisation; and
- Waste Classification (Waste Acceptance Criteria).

Waste Characterisation

The results of the total concentrations from the chemical testing on soil samples have been assessed to determine whether or not they are hazardous in terms of waste characterisation. The results of this assessment indicate that the materials encountered during the investigation can be classified as non-hazardous with the exception of the sample from WS101 at 0.2m. It is recommended that further testing is carried of the shallow soils / asphalt surfacing material.

Waste Classification

In order to determine whether soils can be sent to a licensed landfill for disposal further testing is required comprising landfill Waste Acceptance Criteria (WAC) analysis for both total concentrations for certain chemicals and for leachate analysis. No WAC testing was carried out as part of this investigation. WAC testing will have to be carried out to confirm the landfill waste classification and if any pre-treatment is required. This is best carried out once all material to be

disposed of is stockpiled, and volumes can be accurately assessed. It should be noted that natural clay can be classified as Inert Waste 17 05 04: Soil and stones only (excluding topsoil, peat, soil and stones).

Testing Frequency

There are also set requirements for the required sampling and testing frequencies for materials being sent for disposal at landfills. The required testing frequencies for each different waste type are summarised in **Table 8.1** below.

Table 8.1: Laboratory Sampling Testing Frequencies

Testing Level	Quantity of Waste	Number of Samples	
		Homogeneous	Heterogeneous & New Wastes
Level 1 Characterisation (Description, Total Concentrations & Leaching)	<100T	2	5
	<500T	3	8
	<1000T	5	14
	10,000 T	11	22
	Per additional 10,000T	+5 pro rata	+10 pro rata
Level 2 Compliance For Regularly Generated Wastes (Total Concentrations & Leaching)		1 per defined waste sub-population per year	3 per defined waste sub-population per year
Level 3 Verification		Visual – Each Load	Visual – Each Load
Delivery document & visual check Chemical testing as per Level 2 suite		1 per year per waste stream	3 per year per waste stream

9 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS

9.1 Fieldwork and Laboratory Data Review

The proposed development includes the construction of 23 No. 2 storey- semi-detached dwellings including accessible apartments and access roadways with parking courts, with the retention of the existing Ty Hapus community centre.

The topography of the site slopes from west to east. No loading information has been provided for this report.

9.2 Fieldwork and Laboratory Data Review

The shallow ground conditions predominantly comprise a thin layer of made ground material described as loose slightly sandy gravel of mixed lithologies (subbase). Grass over slightly gravelly fine to coarse sand with gravels of siltstone and mudstone were encountered to the north and south of the existing building.

The drift deposits have been confirmed to comprise TFD described as very soft to firm grey sandy clay proven to 2.60m. This clay material overlies loose becoming medium dense sandy gravel of psammite, quartz and siltstone.

Soil classification tests were carried out on the Tidal Flat Deposits which when plotted against the A-line, **Figure 3** indicated clays intermediate to high plasticity, with liquid limits ranging from 42% to 58%, plastic limits ranging from 19% to 26%, a plasticity index between 22% and 37%, and a moisture content ranging from 25% to 35%. All results are presented in **Appendix F**.

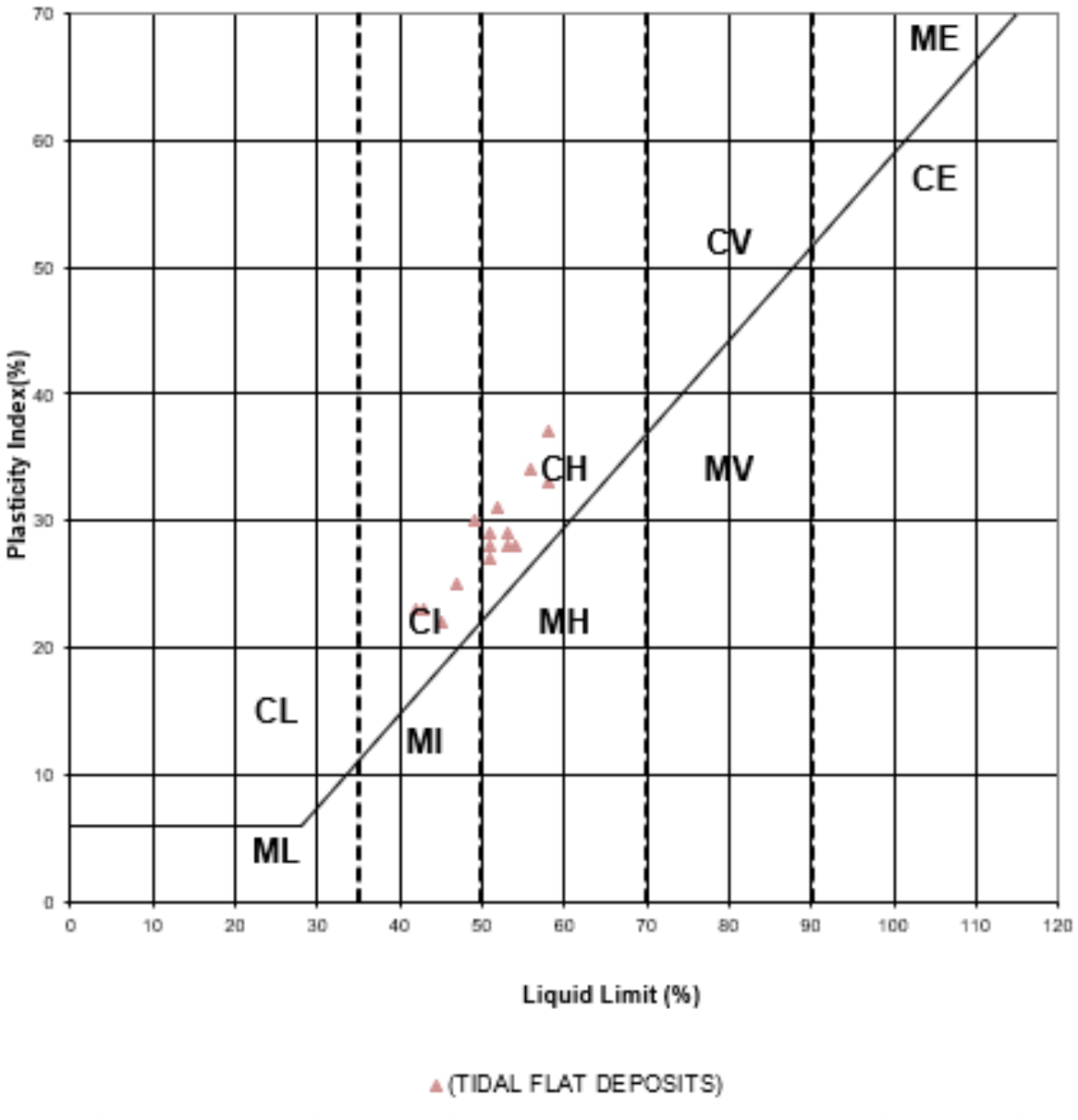


Figure 3: A-Line plot by Geology

Details of the classification testing along with plasticity and volume change potential are summarised in **Table 9-1**

Table 9-1: Summary of Classification Testing

Hole	Depth (m)	Moisture Content (%)	% passing 425um sieve	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Modified Plasticity Index	Plasticity	Volume Change Potential
TP101	0.60	31	95	54	26	28	26	High	Medium
TP101	1.20	*	100	45	23	22	22	Intermediate	Medium
TP102	1.50	27	100	42	19	23	23	Intermediate	Medium
WS101	1.50	32	100	58	21	37	37	High	Medium
WS102	2.00	35	100	43	20	23	23	Intermediate	Medium
WS104	0.50	*	100	51	22	29	29	High	Medium
WS104	2.00	34	100	51	23	28	28	High	Medium
WS105	2.00	29	100	49	19	30	30	Intermediate	Medium
WS105	2.50	28	100	53	25	28	28	High	Medium
WS106	0.50	25	99	51	24	27	26	High	Medium
WS106	1.20	33	100	47	22	25	25	Intermediate	Medium
WS107	0.50	*	100	58	25	33	33	High	Medium
WS109	1.20	30	100	53	24	29	29	High	Medium
WS110	0.50	25	100	56	22	34	34	High	Medium
WS110	1.20	35	100	52	21	31	31	High	Medium
Minimum		25.0	95	42.0	19.0	22.0	22.0		
Average		30.3	99.6	51.4	22.4	28.47	28.27		
Maximum		35.0	100.0	58.0	26.0	37.0	37.0		

* Atterberg undertaken on sample combined for lime stabilisation test

Standard Penetration Tests (SPT)

A total of 46 Standard Penetration Tests (SPT) were completed within the exploratory holes recording a considerable range of N-Values from 0 to 50. When separated by strata type and plotted against depth, **Figure 4**. It can be seen the lower bound values are in the lower clay and upper granular strata between 0 and 4 with values consistently at very soft to soft and very loose respectfully.

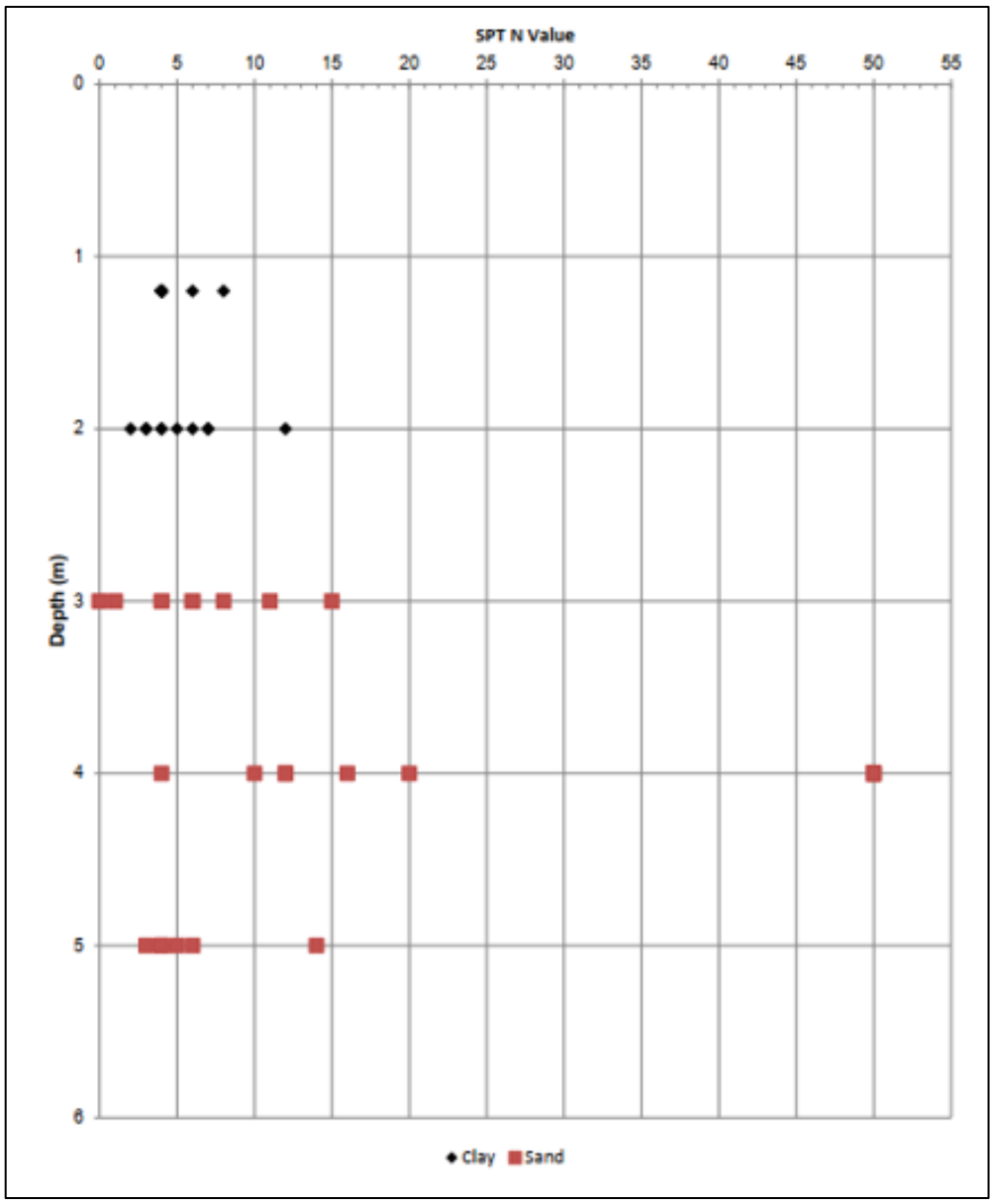


Figure 4: SPT N-Value Vs Depth

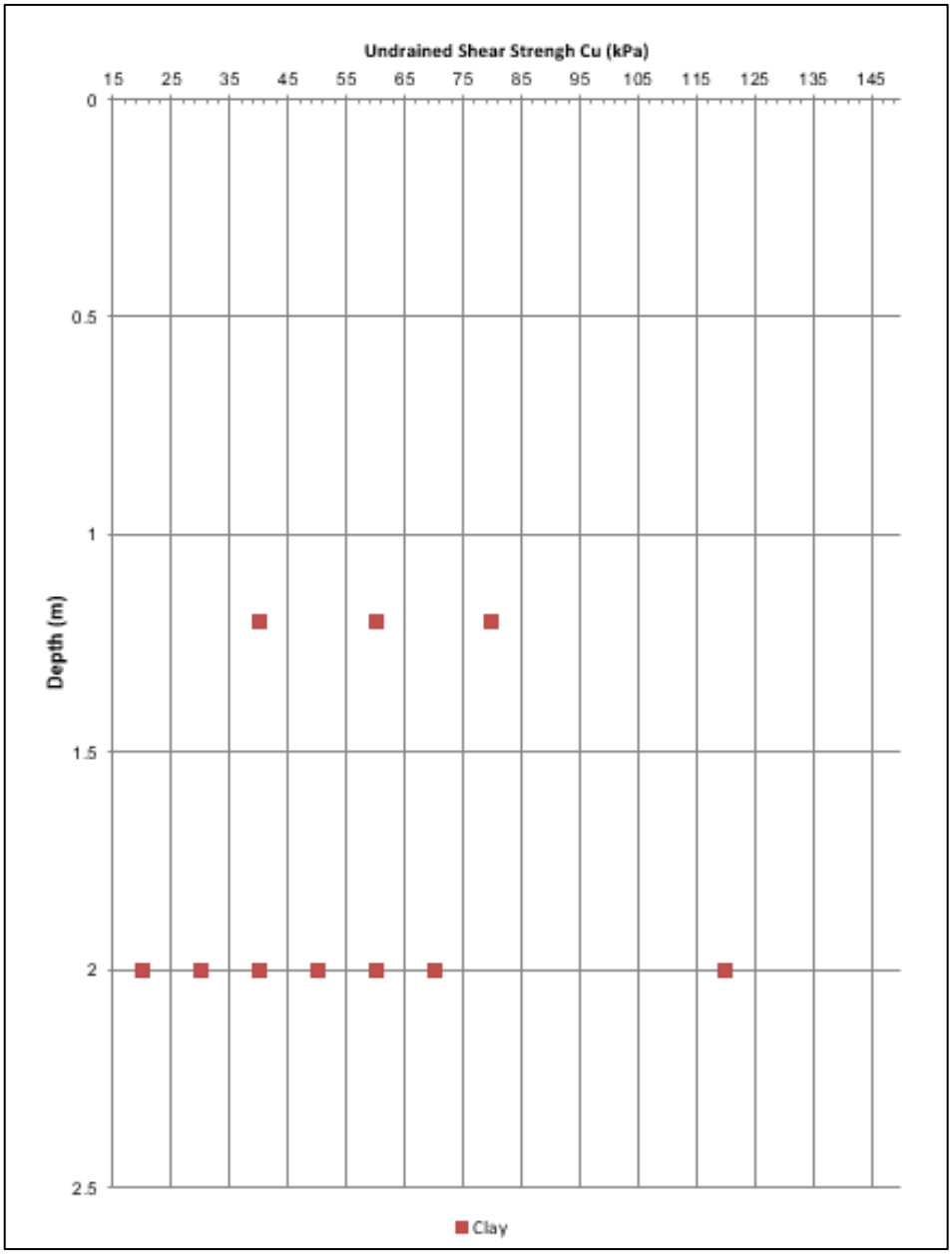


Figure 5 - Undrained Shear Strength Vs Depth

Stroud, 1975 was used to derive undrained shear strength for the clay material utilising an f_1 value of 5. Strength Vs depth plots for the clay material is broadly consistent across the site ranging between 30 to 80kPa (low to high strength) within the upper 2.00m, with an outlier of 120 kPa (High strength) at WS103 at a depth of 2.00m. A Quick Undrained Triaxial test was also undertaken on combined bulk disturbed samples recovered from the upper TFD, comprising of clay strata which was determined to be consistent with derived values.

A total of seven Particle Size Distribution (PSD) tests were carried out on bulk samples the results of which are summarised in Figure 6 below. The results confirm the engineers descriptions with the TFD, with a minimum fines content of 1% for the TFD. Grading curves for the various material types are shown in **Figure 6**

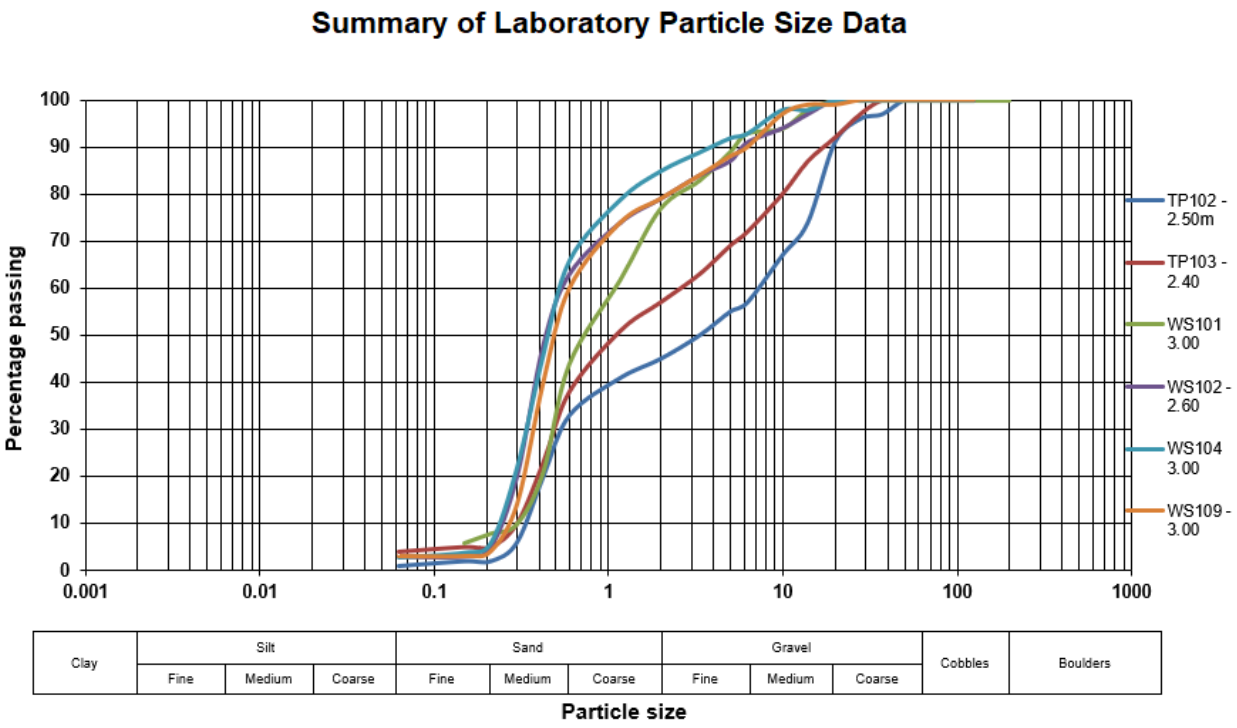


Figure 6: PSD Grading Curves by Geology

9.3 Lime Stabilisation Testing

A sample from WS104 from the shallow soft clay deposits was selected for lime stabilisation testing to improve the shear strength and moisture content. The tests were conducted after adding 1.25%, 2.5% and 5.0% by weight.

The results of the lime stabilisation testing are summarised below.

Table 9-2 – Summary of lime Stabilisation results

Location	Depth (m bgl)	Initial Moisture Content %	Lime Content Added (%)	Moisture Content Post Lime Addition (%)	Shear Strength Cu (kPa)
WS104	0.50	26.9	1.25%	25.6	142
			2.50%	25.0	156
			5.00%	22.6	161

Before the testing was carried out, each sample was described as soft slightly sandy clay with moisture contents ranging between 25% to 35%. The moisture content from each sample has been reduced with the addition of lime.

The results of the triaxial testing have shown that the strength of the clay have increased to a minimum of high strength even with adding the minimum amount of lime of 1.25%.

9.4 Trees

No trees or bushes are located within an influencing distance, however it is understood trees will form part of the proposed landscaping scheme. Classification testing indicates that the clay deposits are all of medium volume change potential. However, the ground conditions are such that the foundation solution, unless ground improvement is implemented, is likely to comprise a piled foundation with suspended floor slab and as such the risk from volume change clays is considered low.

9.5 Foundation Recommendations

Based on proposed plans provided to GSL it is understood that the site will not be subject to extensive reprofiling. No loading information has been provided for this report. Upon completion of the external works drawing, which include any detailed regrading proposals, retaining measures and slab levels, these should be issued to Groundsolve for plot specific foundation assessments.

Due to the soft and variable shallow clay deposits present on the site, it is anticipated that shallow spread footings will not be suitable for the proposed developments.

The foundation solution recommendations outlined below apply to the site as a whole. In response to the ground conditions that have been identified at the site, it is considered that the following foundation solutions are possible:

c) Raft Foundations;
d) Piled Foundations;
c) Ground Improvement by Vibro Stone Columns (VSC)

Lime Stabilisation /Raft Foundations

The lime stabilisation trials have been undertaken on shallow clay deposits. As discussed above, the introduction of lime has increased the shear strength significantly and also reduced the moisture content. It is considered possible that lime could be used to stabilise the shallow clay deposits to moderate depth (1.0-1.5m) combined with the construction of raft foundation for the lightly loaded two storey structures. It is recommended that the maximum mean bearing pressure on the raft foundations is limited to 50kPa in order to keep settlement within acceptable limits.

Current proposals would be to utilise a maximum lime content of 1.25% however based on the success of initial trials it may be possible to further reduce the lime content. Further testing / trials should be undertaken to confirm the minimum required to achieve optimum moisture content and compaction.

Raft foundations will need to be designed by an engineer and constructed in accordance with the recommendations of the NHBC Standards.

The raft foundations are still susceptible to clay volume change. The foundations should be designed based on medium volume change potential clay.

Piles

Piles should be designed to penetrate through any Made Ground and soft clay and should extend a suitable depth into the underlying dense sand deposits. Final pile design will require the completion of further deeper ground investigation to inform the detailed design. When detailed loadings are available then full design of these should be carried out in accordance with BS EN 1997-1: 2004 +A1 2013: Eurocode 7 – Geotechnical Design – Part 1: General rules (including UK National Annex of November 2007) and BS8004: 2015: Code of practice for foundations.

Either bored or driven preformed piling techniques are considered suitable for the ground conditions at the site. Care should be taken for bored and cast in situ piles taken through the Made Ground and loose sands where collapse of the pile shaft or running sand conditions could lead to 'necking' of the pile.

Whilst Groundsolve considers the risks to Controlled Waters from deep foundations to be low, for both piling and the installation of VSCs. The piling contractor will need to carry out a Piling Risk Assessment in accordance with Environment Agency Guidance in order to demonstrate that the piling or installation of VSCs will not create additional risks to Controlled Waters.

Any piling works undertaken from existing ground levels will require a suitable piling mat/platform constructed in accordance with BRE Report 470 (2004). A geotextile may be incorporated into the platform to reduce the required thickness and the platform could be designed as part of the engineering fill required for any earthworks to alter final site levels. Groundsolve can assist in the design if required once the VSC/piling rig types are known.

Ground Improvement - **Vibro Stone Columns**

The Vibro Stone Columns (VSC) will need to be emplaced in accordance with an appropriate specification, which will need to be in accordance with Chapter 4.6 of NHBC Standards and BRE 391 "Specifying Vibro Stone Columns".

Foundations laid on soil reinforced with stone columns are still susceptible to clay volume change and should be designed and deepened accordingly where they are within the zone of influence of existing or proposed trees. Where deepening more than 2.5m below ground level is required, piled foundations may be necessary.

Reinforced concrete strip beams will be needed to transfer the loads to the stone columns and these should be reinforced top and bottom.

9.6 Ground Floor Slab Recommendations

It is recommended that suspended floors are adopted for the building to prevent heave on floor slabs

A final ground floor slab solution will be recommended upon issue of the final report once the ground gas monitoring phase has been completed.

9.7 Groundwater Conditions

Groundwater level varies between 2.20 and 2.90m bgl which was found to be at the horizon between granular and cohesive material. Results from groundwater monitoring will be available within the final issue of the report.

9.8 Groundwater & Excavations

Excavations through the soils are unlikely to be stable due to the soft nature of the clay and will require full face temporary support. As per above this could be incorporated into the groundwater control strategy. All excavations should be carried out in accordance with CIRIA Report 97 “Trenching Practice” and BS6031: 2009: Code of Practice for Earthworks. Further guidance on this aspect of site works is given in the British Standards for “Workmanship on Building Sites”, BS 8000, Parts 1 and 14, and in the Construction Industry Training Board’s Site Safety Note 10.

Excavation depths should generally be readily achieved using conventional hydraulic plant (e.g. wheeled JCB or similar) although larger plant will have higher excavation rates.

9.9 Road Design

The performance of any hard standing will be determined by the weaker areas, therefore based upon the nature of the ground conditions encountered during the site investigations undertaken, it is recommended that a lower bound CBR value of 3% is adopted for design purposes. All exposed formations should be proof rolled and any soft spots revealed should be excavated and replaced with suitable compacted granular fill.

The introduction of lime to the shallow clay will increase the CBR value significantly. Further trial testing can confirm the specification of any proposed lime stabilization works.

9.10 Buried Concrete and Pipework

The results of laboratory pH and sulphate content, **Table 9-3** indicate that ACEC Class AC-1 conditions prevail in accordance with BRE Special Digest 1, 2005 (the Design Concrete Class). Therefore, special precautions are not required at the site for the design of concrete in terms of the durability and structural performance.

