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CARDIFF CITY COUNCIL

FORMER NEW PENNSYLVANIA PUBLIC HOUSE

PHASE I DESK STUDY & SITE INVESTIGATION WORKS

NOVEMBER 2022

wardell armstrong

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CARDIFF CITY COUNCIL

CIRCLE WAY WEST ROAD

PHASE I DESK STUDY & SITE INVESTIGATION WORKS

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DRAWINGS

Drawing No	Title	Scale
CA12409-02A	Site Location Plan	1:20,000
CA12409-006	Exploratory Hole Location Plan	1:500

APPENDICES

EXECUTIVE SUMMARY

Client	Cardiff City Council
Site	Former New Pennsylvania Public House.
Current Land Use	The site is approximately 0.29 hectares and encompasses the former New Pennsylvania public house. The public house is no longer operational and has closed permanently, but the building remains on site.
Past Site Use	Historical land use is limited to operations associated with the public house from 1970s until its closure.
Proposed Development	It is understood that the site is to be potentially redeveloped as residential properties by the Cardiff City Council.
Hydrogeology & Hydrology	The bedrock beneath the site is classified as a Secondary A aquifer and no abstraction licences (>25m^3/day) have been identified within a 250m radius of the site. The site is not located within a Source Protection Zone (SPZ). Records indicate the presence of an inland river not influenced by normal tidal action, located 12m southwest of the site.
Ground Investigation Works	The ground investigation works were progressed on the 13th June 2022 and comprised 5no. windowless sampler boreholes, 5no. trial pits, 3no. soakaway tests and 10no. TRL-dynamic cone penetration tests. Soil samples collected as part of the ground investigation works were subsequently scheduled and tested for a range of geochemical determinants and geotechnical parameters. 1no. round of environmental monitoring, post-intrusive works, was undertaken on the 14th July 2022 in order to record groundwater levels and ground gas concentrations across the site.
Ground Conditions	The ground investigation works encountered a thin horizon of granular made ground deposits, present from c.0.05m bgl to c.0.30m bgl, underlying the hardstanding across the northern area of the site. South of the building, the grassed area was underlain with topsoil up to c.0.20m thick and reworked natural ground in TP5 present to a maximum depth of c,0.70m bgl. Clay-dominant made ground deposits were encountered from c.0.70m bgl to >c.2.0m bgl in TP5 south the building, with various fragments of anthropogenic material recorded. Based on anecdotal evidence provided by a nearby resident, it has been suggested that this area of the site was historically used to bury waste associated with the construction of the adjacent residential buildings. The majority of the site is underlain by a soft to firm reddish-brown clay horizon with varying silt, sand and gravel components. The gravel was recorded as fine to coarse, angular to sub-rounded clasts of mudstone. This horizon is interpreted as the weathered zone of the underlying Raglan Mudstone Formation. The bedrock of the Raglan Mudstone Formation was encountered in the base of each exploratory holes, except for TP5. The bedrock was excavated as a sandy slightly clayey gravel in the trial pit excavations, while the windowless sample boreholes refused upon encountering rockhead, with partial recovery recorded from the standard penetration test (SPT) split spoon. The recovered material was

	commonly described as an extremely to very weak pale pink to reddish brown distinctly weathered mudstone.
Asbestos	An asbestos survey has not been carried out as part of the walkover survey or ground investigation works, and no asbestos containing materials were identified during the intrusive works or within the collected soil samples. However, given the previous commercial usage of the site and the age of the existing site building (built c.1973 according to Ordnance Survey maps), the presence of asbestos containing materials should be considered likely. It is recommended that an asbestos demolition survey of the site building is undertaken prior to any enabling works progressing on site.
Human Health: Future Occupiers and Construction Workers	A total of 20no. soil samples were analysed for a suite of contaminants typically associated with basic brownfield sites. The geochemical testing predominantly returned measurable concentrations of metals, inorganic and organic substances which were not deemed to pose a significant risk to future occupiers. It is noted that the location of the highest concentrations of the heavy metal determinants was consistently either WS3 or WS4, though no exceedances were recorded. Elevated concentrations of total petroleum hydrocarbons were recorded within the shallow made ground and should be taken into consideration when construction workers are undertaking intrusive works.
Groundwater	No groundwater strikes were recorded within any of the exploratory holes during the ground investigation works. Groundwater was recorded within monitoring borehole WS3 at 2.02m bgl during the environmental monitoring visit on the 14th July.
Ground Gas	A maximum flow rate of 0.2l/hr, with peak methane and carbon dioxide concentration of 7%v/v and 14.1%v/v respectively, was recorded in borehole WS3 as part of the environmental monitoring indicating a requirement for ground gas protection measures. However, no measurable flow rates were recorded within two of the three boreholes. The environmental monitoring indicates that ground gas generation for the majority of the site is low and that remedial measures are unlikely to be required. Additional environmental monitoring rounds are recommended to inform a ground gas risk assessment.
Geotechnical Constraints	The bedrock stratum of mudstone, siltstone, and sandstone underlying the site are unlikely to present risks associated with dissolution features, running sands, compressible and collapsible ground, or shrink/swell clays. The potential to create contamination pathways to the Secondary A bedrock aquifer should be considered when assessing foundation solutions for the proposed development. Geochemical testing on soil samples collected during the intrusive works allowed for the classification of the aggressive ground conditions (AC-1s) and concrete design class (DS-1) for any proposed sub-surface structures. The failure of the 3no. soakaway tests across the site indicates that conventional soakaways would not be effective for the redevelopment.

Other Risks	The Zetica pre-desk assessment UXO report indicates that a detailed desk study to assess and potentially zone the Unexploded Ordnance (UXO) hazard level on the site is not considered essential.
Overall Environmental Risk for Site	The environmental risk posed from the site under current layout and conditions to human health, controlled waters, and built environment receptors is considered to be **Very Low to Moderate**. A series of recommendations and mitigation measures have been detailed that would reduce the risk to **Very Low to Low**.

1 INTRODUCTION

Instructions

1.1 This report has been prepared in relation to the terms agreed with Cardiff City Council (CCC) dated 19th May 2022. Wardell Armstrong LLP (WA LLP) was commissioned by CCC to undertake a geo-environmental and geotechnical desk study in relation to the potential redevelopment of the site.

1.2 The 'Standard Terms and 'Limitations' to this Report are presented in **Appendix A**.

Site Location

1.3 The site is located off Cardiff West Way Road, Cardiff, Wales. The site covers an area of approximately 0.29 hectares and is centred at National Grid Reference 319872 E, 180522 N. The site boundary is shown on Drawing no. *CA12409-002A*.

1.4 The site is derelict, comprising a two-storey building (former New Pennsylvania public house) with an above-ground storage tank located on the buildings southern exterior wall, hardstanding (former car parking), grassland to the south of the building and several trees along the site boundary. The site is within a residential area.

1.5 Topographically, the site slopes gently from north (c.49m AOD) to south (c.49m AOD).

1.6 A site boundary is shown in **Figure 1.**

Figure 1: Plan Showing the Approximate Site Boundary (not to scale) (OS Maps)

Purpose and Basis of Report

1.7 The purpose of this report is to identify and examine in broad terms readily available information for the feasibility of the proposed redevelopment.

1.8 Information examined as part of this report will relate to the:

- past and current uses of the site and surrounding area
- nature of any hazards and physical constraints
- environmental setting including geology, mining, hydrogeology, and hydrology
- current and likely future receptors, potential sources of contamination and likely pathways
- information for the preliminary risk assessment
- likely ground conditions beneath the site including soil/rock types, groundwater and potential geohazards
- potential contamination constraints and liabilities that may arise in connection with the present use or proposed use of the site

1.9 The report has been produced in general accordance with Environment Agency's Land Contamination Risk Management (LCRM) (*version 3 - published October 2020*).

Proposed Redevelopment

1.10 It is understood that the site has been identified for potential residential development. This report therefore identifies the associated risks based on the feasibility of constructing a residential property with soft landscaping at the site. At the time of Client instruction on this report, no detailed plans or proposed site development layout has been issued.

Limitations of Report

1.11 The report does not constitute or contain a valuation, nor is it a full rigorous environmental audit or assessment of potential abnormal costs.

1.12 In this instance, this report is prepared as a preliminary feasibility study for the potential redevelopment with regards to geo-environmental and geotechnical conditions across the site. This study has been requested to inform both decision making and the process of risk management with regards to site constraints.

2 DATA SOURCES

Data Sources

2.1 Our desk study researches have been carried out in general accordance with current recognised guidance and with the procedures set out in the following documents:

- Environment Agency's LCRM entitled "How to assess and manage the risks from land contamination" dated October 2020
- British Standard BS EN ISO 21365:2020 Soil quality - Conceptual site models for potentially contaminated sites
- British Standard BS 5930:2015+A1:2020 - Code of practice for ground investigations

2.2 The Desk Study report has been prepared following the examination of the following key information:

- BGS GeoIndex interactive map viewer
- Natural Resources Wales (NRW) Interactive Map Viewer
- NRW Flood Risk Map Viewer
- NRW Environmental Information Portal
- National Library of Scotland Map Finder
- Environment Agency (EA)/Historic Landfill ArcGIS Online Map Viewer
- UK Health Security Agency Online Map Viewer.
- Defra Magic map
- Zetica UXO
- BGS mapping (EW263_Cardiff_v7) and borehole records
- Coal Authority Interactive Map Viewer
- Site walkover details.