Table 9-3: Summary of Sulphate Testing

Exploratory Hole	Depth (m)	pH	Sulphate (Aq Extract) mg/l	Sulphur (Total) %	Sulphate (Acid soluble) %	Total Potential Sulphate (TPS %)	Oxidisable Sulphate (OS %)	Pyrite present Y/N (TPS – OS > 0.3)	Design Sulphate (DS)	ACEC Class	Design Concrete Class (DC)
TP103	0.30	6.8	33.5	0.02	0.07	0.066	-0.004	N	DS-1	AC-1	DC1
TP103	1.00	6.9	10.0	0.00	0.02	0.099	0.079	N	DS-1	AC-1	DC1
WS101	0.20	8.2	22	0.02	0.03	0.045	0.015	N	DS-1	AC-1	DC1
WS103	0.75	7.0	56	0.04	0.07	0.120	0.05	N	DS-1	AC-1	DC1
WS105	0.50	7.9	18	0.01	0.03	0.036	0.006	N	DS-1	AC-1	DC1
WS107	0.20	7.7	16	0.02	0.04	0.045	0.005	N	DS-1	AC-1	DC1
WS108	0.50	7.8	80	0.03	0.05	0.084	0.034	N	DS-1	AC-1	DC1
WS110	0.50	7.7	10	0.0	0.02	0.009	-0.011	N	DS-1	AC-1	DC1

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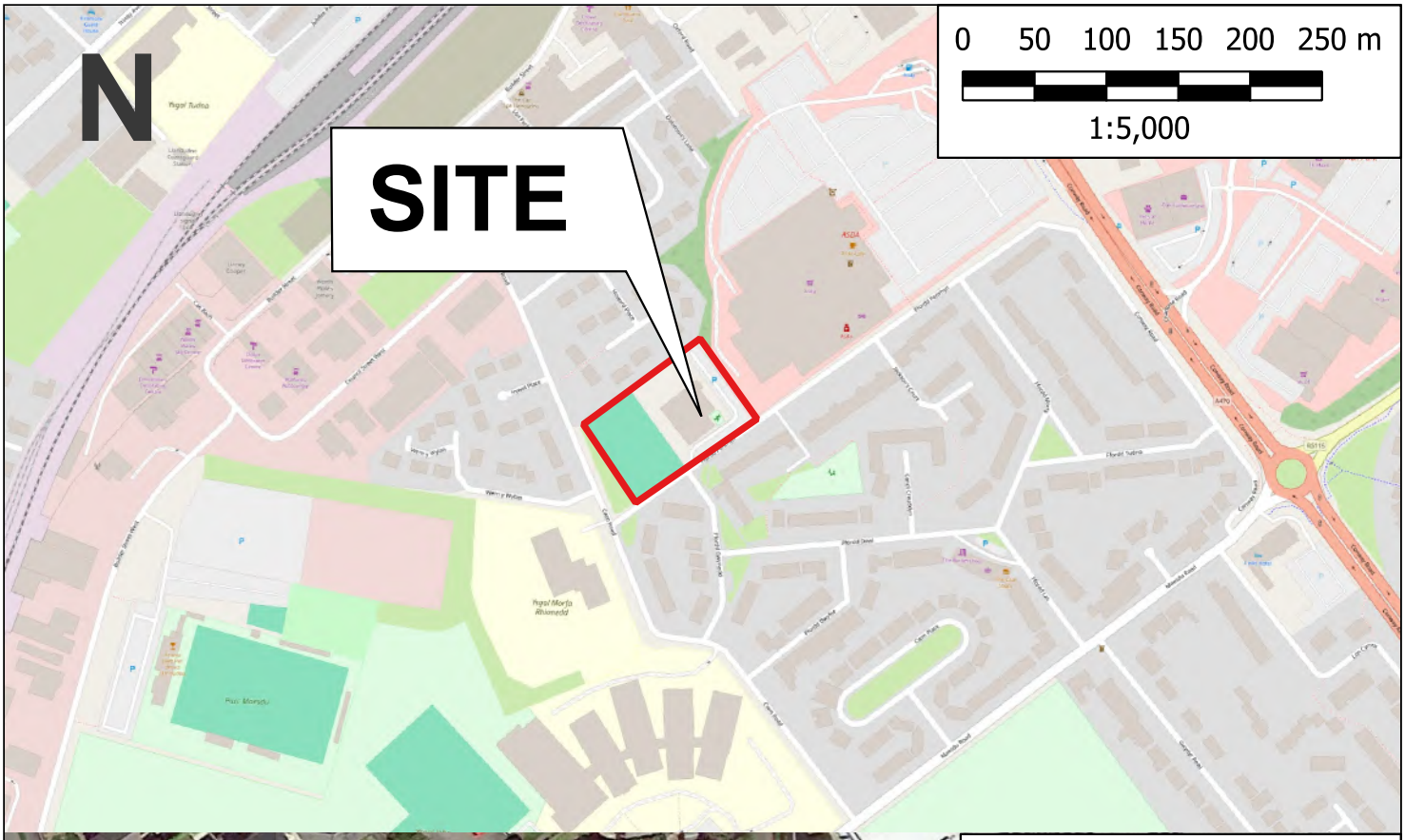
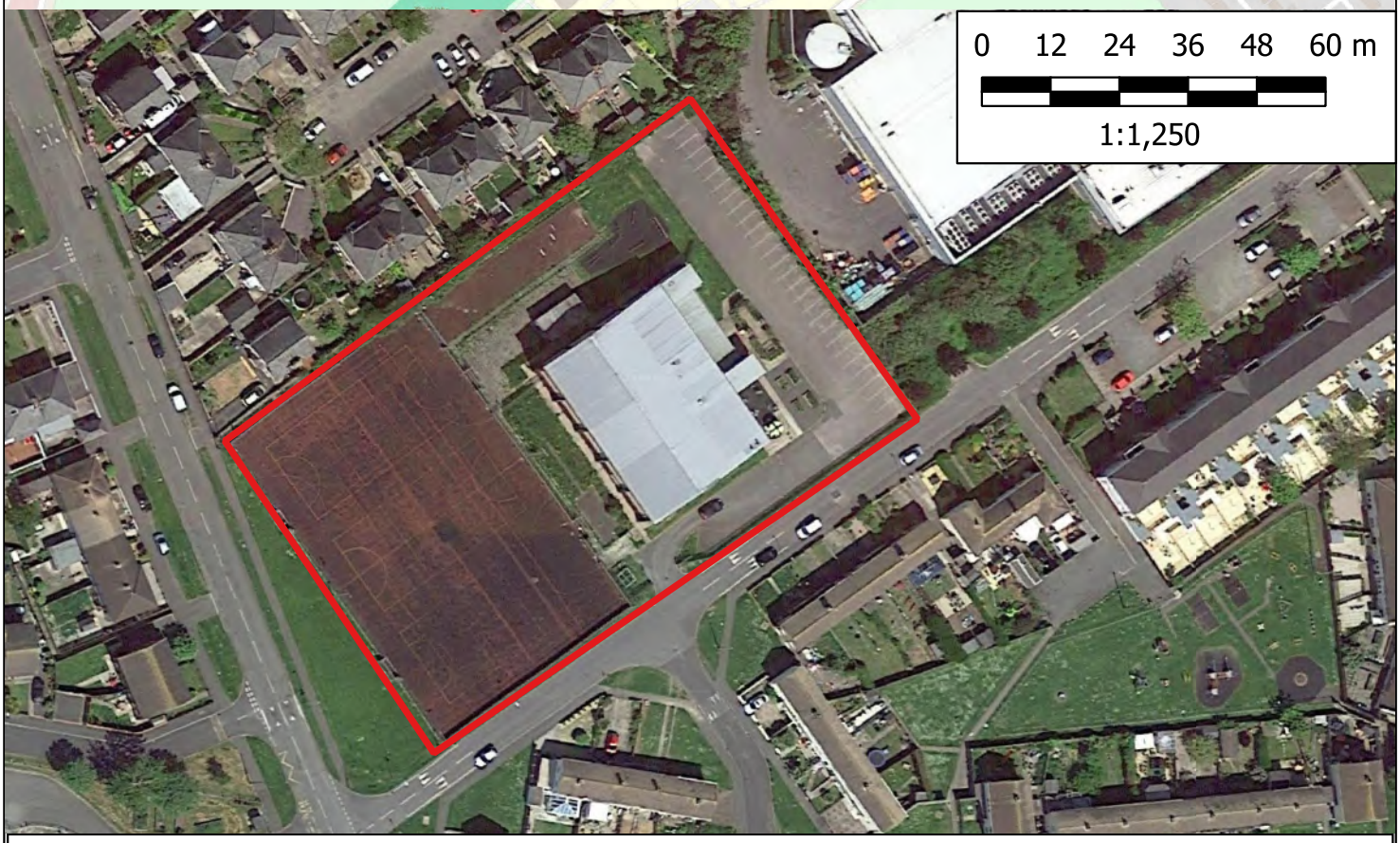
11 DEFINITIONS

AOD	Above Ordnance Datum
bgl	Below ground level
BGS	British Geological Survey
BRE	Building Research Establishment
CBR	California Bearing Ratio (test)
COMAH	Control of Major Accident Hazards (regulations)
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EQS	Environmental Quality Standard
GAC	Generic Assessment Criterion
GQA	General Quality Assessment (Environment Agency)
GQRA	Generic Quantitative Risk Assessment
GSV	Gas Screening Value
HCV	Health Criteria Value
IPPC	Integrated Pollution Prevention and Control (regulations)
NGR	National Grid Reference
NIHHS	Notification of Installations Handling Hazardous Substances (regulations)
OS	Ordnance Survey
ppm	Parts per million
ppmv	Parts per million by volume
SAC	Special Area of Conservation
SPZ	Source Protection Zone
SSAC	Site-Specific Assessment Criterion
SSSI	Site of Special Scientific Interest

APPENDIX A - DRAWINGS





KEY

Site Location

Sampling locations and features annotated are approximate and are based upon observed measurements unless otherwise stated. Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor.

Client: Datrys				Title: Site Location and Boundary Plan	GroundSolve Ltd Consulting Geotechnical Engineers
Site: Ty Hapus, Llandudno				Scale (see scale bar): 1:5,000 @ A4 1:1,250 @ A4	Figure: 1
Job No.: GSL:3222	Drawn By: AR	Checked By: SF	Drawn: January 2025		Revision:

KEY

- Site Location
- Windowless Boreholes
- Trial pits and Soakaways

Sampling locations and features annotated by LK Consult Ltd are approximate and are based upon observed measurements unless otherwise stated. Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor. Where this drawing includes information provbided to LK Consult Ltd by others, LK Consult Ltd gives no warranty, representation or assurance as to the accuracy of such information.

Client:	Datrys
Site:	Ty Hapus, Llandudno
Title:	Exploratory Location plan
Job No:	GSL:3222
Scale (see scale bar):	1:1250 @ A4
Figure:	2
Rev:	
Drawn By:	AR
Checked By:	SF
Drawn:	January 2025

ACCOMMODATION SCHEDULE

	GIFA'S	No.
3No. 2P1B W/C ACCESSIBLE APARTMENT (GF) 3No. 3P2B WALK UP APARTMENTS (FF)	62.9m2 71.1m2	x6
4P2B HOUSE	84.6m2	x5
5P3B HOUSE	96.9m2	x2
2P1B COMMON ACCESS ASSISTED LIVING APARTMENTS	50m2	x6
5No. 2P1B WALK UP APARTMENT (GEN NEEDS) (GF) 5No. 2P1B WALK UP APARTMENT (GEN NEEDS) (FF)	54.8m2 60.4m2	x10

TOTAL UNITS 29

The Rockery

CWM ROAD

NEW ACCESS ROAD

1m GRASS SERVICE MARGIN

PARKING COURT

VISITOR PARKING

BIN STORE

SEATING AREA

TY HAPUS
COMMUNITY CENTRE

FFORDD PENRHYN

Tank

VISUAL SCALE 1:200 @ A1

0m 4m 8m 12m 16m 20m

REV	DESCRIPTION	DATE	BY
E	NEW COMMON & DIRECT ACCESS OPTION A FOR FLAT 24-29. PATH AROUND COMMON ACCESS FLATS 24-29 MOVED CLOSER TO BUILDING FOOTPRINT	24/10/24	GT
D	ACCOMMODATION SCHEDULE AND GIFA'S ADDED	02/10/24	GT
C	CHANGES FOLLOWING HIGHWAYS COMMENTS	08/08/24	IO
B	SECTION ADDED. WINDOWS ADDED TO PLOT 22	10/07/24	IO
A	TOPO SURVEY OVERLAID, RED LINE UPDATED, BIN STORE ADJUSTED, SIDE BAY TO PLOT 17	02/07/24	GT

PROJECT

Cwm Road, Llandudno
for First Choice Housing
and Grŵp Cynefin

DRAWING TITLE

PROPOSED LAYOUT - OPTION 5

SCALE	DATE	DRAWN	CHECKED
1 : 200 @A1	12/12/22	TA	SV

DRAWING STATUS: PRELIMINARY

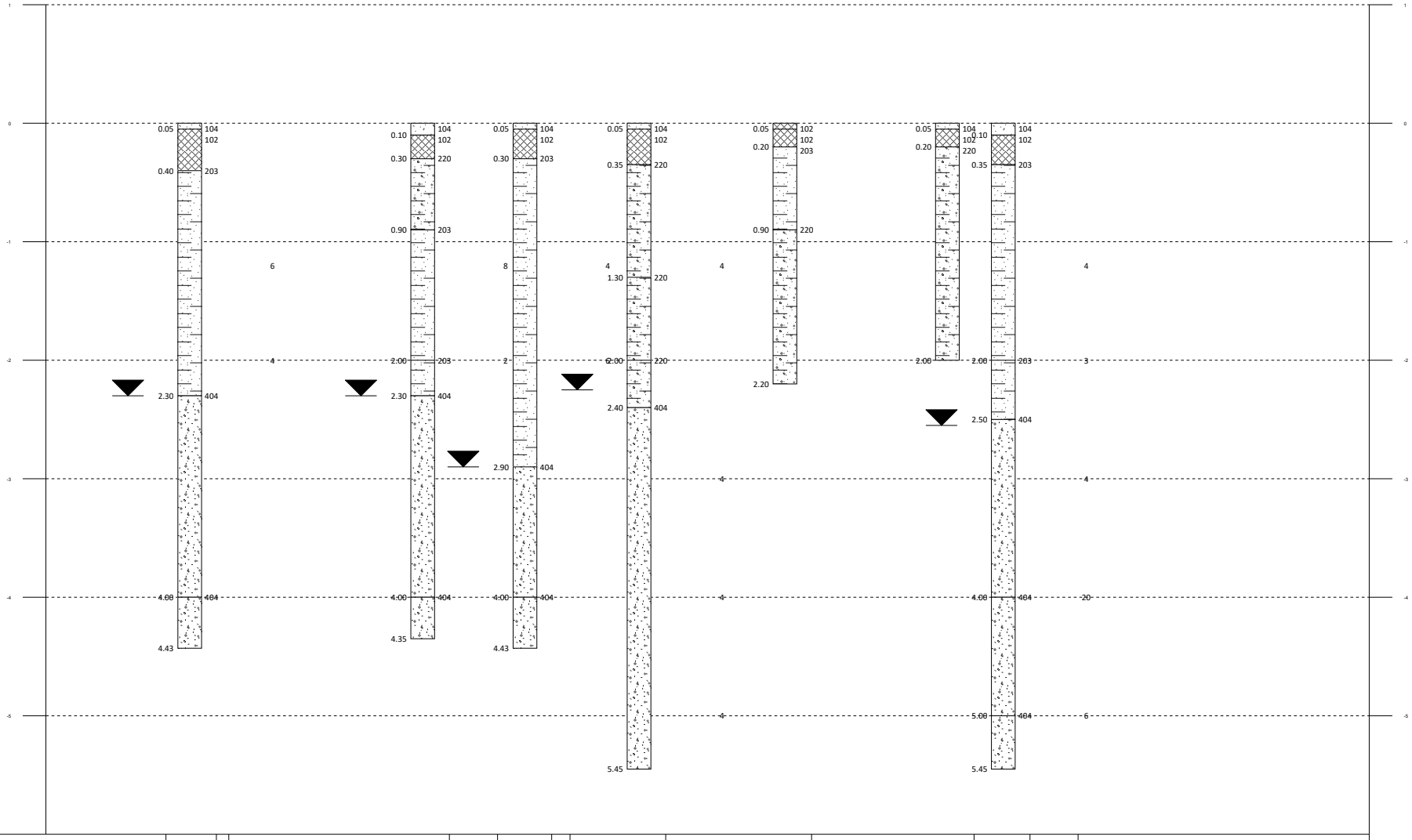
JOB No	DRAWING No	REVISION
C1054	014	E

AINSLEY GOMMON ARCHITECTS
THE OLD POLICE STATION, 15 GLYNNE WAY, HAWARDEN, CH5 3NS
Tel: 01244 537 100 | walesl@agarchitects.co.uk | www.agarchitects.co.uk
Ainsley Gommon Architects Ltd. Registered in England & Wales No.4187948
Registered Office: 1 Price Street, Hamilton Square, Birkenhead CH41 6JN

PRINTED: 24/10/2024 12:18:17

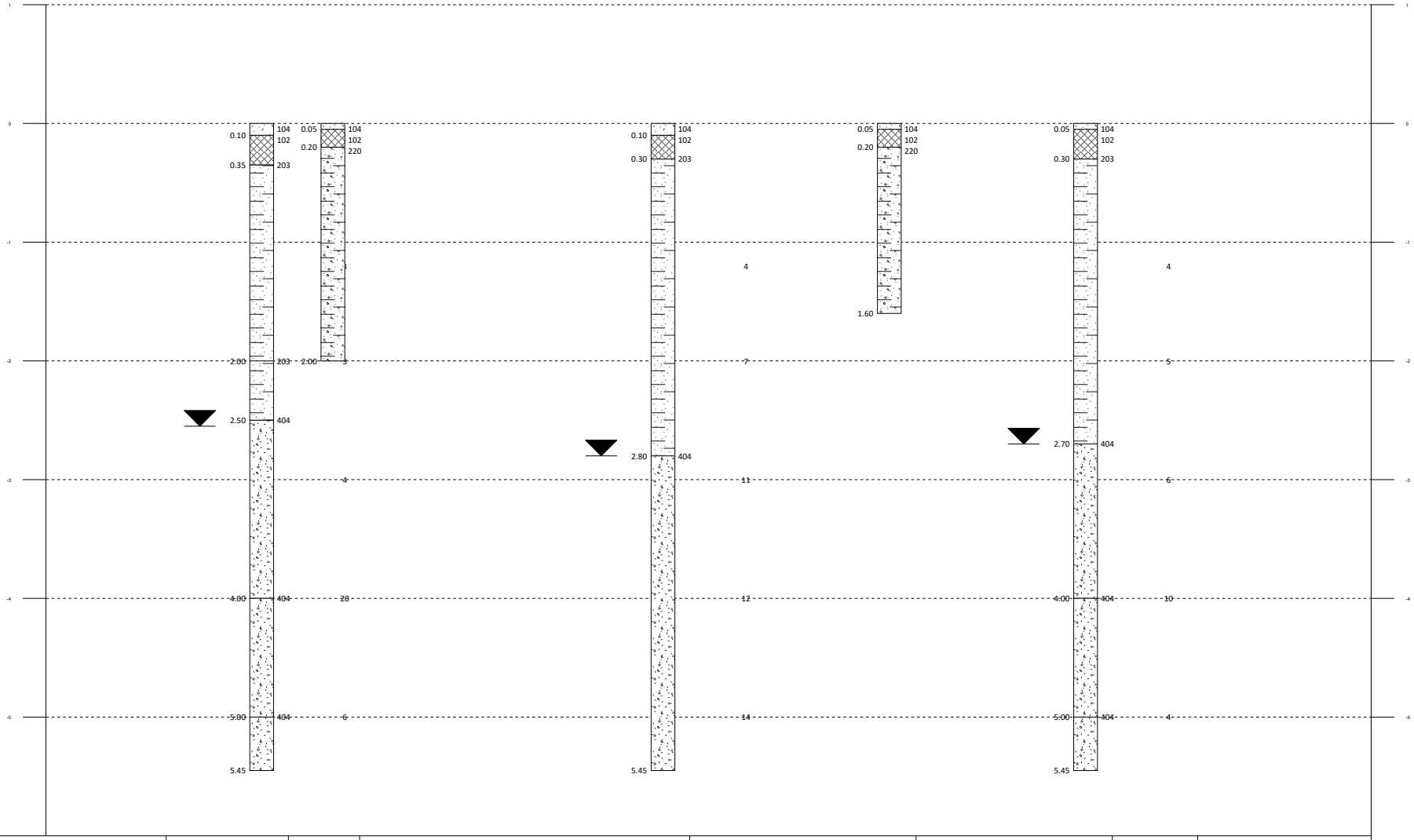
A1

Project Id: 3222	Title: Section Line
Project Title: Ty Hapus,Llandudno	Vertical Scale: 1:50
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Horizontal Scale: 1:500
Client: Datrys	Engineer: AR



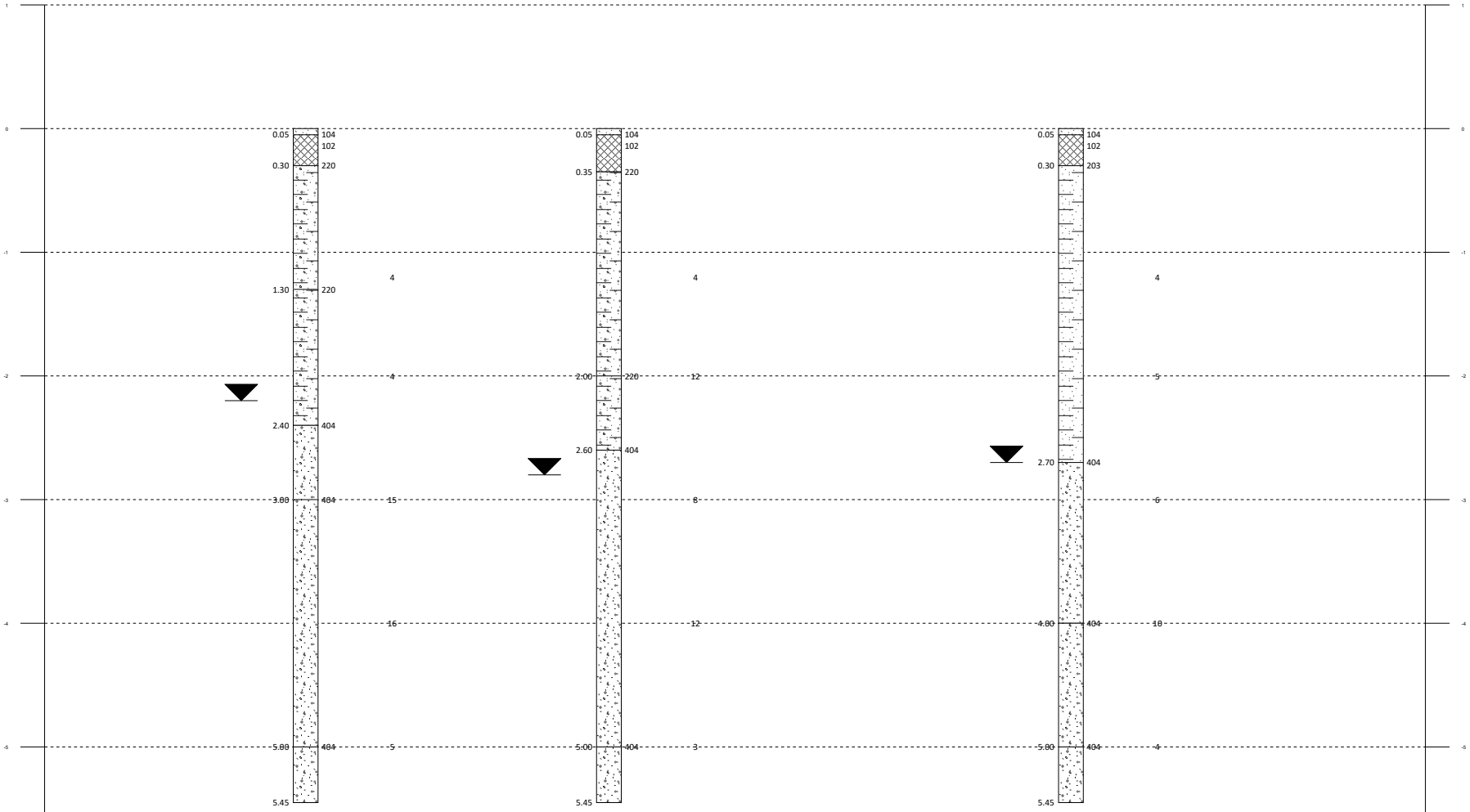
Chainage (m)	0.00	4.25	5.30	23.90	27.96	32.53	34.08	42.15	54.45	68.15	72.87	76.92
Elevation (mAOD)												
Offset (m)	1.10	7.44		3.77		3.64	0.28	1.12		4.21	0.34	

Project Id: 3222	Title: Section Line
Project Title: Ty Hapus,Llandudno	Vertical Scale: 1:50
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Horizontal Scale: 1:400
Client: Datrys	Engineer: AR



Chainage (m)	0.00	8.23	13.03	35.27	50.52	63.74	69.49
Elevation (mAOD)							
Offset (m)		2.02	2.44	3.37	4.54	2.44	

Project Id: 3222	Title: Section Line
Project Title: Ty Hapus,Llandudno	Vertical Scale: 1:50
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Horizontal Scale: 1:275
Client: Datrys	Engineer: AR



-6.00

Chainage (m)	0.00	7.27	20.75	41.29	48.14
Elevation (mAOD)					
Offset (m)	0.87	4.66	1.58		

APPENDIX B – SITE PHOTOGRAPHS

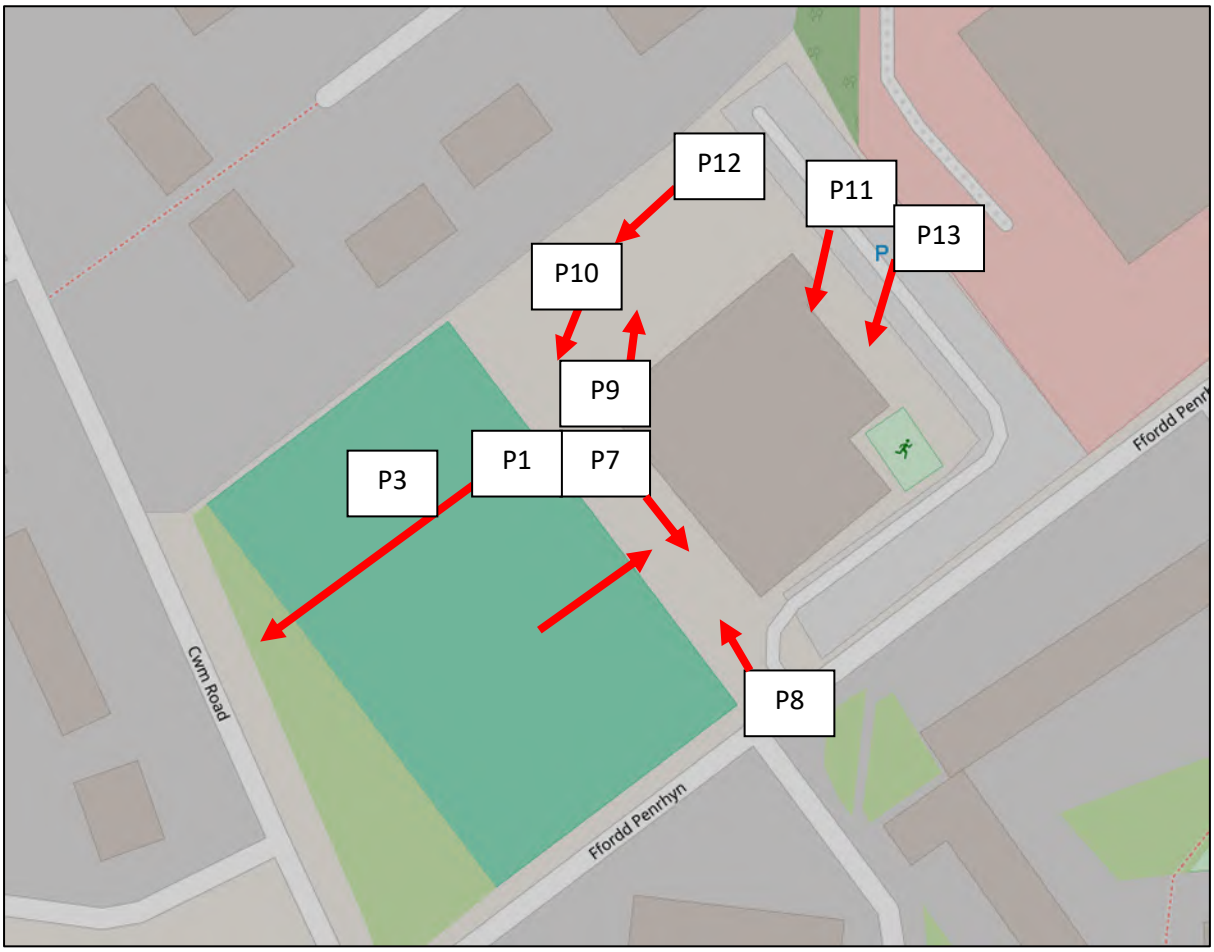

P12
P11
P13
P10
P9
P1
P7
P3
P8
Cwm Road
Ffordd Penrhyn

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

Photo 11

Photo 12

Photo 13

APPENDIX C – EXPLORATORY HOLE RECORDS

GroundSolve Ltd — Machine Dug Trial Pit Record — SA101

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 17/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278483.785 N381622.234
Project No. : 3222	Crew Name: GroundSolve	Equipment: ECR580

Location Number	Location Type	Level	Logged By	Scale	Page Number
SA101	TP		AR	1:25	Sheet 1 of 1

Backfill/ Instal'n	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.10	B		0.05			Coloured Asphalt (MADE GROUND)
		0.30	ES		0.15			Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (sub base) (MADE GROUND)
								Soft dark grey sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine to coarse of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
					1.50			End of Trial Pit at 1.500m

1
2
3
4
5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
1.50	0.45	Stable					

Remarks

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd — Machine Dug Trial Pit Record — SA102

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 17/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278471.255 N381593.661
Project No. : 3222	Crew Name: GroundSolve	Equipment: ECR580

Location Number	Location Type	Level	Logged By	Scale	Page Number
SA102	TP		AR	1:25	Sheet 1 of 1