3 SITE HISTORY AND PRESENT LAND USE

Site History

3.1 Historical maps accessible on the British Library Map Archive and National Library of Scotland Map Finder, (1:10,560 and 1:2,500 scale) have been assessed to identify previous land uses, including any significant potentially contaminative uses. Where other features that may influence proposed development of the site have been identified, they are also described.

3.2 **Table 3.1** summarises the history of the site over the period between 1881 to 2022.

TABLE 3.1
SUMMARY OF HISTORICAL ONSITE LAND USE

Date	Site Land Use	Additional Comments
1881 - 1973	The site has not been noted to be generally unoccupied and empty apart for the southeast of the site which was a woodland during this period.	Records indicate the presence of an inland river not influenced by normal tidal action, 12m southwest of the site.
1973-2022	The site now comprises an operational pub.	The structure of the public house and an adjacent tank can be noted in the east of the site.

3.3 **Table 3.2** summarises the history of the immediate vicinity (within 250m) over the period 1881 to 2022.

TABLE 3.2
SUMMARY OF HISTORICAL OFFSITE LAND USE

Surrounding Site Use/Features	Dates	Location
Woodland	1881-1974	10m southwest of the site.
Police Station	1992	478m south of the site.
Electricity Substation	1988-1990	141m west of the site.
Electricity Transformer	1973	185m north of the site.
Electricity Substation	1990	185m north of the site.

Site Walkover Survey

3.4 A site walkover survey over was carried out on 8th June 2022. The key findings of the site walkover are summarised below and are presented in full within **Appendix B**, along with a collation of photographs presented within **Appendix C**. All photos can be made available upon request.

3.5 The site currently comprises a disused public house and an above ground tank of unknown content located along the building's southern exterior wall.

3.6 Access to the site can be gained via the Circle West Way Road which forms the north-western site boundary.

3.7 The site is bounded by Heras fencing on all boundaries.

3.8 The topography of the site is noted to be sloping towards the south-east and flatten due south towards the rear of the building on-site.

3.9 Based on the Site Walkover Survey, the disused public house is noted to be constructed out of brickwork. There is also an entrance to the rear of the building, possibly relating to the cellar.

3.10 An above ground tank of unknown content is located along the building's southern exterior wall.

3.11 No fly tipping was noted on site. Several waste bins were noted towards the western entrance of the building.

3.12 Overhead power lines were recorded near the outdoor seating area which should be considered as part of any further Intrusive Site Investigation works and construction works. A few mature trees are noted along the western and southern boundaries of the site.

3.13 Made ground is noted on the western side of the site. This section of the site is predominantly covered by hardstanding (concrete and gravel).

4 GEOLOGICAL AND HYDROGEOLOGICAL SETTING

Geology

4.1 The assessment of the site geology is based on BGS GeoIndex online mapping, and geological information obtained as part of the site walkover. A summary of significant geological information is provided below in **Table 4.1.**

TABLE 4.1
SUMMARY OF GEOLOGICAL INFORMATION

Strata	Description
Artificial Deposits	According to the BGS GeoIndex, no artificial deposits are anticipated beneath the site. The closest artificial deposits to the site are recorded approximately 570m to the southwest.
Natural Superficial	According to the BGS GeoIndex, no superficial deposits are present beneath the site. The closest superficial deposits to the site are Devensian Till of diamicton type, which are recorded 329m east.
Bedrock Strata	The bedrock stratum underlying the site is shown to comprise Mudstone, Siltstone, and Sandstone of the Raglan Mudstone Formation.
Linear Features	Based on BGS GeoIndex data, no linear features, such as faults, are recorded as present beneath.
Borehole Records	16no. borehole records are present within 250m of the site, with the closest borehole located 19m northwest of the site, and the farthest borehole located 246m east of the site.

Hydrogeology

4.2 According to BGS GeoIndex, the Ragland Mudstone Formation beneath the site is classified as a Secondary A aquifer.

4.3 There are no groundwater, surface water, potable abstractions zones or source protection zones located within 250m of the site.

4.4 The site is situated within the 'SE Valleys Southern Devonian Old Red Sandstone & Triassic Mercia Mudstone' groundwater body, as designated under the Water Framework Directive.

Hydrology

Surface Water Features

4.5 According to the NRW Interactive Map Viewer, there are 5no. inland rivers present within 250m of the site, with the closest being 12m southwest of the site, and the farthest river being 221m northeast of the site.

4.6 The site is located within the Rhymney River (Nant Cylla to Chapel Wood) surface water body catchment. The water body catchment is managed under the Water Framework Directive (WFD).

Flooding

4.7 NRW maintains national flood maps based on ground levels, which were accessed via the NRW Flood Risk Map Viewer. These flood maps provide predicted flood levels, information on flood defences and local knowledge. The flood maps show the predicted likelihood of flooding in an area in the context of current and the proposed land use (considered in development planning).

Rivers and Coastal

4.8 Based on NRW Flood Risk Map Viewer, the site and the surrounding 250m radius, is not deemed to be at risk from river and coastal flooding.

4.9 The highest risk of surface water flooding onsite and within 50m of the site has been recorded as a 1 in 1,000-year event. It should be noted that the implication of surface water flooding on the majority of site is negligible.

Groundwater

4.10 NRW Flood Risk Map Viewer data indicates the highest risk of groundwater flooding on-site is negligible. This recorded risk covers the site and all areas within 50m of the site.

5 MINING AND QUARRYING

General

5.1 Research of the mining setting at the site is based on examination of published topographical and geological information, and freely available historic ordnance survey maps.

Coal Authority Information

5.2 Information available on the Coal Authority website (Interactive Map Viewer) indicates that the site does not lie within a Coal Mine Reporting Area nor does the site lie within a Development High Risk Area (DHRA).

5.3 Furthermore, the Coal Authority Interactive Viewer indicates that no historical surface ground working features are present onsite.

6 ENVIRONMENTAL DATA AND CONSULTATIONS

6.1 According to historical maps accessible on the National Library of Scotland Map Finder, there is 1no. record of an on-site "tank" dated from 1973 and still present to date and is believed to be associated with the disused public house.

6.2 There are 5 no. electricity substations within 250m of the site, with the closest one being 141m west. Records indicate that there are 2 no. electricity transformers within 250m of the site, with the closest being 185m north of the site and the farthest being 239m south.

Waste Management

6.3 According to EA/Historic Landfill ArcGIS Online Map Viewer data, there are no records of active or recent waste landfill sites (under EA regulation or surveyed by the BGS on behalf of the Department of the Environment) within the site boundary or a 250m radius of the site.

Radon

6.4 The BRE 'Guidance on Protective Measures for New Dwellings' (BR 211) has been consulted to review the geological radon potential of the site as outlined by the BGS.

6.5 The relevant radon data collated from the UK Health and Security Agency (via the UK Radon Online Map Viewer) estimates the percentage of dwellings exceeding the Radon Action Level as less than 1%. The BRE guidance document indicates that no

radon protective measures are thus required for any proposed buildings/enclosed structures on site.

Designated Environmentally Sensitive Sites

6.6 Based on data accessed via the NRW Interactive Map Viewer, no Local Nature Reserve (LNR) designations have been noted on site or within 250m of the site.

6.7 The database also indicates that 5 no. designated ancient woodland designations have been noted within 250m of the site, with the closest being 10m southwest of the site, and the farthest being 211m southeast of the site.

6.8 There are no other environmental designations (such as Ramsar sites, Special Areas of Conservation, green belts, etc.) within 250m of the site.

Asbestos

6.9 The Health and Safety at Work Act requires that Employers provide safe places of work for their employees. The Control of Asbestos Regulations places very heavy specific duties on those who commission and carry out work on asbestos containing materials.

6.10 Construction work that is likely to involve exposure of workers to hazards associated with asbestos in existing buildings will be subject to the Construction (Design and Management) Regulations which impose duties upon Clients, Designers and the Contractors carrying out the work.

6.11 Due to the previous usage of the area, the likelihood of encountering asbestos containing materials at the site is low to moderate but should not be discounted until deemed otherwise.

Unexploded Ordnance (UXO)

6.12 UXO specialist Zetica has carried out a Pre-Desk Assessment of the site. Zetica has not identified any Pre-World War 1 (WWI) Military Activity, WWI Military Activity, WWI Bombing, Interwar Military Activity or World War 2 (WWII) Military Activities on the site or areas affecting the site.

6.13 The Rural District of Cardiff, within which the site is located, officially recorded 502 no. HE bombs with a bombing density of 8.4 bombs per 405 hectares.

6.14 WWII Strategic Targets within 5km of the site have been identified and include Cardiff Docks, RAF Rhoose, military camps and training areas, transport infrastructure and

public utilities, industries important to the war effort, and anti-aircraft and anti - invasion defences.

6.15 Zetica has indicated that a detailed desk study is not considered essential. The Zetica Preliminary Risk Assessment Report is presented in **Appendix D**.

7 CONCEPTUAL SITE MODEL

Methodology

7.1 On 8th October 2020, the Environment Agency (EA) republished the Land Contamination Risk Management (LCRM) guidance which replaced Model procedures for the management of land contamination (CLR11).

7.2 The LCRM approach includes the production of a Conceptual Site Model (CSM) depicting the environmental processes that occur on and in the vicinity of the site and identifying the potential contaminant linkages. The assessment of the significance of these contaminant linkages can then be carried out through the risk assessment process.