Backfill/ Instal'n	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.05			Coloured Asphalt (MADE GROUND)
					0.20			Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (sub base) (MADE GROUND)
		1.00	PP	60.0kPa				Firm grey sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
		1.50	B					
		1.60	PP	50.0kPa	1.60			End of Trial Pit at 1.600m

1 2 3 4 5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
1.10	0.45	Stable					

Remarks

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd — Machine Dug Trial Pit Record — SA103

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 17/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278448.236 N381623.321
Project No. : 3222	Crew Name: GroundSolve	Equipment: ECR580

Location Number	Location Type	Level	Logged By	Scale	Page Number
SA103	TP		AR	1:25	Sheet 1 of 1

Backfill/ Instal'n	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.08	B		0.05			Coloured Asphalt (MADE GROUND)
					0.20			Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (sub base) (MADE GROUND)
		1.00	PP	50.0kPa				Firm grey sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine to coarse of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
		2.00	PP	50.0kPa	2.00			End of Trial Pit at 2.000m

1 2 3 4 5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
1.20	0.45	Stable					

Remarks

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd — Machine Dug Trial Pit Record — TP101

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 17/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278457.117 N381635.043
Project No. : 3222	Crew Name: GroundSolve	Equipment: ECR580

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP101	TP		AR	1:25	Sheet 1 of 1

Backfill/ Instal'n	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.05			Concrete slab (MADE GROUND)
					0.20			Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (sub base) (MADE GROUND)
		0.35	B					
		0.40	ES					
								Firm grey sandy CLAY. (TIDAL FLAT DEPOSITS)
		0.60	B					
		0.60	B					
					0.90			
		1.00	PP	50.0kPa				Firm grey sandy CLAY with frequent rootlets. (TIDAL FLAT DEPOSITS)
		1.20	B					
		1.20	B					
		1.20	ES					
		2.00	B					
		2.00	PP	100.0kPa				
		2.20	PP	25.0kPa	2.20			End of Trial Pit at 2.200m

1 2 3 4 5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
1.50	0.45	Stable					

Remarks

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd — Machine Dug Trial Pit Record — TP102

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 17/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278467.486 N381621.045
Project No. : 3222	Crew Name: GroundSolve	Equipment: ECR580

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP102	TP		AR	1:25	Sheet 1 of 1

Backfill/ Instal'n	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.05			Coloured Asphalt (MADE GROUND)
					0.30			Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (subbase) (MADE GROUND)
		0.80	ES		0.90			Firm grey sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
		1.00	ES					
		1.00	PP	50.0kPa				Firm very thinly laminated grey mottled brown sandy CLAY with rare rootlets. (TIDAL FLAT DEPOSITS)
		1.50	B					
		1.50	B					
		2.00	PP	60.0kPa	2.20			Soft brown sandy CLAY. (TIDAL FLAT DEPOSITS)
		2.30	B		2.40			Loose grey sandy subangular to subrounded fine to coarse GRAVEL of mudstone and siltstone (TIDAL FLAT DEPOSITS)
		2.50	B		2.50			End of Trial Pit at 2.500m
		2.50	B					

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
1.20	0.45	Stable					

Remarks

Water ingress at 2.40m. Pit becomes unstable, unstable to progress.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd — Machine Dug Trial Pit Record — TP103

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 17/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278503.213 N381654.910
Project No. : 3222	Crew Name: GroundSolve	Equipment: ECR580

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP103	TP		AR	1:25	Sheet 1 of 1

Backfill/ Instal'n	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	B					Grass over loose brown slightly clayey slightly gravelly fine to coarse SAND with rootlets. Gravels are subangular fine to coarse of siltstone and mudstone (TOPSOIL)
		0.30	ES		0.30			
		0.50	B		0.45			Loose reddish brown sandy subangular to rounded fine to coarse GRAVEL of siltstone, slate, granite, schist and sandstone with many cobbles. Cobbles are subangular of mudstone, granite and siltstone. (MADE GROUND)
		0.50	ES					
		1.00	B		1.00			Firm very thinly laminated grey mottled brown sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
		1.00	ES					
		1.00	PP	175.0kPa				Stiff very thinly laminated grey mottled brown sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
		1.80	D					
					2.00			Soft brown sandy CLAY. (TIDAL FLAT DEPOSITS)
		2.20	D					
		2.40	B		2.35			Loose grey gravelly fine to coarse SAND. Gravels are subangular to subrounded fine to coarse of mudstone and siltstone (TIDAL FLAT DEPOSITS)
		2.40	B		2.60			End of Trial Pit at 2.600m

1 2 3 4 5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
1.20	0.45	Stable					

Remarks

Water ingress at 2.40m. Pit becomes unstable, unstable to progress.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS101

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 18/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278468.335 N381640.285
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS101	WLS		AR	1:25	Sheet 1 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.05			Coloured Asphalt (MADE GROUND)
		0.20	ES					Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (sub base) (MADE GROUND)
					0.35			Soft grey sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
		0.50	ES					
		1.00	B					
		1.00	ES					
		1.20	SPT	N=4 (1,1/1,1,1,1)				
					1.30			Soft very thinly laminated grey mottled brown sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
		1.50 - 2.00	B					
		2.00	SPT	3 (1 for 225mm/1,1,1,)	2.00			Very soft very thinly laminated grey mottled brown sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
	▼							
					2.40			Loose grey slightly gravelly fine to coarse SAND. Gravels are subangular to rounded fine to medium quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
		3.00 - 4.50	B					
		3.00	SPT	N=4 (1,1/1,1,1,1)				
		4.00	SPT	N=4 (1,1/1,1,1,1)				
		5.00	SPT	N=4 (1,1/1,1,1,1)				

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	72										
5.00	62										

Remarks

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS101

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 18/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278468.335 N381640.285
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS101	WLS		AR	1:25	Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					5.45			Loose grey slightly gravelly fine to coarse SAND. Gravels are subangular to rounded fine to medium quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
								End of Borehole at 5.450m

6
7
8
9
10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	72										
5.00	62										

Remarks

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS102

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 18/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278499.143 N381600.618
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS102	WLS		AR	1:25	Sheet 1 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.05			Coloured Asphalt (MADE GROUND)
					0.30			Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (sub base) (MADE GROUND)
		0.40	ES					Soft dark grey sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine to coarse of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
		0.50 - 1.20	B					
		1.00	ES					
		1.20	SPT	N=4 (1,1/1,1,1,1)				
					1.30			Soft very thinly laminated grey mottled brown sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
		2.00	D					*Between 1.90m and 2.00m occasional rootlets.*
	▼	2.00	SPT	N=4 (1,1/1,1,1,1)				
					2.40			Loose grey slightly gravelly fine to coarse SAND. Gravels are subangular to rounded fine to medium quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
		2.60 - 5.00	B					
		3.00	SPT	N=15 (1,1/3,4,4,4)	3.00			Medium dense grey slightly gravelly fine to coarse SAND. Gravels are subangular to rounded fine to medium quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
		4.00	SPT	N=16 (5,5/5,5,4,2)				
		5.00	SPT	N=5 (1,1/1,1,1,2)	5.00			

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	300										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS102

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 18/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278499.143 N381600.618
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS102	WLS		AR	1:25	Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Loose grey slightly gravelly fine to coarse SAND. Gravels are subangular to rounded fine to medium quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
					5.45			End of Borehole at 5.450m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	300										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS103

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 18/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278490.986 N381589.233
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS103	WLS		AR	1:25	Sheet 1 of 2

Well	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.05			Coloured Asphalt (MADE GROUND)
					0.35			Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (sub base) (MADE GROUND)
		0.75	ES					Soft dark grey sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine to coarse of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
		1.00	D					
		1.00	ES					
		1.20	SPT	N=4 (1,1/1,1,1,1)				
		2.00	ES		2.00			Firm dark grey sandy slightly gravelly CLAY. Gravels are subangular to subrounded fine to coarse of siltstone and mudstone. (TIDAL FLAT DEPOSITS)
		2.00	SPT	N=12 (1,1/3,3,3,3)				
	▼				2.60			Medium dense grey slightly gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
		3.00 - 5.00	B					
		3.00	SPT	N=8 (1,1/2,2,2,2)				
		4.00	SPT	N=12 (5,5/5,3,2,2)				
		5.00	SPT	N=3 (1,0/1,0,1,1)	5.00			

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

Unable to install monitoring well deeper due to collapse of material.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS103

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 18/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278490.986 N381589.233
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS103	WLS		AR	1:25	Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					5.45			Loose grey slightly gravelly fine to coarse SAND. Gravels are subangular to rounded fine to medium quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
								End of Borehole at 5.450m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

Unable to install monitoring well deeper due to collapse of material.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS104

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 18/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278473.021 N381578.813
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS104	WLS		AR	1:25	Sheet 1 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.05			Coloured Asphalt (MADE GROUND)
					0.30			Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (sub base) (MADE GROUND)
		0.50	B					Soft grey mottled brown sandy CLAY. (TIDAL FLAT DEPOSITS)
		0.50	B					
		0.50	B					
		0.50	B					
		0.50 - 1.20	B					
		1.00	ES					
		1.20	SPT	N=4 (1,1/1,1,1,1)				
		2.00	D					
		2.00	SPT	N=5 (1,1/2,1,1,1)				
	▼				2.70			Loose grey slightly gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
		3.00	B					
		3.00	SPT	N=6 (1,1/1,1,2,2)				
		4.00	SPT	N=10 (3,3/4,3,2,1)	4.00			Medium dense grey slightly gravelly fine to coarse SAND. Gravels are subangular to rounded fine to medium quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
		5.00	SPT	N=4 (1,1/1,1,1,1)	5.00			

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

No recovery between 1.20m and 2.00m.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS104

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 18/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278473.021 N381578.813
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS104	WLS		AR	1:25	Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Loose grey slightly gravelly fine to coarse SAND. Gravels are subangular to rounded fine to medium quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
					5.45			End of Borehole at 5.450m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

No recovery between 1.20m and 2.00m.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd — Windowless Sample Record — WS105

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 18/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278456.086 N381601.718
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS105	WLS		AR	1:25	Sheet 1 of 2

Well	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.10			Coloured Asphalt (MADE GROUND)
					0.30			Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (sub base) (MADE GROUND)
		0.50	ES					Soft grey mottled brown sandy CLAY. (TIDAL FLAT DEPOSITS)
		0.50 - 1.00	B					
		1.00	ES					
		1.20	SPT	N=4 (1,1/1,1,1,1)				
		1.65	D					
		2.00 - 2.45	D					
		2.00	SPT	N=7 (1,1/1,2,2,2)				
		2.50	D					
	▼				2.80			Medium dense grey slightly gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
		3.00 - 5.00	B					
		3.00	SPT	N=11 (1,1/1,3,3,4)				
		4.00	SPT	N=12 (2,1/1,4,3,4)				
		5.00	SPT	N=14 (2,3/3,3,3,5)				

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

No recovery between 1.20m and 2.00m.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS105

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 18/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278456.086 N381601.718
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS105	WLS		AR	1:25	Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Medium dense grey slightly gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
					5.45			End of Borehole at 5.450m

6 7 8 9 10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

No recovery between 1.20m and 2.00m.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS106

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 18/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278441.836 N381624.733
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS106	WLS		AR	1:25	Sheet 1 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.10			Coloured Asphalt (MADE GROUND)	
					0.35			Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (sub base) (MADE GROUND)	
		0.50	ES					Soft brown mottled grey sandy CLAY with rare rootlets. (TIDAL FLAT DEPOSITS)	
		0.50 - 1.00	B						
		1.00	ES						1
		1.20 - 2.00	B						
		1.20	SPT	N=4 (1,1/1,1,1,1)					
		2.00	SPT	N=3 (0,0/0,1,1,1)	2.00			Very soft brown mottled grey sandy CLAY with rare rootlets. (TIDAL FLAT DEPOSITS)	2
	▼				2.50			Loose grey slightly gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)	
		2.80 - 5.45	B						
		3.00	SPT	N=4 (0,0/1,1,1,1)					3
		4.00	SPT	N=20 (3,4/4,5,5,6)	4.00			Medium dense grey slightly gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)	4
		5.00	SPT	N=6 (1,1/1,1,2,2)	5.00				5

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS106

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 18/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278441.836 N381624.733
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS106	WLS		AR	1:25	Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					5.45			Loose grey slightly gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
								End of Borehole at 5.450m

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10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS107

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 19/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278484.837 N381635.404
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS107	WLS		AR	1:25	Sheet 1 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.20	ES		0.30			Grass over loose brown slightly clayey slightly gravelly fine to coarse SAND with rootlets. Gravels are subangular fine to coarse of siltstone and mudstone (TOPSOIL)
		0.50 - 1.20	B					Soft brown mottled grey sandy CLAY with rare rootlets. (TIDAL FLAT DEPOSITS)
		0.80	ES					
		1.20 - 2.00	B					
		1.20	SPT	N=4 (1,1/1,1,1,1)				
		2.00	SPT	N=7 (1,1/1,2,2,2)	2.30			
	▼	2.50 - 4.00	B					Loose grey gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
		3.00	SPT	N=6 (1,1/1,1,2,2)				
		4.00	SPT	N=50 (7,8/50 for 290mm)				

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS107

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 19/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278484.837 N381635.404
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS107	WLS		AR	1:25	Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					5.45			Loose grey gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
								End of Borehole at 5.450m

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Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd — Windowless Sample Record — WS108

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 19/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278486.535 N381645.883
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS108	WLS		AR	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.10			Concrete flag stone (MADE GROUND)
		0.20	ES		0.30			Loose reddish brown clayey slightly sandy subangular fine to coarse GRAVEL of sandstone (sub base) (MADE GROUND)
		0.40 - 0.90	B					
		0.50	ES					Soft dark grey sandy slightly gravelly CLAY with low cobble content. Gravels are subangular to subrounded fine to coarse sandstone and brick. Cobbles are subangular of siltstone. (TIDAL FLAT DEPOSITS)
					0.90			Firm grey mottled brown sandy CLAY with occasional rootlets. (TIDAL FLAT DEPOSITS)
		1.00	ES					
		1.20 - 2.00	B					
		1.20	SPT	N=8 (1,1/2,2,2,2)				
		2.00	SPT	N=2 (0,0/0,0,1,1)	2.00			Very soft grey mottled brown sandy CLAY with occasional rootlets. (TIDAL FLAT DEPOSITS)
	▼				2.30			Very loose grey gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
		2.50 - 4.00	B					
		3.00	SPT	1 (0,0/,0,0,1)				
		4.00	SPT	N=50 (6,8/50 for 285mm)	4.00			Very loose grey gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
					4.35			End of Borehole at 4.350m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

Refused at 4.35m. Dynamic Probe follow on undertaken .

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS109

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 19/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278475.700 N381648.657
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS109	WLS		AR	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.05			Coloured Asphalt (MADE GROUND)
					0.30			Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (sub base) (MADE GROUND)
		0.50	ES					Soft brown mottled grey sandy CLAY with rare rootlets. (TIDAL FLAT DEPOSITS)
		1.00	D					
		1.00	D					
		1.20 - 1.65	D					
		1.20	SPT	N=4 (1,1/1,1,1,1)				
		2.00 - 2.45	D					
		2.00	SPT	N=6 (1,1/1,1,2,2)				
	▼				2.90			
		3.00 - 4.00	B					Very loose grey gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
		3.00	SPT	0 (0 for 450mm/0 for 0mm)				
		4.00	SPT	N=50 (6,9/50 for 280mm)	4.00			Very dense grey gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
					4.43			End of Borehole at 4.430m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										
5.00	72										

Remarks

No recovery between 1.20m and 2.00m.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd	Windowless Sample Record	WS110

Project Name: Ty Hapus,Llandudno	Client: Datrys	Date: 19/12/2024
Location: Ffordd Penrhyn, Llandudno LL30 1HB	Contractor: GroundSolve	Co-ords: E278498.571 N381662.162
Project No. : 3222	Crew Name: Regional Drilling	Drilling Equipment: Premier Compact 110

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS110	WLS		AR	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.05			Coloured Asphalt (MADE GROUND)
					0.40			Loose slightly sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies (sub base) (MADE GROUND)
		0.50	ES					Soft brown mottled grey sandy CLAY with rare rootlets. (TIDAL FLAT DEPOSITS)
		0.50 - 1.00	B					
		1.00	ES					
		1.20 - 1.65	D					
		1.20 - 2.00	B					
		1.20	SPT	N=6 (1,1/1,1,2,2)				
		2.00	SPT	N=4 (0,0/1,1,1,1)				
	▼				2.30			Very loose grey gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
		2.50 - 4.00	B					
		3.00	SPT	0 (0 for 450mm/0 for 0mm)				
		4.00	SPT	N=50 (7,9/50 for 275mm)	4.00			Very dense grey gravelly fine to coarse SAND with calcitic bivalve shells . Gravels are subangular to rounded fine to coarse quartz, siltstone and psammite. (TIDAL FLAT DEPOSITS)
					4.43			End of Borehole at 4.430m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	350										
2.00	101										
3.00	92										
4.00	78										

Remarks

Borehole collapsed from 3.00m to 5.00m.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

GroundSolve Ltd
Consulting Geotechnical Engineers

SITE PHOTOGRAPHS

Report No :	3222
Job Title :	Ty Hapus, Llandudno
Date Taken:	17/12/2022

SA101

SA101

SA101 – Reinstated

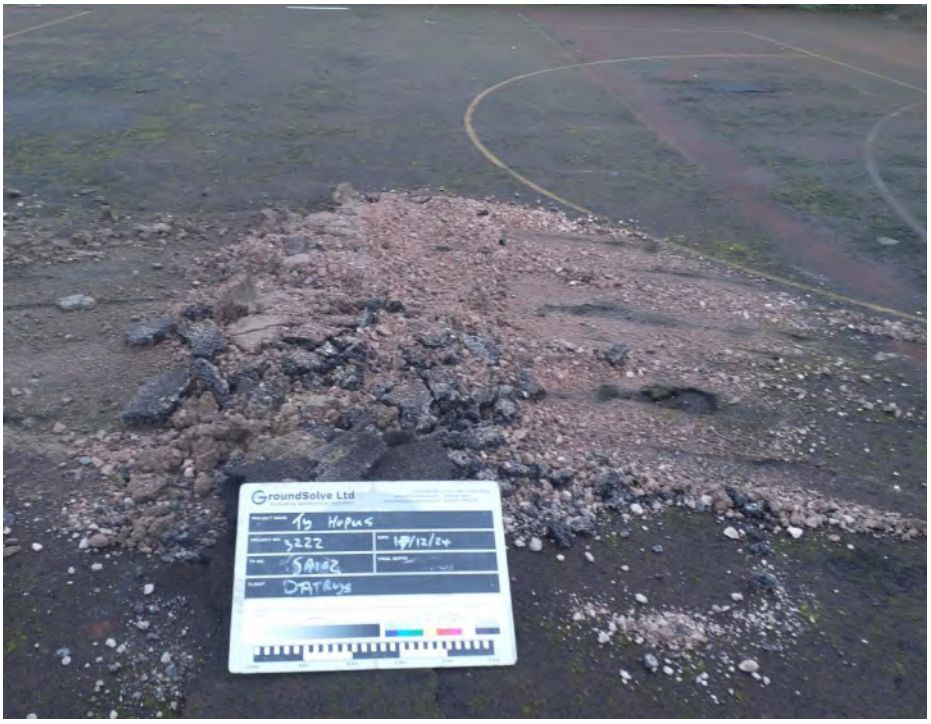

GroundSolve Ltd
PROJECT NAME Ty Hapus
PROJECT NO. 3222
DATE 17/12/24
TP NO. SA102
FINAL DEPTH 1.5
CLIENT DATRys

SA102

SA102

SA102 – Reinstated

SA103



SA103 – Reinstated

GroundSolve Ltd
Consulting Geotechnical Engineers

SITE PHOTOGRAPHS

Report No :	3222
Job Title :	Ty Hapus, Llandudno
Date:	17/12/2022

TP101

GroundSolve Ltd
Consulting Geotechnical Engineers

SITE PHOTOGRAPHS

Report No :	3222
Job Title :	Ty Hapus, Llandudno
Date:	17/12/2022

TP102

TP102

TP102 – Reinstated

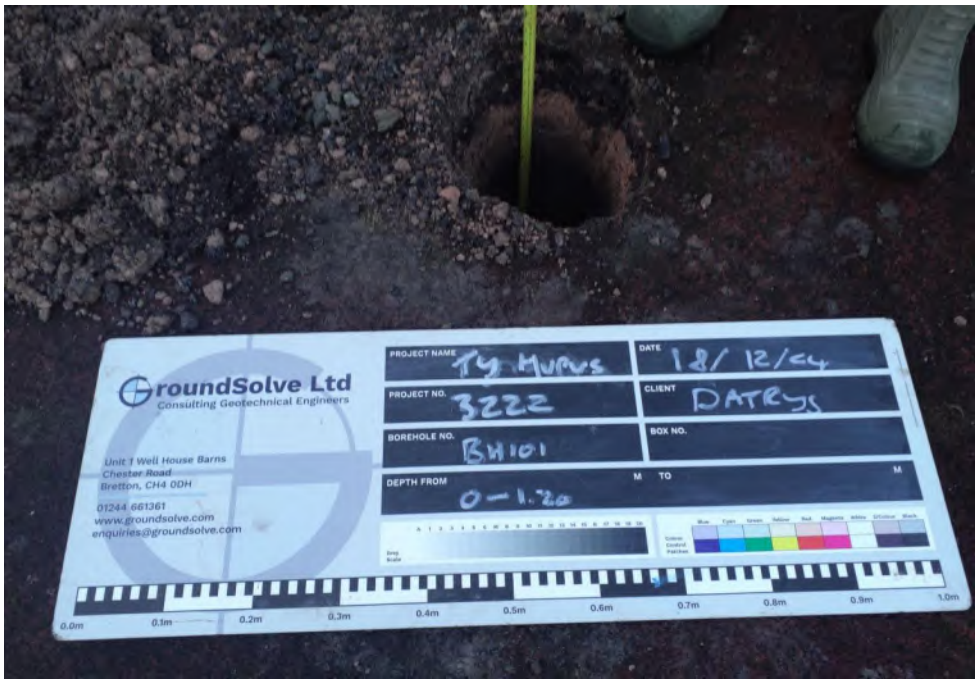

GroundSolve Ltd
Ty Hapus
3277
19/12/24
TP103
DATRys

TP103


GroundSolve Ltd
Ty Hapus
3277
19/12/24
TP103
DATRys

TP103

TP103 – Reinstated


GroundSolve Ltd
Consulting Geotechnical Engineers
Unit 1 Well House Barns
Chester Road
Bretton, CH4 0DH
01244 661361
www.groundsolve.com
enquiries@groundsolve.com
PROJECT NAME Ty Hapus
DATE 18/12/22
PROJECT NO. 3222
CLIENT DATRYS
BOREHOLE NO. BH101
BOX NO.
DEPTH FROM 0 M TO 1.20 M
0.0m 0.1m 0.2m 0.3m 0.4m 0.5m 0.6m 0.7m 0.8m 0.9m 1.0m

WS101


GroundSolve Ltd
Consulting Geotechnical Engineers
PROJECT NAME Ty Hapus
DATE 18/12/22
PROJECT NO. 3222
CLIENT DATRYS
BOREHOLE NO. WS101
BOX NO.
DEPTH FROM 1.20 M TO 5.45 M

WS101

GroundSolve Ltd
Consulting Geotechnical Engineers

SITE PHOTOGRAPHS

Report No :	3222
Job Title :	Ty Hapus, Llandudno
Date:	17/12/2022

WS101 – Reinstated


GroundSolve Ltd
Consulting Geotechnical Engineers
Unit 1 Well House Barns
Chester Road
Bretton, CH4 0DH
01244 661361
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enquiries@groundsolve.com
PROJECT NAME
DATE
12/12/24
PROJECT NO.
3222
CLIENT
DATRYS
BOREHOLE NO.
WS102
BOX NO.
DEPTH FROM
0m
1.20
TO

WS102


GroundSolve Ltd
Consulting Geotechnical Engineers
PROJECT NAME
Ty HAPus
DATE
12/12/24
PROJECT NO.
3222
CLIENT
DATRYS
BOREHOLE NO.
WS102
BOX NO.
DEPTH FROM
1.2
5.48
TO

WS102

GroundSolve Ltd
Consulting Geotechnical Engineers

SITE PHOTOGRAPHS

Report No :	3222
Job Title :	Ty Hapus, Llandudno
Date:	17/12/2022

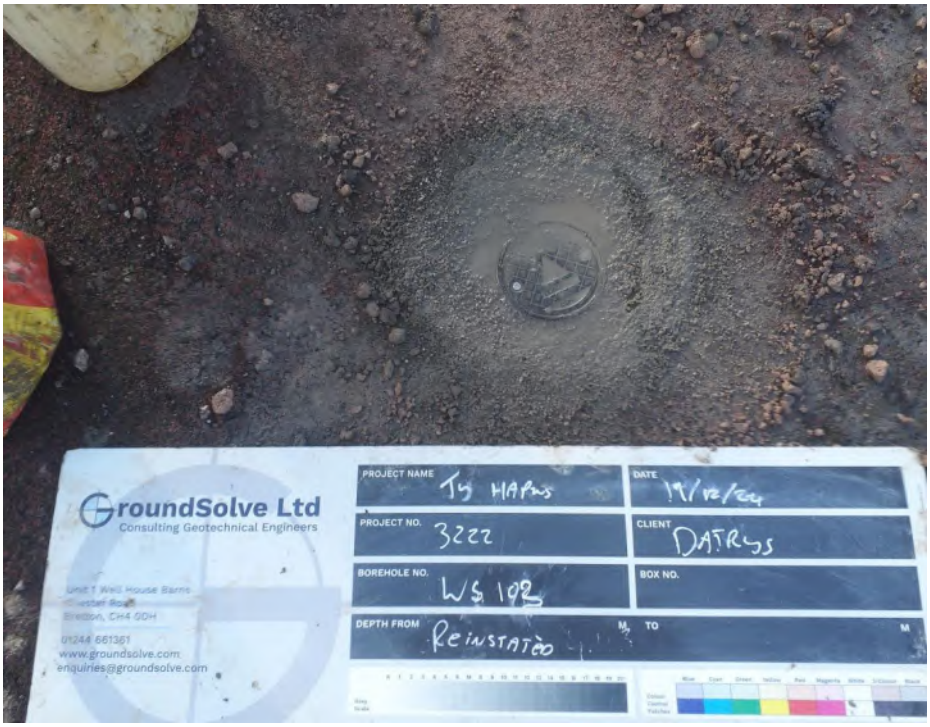
WS102 – Reinstated


GroundSolve Ltd
Consulting Geotechnical Engineers
Unit 1 Well House Barns
Chester Road
Bretton, CH4 0DH
01244 661361
www.groundsolve.com
enquiries@groundsolve.com
PROJECT NAME Ty HAPus
DATE 18/12/22
PROJECT NO. 3223
CLIENT DAFRYS
BOREHOLE NO. WS103
BOX NO.
DEPTH FROM M TO M
0 - 1.2 - S.U.T

WS103


GroundSolve Ltd
Consulting Geotechnical Engineers
PROJECT NAME Ty HAPus
DATE 18/12/22
PROJECT NO. 3222
CLIENT DAFRYS
BOREHOLE NO. WS103
BOX NO.
DEPTH FROM M TO M
0 - 1.2 - S.U.T

WS103



WS103 – Reinstated


GroundSolve Ltd
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Unit 1 Well House Barns
Chester Road
Bretton, CH4 0DH
01244 661361
www.groundsolve.com
enquiries@groundsolve.com
PROJECT NAME
Ty Hapus
DATE
18/12/24
PROJECT NO.
3222
CLIENT
Dittons
BOREHOLE NO.
WS104
BOX NO.
DEPTH FROM
M TO M
0 - 1.2 - 5.45

WS104


GroundSolve Ltd
Consulting Geotechnical Engineers
PROJECT NAME
Ty Hapus
DATE
18/12/24
PROJECT NO.
3222
CLIENT
Dittons
BOREHOLE NO.
WS104
BOX NO.
DEPTH FROM
M TO M
0 - 1.2 - 5.45

WS104

WS104 – Reinstated


GroundSolve Ltd
Consulting Geotechnical Engineers
Unit 1 Well House Barns
Chester Road
Bretton, CH4 0DH
01244 661361
www.groundsolve.com
enquiries@groundsolve.com
PROJECT NAME Ty Hapus
DATE 18/12/24
PROJECT NO. 3222
CLIENT Davies
BOREHOLE NO. WS105
BOX NO.
DEPTH FROM M TO M
0 – 1.2
0.0m 0.1m 0.2m 0.3m 0.4m 0.5m 0.6m 0.7m 0.8m 0.9m 1.0m