7.3 The production of a CSM and the assessment of the associated risk is based upon the identification of the possible sources of contamination ("the sources"), the identification of who or what may be affected by the contaminants ("the receptors") and the possible pathways by which contaminants may migrate to one or more of the receptors ("the pathways").

7.4 The findings of the desk study and site walkover have been used to identify the potential sources, pathways and receptors that exist on the site.

Potential Sources of Contamination

Onsite

7.5 The site comprises a derelict New Penn public house structure and an associated above ground storage tank. Given the age of the public house structure there is potential for asbestos containing materials to have been used as part of construction and/or refurbishment works. There is also potential for remnant fuels/oils to be present with the structure's infrastructure.

7.6 The above ground tank of unknown content located along the building's southern exterior wall could pose a potential contaminative risk. The contents of the tank are unknown.

Offsite

7.7 No historical landfills or associated made ground have been located within the immediate vicinity of the site.

7.8 Electricity sub-stations identified on historic Ordnance Survey mapping within 250m of the site may be a source of contamination, with the closest being 141m west of the site, and the farthest being 248m northwest.

7.9 No major historic polluting incidents have been recorded within 250m of the site.

7.10 The structures and associated tanks etc. located within the vicinity of the site may present a risk of contamination from asbestos (contained within the fabric of the buildings).

Summary of Potential Sources

7.11 The potential sources of contamination are summarised below.

7.12 Onsite contaminants associated with:

- Derelict public house structure and unspecified tank.
- Potential made ground

7.13 Offsite (within 250m) contaminants associated with:

- Energy features (Electricity Sub-stations & Transformer), located 141m to 239m.
- Made ground

Potential Receptors

7.14 Based on the desk study researches, the following potential receptors for contamination have been identified:

- Humans –Construction Workers
- Humans – Future site users & maintenance staff
- Controlled Waters – Inland river, 12m southwest of the site.
- Controlled Waters – Secondary A aquifer (Bedrock)
- Ecosystem – Flora and Fauna associated with the woodland 10m to the southwest
- Built Environment – Proposed sub-surface structures (foundations, water supply pipes, etc).

Identification of Pathways

Human Health Pathways

7.15 There are various routes by which any contaminant(s) present within the soils or groundwater beneath the site may pose a direct risk to humans, either during construction work or following redevelopment. These pathways include:

- Direct ingestion of contaminated dust, soil and/or groundwater
- Dermal contact with contaminated dust, soil and/or groundwater
- Inhalation of dust
- Inhalation of vapours and/or ground gases

Built Environment Pathways

7.16 There is a potential for soil and groundwater containing substances aggressive to concrete to come into direct contact with service pipes / conduits, buried concrete and associated infrastructure.

7.17 Ground gas generation from unrecorded made ground is a possibility at the site, as well as organic vapours associated with the tank. Ground gas has the potential to migrate directly from and through permeable material including potential made ground to accumulate in buildings. Where buildings, or any structure where gas can accumulate, is associated with the potential redevelopment of the site, the level of ground gas risk will need to be assessed in detail.

Controlled Water Pathways

7.18 The nearest surface water body is the inland river, which is located immediately southwest of the site. Contaminants may be transported as leachate or dissolved phase within water to the surface water bodies by shallow groundwater (which is in hydraulic continuity with the surface water), or via surface run-off.

7.19 Any contaminants present within potential made ground/shallow soils on-site and off-site may be in direct contact with the bedrock underlying the site (which are classified as a Secondary A aquifer). Based on the potentially permeable nature of the bedrock, a primary mechanism for the movement of any contaminants within the soil into the bedrock aquifer will be via the leaching of the soil, dissolution into groundwater and groundwater movement.

7.20 Groundwater on-site and off-site has the potential to vertically migrate down into the bedrock (mudstone, siltstone, and sandstone of the Raglan Mudstone Formation) through any potentially contaminated soils. It should also be noted that the made ground potentially lies directly over the bedrock and any contamination within the made ground could be easily transmitted to the bedrock.

Ecosystem Pathways

7.21 Consideration of risks posed to any flora (from phytotoxic compounds) or fauna (direct contact including ingestion of contaminated flora) may be required if observed in future.

8 QUALITATIVE ENVIRONMENTAL RISK ASSESSMENT

Introduction

8.1 In line with EA guidance - LCRM, plausible source, pathway and receptor linkages have been identified through the CSM. The information gathered in the CSM is then used to carry out a Qualitative Risk Assessment (QRA).

8.2 LCRM outlines that for each tier of Risk Assessment the following steps must be taken:

I. Identify the hazard - establish contaminant sources
II. Assess the hazard - use a source-pathway-receptor (S-P-R) contaminant linkage approach to find out if there is the potential for unacceptable risk
III. Estimate the risk - predict what degree of harm or pollution might result and how likely it is to occur by using the tiered approach to risk assessment
IV. Evaluate the risk - decide whether a risk is unacceptable

8.3 LCRM states that the assessment must be based on the potential severity that the risk poses to the receptors against the likelihood of it happening. Subsequently, it is necessary to employ a risk assessment matrix, the CIRIA document *Contaminated Land Risk Assessment – a guide to good practice C552*, 2001 provides a good example of a suitable risk assessment matrices.

8.4 The CIRIA document defines Consequence of Risk, Probability of Risk Being Realised and Risk Classification Definitions. These definitions are provided in **Appendix E**.

8.5 Based on the baseline information collated within this report, a qualitative assessment of the potential geo-environmental risk is provided in **Table 8.1**. Where indicated, these risks may need to be considered for any future redevelopment of the land.

8.6 In order to place the onsite assessment of contamination into full context, the contaminative impact of the present site use is assessed. This assessment is in relation to potential contaminant migration and the general environmental setting of the surrounding area.

TABLE 8.1 PRELIMINARY CONCEPTUAL SITE MODEL				
Source	**Pathway**	**Receptor**	**Risk**	**Commentary**
Human Health				
S-P-R Link #1 **<u>Onsite</u>** • Derelict Pub structure & Tank • Potential made ground **<u>Off-site</u>** • Made Ground • Electrical Sub-stations/Transformers	• Dermal contact with contamination soil and shallow groundwater • Ingestion/inhalation of soils and dust • Ingestion/inhalation of liquids and vapours from tank, the derelict pub structure and associated infrastructure.	Human health – Future Site Users (High receptor sensitivity)	Consequence: Medium Probability: Low Likelihood **Risk: Moderate/Low**	There is potential for contamination of the shallow ground and groundwater associated with the unspecified tank, as well as potential made ground deposits present beneath the site. However, a significant source of contamination is not expected. Soil sample collection and testing as part of the proposed ground investigation works will identify any hotspots of contamination prior to site construction and development. It is assumed that the proposed development will include either hardstanding or a clean capping layer across soft landscape areas and therefore eliminating the S-P-R link. Additionally, clean materials are to be used as backfill in service trenches in order to protect future maintenance workers.
		Human health – Construction workers (Low receptor sensitivity)	Consequence: Medium Probability: Likely **Risk: Moderate**	There is a potential for construction workers to encounter contamination through excavations. However, a limited source of contamination is expected at the site. Soil sample collection and testing as part of the proposed ground investigation works will identify any hotspots of contamination prior to site construction and development.

TABLE 8.1 PRELIMINARY CONCEPTUAL SITE MODEL				
Source	**Pathway**	**Receptor**	**Risk**	**Commentary**
				Construction workers will be provided with Personal Protective Equipment (PPE) and therefore the risk of encountering contamination can be reduced to low.
S-P-R Link #2 **<u>Onsite</u>** • Derelict Pub Structure (Asbestos)	Inhalation of asbestos fibres.	Human health – Future Site Users (High receptor sensitivity)	Consequence: Medium Probability: Unlikely **Risk: Low**	There is potential for contamination of the ground associated with historical activity. It is considered unlikely that future site users will come into contact with asbestos containing materials associated with the derelict pub structure as it is expected to be demolished and removed by suitably qualified workers as part of the enabling works.
		Human health – Construction Workers (Low receptor sensitivity)	Consequence: Mild Probability: Likely **Risk: Moderate/Low**	Construction workers may potentially encounter contamination during excavation and demolition work. However, such works are expected to be undertaken by suitably qualified workers provided with task-appropriate PPE under safe working procedures to mitigate the contamination risk and therefore the consequence is considered mild.
S-P-R Link #3 **<u>Onsite</u>** • Potential made ground **<u>Off-site</u>** • Made Ground	• Generation and inhalation of ground gas • Lateral migration of any gas generated off site.	Human health – Future Site Users (High receptor sensitivity)	Consequence: Severe Probability: Unlikely **Risk: Moderate/Low**	It is considered unlikely that future site users will come into contact with ground gas associated with potential made ground. There are no records of made ground beneath the site and any made ground encountered at shallow depths during the construction works would most likely be removed.
		Human health – Construction workers (Low receptor sensitivity)	Consequence: Medium Probability: Low Likelihood **Risk: Moderate/Low**	Construction workers may potentially encounter ground gas while working in excavations and trenches. However, it would be expected that task-appropriate PPE would be used during such work.