WS105


GroundSolve Ltd
PROJECT NAME Ty Hapus
DATE 18/12/24
PROJECT NO. 3222
CLIENT Davies
BOREHOLE NO. WS105
BOX NO.
DEPTH FROM M TO M
0 – 1.2 – 5.45

WS105

WS105 – Reinstated


GroundSolve Ltd
Consulting Geotechnical Engineers
PROJECT NAME Ty Hapus
DATE 12/12/24
PROJECT NO. 3222
CLIENT Dafrus
BOREHOLE NO. WS105
BOX NO.
DEPTH FROM 0 – 1.2 M TO M

WS106


GroundSolve Ltd
Consulting Geotechnical Engineers
PROJECT NAME Ty Hapus
DATE 12/12/24
PROJECT NO. 3222
CLIENT Dafrus
BOREHOLE NO. WS105
BOX NO.
DEPTH FROM 0 – 1.2 M TO M

WS106

GroundSolve Ltd
Consulting Geotechnical Engineers

SITE PHOTOGRAPHS

Report No :	3222
Job Title :	Ty Hapus, Llandudno
Date:	17/12/2022

WS106 – Reinstated


GroundSolve Ltd
Consulting Geotechnical Engineers
PROJECT NAME Ty Hapus
DATE 19/12/22
PROJECT NO. 3222
CLIENT Dafrys
BOREHOLE NO. WS107
BOX NO.
DEPTH FROM 0 M TO 1.70 M

WS107


GroundSolve Ltd
Ty Hapus
19/12/22
3222
Dafrys
WS107
0 - 1.70 - 4.46

WS107

GroundSolve Ltd
Consulting Geotechnical Engineers

SITE PHOTOGRAPHS

Report No :	3222
Job Title :	Ty Hapus, Llandudno
Date:	17/12/2022

WS107 – Reinstated


GroundSolve Ltd
Consulting Geotechnical Engineers
Unit 1 Well House Barns
Bretton, CH4 0DH
01244 661361
www.groundsolve.com
enquiries@groundsolve.com
PROJECT NAME
Ty Hapus
DATE
19/12/22
PROJECT NO.
3222
CLIENT
Harrys
BOREHOLE NO.
WS108
BOX NO.
DEPTH FROM
M TO
0 - 1.70
0.0m
0.1m
0.2m
0.3m
0.4m
0.5m
0.6m
0.7m
0.8m

WS108


GroundSolve Ltd
Consulting Geotechnical Engineers
PROJECT NAME
Ty Hapus
DATE
19/12/22
PROJECT NO.
3222
CLIENT
Harrys
BOREHOLE NO.
WS108
BOX NO.
DEPTH FROM
M TO
0 - 1.70

WS108

WS108 – Reinstated


GroundSolve Ltd
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Unit 1 Well House Barns
Chester Road
Bretton, CH4 0DH
01244 661361
www.groundsolve.com
enquiries@groundsolve.com
PROJECT NAME Ty Hapus
DATE 19/12/24
PROJECT NO. 3222
CLIENT DATRYS
BOREHOLE NO. WS109
BOX NO.
DEPTH FROM 0 - 1.20 M TO M
0.1m 0.2m 0.3m 0.4m 0.5m 0.6m 0.7m 0.8m 0.9m

WS109


GroundSolve Ltd
Consulting Geotechnical Engineers
Unit 1 Well House Barns
Chester Road
Bretton, CH4 0DH
01244 661361
www.groundsolve.com
enquiries@groundsolve.com
PROJECT NAME Ty Hapus
DATE 19/12/24
PROJECT NO. 3222
CLIENT DATRYS
BOREHOLE NO. WS108
BOX NO.
DEPTH FROM 0 - 1.20 M TO M

WS109

WS109 – Reinstated


GroundSolve Ltd
Consulting Geotechnical Engineers
Unit 1 Well House Barns
Chester Road
Bretton, CH4 0DH
01244 661361
www.groundsolve.com
enquiries@groundsolve.com
PROJECT NAME
Ty Hapus
DATE
PROJECT NO.
3222
CLIENT
DATRYS
BOREHOLE NO.
WS110
BOX NO.
DEPTH FROM
0 - 1.20
M
TO
M
0.0m
0.1m
0.2m
0.3m
0.4m
0.5m
0.6m
0.7m
0.8m
0.9m
1.0m

WS110


GroundSolve Ltd
Consulting Geotechnical Engineers
Unit 1 Well House Barns
Chester Road
Bretton, CH4 0DH
01244 661361
www.groundsolve.com
enquiries@groundsolve.com
PROJECT NAME
Ty Hapus
DATE
PROJECT NO.
3222
CLIENT
DATRYS
BOREHOLE NO.
WS110
BOX NO.
DEPTH FROM
0 - 1.20 - 4.43
TO
M

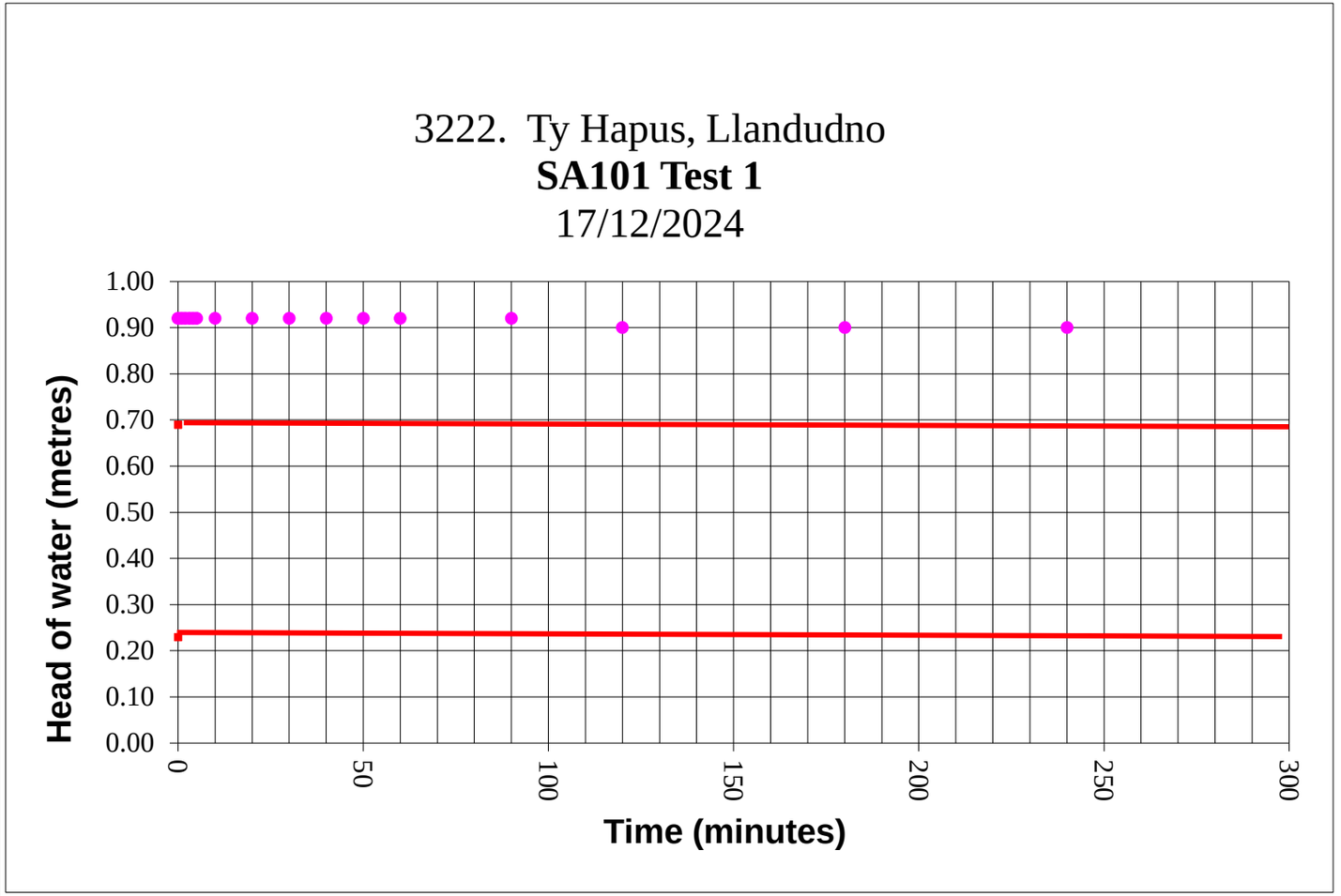
WS110

WS110 – Reinstated

APPENDIX D – INFILTRATION TEST RESULTS

GroundSolve Ltd
Consulting Geotechnical Engineers

Time (Mins)	Depth to Water	Head of Water
0	0.58	0.92
1	0.58	0.92
2	0.58	0.92
3	0.58	0.92
4	0.58	0.92
5	0.58	0.92
10	0.58	0.92
20	0.58	0.92
30	0.58	0.92
40	0.58	0.92
50	0.58	0.92
60	0.58	0.92
90	0.58	0.92
120	0.60	0.90
180	0.60	0.90
240	0.60	0.90
	0.60	0.90

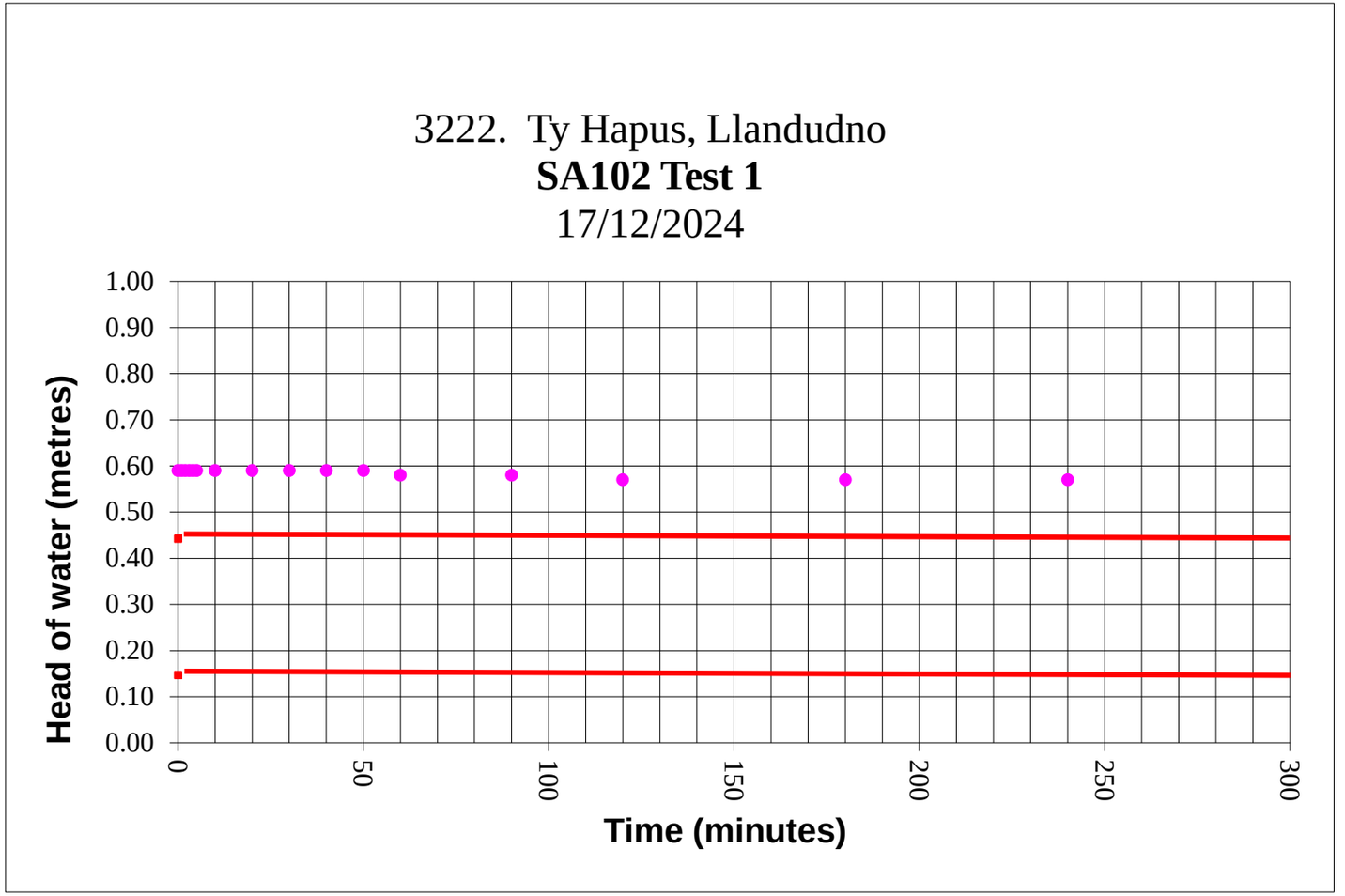


Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjustment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.50	1.50	0.45	0.690	0.23	0.92	2.469	0.000		-	-	N/A

Note:

GroundSolve Ltd
Consulting Geotechnical Engineers

Time (Mins)	Depth to Water	Head of Water
0	0.51	0.59
1	0.51	0.59
2	0.51	0.59
3	0.51	0.59
4	0.51	0.59
5	0.51	0.59
10	0.51	0.59
20	0.51	0.59
30	0.51	0.59
40	0.51	0.59
50	0.51	0.59
60	0.52	0.58
90	0.52	0.58
120	0.53	0.57
180	0.53	0.57
240	0.53	0.57

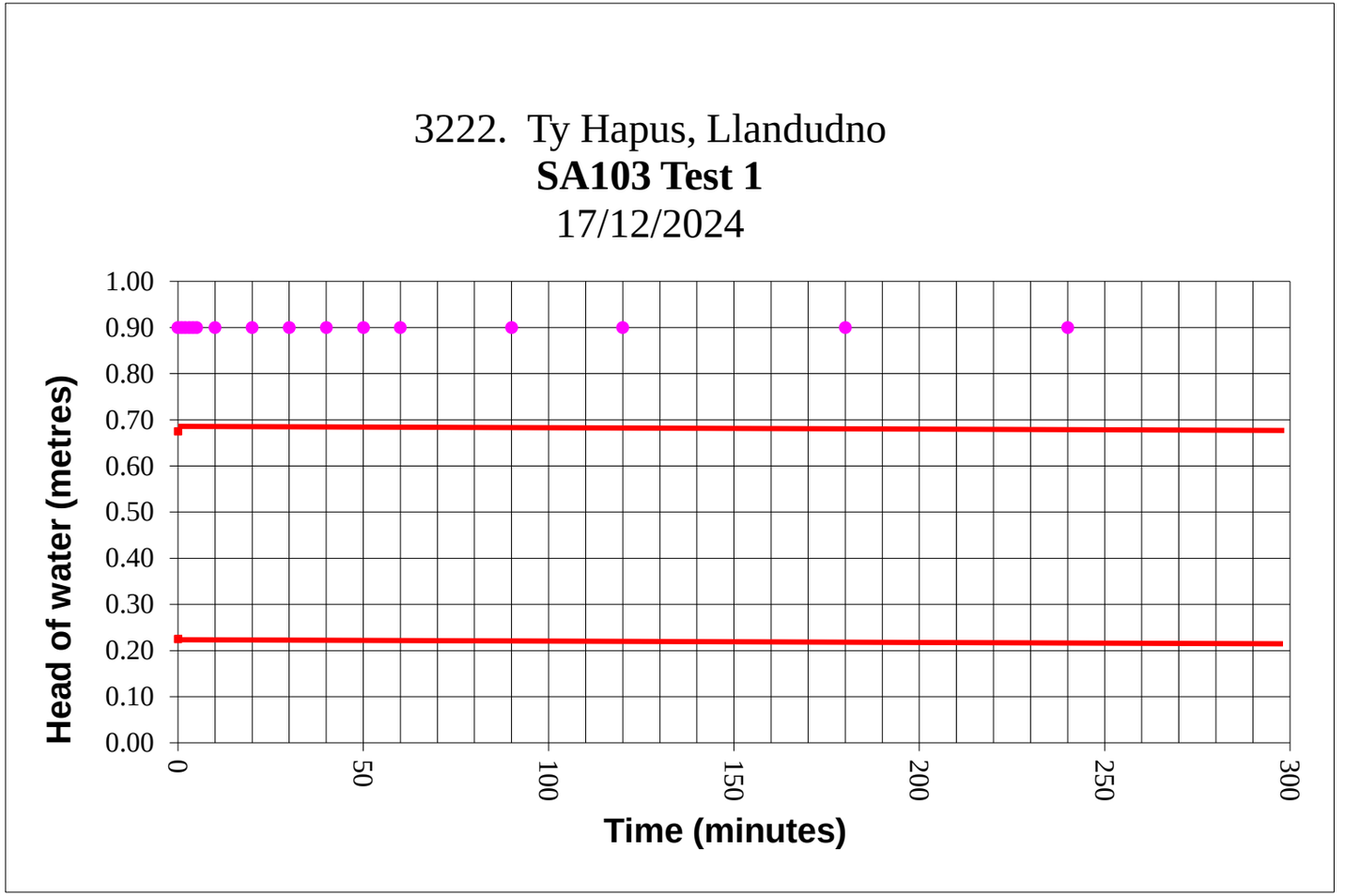


Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjustment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.10	0.45	0.45	0.443	0.15	0.59	0.734	0.000		-	-	N/A

Note:

GroundSolve Ltd
Consulting Geotechnical Engineers

Time (Mins)	Depth to Water	Head of Water
0	0.60	0.90
1	0.60	0.90
2	0.60	0.90
3	0.60	0.90
4	0.60	0.90
5	0.60	0.90
10	0.60	0.90
20	0.60	0.90
30	0.60	0.90
40	0.60	0.90
50	0.60	0.90
60	0.60	0.90
90	0.60	0.90
120	0.60	0.90
180	0.60	0.90
240	0.60	0.90



Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjustment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.50	1.20	0.45	0.675	0.23	0.90	2.025	0.000		-	-	N/A

Note:

APPENDIX E – GAS MONITORING RESULTS

No: 3222

GROUNDWATER AND GROUND GAS MONITORING

GroundSolve Ltd
Consulting Geotechnical Engineers

Site: Ty Hapus Llandudno

Location	Date	Monitored by	Well Details		Groundwater		Gas											Weather
			Standpipe diameter (mm)	Depth to Base (m bgl)	Water Depth (m bgl)	Water Sample Taken?	Atmospheric Pressure (mbar)	Atmospheric Pressure Comment	Relative Pressure (mb)	Flow - Peak (l/h)	Flow - Steady (l/h)	CH_4 (% v/v)	GSV CH_4 (l/hr)	CO_2 (% v/v)	GSV CO_2 (l/hr)	O_2 (% v/v)	Serial No.	Conditions
WS101	06.02.25	AB	50	2.45	1.80	No	1041	Rising	0.01	0.1	0.1	0.1	0.0001	1.7	0.0017	16.4		Clear Sunny
	12.02.25	AB	50	2.43	1.86	No	1019	Falling	0.01	0.1	0.1	0.1	0.0001	1.4	0.0014	18.0		Overcast
	26.02.25	AB	50	2.44	1.75	No	1006	Falling	0.07	0.5	0.5	0.1	0.0005	2.0	0.0100	14.9		Overcast
WS103	06.02.25	AB	50	2.35	1.85	No	1043	Rising	0.01	0.1	0.1	0.1	0.0001	0.4	0.0004	19.7		Clear Sunny
	12.02.25	AB	50	2.36	1.92	No	1021	Falling	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	20.0		Overcast
	26.02.25	AB	50	2.36	1.83	No	1005	Falling	0.02	0.1	0.1	0.1	0.0001	0.2	0.0002	20.7		Overcast
WS107	06.02.25	AB	50	3.00	1.87	No	1041	Rising	0.01	0.1	0.1	0.1	0.0001	0.9	0.0009	19.4		Clear Sunny
	12.02.25	AB	50	2.30	1.94	No	1018	Falling	0.01	0.1	0.1	0.1	0.0001	1.1	0.0011	18.0		Overcast
	26.02.25	AB	50	3.00	1.83	No	1007	Falling	0.03	0.3	0.3	0.1	0.0003	1.2	0.0036	20.5		Overcast
WS110	06.02.25	AB	50	2.69	1.75	No	1039	Rising	0.01	0.1	0.1	0.1	0.0001	0.5	0.0005	19.6		Clear Sunny
	12.02.25	AB	50	2.70	1.84	No	1018	Falling	0.01	0.1	0.1	0.1	0.0001	0.5	0.0005	19.5		Overcast
	26.02.25	AB	50	2.72	1.74	No	1006	Falling	0.05	0.5	0.5	0.1	0.0005	0.7	0.0035	20.9		Overcast

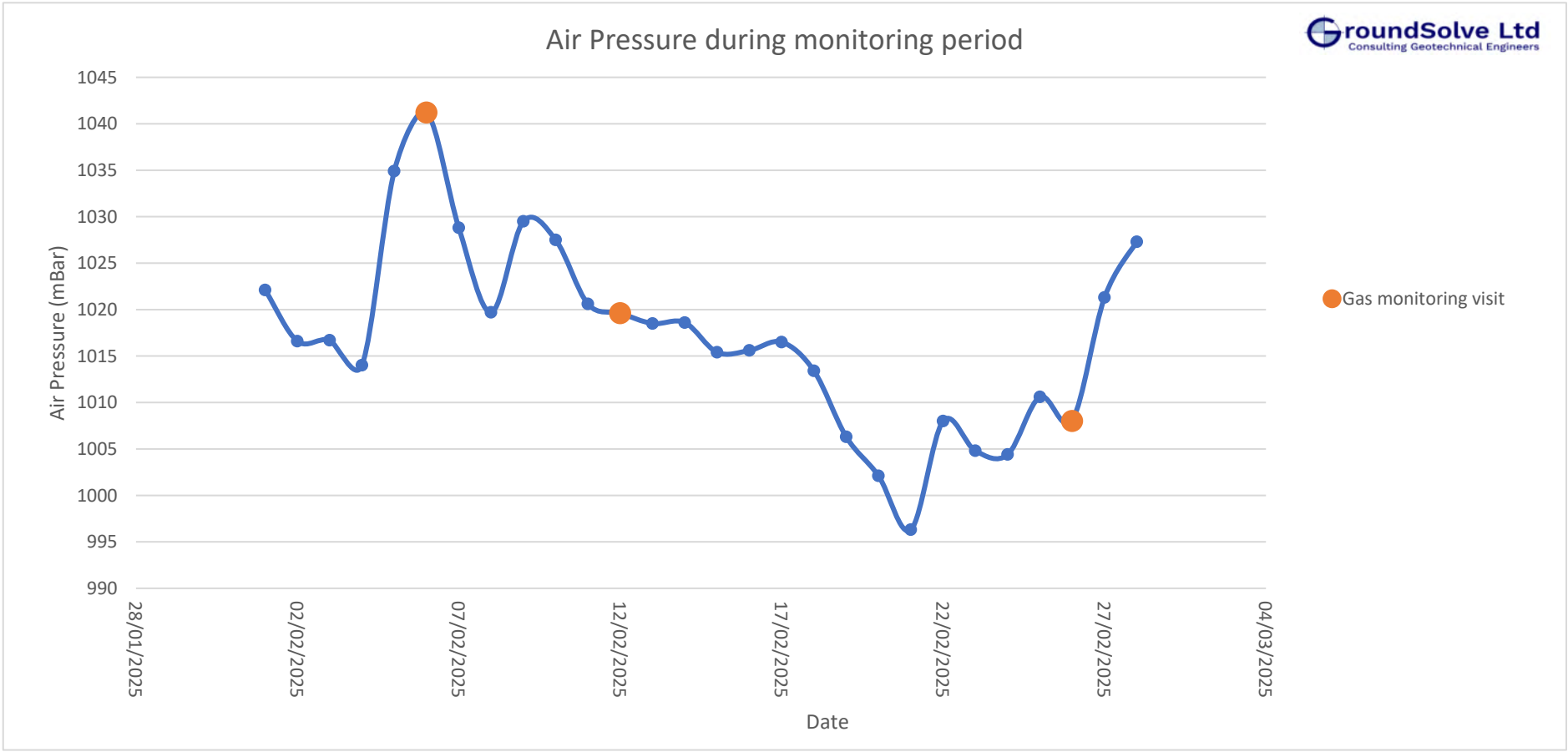
NOTES:

NM = Not Measured.

(x) = Peak value recorded.