TABLE 8.1 PRELIMINARY CONCEPTUAL SITE MODEL				
Source	**Pathway**	**Receptor**	**Risk**	**Commentary**
				The associated probability is considered to be low likelihood, as there are no records of made ground being present beneath the site or the surrounding area.
Ecosystem				
S-P-R Link #4 **<u>Onsite</u>** • Derelict Pub structure & Tank • Potential made ground	• Vertical and/or lateral migration of fuel, oils and leached contaminants into groundwaters, and the subsequent uptake by trees in the woodland.	Flora and Fauna Ancient Woodland southwest of the site.	Consequence: Mild Probability: Unlikely **Risk: Very Low**	There is a potential for contaminants associated with historical land use to be present onsite. However, a significant source of contamination is not expected. Prior to development, a ground investigation will be carried out to assess any contamination at the site. Any material found to be a potential risk to controlled waters and subsequently the ecosystem should be remediated and therefore reduce the potential risk.
Controlled Waters: Groundwater				

TABLE 8.1 PRELIMINARY CONCEPTUAL SITE MODEL				
Source	**Pathway**	**Receptor**	**Risk**	**Commentary**
S-P-R Link #5 **<u>Onsite</u>** • Derelict Pub structure & Tank • Potential made ground	• Vertical migration of fuel, oils and leached contaminants into the underlying aquifer.	Controlled Waters (Bedrock- Secondary A).	Consequence: Medium Probability: Low Likelihood **Risk: Moderate/Low**	There is a potential for contaminants associated with historical land use to be present onsite. However, a significant source of contamination is not expected. Whilst likely to be limited, surface water infiltration and subsequent leachate generate could allow for the vertical migration of contaminants into the Secondary A aquifer. Prior to development, a ground investigation will be carried out to assess any contamination at the site. Any contamination which poses a risk to groundwater should be remediated and therefore the risk to groundwater will be reduced. It is assumed that the proposed development will include either hardstanding or a clean capping layer across soft landscape areas and therefore reducing the leachate generation.
Controlled Waters: Surface Water				
S-P-R Link #6 **<u>Onsite</u>** • Derelict Pub structure & Tank • Potential made ground	• Contaminated surface water run-off flowing into surface water feature Conveying offsite of contamination waters via pipes, culverts and manifolds into surface water feature	Inland river, 12m southwest of the site.	Consequence: Medium Probability: Low Likelihood **Risk: Moderate/Low**	There is a potential for contaminants associated with historical land use to be present onsite. However, a significant source of contamination is not expected. Whilst likely to be limited, surface water could migrate laterally through shallow groundwater or as contaminated surface water run-off towards the inland river.

TABLE 8.1 PRELIMINARY CONCEPTUAL SITE MODEL				
Source	**Pathway**	**Receptor**	**Risk**	**Commentary**
				Prior to development, a ground investigation should be carried out to assess any contamination at the site. Any contamination which poses a risk to surface water should be remediated and therefore the risk to groundwater will be reduced. It is assumed that the proposed development will include either hardstanding or a clean capping layer across soft landscape areas and therefore reducing the potential for leachate generation. Additionally, a detailed surface water drainage strategy is expected to be appropriately designed.
Built Environment				
S-P-R Link #7 **Onsite** • Derelict Pub structure & Tank • Potential made ground **Off-site** • Made Ground	• Generation and migration of ground gas into buildings • Lateral migration of any gas generated off site. (Explosive Risk)	Built Environment (Structures)	Consequence: Severe Probability: Low Likelihood **Risk: Moderate**	There is potential for on- and off-site made ground deposits to generate ground gas. Ground gas has the potential to migrate through permeable superficial deposits onto the site. Site investigation works including the installation and subsequent monitoring of ground gas monitoring wells across the site would allow for the characterisation of the ground gas regime beneath the site and ultimately the recommendation of appropriate levels of ground gas protection measures.
S-P-R Link #8 **Onsite**	Aggressive ground conditions	Built Environment (Sub-surface concrete structures & Water Supply Pipes)	Consequence: Mild Probability: Low Likelihood **Risk: Low**	Soil sample collection and specialised testing as part of the proposed ground investigation works will allow for the classification of the ground conditions beneath the Site and the potential requirement for specific

TABLE 8.1 PRELIMINARY CONCEPTUAL SITE MODEL				
Source	**Pathway**	**Receptor**	**Risk**	**Commentary**
• Derelict Pub structure & Tank • Potential made ground				concrete type for sub-surface structure and PAH-resistant water pipes

9 GEOTECHNICAL PRELIMINARY CONSIDERATION

9.1 In addition to the environmental hazards, geotechnical hazards associated with the stability of the ground and mining issues should be assessed in line with Planning Policy Wales (Edition 11). A brief summary of the geotechnical hazards for the site is provided in **Table 9.1** below.

TABLE 9.1
SUMMARY OF GEOTECHNICAL HAZARDS

Hazard	On-site Hazard rating
Collapsible Ground Stability Hazard	Negligible
Compressible Ground Stability Hazard	Very Low
Ground Dissolution Stability Hazards	Negligible
Landslide Ground Stability Hazards	Low
Running Sand Ground Stability Hazards	Negligible
Shrinking or Swelling Clay Ground Stability Hazards	Very low

Near Surface Soils and Foundations

9.2 Made ground has not been recorded as potentially underlying the site area (based upon BGS records). However, based on previous site use, the possibility of hardstanding concrete, and made ground cannot be ruled out.

9.3 It is also currently assumed that all arisings or material excavated as part of construction works may need to be disposed of to landfill or reused at the site where feasible.

9.4 The entire site is underlain by the Raglan Mudstone Formation where the depth to rockhead may be largely uniform. Geotechnical hazards are negligible to low on site and will likely not impact engineering structures on site.

9.5 An intrusive ground investigation is recommended to delineate the risks associated with near surface soils to inform any future foundation recommendations.

Site Preparation/Temporary Works

9.6 Due to the likely very low compressibility of the Raglan Mudstone Formation, temporary engineering structures should be uncomplicated to erect, although care should be taken. Any design and construction of temporary structures should be informed by the results of an intrusive ground investigation.

Mining

9.7 The site does not lie within a coal mining area. The identified potential underground mining of a mineral vein is unlikely to be at a shallow depth beneath the surface.

Excavations and Groundwater

9.8 Due to the unknown strength of subsurface material, excavations may be difficult within the solid bedrock beneath the site.

9.9 An intrusive ground investigation would assist with verifying the presence of shallow groundwater and, if present, this may need to be considered further as part of a pre-construction phase (especially if deep foundation solutions are being used).

Services and Subsurface Structures

9.10 Utility and services should be located prior to any future ground investigation or redevelopment work.

10 GROUND INVESTIGATION

Introduction

10.1 A one day ground investigation was undertaken on 13th June 2022. The intrusive exploratory positions were established with consideration of the pre-existing ground penetrating radar (GPR) utilities and services survey provided by CCC. The exploratory position are presented in Drawing CA12409-006.

10.2 The ground investigation works comprised windowless sample boreholes, trial pits, soakaways, TRL dynamic cone penetrometer (TRL-DCP) tests, geochemical and geotechnical testing of soil, and post-site works environmental monitoring (gas and groundwater.

10.3 The windowless sampling boreholes were completed by Oakland Site Investigation.

10.4 WA LLP provided full time supervision of the ground investigation. Soils and excavated materials were logged by a suitably qualified WA LLP Engineer.

10.5 Following the completion of the ground investigation works, 1no. post-works ground gas and groundwater monitoring visit has been undertaken. The post-works monitoring visit included the monitoring of groundwater levels, ground gas concentrations, and ground gas flow rates.

10.6 In total, the ground investigation works comprised the following:

- 5no. windowless sampling boreholes
- 5no. trial pits
- 3no. soakaway tests
- 10no. TRL DCPs

10.7 The investigation, including sampling techniques, was carried out in general accordance with BS-5930:2015, *Code of Practice for Ground Investigations* and BS-10175:2011+A2:2017 *Investigation of potentially contaminated sites – Code of Practice*

10.8 The ground investigation was limited to a maximum depth of 3.0m bgl due to refusal in the windowless sampler borehole and difficulty progressing the trial pit excavation within the Raglan Mudstone Formation bedrock.

10.9 Eurofins Chemtest (Chemtest) was appointed as the geo-environmental laboratory for the works in relation to geochemical soil testing. Chemtest is accredited by the United

Kingdom Accreditation Service (UKAS) and EA Monitoring Certification Scheme MCERTS.

10.10 Geo Site & Testing Services (GSTL) was the laboratory selected to undertake the geotechnical testing. The laboratory is accredited by UKAS.

10.11 The general objectives of the windowless sampling, and trial pit excavations were to:

- Assess the nature of the shallow and deep ground conditions including soil type, composition, and estimation of relative density/strength etc.
- Determine the presence of, and depth to, any groundwater bodies.
- Identify key indicators for ground contamination.
- Determine excavation stability.
- Collect disturbed geochemical and geotechnical samples for laboratory analysis.

10.12 Ground investigation locations were scanned with a Cable Avoidance Tool (CAT) and hand dug pits were excavated prior to commencement of works.

Environmental Monitoring

10.13 Newly installed monitoring boreholes were left for approximately 4no. weeks before the monitoring phase commenced, therefore allowing sufficient time for environmental conditions to equilibrate.

10.14 Environmental monitoring was progressed on the 14th July 2022. The monitoring equipment was calibrated and confirmed as being suitable for use. A dip-meter was also used to check both the depth of water and the depth to the base of the standpipe for each monitoring well.

10.15 Gas monitoring recorded the concentrations of methane, carbon dioxide, carbon monoxide, oxygen and hydrogen sulphide. The weather conditions, barometric pressure and gas flow rate were recorded at the same time.