[grey] = Below detection limit.

$$GSV\ (l/HR) = \frac{[\text{gas concentration } (\%v/v)] \times [\text{gas well flow rate } (l/hr)}{100}$$



Note: Air pressure data from Liverpool John Lennon Airport Weather Station

APPENDIX F – GEOTECHNICAL TEST RESULTS

GQF-008-48
Issue 01 - Oct 22

Summary of Classification Test Results

Project No.
J297664

Project Name
Ty Hapus

Hole No.	Sample				Soil Description	Density bulk Mg/m³	Density dry Mg/m³	w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m³	Remarks
	Ref	Top	Base	Type										
TP101		0.60		B	Brown mottled grey slightly gravelly CLAY			31	95	54	26	28		
TP101		1.20		B	Light brown mottled grey slightly sandy CLAY				100	45	23	22		
TP102		1.50		B	Brown CLAY			27	100	42	19	23		
WS101		1.50		B	Grey brown slightly sandy CLAY			32	100	58	21	37		
WS102		2.00		D	Brown slightly sandy CLAY			35	100	43 -1pt	20	23		
WS104		0.50		B	Light brown slightly sandy CLAY				100	51	22	29		
WS104		2.00		D	Brown silty CLAY			34	100	51	23	28		
WS105		2.00		D	Brown CLAY			29	100	49	19	30		
WS105		2.50		D	Brown CLAY			28	100	53	25	28		
WS106		0.50		B	Brown slightly gravelly CLAY			25	99	51	24	27		
WS106		1.20		B	Brown sandy CLAY			33	100	47	22	25		
WS107		0.50		B	Light brown slightly sandy CLAY				100	58	25	33		
WS109		1.20		D	Brown slightly sandy CLAY			30	100	53	24	29		
WS110		0.50		B	Brown CLAY			25	100	56	22	34		
WS110		1.20		B	Brown silty CLAY			35	100	52	21	31		

All tests performed in accordance with BS1377:1990 unless specified otherwise

Date Printed 23/01/2025

Key

Density test
Linear measurement unless :
wd - water displacement
wi - immersion in water

Liquid Limit
4pt cone unless :
cas - Casagrande method
1pt - single point test

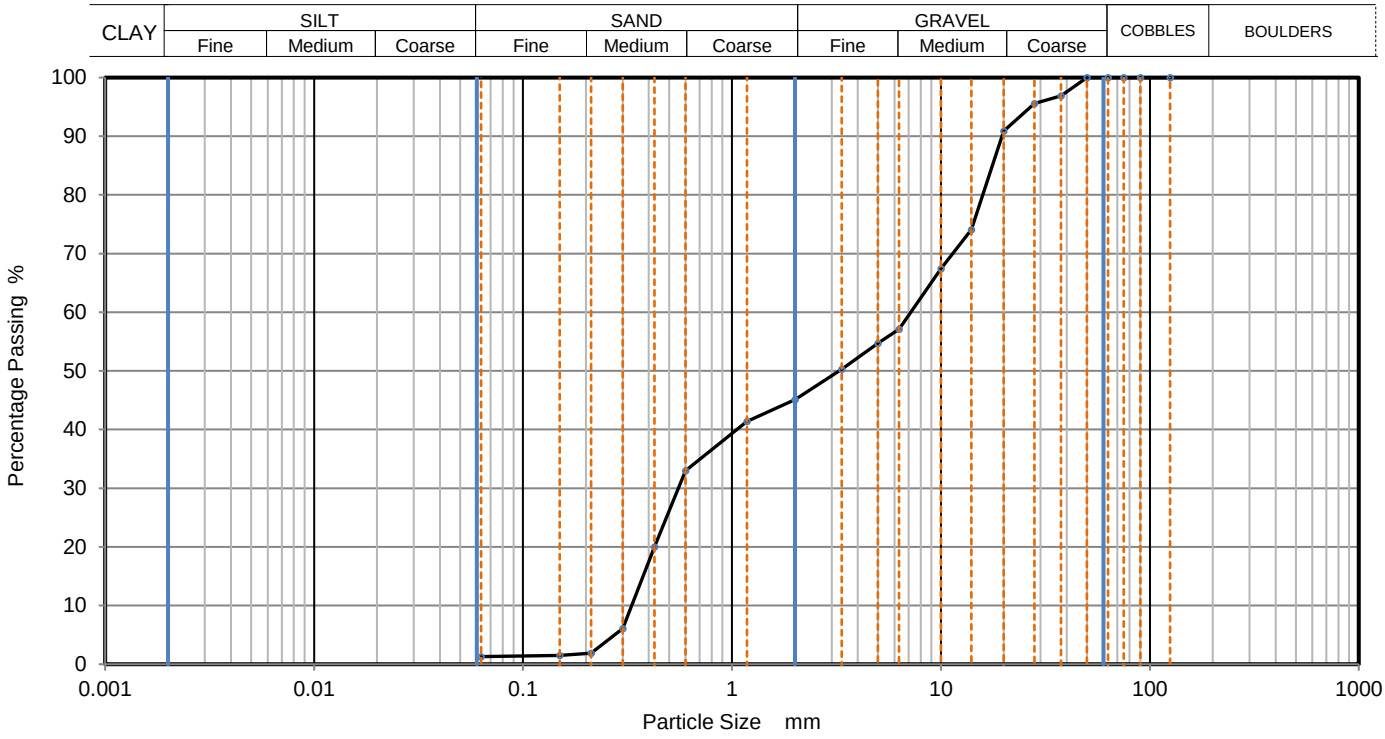
Particle density
sp - small pyknometer
gj - gas jar

TTL

UKAS TESTING
7758

INDEX

GQF-008-55 Issue 01 - Oct 22	**PARTICLE SIZE DISTRIBUTION**			Job Ref	J297664
				Borehole/Pit No.	TP102
Project Name	Ty Hapus			Sample No.	
Soil Description	Brown very sandy GRAVEL			Depth, m	2.50
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	TTLP202501163



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	97		
28	96		
20	91		
14	74		
10	67		
6.3	57		
5	55		
3.35	50		
2	45		
1.18	41		
0.6	33		
0.425	20		
0.3	6		
0.212	2		
0.15	2		
0.063	1		

Dry Mass of sample, g	4825

Sample Proportions	% dry mass
Very coarse	0
Gravel	55
Sand	44
Fines <0.063mm	1

Grading Analysis		
D100	mm	
D60	mm	7.16
D30	mm	0.555
D10	mm	0.331
Uniformity Coefficient		22
Curvature Coefficient		0.13

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Date Printed	23/01/2025

UKAS TESTING
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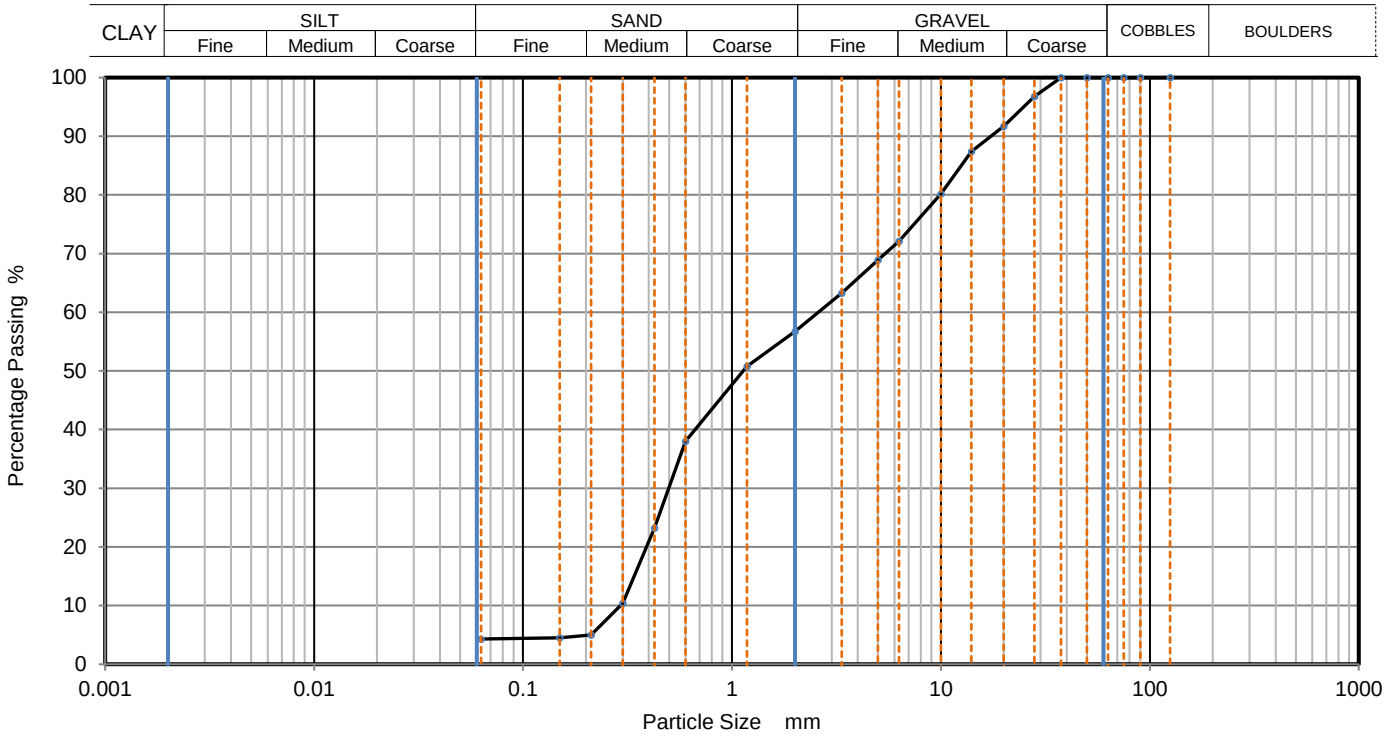
PSD

GQF-008-55 Issue 01 - Oct 22	**PARTICLE SIZE DISTRIBUTION**			Job Ref	J297664
				Borehole/Pit No.	TP103
Project Name	Ty Hapus			Sample No.	
Soil Description	Brown slightly clayey very gravelly SAND			Depth, m	2.40
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	TTLP202501164



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	97		
20	92		
14	87		
10	80		
6.3	72		
5	69		
3.35	63		
2	57		
1.18	51		
0.6	38		
0.425	23		
0.3	10		
0.212	5		
0.15	5		
0.063	4		

Dry Mass of sample, g	4596

Sample Proportions	% dry mass
Very coarse	0
Gravel	43
Sand	52
Fines <0.063mm	4

Grading Analysis		
D100	mm	
D60	mm	2.59
D30	mm	0.498
D10	mm	0.293
Uniformity Coefficient		8.9
Curvature Coefficient		0.33

Remarks

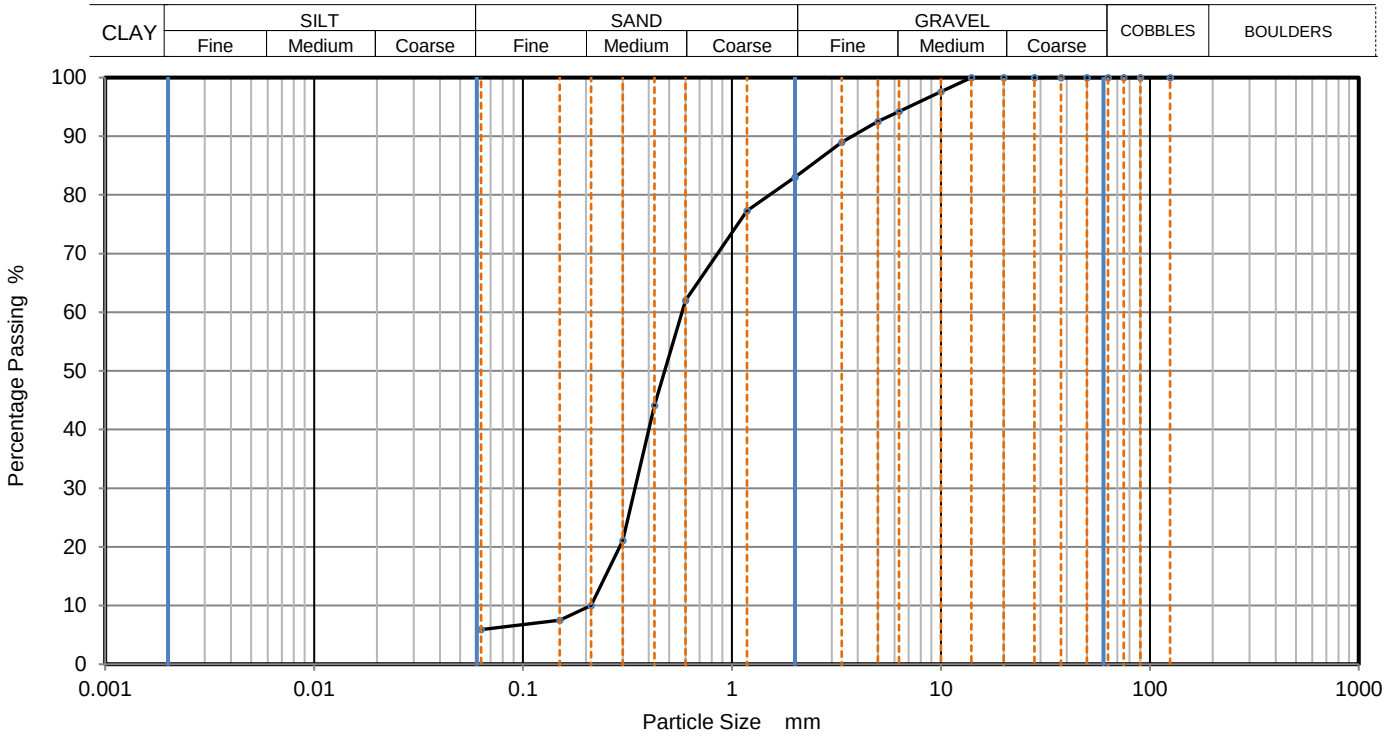
Preparation and testing in accordance with BS1377 unless noted below

Date Printed	23/01/2025

UKAS TESTING
7758

PSD

GQF-008-55 Issue 01 - Oct 22	**PARTICLE SIZE DISTRIBUTION**			Job Ref	J297664
				Borehole/Pit No.	WS101
Project Name	Ty Hapus			Sample No.	
Soil Description	Brown clayey gravelly SAND			Depth, m	3.00
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	TTLP202501166



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	98		
6.3	94		
5	93		
3.35	89		
2	83		
1.18	77		
0.6	62		
0.425	44		
0.3	21		
0.212	10		
0.15	8		
0.063	6		

Dry Mass of sample, g	3541

Sample Proportions	% dry mass
Very coarse	0
Gravel	17
Sand	77
Fines <0.063mm	6

Grading Analysis		
D100	mm	
D60	mm	0.577
D30	mm	0.343
D10	mm	0.212
Uniformity Coefficient		2.7
Curvature Coefficient		0.96

Remarks

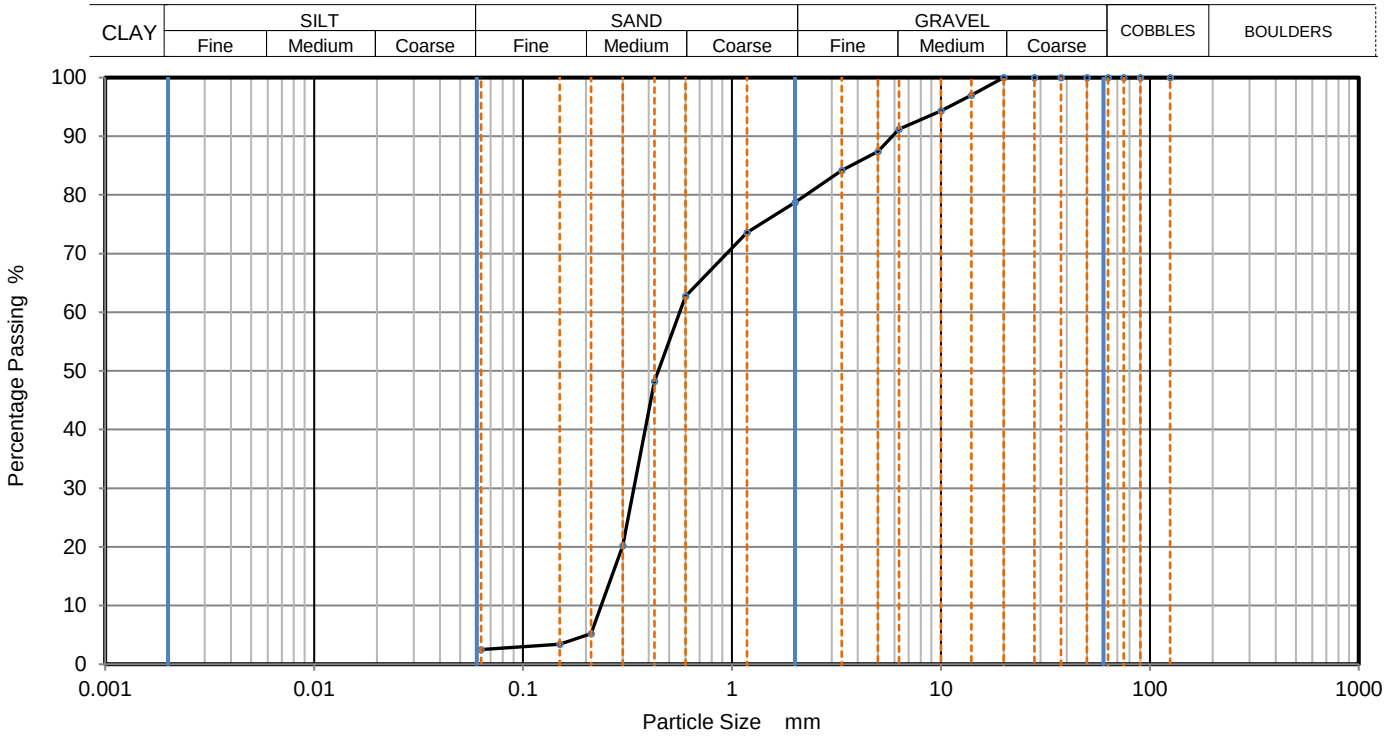
Preparation and testing in accordance with BS1377 unless noted below

Date Printed	23/01/2025

UKAS TESTING
7758

PSD

GQF-008-55 Issue 01 - Oct 22	**PARTICLE SIZE DISTRIBUTION**			Job Ref	J297664
				Borehole/Pit No.	WS102
Project Name	Ty Hapus			Sample No.	
Soil Description	Brown gravelly SAND			Depth, m	2.60
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	TTLP202501168



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	97		
10	94		
6.3	91		
5	87		
3.35	84		
2	79		
1.18	74		
0.6	63		
0.425	48		
0.3	20		
0.212	5		
0.15	3		
0.063	3		

Dry Mass of sample, g	3836

Sample Proportions	% dry mass
Very coarse	0
Gravel	21
Sand	76
Fines <0.063mm	2

Grading Analysis		
D100	mm	
D60	mm	0.563
D30	mm	0.339
D10	mm	0.237
Uniformity Coefficient		2.4
Curvature Coefficient		0.86

Remarks

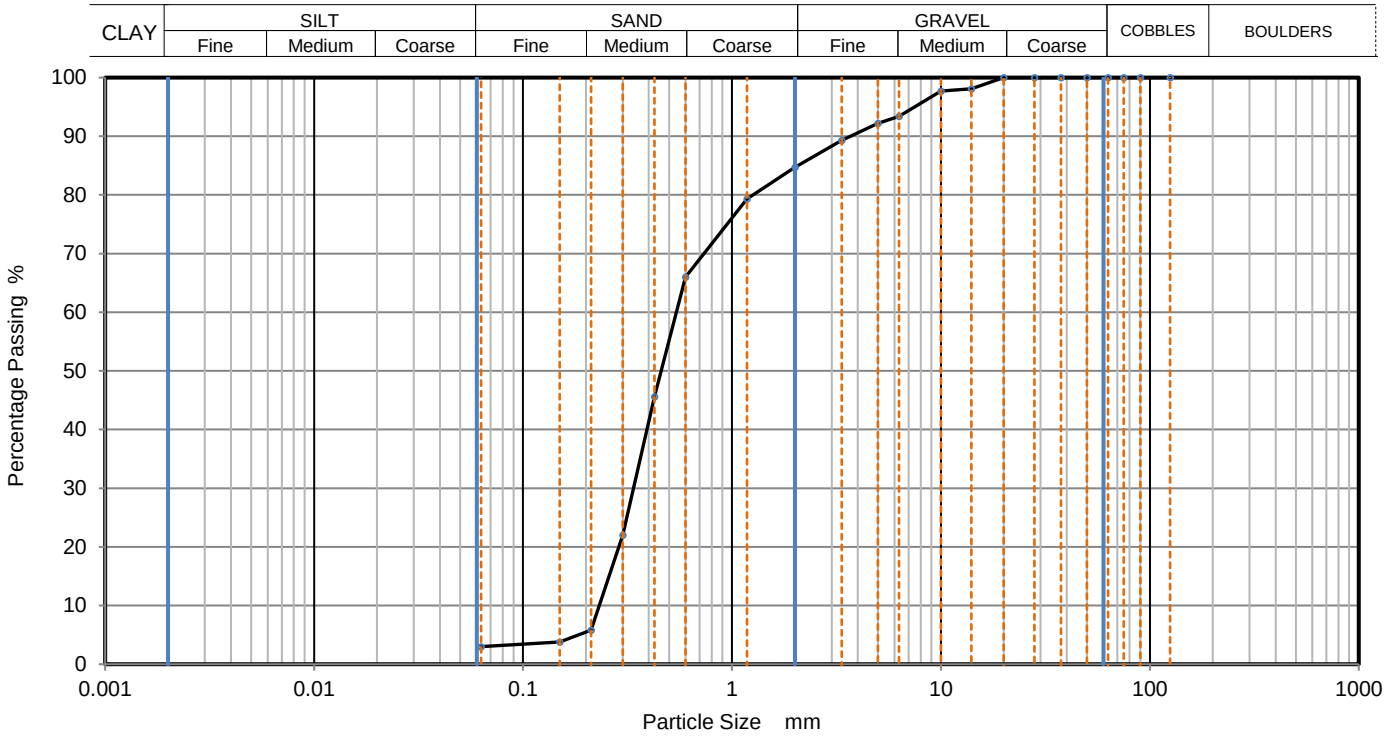
Preparation and testing in accordance with BS1377 unless noted below

Date Printed	23/01/2025

UKAS TESTING
7758

PSD

GQF-008-55 Issue 01 - Oct 22	**PARTICLE SIZE DISTRIBUTION**			Job Ref	J297664
				Borehole/Pit No.	WS104
Project Name	Ty Hapus			Sample No.	
Soil Description	Brown gravelly SAND			Depth, m	3.00
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	TTLP2025011611



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	98		
10	98		
6.3	93		
5	92		
3.35	89		
2	85		
1.18	79		
0.6	66		
0.425	46		
0.3	22		
0.212	6		
0.15	4		
0.063	3		

Dry Mass of sample, g	3093

Sample Proportions	% dry mass
Very coarse	0
Gravel	15
Sand	82
Fines <0.063mm	3

Grading Analysis		
D100	mm	
D60	mm	0.542
D30	mm	0.338
D10	mm	0.232
Uniformity Coefficient		2.3
Curvature Coefficient		0.91

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Date Printed	23/01/2025

UKAS TESTING
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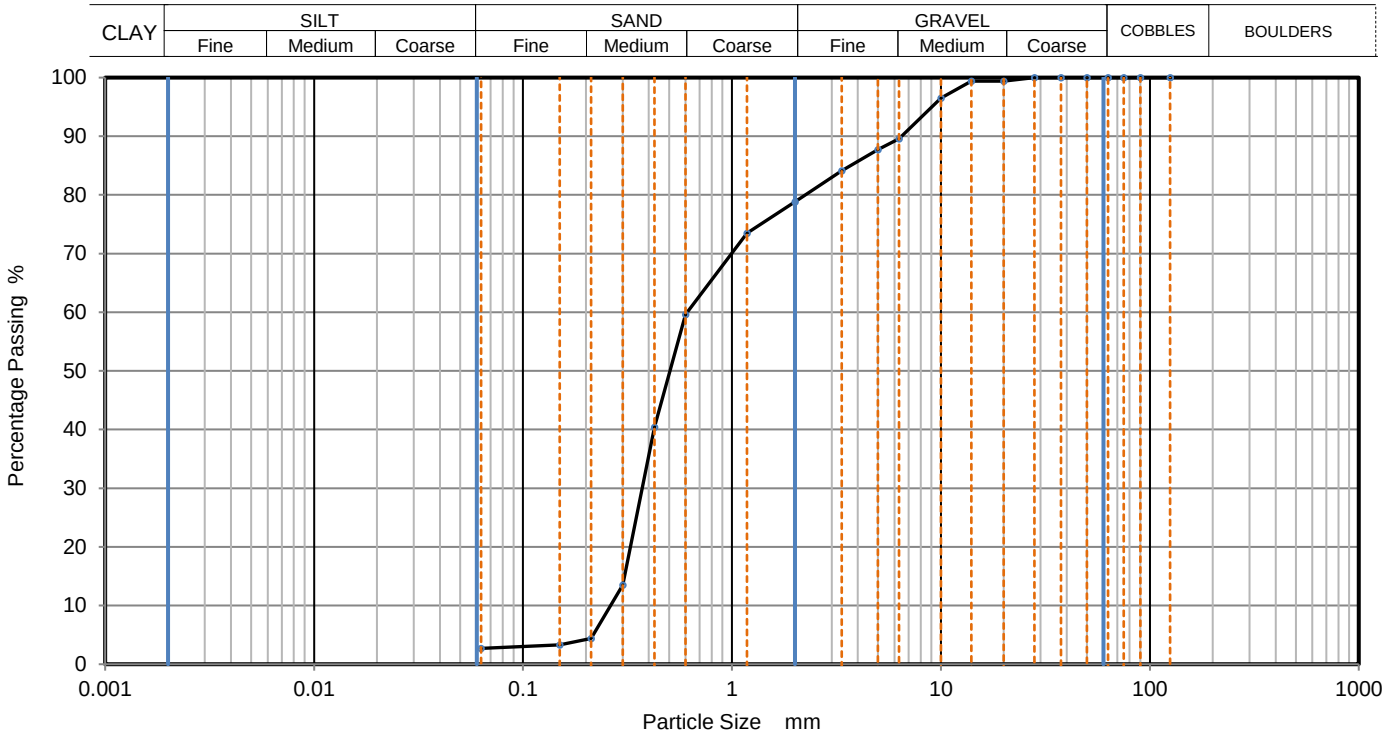
PSD

GQF-008-55 Issue 01 - Oct 22	**PARTICLE SIZE DISTRIBUTION**			Job Ref	J297664
				Borehole/Pit No.	WS109
Project Name	Ty Hapus			Sample No.	
Soil Description	Brown gravelly SAND			Depth, m	3.00
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	TTLP2025011618



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	99		
14	99		
10	97		
6.3	90		
5	88		
3.35	84		
2	79		
1.18	74		
0.6	60		
0.425	40		
0.3	14		
0.212	4		
0.15	3		
0.063	3		

Dry Mass of sample, g	3032

Sample Proportions	% dry mass
Very coarse	0
Gravel	21
Sand	76
Fines <0.063mm	3

Grading Analysis		
D100	mm	
D60	mm	0.611
D30	mm	0.371
D10	mm	0.262
Uniformity Coefficient		2.3
Curvature Coefficient		0.86

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Date Printed	23/01/2025

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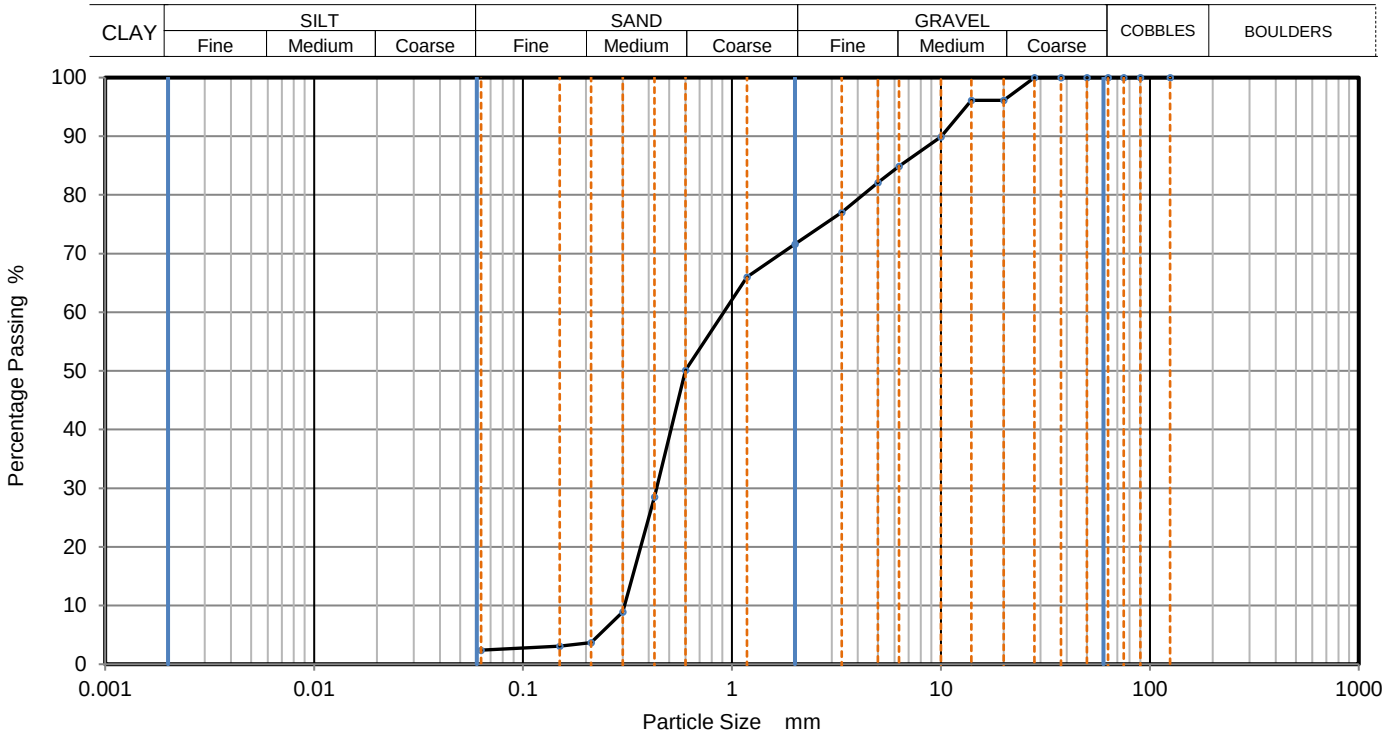
GQF-008-55 Issue 01 - Oct 22	**PARTICLE SIZE DISTRIBUTION**			Job Ref	J297664
				Borehole/Pit No.	WS110
Project Name	Ty Hapus			Sample No.	
Soil Description	Brown very gravelly SAND			Depth, m	2.50
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	TTLP2025011621



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	96		
14	96		
10	90		
6.3	85		
5	82		
3.35	77		
2	72		
1.18	66		
0.6	50		
0.425	29		
0.3	9		
0.212	4		
0.15	3		
0.063	2		

Dry Mass of sample, g	4250

Sample Proportions	% dry mass
Very coarse	0
Gravel	28
Sand	69
Fines <0.063mm	2

Grading Analysis		
D100	mm	
D60	mm	0.914
D30	mm	0.435
D10	mm	0.306
Uniformity Coefficient		3
Curvature Coefficient		0.68

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Date Printed	23/01/2025

UKAS TESTING
7758

PSD

GQF-008-58
Issue 01 - Oct 22

Unconsolidated Undrained Triaxial Compression tests without measurement of pore pressure Summary of Results

Project No.
J297664

Project Name
Ty Hapus

Hole No.	Sample				Soil Description	Test Type	Density bulk Mg/m³	Density dry Mg/m³	w %	Length mm	Diameter mm	σ_3 kPa	At failure				Remarks
	Ref	Top	Base	Type									Axial strain %	$\sigma_1 - \sigma_3$ kPa	c_u kPa	Mode	
WS104	Natural	0.50		B	Light brown slightly sandy CLAY	UUMR	2.00	1.57	26.9	196.5	102.0	25 50 100	2.5 4.1 18.8	44 60 132	22 30 66	P	Combination of TP101 B2, WS107 B 0.5 and WS104 B 0.5
WS104	1.25%	0.50		B		UUMR	1.90	1.51	25.6	198.7	102.9	25 50 100	2.5 4.5 17.6	232 284 384	116 142 192	C	Combination of TP101 B2, WS107 B 0.5 and WS104 B 0.5
WS104	2.50%	0.50		B		UUMR	1.86	1.49	25.0	205.4	103.1	25 50 100	2.9 4.4 12.2	260 312 419	130 156 210	C	Combination of TP101 B2, WS107 B 0.5 and WS104 B 0.5
WS104	5%	0.50		B		UUMR	1.78	1.45	22.6	195.7	102.3	25 50 100	3.1 4.6 11.2	253 321 450	126 161 225	B	Combination of TP101 B2, WS107 B 0.5 and WS104 B 0.5

Legend UU - single stage test (single and multiple specimens)
UUM - Multistage test on a single specimen suffix R - remoulded or recompacted

σ_3 σ_1 - Cell pressure
σ_3 Maximum corrected deviator stress
c_u Undrained shear strength, ½ (σ_1 - σ_3)

Mode of failure ; B - Brittle P - Plastic C - Compound

Notes
Tests carried out in accordance with BS1377:Part 7 : 1990 clause 8 or 9 as appropriate to test type.
Tests performed at a nominal rate of strain of 2%/min unless annotated otherwise. See individual test reports for further details.

Date Printed 22/01/2025

UKAS TESTING 7758

TTL

UU SUM

APPENDIX G – SUMMARY OF CHEMICAL TESTING

Job No: 3222
Site Location: Ty Hapus, Llandudno
Residential with gardens (2.5% SOM)

GroundSolve Ltd

	TP103	TP103	WS101	WS101	WS103	WS105	WS105	WS107	WS108	WS108	WS108	WS110							
Metals & Non-Metals	0.3	1.0	0.2	1.0	0.75	0.5	1.0	0.2	0.2	0.5	1.0	0.5	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Arsenic	-	-	2.4	9.1	-	-	9.6	-	4.7	-	7.5	-	2.4	9.6	5.55	5	37	C4SL	0
Cadmium	-	-	< 1.6	< 1.6	-	-	< 1.6	-	< 1.6	-	< 1.6	-	< 1.6	< 1.6	< 1.6	5	22	C4SL	0
Chromium	-	-	12.4	34.9	-	-	39.3	-	25.3	-	42.2	-	12.4	42.2	25.68	5	910	S4UL	0
Copper	-	-	9.5	10.7	-	-	7.9	-	20	-	13.7	-	7.9	20	10.3	5	2400	S4UL	0
Lead	-	-	19.3	15.6	-	-	16.6	-	99	-	16.5	-	15.6	99	27.83	5	200	C4SL	0
Mercury	-	-	0.9	< 0.7	-	-	< 0.7	-	< 0.7	-	< 0.7	-	0.9	0.9	0.62	5	1.2	S4UL	0
Nickel	-	-	5.2	21.9	-	-	27.5	-	12.1	-	23.7	-	5.2	27.5	15.07	5	130	S4UL	0
Total Monohydric Phenols	-	-	< 0.50	< 0.50	-	-	< 0.50	-	< 0.50	-	< 0.50	-	< 0.50	< 0.50	< 0.50	5	200	S4UL	0
Selenium	-	-	< 3.0	< 3.0	-	-	< 3.0	-	< 3.0	-	< 3.0	-	< 3.0	< 3.0	< 3.0	5	250	S4UL	0
Zinc	-	-	44.5	56.3	-	-	65.5	-	104	-	69.6	-	44.5	104	56.65	5	3700	S4UL	0

	TP103	TP103	WS101	WS101	WS103	WS105	WS105	WS107	WS108	WS108	WS108	WS110							
Petroleum Hydrocarbons	0.3	1.0	0.2	1.0	0.75	0.5	1.0	0.2	0.2	0.5	1.0	0.5	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Benzene	-	-	< 0.0005	< 0.0005	-	-	< 0.0005	-	< 0.0005	-	< 0.0005	-	< 0.0005	< 0.0005	< 0.0005	5	0.87	C4SL	0
Toluene	-	-	< 0.001	< 0.001	-	-	< 0.001	-	< 0.001	-	< 0.001	-	< 0.001	< 0.001	< 0.001	5	290	S4UL	0
Ethylbenzene	-	-	< 0.001	< 0.001	-	-	< 0.001	-	< 0.001	-	< 0.001	-	< 0.001	< 0.001	< 0.001	5	110	S4UL	0
xylenes	-	-	< 0.002	< 0.002	-	-	< 0.002	-	< 0.002	-	< 0.002	-	< 0.002	< 0.002	< 0.002	5	17000	S4UL	0
Diesel Range Organics (>C10-C25)	-	-	1020	< 12	-	-	< 12	-	29	-	< 12	-	29	1020	180.83	5			
>C10-C40 Soil	-	-	6680	19.3	-	-	23.2	-	118	-	24.7	-	19.3	6680	1144.2	5			
Mineral Oil (>C10-C40 Total)	-	-	6330	< 19	-	-	< 19	-	72	-	< 19	-	72	6330	1076.5	5			

	TP103	TP103	WS101	WS101	WS103	WS105	WS105	WS107	WS108	WS108	WS108	WS110							
Polyaromatic Hydrocarbons (PAH)	0.3	1.0	0.2	1.0	0.75	0.5	1.0	0.2	0.2	0.5	1.0	0.5	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Acenaphthene	-	-	< 0.013	< 0.013	-	-	< 0.013	-	< 0.013	-	0.023	-	0.023	0.023	0.01	5	510	S4UL	0
Acenaphthylene	-	-	< 0.015	< 0.015	-	-	< 0.015	-	< 0.015	-	0.019	-	0.019	0.019	0.01	5	420	S4UL	0
Anthracene	-	-	< 0.017	< 0.017	-	-	< 0.017	-	0.032	-	0.022	-	0.022	0.032	0.02	5	5400	S4UL	0
Benzo(a)anthracene	-	-	< 0.012	< 0.012	-	-	< 0.012	-	0.187	-	0.036	-	0.036	0.187	0.04	5	11	S4UL	0
Benzo(a)pyrene	-	-	< 0.019	< 0.019	-	-	< 0.019	-	0.246	-	0.025	-	0.025	0.246	0.05	5	5	C4SL	0
Benzo(b)fluoranthene	-	-	0.082	< 0.020	-	-	< 0.020	-	0.273	-	0.027	-	0.027	0.273	0.07	5	3.3	S4UL	0
Benzo[g,h,i]perylene	-	-	0.071	< 0.019	-	-	< 0.019	-	0.191	-	0.025	-	0.025	0.191	0.05	5	340	S4UL	0
Benzo(k)fluoranthene	-	-	< 0.025	< 0.025	-	-	< 0.025	-	0.103	-	< 0.025	-	0.103	0.103	0.03	5	93	S4UL	0
Chrysene	-	-	< 0.028	< 0.028	-	-	< 0.028	-	0.207	-	0.029	-	0.029	0.207	0.05	5	22	S4UL	0
Dibenzo(a,h)anthracene	-	-	< 0.017	< 0.017	-	-	< 0.017	-	0.046	-	0.022	-	0.022	0.046	0.02	5	0.28	S4UL	0
Fluoranthene	-	-	0.028	< 0.017	-	-	< 0.017	-	0.332	-	0.031	-	0.028	0.332	0.07	5	560	S4UL	0
Fluorene	-	-	< 0.013	< 0.013	-	-	< 0.013	-	< 0.013	-	0.021	-	0.021	0.021	0.01	5	400	S4UL	0
Indeno(1,2,3-cd)pyrene	-	-	< 0.019	< 0.019	-	-	< 0.019	-	0.212	-	0.026	-	0.026	0.212	0.05	5	36	S4UL	0
Naphthalene	-	-	< 0.016	< 0.016	-	-	< 0.016	-	< 0.016	-	0.022	-	0.022	0.022	0.01	5	5.6	S4UL	0
Phenanthrene	-	-	< 0.014	< 0.014	-	-	< 0.014	-	0.106	-	0.029	-	0.029	0.106	0.03	5	220	S4UL	0
Pyrene	-	-	0.104	< 0.016	-	-	< 0.016	-	0.294	-	0.03	-	0.03	0.294	0.08	5	1200	S4UL	0

	TP103	TP103	WS101	WS101	WS103	WS105	WS105	WS107	WS108	WS108	WS108	WS110							
Other Contaminants / Testing	0.3	1.0	0.2	1.0	0.75	0.5	1.0	0.2	0.2	0.5	1.0	0.5	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Soil Organic Matter	-	-	2.79	0.88	-	-	0.79	-	1.43	-	1.34	-	0.79	2.79	1.21	5	-	-	-
pH	6.8	6.9	8.2	7.7	7	7.9	7.7	7.7	7.9	7.8	7.8	7.7	6.8	8.2	7.01	12	-	-	-
Total Cyanide	-	-	< 1.0	< 1.0	-	-	< 1.0	-	< 1.0	-	< 1.0	-	< 1.0	< 1.0	0.83	5	-	-	-
Water Soluble Sulphate	-	-	0.022	< 0.010	-	-	< 0.010	-	0.028	-	0.019	-	< 0.010	0.028	0.01	5	-	-	-
Asbestos Identification			No Asbestos Detected	No Asbestos Detected			No Asbestos Detected		No Asbestos Detected		No Asbestos Detected					5			

ANALYTICAL TEST REPORT

Report Number	25-00102, issue number 1
Contract name:	Ty Hapus
Client reference:	3222
Clients name:	GroundSolve Ltd
Clients address:	GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton Flintshire CH4 0DH
Samples received:	08/01/2025
Analysis started:	08/01/2025
Analysis completed:	14/01/2025
Report issued:	14/01/2025

Key	U UKAS accredited test M MCERTS & UKAS accredited test $ Test carried out by an approved subcontractor I/S Insufficient sample to carry out test U/S Sample not suitable for testing NAD No Asbestos Detected
Approved by:	Abbie Neasham-Bourn Senior Reporting Administrator

SAMPLE INFORMATION

MCERTS (Soils):

Soil descriptions are only intended to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions. MCERTS accreditation applies for sand, clay and loam/topsoil, or combinations of these whether these are derived from naturally occurring soils or from made ground, as long as these materials constitute the major part of the sample. Other materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

Lab ref	Sample ID	Depth (m)	Sample description	Material removed	% Removed	% Moisture
29036	TP103	0.3	Brown Sandy Loamy Clay with Gravel.	-	-	19.2
29037	TP103	1.0	Brown Loamy Clay with Gravel.	-	-	16.5
29038	WS101	0.2	Brown Sandy Clay with Gravel.	-	-	8.0
29039	WS101	1.0	Brown Loamy Clay with Gravel.	-	-	15.9
29040	WS103	0.75	Brown Loamy Clay with Gravel.	-	-	20.0
29041	WS105	0.5	Brown Loamy Clay with Gravel.	-	-	17.7
29042	WS105	1.0	Brown Loamy Clay with Gravel.	-	-	17.9
29043	WS107	0.2	Brown Sandy Loamy Clay with Gravel.	-	-	17.9
29044	WS108	0.2	Brown Loamy Clay with Gravel.	-	-	11.2
29045	WS108	0.5	Brown Loamy Clay with Gravel.	-	-	17.8
29046	WS108	1.0	Brown Loamy Clay with Gravel.	-	-	16.2
29047	WS110	0.5	Brown Loamy Clay with Gravel.	-	-	17.8
29048	*SA101	0.3	-	-	-	-
29049	TP101	0.4	-	-	-	-
29050	TP101	1.2	-	-	-	-
29051	TP102	0.8	-	-	-	-
29052	TP102	1.0	-	-	-	-
29053	TP103	0.5	-	-	-	-
29054	WS101	0.5	-	-	-	-
29055	WS102	0.4	-	-	-	-
29056	WS102	1.0	-	-	-	-
29057	WS103	1.0	-	-	-	-
29058	WS104	1.0	-	-	-	-
29059	WS106	0.5	-	-	-	-
29060	WS106	1.0	-	-	-	-
29061	WS107	0.8	-	-	-	-
29062	WS109	0.5	-	-	-	-
29063	WS110	1.0	-	-	-	-

DEVIATING SAMPLE INFORMATION

Comments
Sample deviation is determined in accordance with the UKAS note "Guidance on Deviating Samples" and based on reference standards and laboratory trials.
For samples identified as deviating, test result(s) may be compromised and may not be representative of the sample at the time of sampling.
Chemtech Environmental Ltd cannot be held responsible for the integrity of sample(s) received if Chemtech Environmental Ltd did not undertake the sampling. Such samples may be deviating.

Key

a	Sampling date not provided
b	Sampling time not provided (waters only)
c	Sample not received in appropriate containers
d	Storage Temperature
e	Headspace present in sample container
f	Sample exceeded sampling to reciept
g	Sample exceeded holding time(s)

Lab ref	Sample ID	Depth (m)	Deviating	Tests (Reason for deviation)
29036	TP103	0.3	Y	pH of Solids (f,g)
29037	TP103	1.0	Y	pH of Solids (f,g)
29038	WS101	0.2	Y	BTEX in solids (f,g), pH of Solids(g), Cyanides in Solids (f), PAH in Soil(g), EPH in Solids(g)
29039	WS101	1.0	Y	BTEX in solids (f,g), pH of Solids(g), Cyanides in Solids (f), PAH in Soil(g), EPH in Solids(g)
29040	WS103	0.75	Y	pH of Solids(g)
29041	WS105	0.5	Y	pH of Solids(g)
29042	WS105	1.0	Y	BTEX in solids (f,g), pH of Solids(g), Cyanides in Solids (f), PAH in Soil(g), EPH in Solids(g)
29043	WS107	0.2	Y	pH of Solids(g)
29044	WS108	0.2	Y	BTEX in solids (f,g), pH of Solids(g), Cyanides in Solids (f), EPH in Solids(g)
29045	WS108	0.5	Y	pH of Solids(g)
29046	WS108	1.0	Y	BTEX in solids (f,g), pH of Solids(g), Cyanides in Solids (f), EPH in Solids(g)
29047	WS110	0.5	Y	pH of Solids(g)

SOILS

Lab Number					29036	29037	29038	29039	29040
Sample ID					TP103	TP103	WS101	WS101	WS103
Depth (m)					0.3	1.0	0.2	1.0	0.75
Sampling Date					17/12/2024	17/12/2024	18/12/2024	18/12/2024	18/12/2024
Test	**Method**	**Accred**	**LoD**	**Units**					
Asbestos									
Asbestos Identification	SUBCON	SU	0	-	n/t	n/t	NAD	NAD	n/t
Soil sample preparation parameters									
Stones Content	CE001	N	0.1	%	n/t	n/t	< 0.1	< 0.1	n/t
Metals									
Water Soluble Magnesium	CE061	N	1	mg/l	4.27	1.33	2.23	n/t	3.52
Water Soluble Sulphate	CE061	M	10	mg/l	33.5	< 10.0	22.1	n/t	55.8
Water Soluble Sulphate	CE061	M	0.01	g/l	n/t	n/t	0.022	< 0.010	n/t
Acid Soluble Sulphate (SO4)	CE062	M	0.01	%	0.07	0.02	0.03	n/t	0.07
Arsenic	CE264	U	1.8	mg/kg	n/t	n/t	2.4	9.1	n/t
Cadmium	CE264	M	1.6	mg/kg	n/t	n/t	< 1.6	< 1.6	n/t
Chromium	CE264	U	2	mg/kg	n/t	n/t	12.4	34.9	n/t
Copper	CE264	M	1.6	mg/kg	n/t	n/t	9.5	10.7	n/t
Lead	CE264	U	2.3	mg/kg	n/t	n/t	19.3	15.6	n/t
Mercury	CE264	U	0.7	mg/kg	n/t	n/t	0.9	< 0.7	n/t
Nickel	CE264	M	2.1	mg/kg	n/t	n/t	5.2	21.9	n/t
Selenium	CE264	U	3	mg/kg	n/t	n/t	< 3.0	< 3.0	n/t
Sulphur %	CE264	N	0.0032	%	0.0222	< 0.0032	0.0153	n/t	0.0405
Zinc	CE264	M	4	mg/kg	n/t	n/t	44.5	56.3	n/t
Colourimetric									
Nitrate as N	CE261	U	1	mg/l	3.88	1.19	4.10	n/t	5.59
Ammoniacal Nitrogen as NH4	CE262	N	0.14	mg/kg	10.1	10.7	8.66	n/t	32.7
Total Monohydric Phenols	CE078	N	0.5	mg/kg	n/t	n/t	< 0.50	< 0.50	n/t
Total Cyanide	CE077	N	1	mg/kg	n/t	n/t	f < 1.0	f < 1.0	n/t
Combustion									
Moisture Content	CE001	N	0.1	%	19.2	16.5	8.0	15.9	20.0
Total Organic Carbon	CE197	N	0.1	%	n/t	n/t	1.62	0.51	n/t
Soil Organic Matter	CE072	N	0.1	%	n/t	n/t	2.79	0.88	n/t
Polyaromatic hydrocarbons									
Naphthalene	CE087	M	0.016	mg/kg	n/t	n/t	g < 0.016	g < 0.016	n/t
Acenaphthylene	CE087	M	0.015	mg/kg	n/t	n/t	g < 0.015	g < 0.015	n/t

SOILS

Lab Number					29036	29037	29038	29039	29040
Sample ID					TP103	TP103	WS101	WS101	WS103
Depth (m)					0.3	1.0	0.2	1.0	0.75
Sampling Date					17/12/2024	17/12/2024	18/12/2024	18/12/2024	18/12/2024
Acenaphthene	CE087	M	0.013	mg/kg	n/t	n/t	g < 0.013	g < 0.013	n/t
Fluorene	CE087	U	0.013	mg/kg	n/t	n/t	g < 0.013	g < 0.013	n/t
Phenanthrene	CE087	M	0.014	mg/kg	n/t	n/t	g < 0.014	g < 0.014	n/t
Anthracene	CE087	U	0.017	mg/kg	n/t	n/t	g < 0.017	g < 0.017	n/t
Fluoranthene	CE087	M	0.017	mg/kg	n/t	n/t	g 0.028	g < 0.017	n/t
Pyrene	CE087	M	0.016	mg/kg	n/t	n/t	g 0.104	g < 0.016	n/t
Benzo(a)anthracene	CE087	U	0.012	mg/kg	n/t	n/t	g < 0.012	g < 0.012	n/t
Chrysene	CE087	M	0.028	mg/kg	n/t	n/t	g < 0.028	g < 0.028	n/t
Benzo(b)fluoranthene	CE087	M	0.02	mg/kg	n/t	n/t	g 0.082	g < 0.020	n/t
Benzo(k)fluoranthene	CE087	M	0.025	mg/kg	n/t	n/t	g < 0.025	g < 0.025	n/t
Benzo(a)pyrene	CE087	U	0.019	mg/kg	n/t	n/t	g < 0.019	g < 0.019	n/t
Indeno(1,2,3-cd)pyrene	CE087	M	0.019	mg/kg	n/t	n/t	g < 0.019	g < 0.019	n/t
Dibenzo(a,h)anthracene	CE087	M	0.017	mg/kg	n/t	n/t	g < 0.017	g < 0.017	n/t
Benzo(g,h,i)perylene	CE087	M	0.019	mg/kg	n/t	n/t	g 0.071	g < 0.019	n/t
Coronene	CE087	N	0.02	mg/kg	n/t	n/t	g < 0.020	g < 0.020	n/t
Total PAH(17)	CE087	N	0.3	mg/kg	n/t	n/t	g < 0.300	g < 0.300	n/t
BTEX									
Benzene	CE267	U	0.0005	mg/kg	n/t	n/t	fg < 0.0005	fg < 0.0005	n/t
Toluene	CE267	U	0.001	mg/kg	n/t	n/t	fg < 0.001	fg < 0.001	n/t
Ethylbenzene	CE267	U	0.001	mg/kg	n/t	n/t	fg < 0.001	fg < 0.001	n/t
MTBE	CE267	N	0.002	mg/kg	n/t	n/t	fg < 0.002	fg < 0.002	n/t
Total BTEX	CE267	N	0.006	mg/kg	n/t	n/t	fg < 0.006	fg < 0.006	n/t
m,p-Xylene	CE267	U	0.002	mg/kg	n/t	n/t	fg < 0.002	fg < 0.002	n/t
oXylenes	CE267	U	0.002	mg/kg	n/t	n/t	fg < 0.002	fg < 0.002	n/t
Wet Chem									
pH	CE004	M	0.1	pH units	fg 6.8	fg 6.9	g 8.2	g 7.7	g 7.0
EPH									
>C10-C40 Soil (EH_1D_Total)	CE033	M	19	mg/kg	n/t	n/t	g 6680	g 19.3	n/t
Diesel Range Organics (>C10-C25) (EH_1D_	CE033	M	12	mg/kg	n/t	n/t	g 1020	g < 12	n/t
Mineral Oil (>C10-C40 Total) (EH_CU_1D_T	CE162	N	19	mg/kg	n/t	n/t	6330	< 19	n/t

SOILS

Lab Number					29041	29042	29043	29044	29045
Sample ID					WS105	WS105	WS107	WS108	WS108
Depth (m)					0.5	1.0	0.2	0.2	0.5
Sampling Date					18/12/2024	18/12/2024	19/12/2024	19/12/2024	19/12/2024
Test	**Method**	**Accred**	**LoD**	**Units**					
Asbestos									
Asbestos Identification	SUBCON	SU	0	-	n/t	NAD	n/t	NAD	n/t
Soil sample preparation parameters									
Stones Content	CE001	N	0.1	%	n/t	< 0.1	n/t	< 0.1	n/t
Metals									
Water Soluble Magnesium	CE061	N	1	mg/l	2.20	n/t	2.73	n/t	5.72
Water Soluble Sulphate	CE061	M	10	mg/l	18.3	n/t	15.6	n/t	80.3
Water Soluble Sulphate	CE061	M	0.01	g/l	n/t	< 0.010	n/t	0.028	n/t
Acid Soluble Sulphate (SO4)	CE062	M	0.01	%	0.03	n/t	0.04	n/t	0.05
Arsenic	CE264	U	1.8	mg/kg	n/t	9.6	n/t	4.7	n/t
Cadmium	CE264	M	1.6	mg/kg	n/t	< 1.6	n/t	< 1.6	n/t
Chromium	CE264	U	2	mg/kg	n/t	39.3	n/t	25.3	n/t
Copper	CE264	M	1.6	mg/kg	n/t	7.9	n/t	20.0	n/t
Lead	CE264	U	2.3	mg/kg	n/t	16.6	n/t	99.0	n/t
Mercury	CE264	U	0.7	mg/kg	n/t	< 0.7	n/t	< 0.7	n/t
Nickel	CE264	M	2.1	mg/kg	n/t	27.5	n/t	12.1	n/t
Selenium	CE264	U	3	mg/kg	n/t	< 3.0	n/t	< 3.0	n/t
Sulphur %	CE264	N	0.0032	%	0.0121	n/t	0.0159	n/t	0.0281
Zinc	CE264	M	4	mg/kg	n/t	65.5	n/t	104	n/t
Colourimetric									
Nitrate as N	CE261	U	1	mg/l	6.80	n/t	3.50	n/t	< 1.00
Ammoniacal Nitrogen as NH4	CE262	N	0.14	mg/kg	24.2	n/t	11.7	n/t	52.5
Total Monohydric Phenols	CE078	N	0.5	mg/kg	n/t	< 0.50	n/t	< 0.50	n/t
Total Cyanide	CE077	N	1	mg/kg	n/t	f < 1.0	n/t	f < 1.0	n/t
Combustion									
Moisture Content	CE001	N	0.1	%	17.7	17.9	17.9	11.2	17.8
Total Organic Carbon	CE197	N	0.1	%	n/t	0.46	n/t	0.83	n/t
Soil Organic Matter	CE072	N	0.1	%	n/t	0.79	n/t	1.43	n/t
Polyaromatic hydrocarbons									
Naphthalene	CE087	M	0.016	mg/kg	n/t	g < 0.016	n/t	< 0.016	n/t
Acenaphthylene	CE087	M	0.015	mg/kg	n/t	g < 0.015	n/t	< 0.015	n/t

SOILS

Lab Number					29041	29042	29043	29044	29045
Sample ID					WS105	WS105	WS107	WS108	WS108
Depth (m)					0.5	1.0	0.2	0.2	0.5
Sampling Date					18/12/2024	18/12/2024	19/12/2024	19/12/2024	19/12/2024
Acenaphthene	CE087	M	0.013	mg/kg	n/t	g < 0.013	n/t	< 0.013	n/t
Fluorene	CE087	U	0.013	mg/kg	n/t	g < 0.013	n/t	< 0.013	n/t
Phenanthrene	CE087	M	0.014	mg/kg	n/t	g < 0.014	n/t	0.106	n/t
Anthracene	CE087	U	0.017	mg/kg	n/t	g < 0.017	n/t	0.032	n/t
Fluoranthene	CE087	M	0.017	mg/kg	n/t	g < 0.017	n/t	0.332	n/t
Pyrene	CE087	M	0.016	mg/kg	n/t	g < 0.016	n/t	0.294	n/t
Benzo(a)anthracene	CE087	U	0.012	mg/kg	n/t	g < 0.012	n/t	0.187	n/t
Chrysene	CE087	M	0.028	mg/kg	n/t	g < 0.028	n/t	0.207	n/t
Benzo(b)fluoranthene	CE087	M	0.02	mg/kg	n/t	g < 0.020	n/t	0.273	n/t
Benzo(k)fluoranthene	CE087	M	0.025	mg/kg	n/t	g < 0.025	n/t	0.103	n/t
Benzo(a)pyrene	CE087	U	0.019	mg/kg	n/t	g < 0.019	n/t	0.246	n/t
Indeno(1,2,3-cd)pyrene	CE087	M	0.019	mg/kg	n/t	g < 0.019	n/t	0.212	n/t
Dibenzo(a,h)anthracene	CE087	M	0.017	mg/kg	n/t	g < 0.017	n/t	0.046	n/t
Benzo(g,h,i)perylene	CE087	M	0.019	mg/kg	n/t	g < 0.019	n/t	0.191	n/t
Coronene	CE087	N	0.02	mg/kg	n/t	g < 0.020	n/t	0.036	n/t
Total PAH(17)	CE087	N	0.3	mg/kg	n/t	g < 0.300	n/t	2.27	n/t
BTEX									
Benzene	CE267	U	0.0005	mg/kg	n/t	fg < 0.0005	n/t	fg < 0.0005	n/t
Toluene	CE267	U	0.001	mg/kg	n/t	fg < 0.001	n/t	fg < 0.001	n/t
Ethylbenzene	CE267	U	0.001	mg/kg	n/t	fg < 0.001	n/t	fg < 0.001	n/t
MTBE	CE267	N	0.002	mg/kg	n/t	fg < 0.002	n/t	fg < 0.002	n/t
Total BTEX	CE267	N	0.006	mg/kg	n/t	fg < 0.006	n/t	fg < 0.006	n/t
m,p-Xylene	CE267	U	0.002	mg/kg	n/t	fg < 0.002	n/t	fg < 0.002	n/t
oXylenes	CE267	U	0.002	mg/kg	n/t	fg < 0.002	n/t	fg < 0.002	n/t
Wet Chem									
pH	CE004	M	0.1	pH units	g 7.9	g 7.7	g 7.7	g 7.9	g 7.8
EPH									
>C10-C40 Soil (EH_1D_Total)	CE033	M	19	mg/kg	n/t	g 23.2	n/t	g 118	n/t
Diesel Range Organics (>C10-C25) (EH_1D_	CE033	M	12	mg/kg	n/t	g < 12	n/t	g 29	n/t
Mineral Oil (>C10-C40 Total) (EH_CU_1D_T	CE162	N	19	mg/kg	n/t	< 19	n/t	72	n/t