Sampling and Testing

10.16 Within exploratory holes, small disturbed environmental samples were taken at specific points such as consistent depths, changes in strata and any discrete horizon with visual/olfactory evidence of contamination or a perceived high potential to retain contaminants. The exploratory holes were logged in general accordance with BS 5930:2015.

10.17 Bulk disturbed geotechnical samples were recovered from exploratory holes at specific points such as changes in strata type or material properties.

10.18 All soil samples were collected in general accordance with best guidance.

10.19 The scheduled laboratory analyses were selected to establish the type, level and distribution of potential contamination present beneath the site and proposed development footprint.

10.20 Soil samples were analysed for a range of substances depending on depth and their positions on site relative to potential contaminative sources.

10.21 The scheduled brownfield suite analysis is presented in **Table 10.1**.

TABLE 10.1 - Summary of Soil Sample Brownfield Suite Analysis Schedule	
Substances	**No. Soil Samples**
WA Brownfield Suite: Arsenic, Antimony, Barium, Beryllium, water-soluble Boron, Cadmium, Chromium (III and VI), Copper, Lead, Manganese, Molybdenum, Mercury, Nickel, Selenium Vanadium, Zinc, pH, Soil Organic Matter, water-soluble and total sulphate, sulphide, Cyanide (total), Total Petroleum Hydrocarbons (TPH) (Aliphatic and Aromatic C5-C44), speciated Polycyclic Aromatic Hydrocarbons (PAHs), Total Phenols and asbestos ID.	20

10.22 The results of the soil geochemical analyses are attached within **Appendix F**.

10.23 The geotechnical testing was planned to classify site materials and their engineering properties. The scheduled analysis is presented in **Table 10.2** and the geotechnical results are attached in **Appendix G**.

TABLE 10.2 - Summary of Geotechnical Testing Schedule	
Geotechnical Testing	**No. Samples**
Moisture Content	7
Atterberg Testing (4-point)	7
Particle Size Distribution (Wet Sieve Method) + Pipette	7
BRE Reduced Suite	7
4.5kg Rammer Compaction	3

10.24 All tests were performed by an accredited geotechnical laboratory (GSTL) and all samples were tested in accordance with the appropriate British Standard: BS1377-1990 and the International Society for Rock Mechanics (ISRM) Methods:1985.

10.25 The soil samples were collected, transferred to the laboratory under chain of custody and analysed to ensure traceability and reliability of analytical results. Based on the laboratory QA data, the analytical results are considered acceptable for interpretative use.

11 GROUND CONDITIONS

Overview

11.1 This section of the report considers the results of the WA LLP ground investigation. The exploratory hole logs can be viewed in **Appendix H**.

11.2 The general site conditions comprised made ground over a weathered zone and underlying Raglan Mudstone Formation bedrock. The depths and thicknesses of deposits are shown in **Table 11.1**.

Table 11.1 – Summary of Ground Conditions

Strata	Exploratory hole locations	Min. depth to top of strata (m bgl)	Max. depth to base strata (m bgl)	Max. thickness (m)
Tarmacadam	WS1-WS4; TP1-TP4	Ground Level	0.05	0.05
Topsoil	WS5 & TP5	Ground Level	0.20	0.20
Reworked Natural	WS5 & TP5	0.15	0.70	0.50
Made ground	WS1-WS4; TP1-TP5	0.05	2.00	1.30
Raglan Mudstone Formation – Weathered Zone	WS1-WS5; TP1-TP4	0.15	2.95	2.75
Raglan Mudstone Formation	WS1-WS5; TP1-TP4	0.95	3.00*	>0.20
**Raglan Mudstone Formation recorded at the base of deepest borehole (WS3).*				

Hardstanding and Topsoil

11.3 The area to the north of the site building, as well as western and central extents of the site, is predominantly covered by tarmacadam hardstanding of 0.05m. Stone gravel is the prevalent hardstanding/surface cover across the eastern section of the site (i.e. the disused public house garden area).

11.4 At WS5 and TP5 exploratory locations, topsoil was encountered from ground level to a maximum depth of 0.20m bgl (TP5) as a firm orangish brown slightly sandy, slightly gravelly clay with rootlets.

Made Ground

11.5 The made ground deposits were encountered within all exploratory positions and was recorded immediately beneath hardstanding cover (across the derelict public house car parking and seating areas to the north of the site building); or beneath topsoil and reworked ground (across the grassed area to the south of the site building).

11.6 Reworked or impacted natural ground was encountered WS5 (0.15m thick) and TP5 (0.50m). The material was recorded as a sandy, gravelly clay containing fragments of anthropogenic materials such as brick and glass.

11.7 The maximum recorded thickness of made ground was 1.30m in TP5.

11.8 The made ground was predominantly recorded as a brown to light grey gravel. The minor constituents of the made ground were typically recorded as sand, less commonly as clay, and infrequently as cobbles.

11.9 The gravel and cobble components were described as fine to coarse-grained, angular to sub-angular clasts type 1 stone material.

11.10 The made ground deposits encountered in TP5, located within the grassed area to the south of the site building, were observed at a greater depth (0.70m bgl), thickness (1.3m), and different composition to those identified within the exploratory positions to the north of the site building.

11.11 Based on anecdotal evidence provided by a local resident of the surrounding residential area, it is understood that the grassed area to the south of the site building may have been part of a larger area which was used to bury/retain waste soils. These waste soils were said to originate from the construction of the adjacent residential properties surrounding the site.

11.12 The made ground in TP5 was recorded as soft, grey-brown clay with minor constituents of sand and gravel, and occasional cobbles. The gravel and cobbles were fine to coarse, angular to sub-rounded clasts of mudstone, and gravel to cobble-sized fragments of glass, metal sheeting, metal rebar, plastic, tile and wood. The base of the made ground materials/horizon encountered in TP5 was not observed. The trial pit at this location was terminated prematurely due to concerns regarding the instability of excavation.

11.13 A slight hydrocarbon malodour was recorded within the made ground deposits encountered at TP5.

11.14 No asbestos containing materials were identified within the made ground materials across the site.

Raglan Mudstone Formation – Weathered Zone

11.15 A clay-dominant soil horizon was encountered underlying the topsoil and made ground deposits in all exploratory holes except for TP5. The clay-dominant soil horizon has been interpreted as the weathered zone of the Raglan Mudstone Formation.

11.16 Across the site, the weathered zone was recorded from 0.15m bgl (WS5) down to 2.95m bgl (WS3) with a maximum recorded thickness of 2.75m (WS3).

11.17 The soil horizon was recorded as a predominantly soft becoming firm with depth, reddish brown clay with minor constituents of silt, sand and gravel. The gravel component was commonly observed as fine to coarse, angular to sub-rounded clasts of mudstone.

11.18 No visual or olfactory sign of contamination were noted within the weathered zone of the Ragland Mudstone Formation.

Raglan Mudstone Formation

11.19 The bedrock of the Raglan Mudstone Formation was encountered in all exploratory holes excluding TP5.

11.20 In windowless sample boreholes (WS1-WS5), the bedrock was observed within the sample taken in the base of each borehole. In the trial pit excavations (TP1-TP4), the bedrock was observed in the base of each excavation. Progress through the bedrock was noted to be extremely difficult and a maximum advancement of 0.20m through bedrock was recorded in TP3.

11.21 The bedrock was logged at the base of each exploratory hole and recorded at a minimum depth of 0.95m bgl in WS1 and a maximum depth 3.0m bgl in WS3. The maximum observed thickness of the Raglan Mudstone Formation was 0.20m in TP3.

11.22 The Raglan Mudstone Formation was observed as an extremely to very weak, pale pink to reddish brown distinctly weathered calcareous mudstone. In the trial pit excavations, the bedrock was commonly excavated as a slightly clayey, sandy gravel with cobbles.

Groundwater

11.23 Groundwater strikes were not encountered in any of the exploratory holes during the ground investigation.

11.24 At the time of writing this report, 1no. round of groundwater monitoring (14th July 2022) has been undertaken. Groundwater levels were measured in selected monitoring wells using a dip meter. Groundwater elevations measured relative to ground level are shown in **Table 11.2**.

11.25 The groundwater monitoring results are presented in **Appendix I.**

Table 11.2 – Summary of Groundwater Monitoring Levels	
Exploratory Hole	Depth to Water (m bgl)
	14/07/2022
WS1	Dry
WS3	2.02
WS5	Dry

Ground Gas

11.26 Following the ground investigation works, a total of 1no. round of ground gas monitoring (14th July 2022) has been undertaken. Ground gas monitoring results are attached at **Appendix I.**

11.27 A summary of ground gas results is displayed within **Table 11.3**.

11.28 Using CIRIA C655 and the gas monitoring results recorded from WS3,(as a worst-case scenario for the site) an overall gas screening value (GSV) of 1.40 l/hr has been calculated for methane and 2.82 l/hr for carbon dioxide.

11.29 Based upon the measured concentrations of methane and carbon dioxide in monitoring borehole WS03 and the derived GSVs, a worst-case classification for the site is Gas Characteristic Situation 3 (CIRIA R149), using the Modified Wilson and Card classification. However, it should be noted that the monitoring results from WS1 & WS5 indicate the site classification is Gas Characteristic Situation 1.