SOILS

Lab Number					29046	29047
Sample ID					WS108	WS110
Depth (m)					1.0	0.5
Sampling Date					19/12/2024	19/12/2024
Test	**Method**	**Accred**	**LoD**	**Units**		
Asbestos						
Asbestos Identification	SUBCON	SU	0	-	NAD	n/t
Soil sample preparation parameters						
Stones Content	CE001	N	0.1	%	< 0.1	n/t
Metals						
Water Soluble Magnesium	CE061	N	1	mg/l	n/t	2.53
Water Soluble Sulphate	CE061	M	10	mg/l	n/t	10.0
Water Soluble Sulphate	CE061	M	0.01	g/l	0.019	n/t
Acid Soluble Sulphate (SO4)	CE062	M	0.01	%	n/t	0.02
Arsenic	CE264	U	1.8	mg/kg	7.5	n/t
Cadmium	CE264	M	1.6	mg/kg	< 1.6	n/t
Chromium	CE264	U	2	mg/kg	42.2	n/t
Copper	CE264	M	1.6	mg/kg	13.7	n/t
Lead	CE264	U	2.3	mg/kg	16.5	n/t
Mercury	CE264	U	0.7	mg/kg	< 0.7	n/t
Nickel	CE264	M	2.1	mg/kg	23.7	n/t
Selenium	CE264	U	3	mg/kg	< 3.0	n/t
Sulphur %	CE264	N	0.0032	%	n/t	< 0.0032
Zinc	CE264	M	4	mg/kg	69.6	n/t
Colourimetric						
Nitrate as N	CE261	U	1	mg/l	n/t	2.74
Ammoniacal Nitrogen as NH4	CE262	N	0.14	mg/kg	n/t	24.5
Total Monohydric Phenols	CE078	N	0.5	mg/kg	< 0.50	n/t
Total Cyanide	CE077	N	1	mg/kg	f < 1.0	n/t
Combustion						
Moisture Content	CE001	N	0.1	%	16.2	17.8
Total Organic Carbon	CE197	N	0.1	%	0.78	n/t
Soil Organic Matter	CE072	N	0.1	%	1.34	n/t
Polyaromatic hydrocarbons						
Naphthalene	CE087	M	0.016	mg/kg	0.022	n/t
Acenaphthylene	CE087	M	0.015	mg/kg	0.019	n/t

SOILS

Lab Number					29046	29047
Sample ID					WS108	WS110
Depth (m)					1.0	0.5
Sampling Date					19/12/2024	19/12/2024
Acenaphthene	CE087	M	0.013	mg/kg	0.023	n/t
Fluorene	CE087	U	0.013	mg/kg	0.021	n/t
Phenanthrene	CE087	M	0.014	mg/kg	0.029	n/t
Anthracene	CE087	U	0.017	mg/kg	0.022	n/t
Fluoranthene	CE087	M	0.017	mg/kg	0.031	n/t
Pyrene	CE087	M	0.016	mg/kg	0.030	n/t
Benzo(a)anthracene	CE087	U	0.012	mg/kg	0.036	n/t
Chrysene	CE087	M	0.028	mg/kg	0.029	n/t
Benzo(b)fluoranthene	CE087	M	0.02	mg/kg	0.027	n/t
Benzo(k)fluoranthene	CE087	M	0.025	mg/kg	< 0.025	n/t
Benzo(a)pyrene	CE087	U	0.019	mg/kg	0.025	n/t
Indeno(1,2,3-cd)pyrene	CE087	M	0.019	mg/kg	0.026	n/t
Dibenzo(a,h)anthracene	CE087	M	0.017	mg/kg	0.022	n/t
Benzo(g,h,i)perylene	CE087	M	0.019	mg/kg	0.025	n/t
Coronene	CE087	N	0.02	mg/kg	< 0.020	n/t
Total PAH(17)	CE087	N	0.3	mg/kg	0.387	n/t
BTEX						
Benzene	CE267	U	0.0005	mg/kg	fg < 0.0005	n/t
Toluene	CE267	U	0.001	mg/kg	fg < 0.001	n/t
Ethylbenzene	CE267	U	0.001	mg/kg	fg < 0.001	n/t
MTBE	CE267	N	0.002	mg/kg	fg < 0.002	n/t
Total BTEX	CE267	N	0.006	mg/kg	fg < 0.006	n/t
m,p-Xylene	CE267	U	0.002	mg/kg	fg < 0.002	n/t
oXylenes	CE267	U	0.002	mg/kg	fg < 0.002	n/t
Wet Chem						
pH	CE004	M	0.1	pH units	g 7.8	g 7.7
EPH						
>C10-C40 Soil (EH_1D_Total)	CE033	M	19	mg/kg	g 24.7	n/t
Diesel Range Organics (>C10-C25) (EH_1D_	CE033	M	12	mg/kg	g < 12	n/t
Mineral Oil (>C10-C40 Total) (EH_CU_1D_T	CE162	N	19	mg/kg	< 19	n/t

LEACHATE

Lab Number					29036	29037	29038	29040	29041
Sample ID					TP103	TP103	WS101	WS103	WS105
Depth (m)					0.3	1.0	0.2	0.75	0.5
Sampling Date					17/12/2024	17/12/2024	18/12/2024	18/12/2024	18/12/2024
Test	**Method**	**Accred**	**LoD**	**Units**					
Colourimetric									
Chloride	CE257	U	0.4	mg/l	15.1	4.53	18.9	13.4	6.17

LEACHATE

Lab Number					29043	29045	29047
Sample ID					WS107	WS108	WS110
Depth (m)					0.2	0.5	0.5
Sampling Date					19/12/2024	19/12/2024	19/12/2024
Test	**Method**	**Accred**	**LoD**	**Units**			
Colourimetric							
Chloride	CE257	U	0.4	mg/l	15.6	19.0	11.2

METHOD DETAILS

METHOD	TESTNAME	METHOD SUMMARY	ANALYSIS BASIS
SUBCON	Asbestos Solid	HSG248	Air Dried Sample
CE061	W. Sol Metals	ICPOES	Air dried sample
CE033	EPH in Solids	Acetone:Hexane Extraction and GCFID	As submitted sample
CE062	Acid Soluble Sulphate in Solids	Primacs	Air dried sample
CE264	Metals by ICP in Soil	ICPOES	Air dried sample
CE267	BTEX in solids	Analysis by HSGCFID	As submitted sample
CE261	Anions by Discrete Analyser in Solids	Gallery	Air dried sample
CE257	Anions by Discrete Analyser in Leachate	Gallery	As submitted sample
CE087	PAH in Soil	DCM Extraction and GCMS	As submitted sample
CE078	Phenols in Solids	Continuous Flow Analyser	As submitted sample
CE077	Cyanides in Solids	Continuous Flow Analyser	As submitted sample
CE197	Primacs in Solids	Primacs	Air dried sample
CE162	Mineral Oil in Solids	Acetone:Hexane extract, Floriil clean up and GCFID	As submitted sample

REPORT INFORMATION

Report No.:25-00102, issue number 1

Key	
U	ISO17025 Accredited Result
M	ISO17025 and MCERTS Accredited Result
N	Do not currently hold accreditation
^	MCERTS accreditation not applicable for sample matrix
*	ISO17025 accreditation not applicable for sample matrix
S	Subcontracted
I/S	Insufficient Sample
U/S	Unsuitable sample
N/T	Not tested
<	Means "less than"
>	Means "greater than"

LOD refers to limit of detection, except in the case of pH soils and pH waters where it means limit of discrimination.

Opinions and interpretations expressed herein are outside the UKAS accreditation scope.

All testing carried out at Unit 6 Parkhead, Stanley, DH9 7YB, except for subcontracted testing.

The results relate only to the sample received.

Unless otherwise stated, sample information has been provided by the client. This may affect the validity of the results.

Moisture Content Calculated on a Wet Weight basis

Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling.

Sampling was undertaken by Chemtech Environmental Limited and is outside the UKAS accreditation scope.

Methods, procedures and performance data are available on request.

Results reported herein relate only to the material supplied to the laboratory.

BTEX compounds are identified by retention time only and may include interference from co-eluting compounds.

For soils and solids, all results are reported on a dry basis. Samples dried at no more than 30°C in a drying

For soils and solids, analytical results are inclusive of stones, where applicable.

Sample Retention and Disposal

All soil samples will be retained for a period of 4 weeks from the point of receipt

All water samples will be retained for a period of 2 weeks from the point of Reporting

Charges may apply to extended sample storage

TPH Classification - HWOL Acronym System

HS	Headspace analysis
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent
CU	Clean-up - e.g. by florisil, silica gel
1D	GC - Single coil gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics only
AR	Aromatics only
2D	GC-GC - Double coil gas chromatography
#1	EH_Total but with humics mathematically subtracted
#2	EH_Total but with fatty acids mathematically subtracted
_	Operator - underscore to separate acronyms (exception for +)
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total
MS	Mass Spectrometry

APPENDIX H – CURRENT GUIDANCE FOR GROUND GAS RISK ASSESSMENT

Current Guidance for Ground Gas Risk Assessment

Origin of Ground and Landfill Gases

When carrying out a ground gas risk assessment for permanent ground gases (e.g., methane and carbon dioxide), the origin or source of the gases is important as potential risks will vary depending on the source. This Appendix relates to the risk of the two main ground gases of concern: methane and carbon dioxide and does not apply to other ground gases (e.g., radon or vapours from hydrocarbon spills). Methane and carbon dioxide are major constituents of landfill gas but can also occur from a variety of anthropogenic and natural sources, as summarised in Table G1 below:

Table G1. Potential Sources of Ground Gases

Gas	Source	Comments
Landfill Gas	Anaerobic decomposition of degradable waste within landfill sites. Typically, 60% methane and 40% carbon dioxide during methanogenic phase.	Composition varies over time, particularly in early stages. Contains a range of minor constituents (particularly carbon monoxide and hydrogen sulphide).
Landfill Associated Gases	- Anaerobic degradation of leachate external to the site; - Degassing of dissolved gases in groundwater; - Evolution of gases following interaction between leachate and groundwater	Can result in secondary (external) production of methane or carbon dioxide.
Made Ground	Anaerobic degradation of organic components	Very variable depending on source
Sewer Gas, Cess Pits	Anaerobic degradation of organic components of sewage producing methane and carbon dioxide.	Often characterised by hydrogen sulphide odour.
Mains Gas	Leakage from underground pipework or storage tanks. Mainly methane but often contains higher alkanes.	An odouriser is added to permit detection of leaks. Typically, 90% CH_4, but 1 to 27% C_2-C_4 alkanes, May also contain other trace gases e.g., CO, helium and CO_2 (from degradation of CH_4 in the ground).
Other Anthropogenic Sources	- Degradation of leaked or spilled hydrocarbons or other industrial chemicals; - Anaerobic degradation of organic contaminants in groundwaters (e.g., silage liquor); - Reactions between monitoring well construction components and environment; - Burial grounds/cemeteries.	Hydrocarbon spillages often have an 'oily' odour. Fuel spillages common – Petrol or Diesel and can contain a wide range of VOC's. Can degrade to produce methane / carbon dioxide.
Alluvium / Marsh / Peat Gas	Anaerobic microbial degradation of organic material (usually waterlogged vegetation / peat). Often associated with the presence of alluvial deposits or dredgings.	
Geogenic Gas	Natural seepages of carbon dioxide and hydrocarbon gases derived from geologic sources such as coal seams and deep oil / gas source formations. Can be present in solution in groundwaters.	Methane most common but can contain carbon dioxide and higher alkanes.
Mine Gases	Various types. Most common is "fire damp" with high methane, produced by the desorption of gas trapped in coal. "Black damp" (Stythe gas) with high carbon dioxide and denser than air. "White damp" is high in carbon monoxide.	Methane most common. Can contain higher alkanes, carbon dioxide and carbon monoxide. Often low in oxygen.
Natural Shallow Ground Gas	Various types - high carbon dioxide formed by subsurface aerobic activity leading to depleted oxygen and elevated carbon dioxide; - chemical degradation of rocks (e.g., carbonates) producing carbon dioxide; - carbon dioxide production in root zone of soils by plants.	Gases can be emitted from ground under falling barometric pressure conditions.

This Appendix concentrates on the assessment of risk from methane and carbon dioxide. This Appendix does not provide guidance for the assessment of risk when other gases are present due to 'Other Sources' from the above table (particularly organic compounds such as BTEX and VOC's or for the risk from radon or hydrogen sulphide).

To determine the origin of the gas a range of factors must be considered together, including;

1. Proximity of likely sources;
2. Ground conditions (geology, hydrogeology, anthropogenic pathways etc);
3. Properties of gases present including:
    a. Chemical composition;
    b. Physical properties;
    c. Ratios of components e.g., methane : carbon dioxide.
4. Timeframe of activities such as infilling periods, capping works, installation of gas control systems etc.

Identification of the originating source may be problematic given that there may be more than one source present and trace gas analysis may be required. Identification of the sources of the gases encountered during monitoring is usually carried out through a process of eliminating the most unlikely potential sources (given the site setting) and selecting those which are the more likely candidates.

Hazards Associated with Presence of Ground Gases

Methane gas is combustible and potentially explosive. When the concentration of methane in air is between the limits of 5.0%v/v and 15.0%v/v an explosive mixture is formed. The Lower Explosive Limit (LEL) of methane is 5.0%v/v, which is equivalent to 100% LEL. The 15.0%v/v limit is known as the Upper Explosive Limit (UEL), but concentrations above this level cannot be assumed to represent safe concentrations. Further, the LEL and UEL will vary (up and down) depending upon the proportion of other gases (including oxygen). However, the fact that methane is a colourless, odourless gas means that there is no simple indicator of the presence of the gas until such a time as explosive limits are reached, and an incident occurs. Methane is lighter than air and has a low toxicity. However, at high concentrations it can result in asphyxiation due to oxygen displacement.

Carbon dioxide is a colourless, odourless gas, which, although non-flammable, is both toxic and an asphyxiant. As carbon dioxide is denser than air, it will collect in low points and depressions. The UK Health & Safety Executive (HSE) has published information relating to concentrations of carbon dioxide that humans may be exposed to, which uses concentrations contained in the Control of Substances Hazardous to Health Regulations 2002 (as amended). These are the Long-Term Occupational Exposure Limit (LTOEL, 8-hour period) and the Short-Term Occupational Exposure Limit (STOEL, 15-minute period), which are 0.5% and 1.5% carbon dioxide, respectively.

Parameters Influencing the Rate of Ground Gas Production

Figure G2 is taken from EA guidance document LFTGN 03 illustrates typical ground gas generation curves from biodegradable materials:

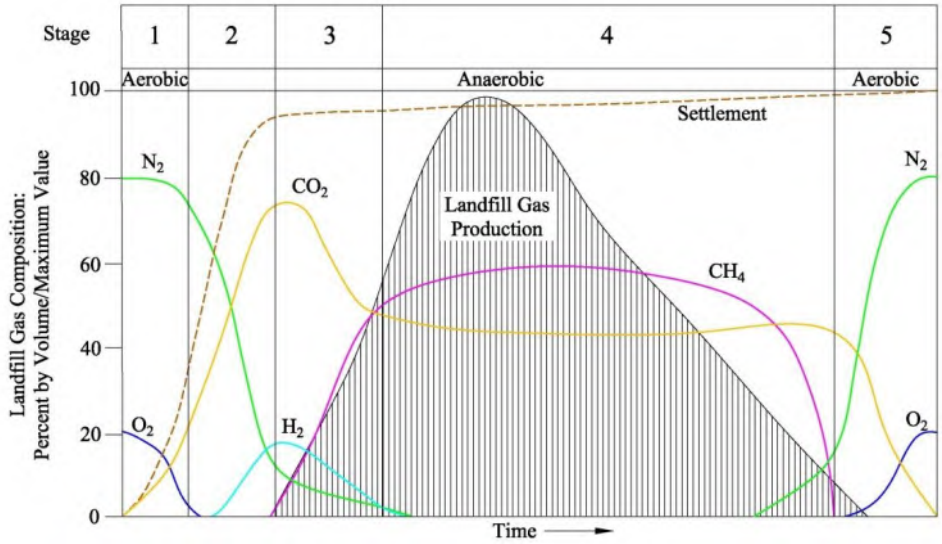


Figure G2. Idealised Representation of Landfill Gas Generation.

The production of methane and carbon dioxide at a landfill site may be expected to be considerable and ongoing. Concentrations of methane will eventually decrease, followed by concentrations of carbon dioxide, but the duration and rate of gas production can vary markedly between sites. Five distinct phases of gas production occur during the process which are, in order of event (as marked on Figure G2), as follows:

1. An aerobic phase involving oxygen depletion and temperature increase through aerobic respiration;
2. The establishment of anaerobic conditions and the evolution of carbon dioxide and hydrogen through acidogenic activity;
3. Commencement of methanogenic activity; the establishment of populations of methanogenic bacteria;
4. A phase of stable methanogenic activity, which may go on for many tens of years;
5. A phase of decreasing methanogenic activity, representing depletion of the organic material and a return to aerobic conditions.

The time scale for the return to the normal ground gas concentrations will be highly variable, depending upon the types and quantities of materials present. In addition, the optimum parameters influencing the rate of decomposition and ground gas production within the ground at a site are as follows:

- High water content with adequate rainfall and water infiltration to provide moisture content between approximately 20 to 26%;

- Conditions that either are or are very close to anaerobic;
- High proportion of biodegradable materials;
- A pH between 6.5 and 8.5, ideally verging slightly on the acidic between pH 6 to 7;
- Temperature between 25°C and 55°C;
- The ratio of the biochemical and chemical oxygen demands (BOD:COD);
- High permeability;
- Small particle size, as finer subsurface materials possess a greater surface area to provide a growing 'face' for the micro-organisms but high fines levels reduces permeability and reduces decomposition rate.

For this reason, it is vital that sources of methane and carbon dioxide are identified prior to the commencement of any work on a construction site, and that the ground gas regime is characterised at the worst temporal conditions a site may experience. From this, a risk assessment is carried out to identify the risk at the site from ground gases so that suitable protection measures can be designed and incorporated into a development to prevent a dangerous build-up of gas occurring.

Factors Influencing the Migration and Behaviour of Ground Gases

There are many factors that influence the migration of ground gases which can affect the risk from a gassing source:

- driving force – pressure differential along a pathway, diffusion and dissolved in solution;
- meteorological conditions – short term and seasonal conditions including atmospheric pressure changes (e.g., rapidly falling pressure causes gas to expand increasing emission rates), rainfall, frozen ground and thawing, temperature;
- geological and groundwater conditions – these can have the over-riding influence on the direction/pathways and quantity of migrating gas;
- anthropogenic influences – man-made pathways include mine shafts, service runs/drains, foundation piles, underground voids/pits/basements, foundation/building design/construction

Guidance Documents

Currently in the UK, there are no statutory threshold limits for hazardous gases in the ground as site specific variables mean that standard threshold values cannot be applied. The published guidance relating to development of sites where methane and carbon dioxide are present has been produced in response to building projects on or close to landfill sites, as both gases are principal constituents of landfill gas. Much of the historic guidance that has been produced on gas risk assessment focused on landfill sites and as a result there has previously been a lack of clarity when relating the process to gas conditions on non-landfill sites.

Statutory guidance regarding methane in the ground has previously taken a limiting concentration of 1.0 % by volume methane (equal to 20% of the lower explosive limit of methane in air) above which necessary actions will be appropriate. For carbon dioxide the limiting recommended trigger was 1.5 % by volume (the Long-Term Exposure Limit for carbon dioxide). Above these concentrations the Building Regulations Approved Document C (1992) stated that consideration should be given to whether actions may be appropriate, whilst more specific solutions would be likely to be necessary at concentrations greater than 5% by volume of carbon dioxide (Building Regulations Approved Document C, 1992). However, the latest fully revised version of Approved Document C (DoE, 2004) no longer endorses this approach and instead requires the use of a risk-based approach in interpreting the findings of a gas monitoring survey. Further, the latest EA documentation on landfill gas (LFTGN 03, 2004) continues to sanction the use of a risk-based approach through a structured approach to the assessment of ground gases and links with the risk assessment process outlined within CLR 11 for soil contaminants.

With the above in mind, recent guidance has been produced in 2006 and 2007 with the aim of providing up to date advice in relation to residential and commercial development. The guidance does not address issues associated with gas derived from landfills, for this refer to *"Guidance on the Management of Landfill Gas"* (Environment Agency 2004) for an overview.

Recent guidance relevant to gas assessments for residential and commercial development includes;

- **Wilson *et al.* (CIRIA C665, December 2007) *"Assessing Risks Posed by Hazardous Ground Gases for Buildings."***

  This document provides up to date advice on all aspects of ground gas risk assessment such as investigation, monitoring programmes, data collection and interpretation. The guidance presents separate methodologies for the characterisation of:

  - **All development types except low rise housing with gardens and for Low Rise Buildings without a 150mm void** (Situation A) (Table 8.5 CIRIA C665)

  and;

  - **Low rise housing with gardens with a 150mm ventilated sub-floor void** (Situation B) (Table 8.7 CIRIA C665)
    (See below for further explanation of the methods of characterisation)

- **Boyle and Witherington (NHBC / RSK Group, Report 10627-R01(04) January 2007) *"Guidance on the Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present."***

  This document presents the "Traffic Lights System" detailed below and is relevant only for low rise properties (e.g., bungalows and town houses) that have a ventilated sub-floor void (i.e., Situation B as described in CIRIA C665).

- **Wilson and Card (CIEH, expected 2011) *"Ground Gas Handbook for Designers and Regulators"***

  This document is expected to provide practical guidance on ground gas assessments and the design and evaluation of protection measures.

- **British Standard (BS 8485+A1, January 2019)** ***"Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings"***

  This document provides an overview of gas characterisation and assessment. The Standard is intended to be used by designers of gas protection measures and regulators involved in the assessment of design solutions. The Standard provides a framework in line with CLR11 allowing designers to judge the adequacy of ground gas and related site investigation data. The document provides an approach to determine appropriate ground gas parameters that can be used to identify a range of possible construction solutions mitigating against the presence of ground gas on a development site.

Each of these documents continues to highlight the importance of, and give further guidance towards, carrying out a tiered risk-based decision-making process in accord with government policy on dealing with contamination from historic or natural sources and highlight the importance of the Conceptual Model in site characterisation. These documents also stress the importance that the assessor should be confident that the ground gas monitoring results are representative of the likely worse case ground gas regime on a site and that the data collected from the site is sufficient. With this in mind, CIRIA C665 sets out ideal monitoring periods as below.

Idealised Frequency and Period of Monitoring (after Table 5.5a and 5.5b, CIRIA C665)

		Generation Potential of Source				
		Very Low	**Low**	**Moderate**	**High**	**Very High**
Sensitivity of Development	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with Gardens)	6/3	9/6	12/6	24/12	24/24

Notes

1. First number is the number of readings and the second is the minimum period in months (e.g., 6/2 – six sets of readings over two months).

2. At least two sets of readings must be at low (preferably under 1,000 mb) and falling pressure.

3. High sensitivity end use on high or very high hazard site will not normally be acceptable unless the source is treated to reduce gassing potential.

Before the latest guidance, good practice for site characterisation had been based upon the method proposed by Wilson and Card (1999). CIRIA C665 (2007) effectively supersedes Wilson and Card (1999) and includes a modified version of the Wilson and Card method (Tables 8.5, 8.6 and Box 8.1). Gas concentrations and flow rates for either methane and/or carbon dioxide measured at a site to 'Characteristic Situations.' Appropriate protection measures are selected from Table 8.6 (if using modified Wilson & Card method) and from Box 8.4 from CIRIA C665 (if using the NHBC traffic lights method). Throughout the risk assessment process, strong regard must be given to the nature of the gassing source, the flow rates and the estimated surface emissions. Note that certain protection measures are stated in CIRIA Report 149 that are now considered wholly inappropriate to certain developments and consequently should not be used without modification. Throughout the process, it is important to remember that these tables are not

intended to be used as a definitive design tool and have been prepared to show the typical scope of measures for gas control.

Both the NHBC (2007) and CIRIA (2007) guidance documents and BS 8485+A1 (2019) propose that both ground gas concentrations and flow rates are used to calculate the limiting gas well gas volume flow rates for methane and carbon dioxide, based on the ground gas conditions monitored for during the worse-case temporal conditions. This limiting gas well volume flow rate is termed the Gas Screening Value (GSV, note that this was termed borehole gas volume flow), and is calculated as follows:

$$\textbf{GSV}\ (\text{l/hr}) = \frac{[\text{gas well gas concentration (\%v/v)}] \times [\text{gas well flow rate (l/hr)}]}{100}$$

These GSVs are then compared to generic 'Traffic Lights' contained within the NHBC guidance, which present typical maximum gas concentrations and limiting GSV's, for 'Situation B Development' (Low rise housing with gardens).

Table 8.7 NHBC Traffic light system for 150 mm void

Traffic Light	Methane [1]		Carbon Dioxide [2]	
	Typical max concentration [3] (% by volume)	Gas Screening Value [2,4] (litres/hour)	Typical max concentration [3] (% by volume)	Gas Screening Value [2,4] (litres/hour)
Green	1	0.13	5	0.78
Amber 1	5	0.63	10	1.6
Amber 2	20	1.60	30	3.10
Red				

Notes:

1. The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter will be the decider as to what Traffic Light is allocated;
2. Borehole Gas Volume Flow Rate, in litres per hour as defined in Wilson and Card (1999), is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered;
3. The Typical Maximum Concentrations can be exceeded in certain circumstances should the Conceptual Site Model indicate it is safe to do so;
4. The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

Box 8.4 of CIRIA C665 Gas protection measures for low-rise housing development based upon allocated NHBC Traffic light (Boyle and Witherington, 2007)	
Traffic Light Classification	**Protection Measures Required**
Green	Negligible gas regime identified, and gas protection measures are not considered necessary.
Amber 1	Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.
Amber 2	Intermediate to high gas regime identified, which requires high-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Membranes should always be fitted by a specialist Contractor. As with Amber 1, ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.
Red	High gas regime identified. It is considered that standard residential housing would not normally be acceptable without a further Gas Risk Assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

For a 'Situation A Development' (All development except low rise housing with gardens), the GSV value is used to derive the appropriate Characteristic Situation from Table 8.5 of CIRIA C665 (below):

Table 8.5 from CIRIA C665 Modified Wilson and Card Classification					
Characteristic Situation (CIRIA R149)	**Comparable Partners in Technology gas Regime (see Box 8.2)**	**Risk Classification**	**Gas Screening Value (CH_4 or CO_2) (l/hr)[1]**	**Additional Factors**	**Typical Source of Generation**
1	A	Very low risk	<0.07	Typically, methane ≤ 1% and/or carbon dioxide ≤ 5%. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" made ground
2	B	Low risk	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to characteristic Situation 3	Natural soil, high peat/organic content. "Typical" made ground
3	C	Moderate risk	<3.5		Old landfill, inert waste, mine working flooded
4	D	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mine working susceptible to flooding, completed landfill (WMP 26B criteria)
5	E	High risk	<70		Mine working unflooded inactive with shallow workings near surface
6	F	Very high risk	>70		Recent landfill site

It was intended in CIRIA C665 that the characteristic situation allocated to the development from the table above would then be used in Table 8.6 of CIRIA C665 in order to determine the level of gas protection the development requires. However, BS8485:2015 superseded this document and a different set of mitigation standards were put forward.

The recommended minimum gas protection score (points) be selected based on the building type (Table 3 which defines four building types) and the ground gas Characteristic Situation as detailed in Table 4 of BS8485:2015+A1:2019 (see below).

The first step in the decision-making process is to obtain the level of gas protection necessary in the range 0 to 7.5 from Table 4. Then a combination of structural barriers (Table 5) ventilation protection measures (Table 6) and/or gas resistant membranes (Table 8)should be chosen to meet that requirement. The level of gas protection necessary should take into account the characteristic gas situation and a number of other factors. The whole decision-making process should be made transparent, where all parties can see the approach being taken, can understand the various steps and decisions made and be confident that a risk-assessed solution has been designed and installed commensurate with the construction and site constraints.

Where the gas Characteristic Situation is 4 or more (and for NHBC Red situations according to CIRIA C665), the site requires a comprehensive risk assessment to confirm the scope of protection measures. These are higher risk sites and reliance on Table 4 alone is not sufficient.

BS8485:2015+A1:2019 Table 3 Building Types				
	Type A	**Type B**	**Type C**	**Type D**
Ownership	Private	Private or commercial/ public, possible multiple	Commercial / public	Commercial / industrial
Control (change of use, structural alterations, ventilation	None	Some but not all	Full	Full
Room sizes	Small	Small / medium	Small to large	Large industrial / retail park style

BS8485:2015+A1:2019 Table 4 Gas Protection Score by CS and Type of Building				
CS	Required Gas Protection			
	High risk	Medium risk	Low risk	
	Type A	Type B	Type C	Type D
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6.5 (A)	5.5(A)	4.5	3.5
5	(B)	6A)	5.5	4.5
6	(B)	(B)	(B)	6
a) Residential building should not be built on CS4 or higher sites unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g., high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g., in institutional and/or fully serviced contractual situations.				
b) The gas hazard is too high for this empirical method to be used to define the gas protection measures				
NOTE 3 The NHBC has published guidance for use on residential developments, which utilise an alternative classification ("traffic light") system. This guidance typically applies to Type A buildings utilising beam and block floor constructions with clear void ventilation. The design choice variables are limited to decisions relating to the membrane specification and verification recommendations (see Table 7). Designers utilising this system would therefore need to refer to NHBC to assess compliance for specific recommendations [see 8485:2015 for further on this note]				
NOTE4 The method of selecting the combination of these types of protection is given in section 7.2 of BS8485:2015. Once type of measures has been decided, the detailed design and specification of the measures should be undertaken (section 7.3)				

Section 7.2 defines the order of selecting protective measures. The first choice is provided by structural barriers as defined in Table 5.

BS8485+A1:2019 Table 5 Gas protection scores for structural barriers		
PROTECTION ELEMENT/SYSTEM	SCORE	COMMENTS
Floor and substructure design		
Floor slabs Block and beam floor slab	0	*General – score conditional that breaches of slab are sealed*
Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)	0.5	
Cast in situ monolithic reinforced ground-bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations (with only nominal mesh reinforcement)	1 or 1.5	*To achieve 1.5, raft or suspended slab to be well reinforced to prevent cracking and minimal penetrations*
Basement floor and walls to BS 8102:2009, Grade 2 waterproofing – See notes in BS8485:2015+A1:2019	2	
Basement floor and walls to BS 8102:2009, Grade 3 waterproofing - See notes in BS8485:2015+A1:2019	2.5	*Conditional that waterproofing is not based on geosynthetic clay liner*

Ventilation methods are detailed in Table 6, and points can only be gained from using one of the five types:

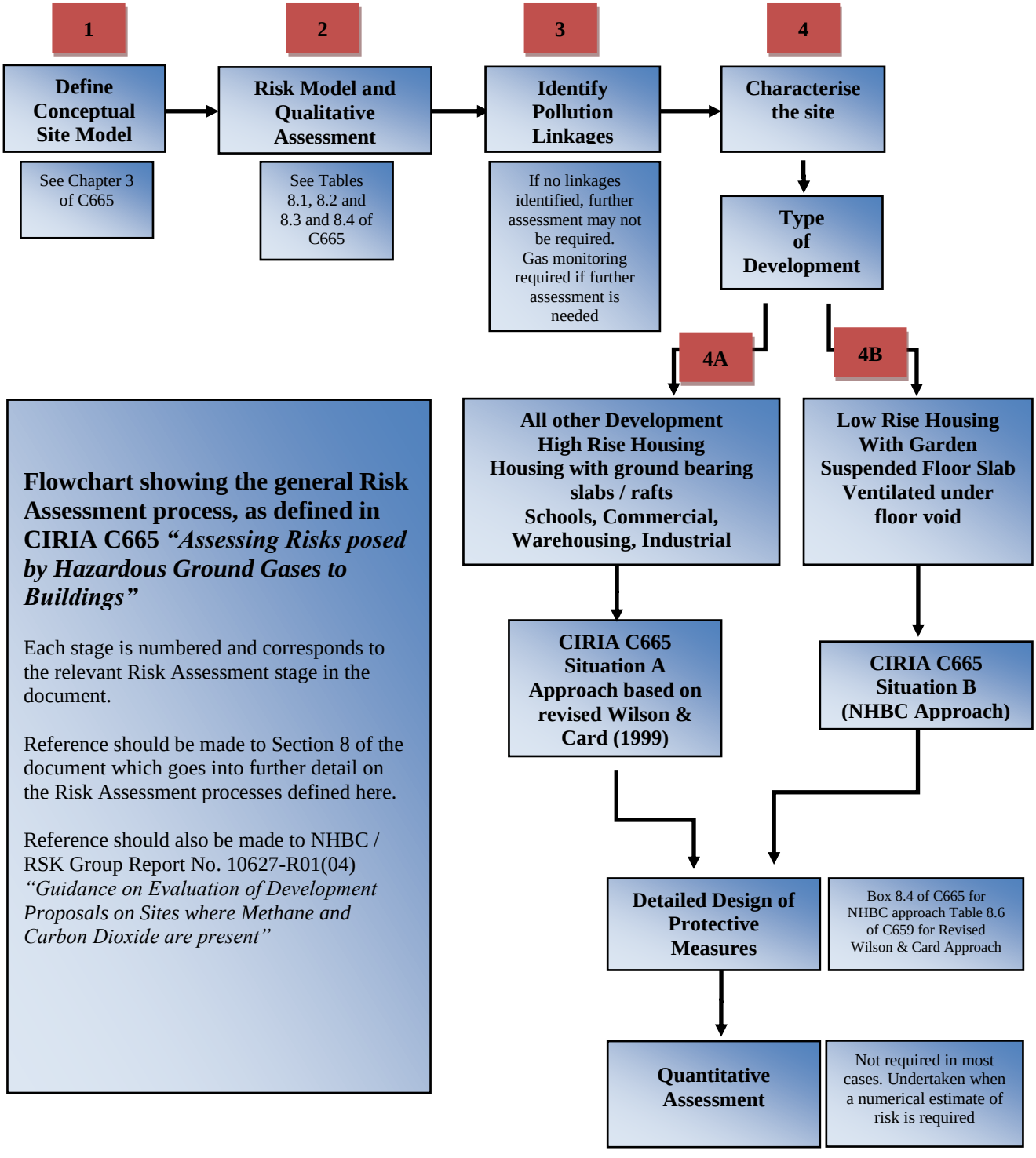
BS8485:2015+A1:2019 Table 6 Gas Protection Scores for Ventilation Protection Measures		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
a) Pressure relief pathway (usually formed by low fines gravel or with a thin geocomposite blanket with strips terminating in a gravel trench external to the building	0.5	*Whenever possible, a pressure pathway relief pathway (as a minimum) should be installed in all gas protection measures systems.* *If a layer has a low permeability and/or is not terminating in a venting trench (or similar), then the score is zero.*
b) Passive sub floor dispersal layer Very good performance Good performance Media used to provide the dispersal layer are: • Clear void • Polystyrene void forming blanket • Geocomposite void former blanket • No-fines gravel layer with gas drains • No-fines gravel layer	 2.5 1.5	*Performance criteria shown in Fig B.6 and B.7 of BS 8484:2015.[See Annex B]*
c) Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution layer, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers	1.5 to 2.5	*This system relies on continued serviceability of the pumps; therefore, alarm and response systems should be in place. [See Annex B].*
d) Active positive pressurisation by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket	1.5 to 2.5	*This system relies on continued operation of the pumps; therefore, alarm and response systems should be in place. [See Annex B].*
e) Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or under croft)	4	*Assumes car park is vented , designed to Building Regulations 2000, Approved Document F.*

Membrane methods are detailed in Table 7.

BS8485:2015+A1:2019 Table 7 Gas protection score for gas resistant membrane		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
Gas resistant membrane meeting all of the following criteria: • Sufficiently impervious to gases with a methane gas transmission rate <40.0 ml/day/m²/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method) • Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; • Sufficiently strong to withstand in-service stresses (e.g., settlement if placed below a floor slab); • Sufficiently strong to withstand the installation process and following trades until covered (e.g., penetration from steel fibres in fibre reinforced concrete, dropping tools etc); and to withstand in-service stresses (e.g., settlement if placed below a floor slab) • capable, after installation, of providing a complete barrier to the entry of the relevant gas; and • verified in accordance with CIRIA C735	2	*The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints.* *If a membrane is installed that does not meet the criteria, then the score is zero.*
See notes in BS8485:2015+A1:2019 regarding membrane requirements		

For a site which is impacted by migratory gases from an off source, the development may be protected by imposing pathway intervention methods, which if successfully validated, could also remove the need for further analysis. It is essential that the gas regime in these circumstances has been fully characterised and that the only source impacting the site is located off site and that the pathway is clearly defined and its interception equally proven before construction commences. Pathway intervention methods may include vertical membrane installations, venting trenches, rows of stone columns, activated trenches and various proprietary systems. These systems are particularly relevant to domestic housing where there is limited scope for foundation type solutions.

Following the choice of protection measures, detailed design should be entered into [Section 8 of BS 8485:2015+A1:2019].



Flowchart showing the general Risk Assessment process, as defined in CIRIA C665 *"Assessing Risks posed by Hazardous Ground Gases to Buildings"*

Each stage is numbered and corresponds to the relevant Risk Assessment stage in the document.

Reference should be made to Section 8 of the document which goes into further detail on the Risk Assessment processes defined here.

Reference should also be made to NHBC / RSK Group Report No. 10627-R01(04) *"Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are present"*

APPENDIX I – GUIDANCE FOR CLASSIFICATION OF SOIL FOR OFF SITE DISPOSAL AT A LANDFILL SITE

GroundSolve Ltd

Guidance for Classification of Soil for Off Site Disposal at a Landfill Site

Many site developments create a portion of excess soils and Made Ground which if not re-usable, are required to be disposed off-site at a suitably licensed landfill site. The regulations and associated guidance published by the Environment Agency is relatively complex and lengthy. This guidance provides a summary of the following documents which should be referred to when assessing soil (and common constituents found within Made Ground on remediation sites) for off-site disposal:

- Guidance for Waste destined for disposal in landfills: Interpretation of the Waste Acceptance Requirements of the Landfill (England and Wales) Regulations 2002 (as amended) (EA, 2004);
- Guidance on Sampling and Testing of Wastes to Meet Landfill Waste Acceptance Procedures (EA, April 2005);
- WM3 - Hazardous Waste: Interpretation of the Definition and Classification of Hazardous Wastes (EA, May 2015);
- European Regulation No 1272/2008 on Classification, Labelling and Packaging of substances 2015 (CLP 2015);
- Guidance on Waste Destined for Disposal in Landfill (EA, June 2006);
- Treatment of Non-hazardous wastes for Landfill (EA, February 2007).

It is important to distinguish between the waste classification system and the designation of materials as "suitable for use" on site. A material may be retained on site for an appropriate end use if that end-use is clearly designated and that a site-specific risk assessment ensures that it does not pose a risk to human health or controlled waters. However, if this material is excavated and sent for disposal, the material is then subject to waste management regulations and the two systems cannot be directly correlated. It is therefore important to note that classifying a material as hazardous (should it be excavated and become a waste) does not necessarily indicate that it might not be suitable to be kept on site for re-use. Separate guidance in the form of a Code of Practice (CL:AIRE Version 2, 2011) has been developed jointly between the development industry and the Environment Agency to provide best practice when assessing whether materials are wastes or not, and for determining when waste can cease to be waste for a particular use.

In accordance with the current waste regulations (or Landfill Directive, as they are more commonly known), from 30th October 2007 all waste materials produced from construction sites have to be pre-treated prior to disposal. Pre-treatment includes waste minimisation, recovery (e.g., separation of demolition waste to be used as hardcore) and separation of materials into different waste categories (e.g., separate inert waste from hazardous waste etc). Mixing of different waste types shall be avoided and intentional mixing of inert materials with hazardous waste to 'dilute it' and hence change its waste classification, is illegal.

The current waste regulations (based on the EU landfill directive) introduced a two-tier classification system for waste materials, defining them as either being hazardous or non-hazardous. Landfills are licensed to take wastes based on a three-tier classification system with the non- hazardous waste divided into two sub-categories:

- Non-Hazardous - inert;
- Non-Hazardous - non-hazardous;
- Hazardous.

Waste materials are categorised with a six-figure numeric code in the European Waste Catalogue. Commonly found construction and demolition wastes including excavated soil from contaminated sites and Made Ground with their waste codes are summarised below (this is not a comprehensive list):

Waste Code	What is it?	Likely Waste Category–		
		Inert Waste	Non-Hazardous	Hazardous Waste
17 01 01 Concrete	Concrete, possibly with reinforcement (from Construction & Demolition)	✓		
17 01 02 Bricks		✓		
17 01 06* Mixtures of concrete, bricks, tiles & ceramics containing dangerous substances	These are not normally considered hazardous but if they are contaminated (e.g., by asbestos) then could be hazardous – see comment above			✓
17 01 07 Mixtures of concrete, bricks, tiles & ceramics other than those in 17 01 06	This is mixed inerts c.f. 17 09 04	✓		
17 05 03* soils and stones containing dangerous substances				✓
17 05 04 soils and stones other than those mentioned in 17 05 03	Soil and stones only (excluding top soil, peat, soil and stones from contaminated sites)	✓		
17 06 05* Construction materials containing asbestos	e.g., corrugated asbestos sheeting			✓
17 08 02 Gypsum-based construction materials other than those mentioned in 17 08 01	Plaster & plasterboard (although specific disposal requirements are required for high sulphate waste – see EA guidance 'Understanding the Landfill Directive' version 1.0 March 2010.		✓	
17 09 01* Construction & demolition wastes containing mercury				✓
17 09 02* Construction & demolition wastes containing PCBs	Waste with more than 50 mg/kg of PCB's are hazardous			✓

Waste Code	What is it?	Likely Waste Category–		
		Inert Waste	Non-Hazardous	Hazardous Waste
17 09 03* Other mixed construction & demolition wastes containing dangerous substances	Broad range of potentially (see notes below – if asterix the waste is hazardous) hazardous wastes			✓
17 09 04 Mixed construction & demolition wastes other than those mentioned in 17 09 01, 17 09 02 & 17 09 03	Mixed inerts with soil, tarmac, cables, vegetation, plaster, etc. (this waste can only be considered inert if it passes the waste acceptance criteria identified in the regulations).	✓	✓	

Note: all wastes with an asterix code are hazardous regardless of whether they are mirror or absolute entries in the EWC list the decision to with regard to composition must come before applying the code for mirror entries.

Some materials are classified as Inert Waste based in its origin (e.g., 17 01 01 Concrete, or glass) without any requirement for laboratory chemical analysis.

However, most soils will require laboratory testing to confirm whether they are classified as Hazardous Waste. The protocol for assessing these materials and the appropriate threshold values is complicated and are set out in the Environment Agency's "Technical Guidance *WM3* Hazardous Waste – Interpretation of the Definition and Classification of Hazardous Waste" (2015). If the test results for the waste indicates that it is not hazardous then further analysis of the waste is required to determine whether it is Inert Waste. If the waste does not meet the criteria for either Hazardous or Inert, then it is by default classified as Non-hazardous Waste.

As an alternative location to landfills for off-site disposal of inert and non-hazardous waste, there are a number of sites which have Waste Permit Exemptions that can accept certain categories of inert and non-hazardous wastes. Additionally, some quarries can accept certain types of wastes to be used for quarry restoration material. For both alternatives to disposal at landfill sites the material still requires chemical testing as these sites have site specific acceptance criteria for wastes. It should also be noted that these types of sites do not incur landfill tax which in the 2018/19 tax year is £2.80 for inactive waste (inert and some types of non-hazardous waste) and £88.95/Tonne for active waste (some types of non-hazardous waste and hazardous waste. Note that the Inland Revenue uses a different classification scheme for waste for tax purposes to the European Waste Classification scheme.

Waste Categorisation

The process of determining the category of wastes is a three-stage process:

- Stage 1 – is the waste either Hazardous or Inert by definition without the requirement for chemical analysis (if it is then Stages 2 and 3 are not required);
- Stage 2 - Waste characterisation;
- Stage 3 - WAC classification.

Waste characterisation determines if a waste is hazardous or not. Excavated soil is characterised using a system based on the contaminants present and their hazardous properties. The system uses total concentrations of the contaminants. Thresholds (as a percentage of the waste) have been set for the various hazardous properties.

Fourteen hazardous properties together with other scenarios where material could cause a hazard have been defined:

- Hazardous properties: explosive, oxidising, highly flammable/flammable, irritant, harmful, toxic, carcinogenic, corrosive, infectious, toxic for reproduction, mutagenic and ecotoxic;
- Substances which can release toxic/very toxic gases in contact with water, acid or air;
- Substances which, after disposal, can yield another substance, e.g., a leachate, which possesses any of the above hazardous properties.

Some of the hazardous properties are sub-divided e.g., there are three categories of carcinogenic, mutagenic and toxic for reproduction substances. The hazardous properties were originally defined in the European Hazardous Waste Directive 91/689/EC. Should a waste contain a contaminant with one or more of the listed hazardous properties at a concentration equal to or above the threshold value for the particular property, then the waste is hazardous. The hazardous properties of a wide range of chemicals are sourced from CLP 2015.

There are many reasons why waste soil is classified as being hazardous, but the majority of reasons can be divided into the following four groups:

- Hydrocarbons – this is probably the most common reason for the hazardous classification of soils. For most soils hydrocarbon analysis will be required for both Polycyclic Aromatic Hydrocarbons (PAH) and speciated Petroleum Hydrocarbons (PHCs) but depending on the site's history other groups of organic contaminants may also be is included in any analysis suite for soil samples;
- Metals – Particularly sites from former metal processing or mining sites and also some types of ash have metal concentrations that are sufficiently high to characterise materials requiring disposal as hazardous waste.
- Asbestos;
- Anions – e.g., sulphate in plasterboard (there are special disposal requirements for high sulphate waste and specific WAC requirements); it is possible that sulphate salts of metals and semi-metals could make the waste hazardous – the sulphate concentration could possibly be significant under H12, H13 and H14.

The characterisation of wastes with significant metal concentrations involves some processing of the analysis data. The chemical analysis results for inorganic substances are generally reported as total concentrations e.g., total lead, total arsenic, total sulphate etc. However, CLP 2015 deals with the hazardous properties of actual compounds e.g., lead sulphate, arsenic pentoxide, nickel carbonate. Therefore, the total metal results have to be converted into assessed chemical analysis results for the compound most likely to be present in the soil samples. For example, if the sample contains high total lead concentrations and high sulphate concentrations, then the lead is likely to be present

in the soil as lead sulphate. The most likely compounds can often be determined from a desk study or previous site uses. If the site has been derelict for a number of years, consideration should be given as to whether water soluble compounds should or should not be chosen, as rainfall could have removed them from the soil (this does not apply if the soil has been taken from below under a concrete slab etc). Chemical knowledge and common sense needs to be used in choosing a suitable compound.

If no data is available, then a worst-case scenario has to be assumed and the most hazardous compound likely to be present has to be chosen. For example, metal chromates (lead chromate, nickel chromate) are often the most hazardous compounds formed by many metals, but if the chromium concentrations in the soil are low, chromates are unlikely to be present. It should also be noted that for many of the hazard categories, the cumulative hazard from different compounds is added (e.g., add the concentrations of the copper, lead and zinc compounds together to assess the Hazard Category H14 Ecotoxicity).

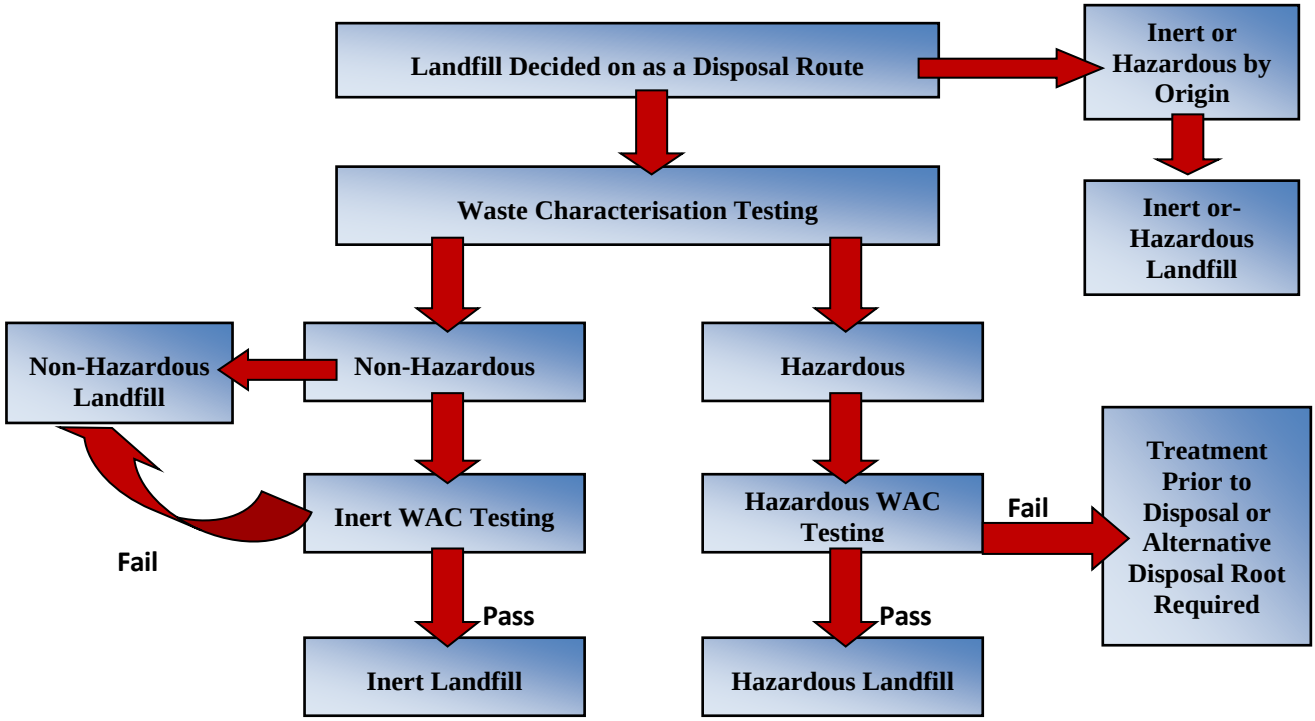
If the results of the above assessment determine that the waste is hazardous, it must then be analysed for the Waste Acceptance Criteria (WAC) analysis contained within appropriate Environmental Permitting Regulations (this comprises mainly leachate but also analysis for TOC and Loss on ignition). WAC limit values have been set for the listed determinands. If any of the determinands exceed their limit value, the waste must be pre-treated to reduce concentrations to below the limit values before the waste may be disposed of at a landfill site licensed to take hazardous waste.

For waste classified as not being hazardous, then there are two options available. Currently, waste correctly characterised as not being hazardous may be disposed of without WAC testing to a non-hazardous landfill. Alternatively, WAC testing for Inert Waste can be carried out (this is similar to the list for hazardous waste with the addition of PAH's, BTEX and Mineral Oil). If the results pass the Inert WAC criteria it can be disposed of at an Inert Waste Landfill. If any of the WAC test results exceed the Inert WAC criteria the waste has to be disposed at a non- hazardous landfill. There are WAC limits for non-hazardous waste set for pH and TOC. If these two criteria are not met then the waste must be pre-treated to so that it meets the criteria before it can be disposed.

If materials fail the WAC criteria it may be possible to pre-treat the waste on-site or be taken to a soil treatment centre for pre-treatment to reduce the soil's hazardous properties (e.g., by bioremediation of hydrocarbons).

It should be noted that in order to dispose of Hazardous Waste, the site must register as a producer of Hazardous Waste with the Environment Agency. When disposing of waste materials to landfill sites the appropriate Duty of Care Waste Transfer procedures must be followed.

Landfilled Waste Decision Tree



Landfill Tax

It should be noted that HM Revenue and Customs (HMRC) classify wastes for tax purposes using a different scheme to the threefold landfill EU Landfill Directive scheme (i.e., the hazardous, non-hazardous and inert). HMRC have a two-fold system for landfill tax. The Standard Landfill Tax is currently £88.95/T and applies to all wastes unless they qualify for the reduced rate of landfill tax of £2.80/T. The wastes that qualify for the reduced rate of Landfill Tax are set out in The Landfill Tax (Qualifying Material) Order 2011 with supplementary information on the interpretation of these regulations in HMRS "Notice LFT1 – A General Guide to Landfill Tax" (May 2012) and HMRC Briefing Notes 15/12 and 18/12.

APPENDIX J – UNFORESEEN GROUND CONTAMINATION

Unforeseen Ground Contamination

There is the potential for areas of previously unexpected contamination to be present, as is the case with any "brownfield" site. Any significant quantities of asbestos, significant ashy soils, unusual, brightly coloured or significantly oily or odorous material should be considered in this category. If unexpected contamination is found the following procedures should be adhered to:

1. All site works at the position of the suspected contamination will cease.
2. A suitably trained geo-environmental specialist should assess the visual and olfactory observations of the condition of the ground and the extent of contamination, and the Client and the Local Authority should be informed of the discovery. Should the contamination be likely to affect controlled waters the Environment Agency shall also be informed.
3. The suspected contaminated material will be investigated and tested appropriately in accordance with the assessed risks. The investigation works will be carried out in the presence of a suitably qualified geo-environmental engineer. The investigation works shall commence to recover samples for testing and, using visual and olfactory observations of the condition of the ground, delineate the area over which contaminated materials are present.
4. The unexpected, contaminated material will either be left in situ or be stockpiled whilst testing is carried out and suitable assessments completed to determine whether the material can be re-used on site or requires to be disposed as appropriate.
5. Where the material is left in situ awaiting results it will be reburied or covered with plastic sheeting.
6. Where the potentially contaminated material is to be temporarily stockpiled it will either be placed either on a prepared surface of clayey Alluvium, or on 2000-gauge Visqueen sheeting (or other impermeable surface) and covered to prevent dust and odour emissions.
7. Any areas where unexpected visual or olfactory ground contamination will be surveyed, a photographic record kept, and testing results incorporated into the Verification Report.
8. A photographic recorded will be made of relevant observations.
9. The testing suite will be determined by the independent geo-environmental specialist on the basis of visual and olfactory observations.
10. Test results will be compared against current assessment criteria suitable for the future use of the area of the site affected.
11. The results of the investigation and testing of any suspect unexpected contamination will be used to determine the relevant actions. After consultation with the Local Authority and if necessary the Environment Agency, materials should either be:

    - re-used in areas where test results indicate that it meets compliance targets so it can be reused without treatment; or
    - treatment of material on site to meet compliance targets so it can be reused; or

- removal from site to a treatment centre or to a suitably licensed landfill or permitted treatment facility.

12. Verification Report will be produced for the work.

Asbestos

Asbestos cement products and asbestos fibres have not been encountered in the soils at the site but based on the age of the Made Ground material containing asbestos could be expected to be encountered. If non-notifiable asbestos (e.g., chrysotile asbestos cement board) is encountered in excavations then it will be dealt with in accordance with the Control of Asbestos Regulations 2012 (CAR 2012) and the HSE's ACoP for asbestos (2013). Finding non-notifiable asbestos is a very common occurrence on brownfield sites and is a relatively low risk activity and can be dealt with as a matter of routine. Therefore, it is not proposed that the Council will be notified but an appropriate record will be kept of confirmatory testing and disposal. This will be included in remediation verification reports.

If suspect notifiable asbestos is encountered then the Council and the HSE will be notified. An appropriate action plan will be agreed with the Council and the HSE in accordance with CAR 2012. The action plan will include the preparation of the Risk Assessment and Plan of Work in accordance with CAR and other statutory requirements including:

- Site mobilisation;
- Excavation methodology;
- Handling, movement and storage on-site of excavation arisings;
- Any processing of excavation arisings containing ACMs;
- Movement and placement of arisings to final destination;
- Placing of cover system over soils with and ACMs remaining on-site;
- Off-site disposal of ACMs;
- Licences;
- PPE & RPE; and,
- Dust and fibre monitoring.

Potential mitigation measures that would be required include:

- Ensuring works are carried out by suitably trained and experienced personnel with working with asbestos;
- Site investigation and risk assessment;
- Removal or treatment of asbestos hotspots;
- Use of PPE and RPE by construction workers; and,

- Compliance monitoring.

Unexpected Tanks

No buried underground fuel storage tanks have been encountered during the site investigation works; however, there remains a low risk that tanks are present on-site. Should an underground tank be encountered, operations should cease in the area. Additionally, there may be pipework associated with these tanks which could have oily residues. The following procedures are to be adhered to if tanks and pipework are identified:

1. All site works at the position of the tanks/pipework should stop.
2. A description of the tank should be made by the geo-environmental engineer including; condition and surround, along with visual and olfactory observations should any contents in the tank be apparent. A photographic recorded will also be made of relevant observations.
3. The tank's position and depth should be determined and marked on a plan of the site.
4. The independent geo-environmental engineer will inform Client and the Local Authority.
5. During the presence of the independent geo-environmental engineer, investigation works should be undertaken to obtain samples of any liquid or sludge contents and to establish dimensions of the tank.
6. Testing will be determined on the basis of visual and olfactory observations by independent geo-environmental engineer.
7. Test results will be compared against current assessment criteria and proposals for disposal of any contents determined in agreement with the appropriate Regulatory Parties.
8. Emptying the tank and disposal of contents to a suitable licenced disposal facility.
9. Degassing and removal of the tank by a suitably qualified contractor will be required, and a Naked Flame Certificate should be provided.
10. Once the tank has been emptied in accordance with the above proposals, it is to be removed for disposal to a licensed waste management facility. Copies of the relevant waste consignment notes are to be kept and included in the Verification Report.
11. Excavation and remediation of any contaminated soils around the tank will be carried out.
12. Samples of the base and sides of the resultant hole will be sampled and supervised by the independent geo-environmental engineer to confirm whether risks to human health or controlled waters.