TABLE 11.3: Summary of Gas Monitoring Data.						
Borehole Location	Max CH_4 (%)	Max CO_2 (%)	Max Flow Rate (l/hr)	GSV (l/hr)		Characteristic Situation Number
				CH_4	CO_2	
WS1	0.2	7.6	0.0	0	0	1
WS3	7.0	14.1	0.2	1.40	2.82	3

TABLE 11.3: Summary of Gas Monitoring Data.						
Borehole Location	**Max CH_4 (%)**	**Max CO_2 (%)**	**Max Flow Rate (l/hr)**	**GSV (l/hr)**		**Characteristic Situation Number**
				CH_4	***CO_2***	
WS5	0.5	0.7	-0.1	0.05	0.07	1

Observations of Contamination

11.30 No visual signs of contamination were recorded during the ground investigation works.

11.31 The only malodour recorded during the ground investigation works related to the hydrocarbon odour reported in the made ground materials at TP5 (between 0.7-2.0m bgl).

12 LABORATORY CHEMICAL TEST RESULTS

12.1 A total of 20no. soil samples were collected from the made ground materials and superficial deposits encountered within the intrusive exploratory holes progressed across the site.

12.2 All samples were placed in laboratory-supplied sample containers and kept in a cool box with freezer packs in order to preserve the samples' integrity.

12.3 The collected samples were delivered to Chemtest for analysis in relation to a suite of contaminants as detailed in **Table 10.1**.

12.4 All chemical test results for soil samples are attached at **Appendix F** and summarised within **Table 12.1** below.

Table 12.1: Summary of Soil Geochemical Testing Results

Determinant	No. Samples	Range of Results (mg/kg)		Location of Maximum Concentration
		Minimum Concentration	Maximum Concentration	
pH	20	7.4	9.2	WS4 ES1 (0.1-0.3m)
Soil Organic Matter	20	<0.40	17	WS4 ES1 (0.1-0.3m)
Boron	20	<0.40	1.70	WS4 ES1 (0.1-0.3m)
Sulphate (2:1 Water Sol., g/l)	20	0.011	0.21	WS4 ES1 (0.1-0.3m)
Cyanide	20	<0.50	<0.50	-
Sulphide	20	<0.50	<0.50	-
Arsenic	20	0.50	6.80	WS3 ES1 (0.05-0.25m)
Cadmium	20	<0.10	0.51	WS4 ES1 (0.1-0.3m)
Chromium	20	6.0	21	WS3 ES2 (2.0-2.5m)
Copper	20	2.8	7.2	WS3 ES2 (2.0-2.5m)
Mercury	20	<0.05	<0.05	-
Nickel	20	2.2	24	WS3 ES2 (2.0-2.5m)
Lead	20	5.2	24	WS3 ES1 (0.05-0.25m)
Selenium	20	<0.25	0.87	WS4 ES1 (0.1-0.3m)
Zinc	20	17	70	WS4 ES1 (0.1-0.3m)
Chromium (Hexavalent)	20	<0.50	<0.50	-
Total Petroleum Hydrocarbons	20	<10	590	WS4 ES1 (0.1-0.3m)
Total of 16 PAHs	20	<2	<2	-
Total Phenols	20	<0.10	<0.10	-

13 GUIDANCE ON CONTAMINATION RISK ASSESSMENT

Introduction

13.1 The following section aims to assess the magnitude and significance of potential risks to human health, surface water, groundwater, ecosystems and buildings from contaminated soil and groundwater. The assessment provides information that is fit for purpose given the regulatory context and is completed in accordance with UK best practice. A summary of the risk assessment process is presented below. More detailed information on risk assessments is contained in various reports published by the EA and Department of Environment, Food and Rural Affairs (DEFRA) including:

- Land Contamination Risk Management (LCRM)
- Contaminated Land Science Reports (SR2 to 4)

General Soil Contamination Guidance

13.2 NRW has a statutory duty to ensure the protection of the environment and the remediation of contaminated land and groundwater. To achieve this, NRW employ the risk assessment principle – outlining the risk of a contaminant source causing harm or pollution via a given pathway to an identified receptor.

13.3 If one of the source-pathway-receptor linkages is not considered to be present, then there is deemed to be no risk. However, if a contaminant source is present and there is a pathway for that contaminant to reach a receptor, then there is a potential risk of significant harm to the receptor. Therefore, if the source-pathway-receptor linkages are complete, there is a requirement to undertake a risk assessment related to the receptor of concern, be it human health, surface water, groundwater, buildings (or other property) or ecological issues.

13.4 The first stage in the assessment of a site is development of a conceptual model. This includes consideration of all possible sources of contamination on the site, the potential receptors and whether there is a plausible pathway between linking the two. This allows evaluation of whether an additional, more complex, risk assessment for an identified receptor is necessary.

13.5 A site conceptual model, based upon **Table 8.1**, is presented in **Section 15** and revised based upon the findings of the WA LLP ground investigation.

Generic Assessment Criteria

13.6 In March 2002, the EA and DEFRA released a package of guidance to assess the health risks posed by contaminated land as part of the relevant statutory framework.

13.7 The Contaminated Land Exposure Assessment (CLEA) model is a framework for estimating the likely exposure to contaminants in soil as part of the wider approach of the UK's assessment of risk and suitability for use. The methodology adopted for CLEA builds upon the source-pathway-receptor model for the assessment of risk. Following the CLEA model, generic Soil Guideline Values (SGVs) were developed to act as triggers for intervention in a number of end-use scenarios. The EA commenced a programme looking at 55no. contaminants. The CLEA methodology has been updated and the SGVs were withdrawn from use in August 2008. New SGVs have been published by the EA since March 2009 onwards.

13.8 The CLEA SGVs are derived using specific parameters, which may not be relevant to each site. The CLEA software allows parameters to be changed and subsequently, site-specific assessment criteria (SSAC) can be developed. The CLEA methodology also uses a statistical evaluation of all the data collected in order to give an overall impression of the site and therefore the exposure to a modelled receptor rather than using individual contaminant values, which may vary dramatically across the site.

13.9 The SGVs derived from the CLEA model are intended for use in assessing the risk to long-term human users of the site. There is also a requirement to consider the potential for harm from short-term exposure to contaminants at the site, e.g., to construction workers who may be exposed to risk via inhalation of dust or dermal contact with the contaminated material.

13.10 In the absence of SGVs published under the new CLEA methodology, Land Quality Management (LQM) and the Chartered Institute of Environmental Health (CIEH) published their third edition of generic assessment criteria (GAC) for 82no. inorganic and organic substances (with the exception of lead) which are termed Suitable 4 Use Levels or S4ULs. This edition of GAC was published in January 2015.

13.11 Category 4 Screening Levels (C4SLs) were published in 2014 which adopt a "low level of toxicological concern" (LLTC) as the toxicological benchmark. WA LLP have adopted the C4SL criteria for lead for this site and adopted S4ULs for all other determinants.

13.12 In addition, GAC values for 30no. separate organic compounds were published in December 2009 by the Environmental Industries Commission (EIC), the Association of

Geotechnical and Geo-environmental Specialists (AGS) and CL:AIRE. These GAC values have been derived in the same vein as SGVs and are intended to be used in the same manner. Additionally, the GAC values have been produced for varying soil organic matter content (i.e., 1%, 2.5% and 6%).

13.13 Whilst a failure against a screening target value does not necessarily present a "significant possibility of significant harm", the screening provides an indication of the level of additional assessment/remediation that may be required should high levels of contaminants be detected.

13.14 The proposed redevelopment is understood to be residential land use with associated garden/produce. As such, the most appropriate and conservative end use criteria for assessment are that of *Residential with Produce*.

13.15 The principal pathways of concern for human health are dermal contact, ingestion, and inhalation.

13.16 GAC values derived using 2.5% SOM have been selected based on the average soil organic matter percentage of 2.65% for the analysis data set.

13.17 The pH of the soil during this investigation ranged from 7.40pH units in sample TP3ES1 (0.25-0.50m bgl) to 9.2pH in sample WS4ES1 (0.10-0.30m bgl). The average pH across the site was recorded as 8.1pH.

13.18 The Chemtest laboratory certificates and the screening data are presented in **Appendix F**.

Soil Results

Asbestos

13.19 All 20no. soil samples were scheduled for asbestos identification testing, with no samples returning positive identification for asbestos containing materials.

Heavy Metals

13.20 Testing of the 20no. representative soil samples for metal determinants and subsequent screening against available residential with produce GACs returned no exceedances. It should be noted that the maximum concentrations of metal determinants, where measurable, were consistently recorded in samples WS3ES1, WS3ES2 or WS4ES1.

Total Petroleum Hydrocarbons

13.21 All 20no. soil samples were scheduled for Total Petroleum Hydrocarbons (TPH) C6-C40 testing.

13.22 The majority of the samples (15no. samples) returned TPH concentrations lower than the laboratory detection limit concentration (10m/kg), with 5no. samples returning measurable concentrations. The measurable concentrations ranged from 37mg/kg (TP2ES1 0.25-1.0m bgl) to 590mg/kg (WS4 EA1 (0.1-0.3m bgl).

13.23 There are no generic assessment criteria for total TPH C6-C40 concentration; however, the 5no. samples which returned measurable concentrations over 100mg/kg should be considered as elevated concentrations and therefore deemed to pose a potential risk to construction workers during the enabling works of the proposed development.

Polycyclic Aromatic Hydrocarbons

13.24 Testing of the 20no. representative soil samples for speciated Polycyclic Aromatic Hydrocarbons (PAHs) returned results lower than laboratory detection limit for all samples and individual determinants.

Preliminary Ground Gas Protection Measures

13.25 The proposed development is understood to be based on proposed residential land use with associated garden/produce.

13.26 Procedures set out in CIRIA C655 '*Assessing risks posed by hazardous ground gases to buildings*' have been used to determine the requirements for gas protection measures to effectively mitigate the identified risk.

13.27 The results of the preliminary ground gas protection measures, as summarised in **Table 11.3**, indicate that the worst-case scenario across the site to be Characteristic Situation 3.

13.28 For a proposed residential development with Characteristic Situation 3, the CIRIA 665 technical guidance indicates that a total of 2no. levels of protection are required. Typical scope of protective measures can include but not limited to the following:

- Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft) with at least 1200 g DPM and underfloor venting.
- Beam and block or pre-cast concrete and 2000g DPM/ reinforced gas membrane and underfloor venting.

- Proprietary gas resistant membrane and passively ventilated underfloor subspace or positively pressurised underfloor sub-space, oversite capping or blinding and in-ground venting layer.

13.29 For a proposed residential development with Characteristic Situation 1, the CIRIA 665 technical guidance indicates that no special precautions are required.

14 GEOTECHNICAL RESULTS

14.1 The geotechnical results from the ground investigation works have been summarised below into a geotechnical ground model.

14.2 In total, 7no. samples were collected from various depths and scheduled for a range of geotechnical parameters including:

- 7no. Moisture Content
- 7no. Atterberg Testing (4-point)
- 7no. Particle Size Distribution (Wet Sieve Method)
- 7no. BRE Reduced Suite
- 3no. 4.5kg Rammer Compaction

14.3 All geotechnical results can be found within **Appendix G**.

Particle Size Distribution Test

14.4 Particle Size Distribution (PSD) tests and sedimentation analysis were performed on 7no. samples. The range in quantity of each soil fraction is summarised in **Table 14.1**.

Table 14.1 – Summary of the Particle Size Distribution test results			
Sample ID	**Sample Depth (m bgl)**	**Lab Soil Description**	**Total Percentage**
WS1B1	0.60-1.00	Brown fine to medium gravelly fine to coarse sandy silty CLAY	• Clay: 48% • Silt: 8% • Sand: 24% • Gravel: 20% • Cobbles: 0%
WS2B1	0.50-1.00	Brown slightly sandy fine to coarse gravelly silty CLAY	• Clay: 63% • Silt: 11% • Sand: 7% • Gravel: 19% • Cobbles: 0%
WS3B1	1.00-2.00	Brown slightly gravelly fine to coarse sandy silty CLAY	• Clay: 71% • Silt: 9% • Sand: 11% • Gravel: 9% • Cobbles: 0%
WS4B1	1.00-1.50	Brown fine to coarse sandy fine to coarse gravelly silty CLAY	• Clay: 60% • Silt: 9% • Sand: 23% • Gravel: 8% • Cobbles: 0%
TP1B1	1.20-1.50	Brown slightly gravelly fine to coarse sandy silty CLAY	• Clay: 60% • Silt: 9% • Sand: 23% • Gravel: 8% • Cobbles: 0%
TP2B1	1.30-1.50	Brown slightly gravelly silty CLAY	• Clay: 84% • Silt: 8% • Sand: 0% • Gravel: 8% • Cobbles: 0%
TP3B1	1.00-1.40	Brown slightly silty fine to coarse sandy clayey fine to coarse GRAVEL	• Clay: 30% • Silt: 8% • Sand: 13% • Gravel: 49% • Cobbles: 0%

Atterberg Limits

14.5 Atterberg Limit testing was progressed on 7no. samples. A breakdown of the results from Atterberg Tests and plasticity indexes are detailed in **Table 14.2**.

TABLE 14.2 - Atterberg Limit Test Results

Sample ID	Sample Depth (m bgl)	Lab Description	Casagrande Classification	Moisture Content (%)	Plasticity Index (%)	Passing 0.425mm (%)	Volume Change Potential
WS1B1	0.60-1.00	Brown fine to medium gravelly fine to coarse sandy silty CLAY	CI	12	23	60	I'P: 13.8 **Low**
WS2B1	0.50-1.00	Brown slightly sandy fine to coarse gravelly silty CLAY	CI	20	25	76	I'P: 19 **Low**
WS3B1	1.00-2.00	Brown slightly gravelly fine to coarse sandy silty CLAY	CI	14	24	81	I'P: 19.4 **Low**
WS4B1	1.00-1.50	Brown fine to coarse sandy fine to coarse gravelly silty CLAY	CL	7.0	10	58	I'P: 2.8 **Low**
TP1B1	1.20-1.50	Brown slightly gravelly fine to coarse sandy silty CLAY	CI	18	20	73	I'P: 14.6 **Low**
TP2B1	1.30-1.50	Brown slightly gravelly silty CLAY	CI	16	25	92	I'P: 23 **Medium**
TP3B1	1.00-1.40	Brown slightly silty fine to coarse sandy clayey fine to coarse GRAVEL	NP	6.0	-	39	-

Notes: CI – inorganic clays of intermediate plasticity; CL – inorganic clays of low plasticity; & NP: non-plastic materials. I'P – Modified Plasticity Index (%).

4.5kg Rammer Compaction

14.6 A total of 3no. samples were scheduled for compaction density using a 4.5kg rammer in order to determine optimum moisture content and dry density.

14.7 The results of the compaction tests are summarised in **Table 14.3**.

Table 14.3 - Compaction Test Results

Sample ID	Sample Depth	Lab Soil Description	Optimum Moisture Content (%)	Initial Dry Density (Mg/m^3)
WS2B1	0.50-1.00	Brown slightly sandy fine to coarse gravelly silty CLAY	12	1.86
WS3B1	1.00-2.00	Brown slightly gravelly fine to coarse sandy silty CLAY	11	1.87
WS4B1	1.00-1.50	Brown fine to coarse sandy fine to coarse gravelly silty CLAY	10	1.80

BRE Suite Testing

14.8 A total of 7no. soil samples were scheduled for the BRE Reduced SD suite including pH, water soluble 2:1 sulphate, total sulphate, and total sulphur.

14.9 Summarised results can be seen in **Table 14.4**.

TABLE 14.4 - Summary of BRE SD1 Results

Test	Determinant Concentrations	
	Min	Max
pH	6.5	8.4
Water soluble 2:1 Sulphate (mg/l)	14	48
Water soluble 2:1 Magnesium (mg/l)	3.7	11
Water soluble 2:1 Nitrate (mg/l)	2.4	3.8
Water soluble 2:1 Chloride (mg/l)	1.4	3.5
Total Sulphate (%)	<0.01	0.02
Total Sulphur (%)	<0.01	0.02

14.10 Concentrations returned from the BRE testing suite together with the Tables C2 and D1 presented within *BRE Special Digest 1: 2005 Concrete in aggressive ground* (BRE

SD1) guidance document were reviewed. This information was used to classify the aggressive chemical environment across the site and specify the concrete design class recommended for use for any sub-surface structures proposed for the site.

14.11 For the purposes of the aggressive ground condition classification and based on limited groundwater recorded, it has been assumed there is a "*static water environment*" (as defined in Section C3.1 of BRE SD1) beneath the site. Furthermore, the low-permeability nature of the clay-dominant weathered zone of the Raglan Mudstone Formation was also identified as an assumed parameter.

14.12 Using Table C1 in BRE SD1, the aggressive chemical environment for concrete (ACEC) classification for the site is derived as AC-1s, resulting in a design sulphate class for the site of DS-1.

14.13 Using the derived the AC-1s and DS-1 classifications for the ground beneath the site, the concrete design class for any sub-surface structures as part of the site redevelopment, (assuming an intended working life over at least 50 years) is DC-1.

14.14 A concrete design class of DC-1 indicates that there are no recommended restrictions on the maximum free-water/cement or combination ratio or the minimum cement or combination content.

15 IN SITU TESTING

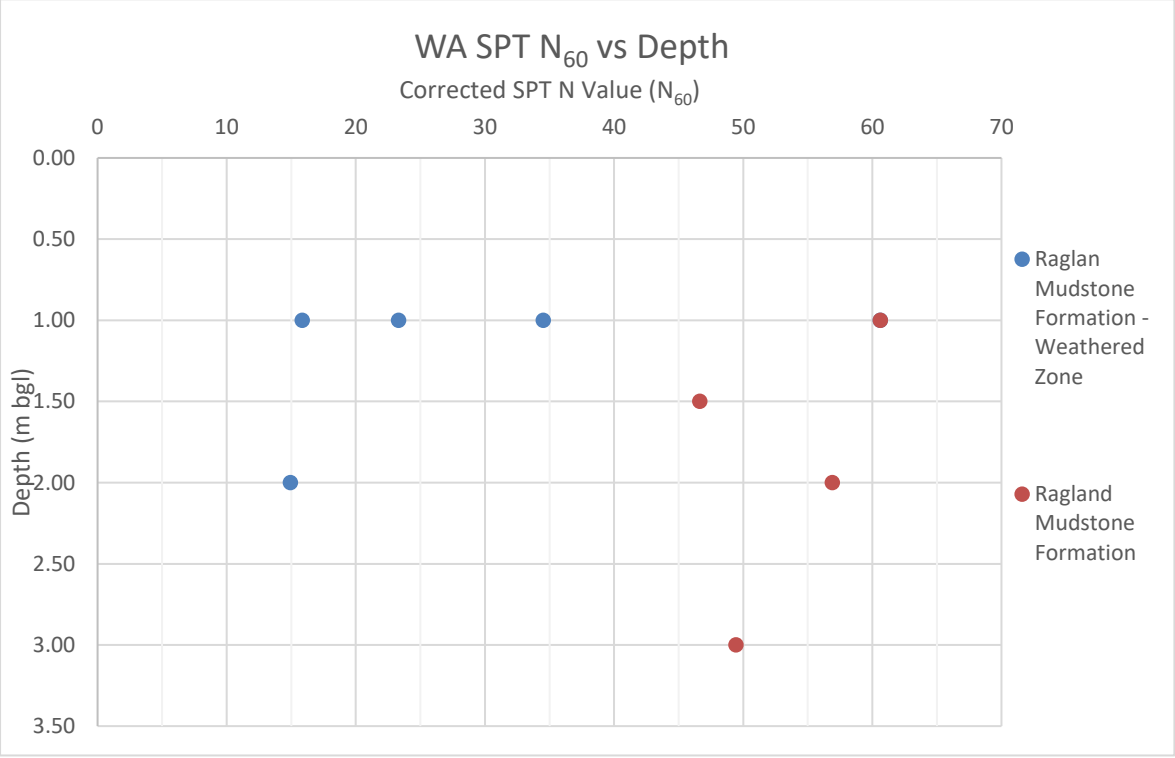
Standard Penetration Testing

15.1 In addition to laboratory geotechnical testing, in-situ standard penetration tests (SPTs) were carried out within the boreholes during the ground investigation. The results are presented in **Figure 2**.

15.2 Raw SPT N values have been corrected to 60% of the theoretical free fall hammer energy. SPT Calibration Certificates were obtained for the drilling rigs utilised during the ground investigation works.

15.3 The SPT N60 values presented in Figure 2 indicates a notable difference in the relative strength between the weathered zone (SPT N_{60} 14-34) and the bedrock (SPT N_{60} 46-61) of the Raglan Mudstone Formation.

Figure 2: Graph of N60 values against depth



TRL-DCP Testing

15.4 A total of 10no. Transport Research Laboratory - Dynamic Cone Penetration (TRL-DCP) tests were sunk to depths of between 200mm and 900mm bgl.

15.5 The DCP probe consists of a cone fixed to the bottom of a vertical rod (1.0m in length). A hammer is repeatedly lifted and dropped onto a coupling at the mid-height of the rod to deliver a standard impact, or 'blow', to the cone and drive it into the ground.

15.6 A vertical scale alongside the rod is used to measure the depth of penetration of the cone.

15.7 The penetration and the number of blows were recorded during the DCP testing on site. The penetration rate was recorded as the cone was driven into the ground and used to calculate the strength of the material through which the cone was passing. A change in penetration rate indicates a change in strength between materials, therefore allowing layers to be identified and the thickness and strength of each to be determined.

15.8 The tests were progressed to provide rapid, in-situ California Bearing Ratio (CBR) values across the proposed site area with depth information.

15.9 The TRL-DCP test reports are located within **Appendix J**.

Soakaway Testing

15.10 A total of 3no. soakaway tests were attempted within the weathered horizon of the Raglan Mudstone Formation encountered in TP01, TP02 and TP03.

15.11 All 3no. soakaway tests failed due to the very low permeability of the clay-dominant Raglan Mudstone Formation.

15.12 The results of soakaway tests are displayed within **Appendix K**.

16 ENGINEERING PROPERTIES

16.1 The geotechnical results from the ground investigation works have been summarised below.

16.2 Due to the variability of the made ground, no engineering parameters have been assigned; furthermore, WA assume that the majority /all the made ground deposits will be removed as part of the site earthworks or preparatory works. The Raglan Mudstone Formation also has no engineering parameters assigned due to no testing possible within the bedrock.

Raglan Mudstone Formation – Weathered Zone

16.3 The Raglan Mudstone Formation – Weathered Zone was encountered consistently across the site as a clay-dominant horizon underlying the topsoil and/or made ground deposits in all exploratory holes except for TP5. The weathered zone was recorded from 0.15m bgl (WS5) down to 2.95m bgl (WS3) with a maximum recorded thickness of 2.75m (WS3).

16.4 A summary of the derived engineering parameters for the weathered zone are presented in **Table 16.1**.

Material Classification

16.5 The Particle Size Distribution test results for the weathered zone have been classified in accordance with the Series 600 of the Specification for Highway Works (SHW) and indicate the material is 2A to 2C.

Plasticity and Volume Change Potential (VCP)

16.6 The results of the 6no. samples indicate that the weathered zone material to be of low to intermediate plasticity, while the sample collected from TP3 (1.00-1.40m bgl) returned a non-plastic classification.

16.7 Derived plasticity indexes ranged from 10% to 25% (low to intermediate) and the modified plasticity index were calculated between 2.8% to 23% indicating the volume change potential (VCP) of the material on-site. The results display 5no. samples of low VCP and 1no. samples of medium VCP.

Shear Strength

16.8 The estimated undrained shear strength of the Raglan Mudstone weathered zone, using correlations between plasticity index and SPT N_{60} by Stroud (1974), is approximately 80 – 296kN/m^2, averaging 122.4 kN/m^2.

Coefficient of Volume Compressibility, m_v

16.9 The coefficient of volume compressibility has been derived using Stroud (1974) method. Using the SPT N_{60} and plasticity index values the coefficient of volume compressibility was calculated to be between 0.030 and 0.123 m^2/MN with an average estimated to be approximately of 0.076m^2/MN.

TABLE 16.1 – SUMMARY OF ENGINEERING PARAMETERS OF THE ALLUVIAL DEPOSITS

Soil Parameter	Range
Series 600 SHW Classification	Class 2A/2B/2C
Plasticity Index (%)	10-25 (Low to Intermediate)
Volume Change Potential	Low to Medium
Moisture Content (%)	6-20
SPT N_{60} value	16-37
Undrained Shear Strength, c_u (kN/m^2)	80-296
Coefficient of volume compressibility, m_v (m^2/MN)	0.030-0.123
Design Sulphate Class	DS-1
ACEC Class	AC-1s

17 REVISED CONCEPTUAL SITE MODEL

17.1 A preliminary conceptual site model is presented in **Table 8.1**. A revised CSM is presented in this section which is based on the findings of the WA LLP ground investigation works and associated geochemical testing.

Potential Sources of Contamination

Onsite

17.2 The ground investigation works identified made ground deposits across the site with elevated metal and total petroleum hydrocarbon concentrations.

17.3 Additionally, the anecdotal evidence provided by a local resident, and the ground conditions recorded in TP5, indicate that buried construction waste may be present beneath the grassed area to the south of the site building.

17.4 Another potential source of contamination is the above ground tank of unknown content located along the building's southern exterior wall., which is believed to be associated with the disused public house.

Offsite

17.5 No major historic polluting incidents have been noted within 250m of the site.

17.6 The ground investigation found no evidence to suggest that contamination is migrating onto site from the previously identified potential off-site sources (i.e., electrical sub-stations and made ground).

Confirmed Sources of Potential Contamination

17.7 The sources of potential contamination are summarised below.

17.8 On-site contaminants associated with:

- Made ground deposits (Elevated metals and Total Petroleum Hydrocarbons).
- Derelict public house structure and associated unspecified tank (Potential asbestos containing materials and Total Petroleum Hydrocarbons).

Identification of Receptors and associated Pathways

17.9 The findings of the desk study and ground investigation works, the following receptors and their for contamination have been identified:

- Humans –Construction Workers

- Humans – Future site users & maintenance staff
- Surface Waters –Inland river, 12m to the southwest of the site.
- Controlled Waters – Secondary A aquifer (Raglan Mudstone Formation)
- Ecosystem – Flora and Fauna associated with the woodland to the 10m southwest.

Identification of Pathways

Human Health Pathways

17.10 There are various routes by which any contaminant(s) present within the soils or groundwater beneath the site may pose a direct risk to humans, either during construction work or following redevelopment. These pathways include:

- Direct ingestion of contaminated dust, soil and/or groundwater.
- Dermal contact with contaminated dust, soil and/or groundwater.
- Inhalation of dust
- Inhalation of vapours and/or gases

Built Environment Pathways

17.11 There is a potential for soil and groundwater containing substances aggressive to concrete to come into direct contact with service pipes / conduits, buried concrete and associated infrastructure.

17.12 There is limited potential for the generation of ground gas and vapour from the made ground and the unspecified tank. Associated ground gas and vapours have the potential to migrate directly from and through permeable material including the made ground to accumulate in buildings.

Controlled Water Pathways

17.13 The nearest surface water body is the inland river, that is located 12m southwest of the site. Contaminants may be transported as leachate or dissolved phase within water to the surface water bodies by shallow groundwater (which is in hydraulic continuity with the surface water) or via surface run-off.

17.14 Contaminants present within made ground may be in direct contact with the Raglan Mudstone Formation underlying the site (which is classified as a Secondary A aquifer).

Based on the potentially permeable nature of the bedrock, a primary mechanism for the movement of any contaminants within the soil into the bedrock aquifer will be through the leaching of the soil, dissolution into groundwater and/or groundwater movement.

17.15 Groundwater at the site has the potential to vertically migrate down into the bedrock (mudstone, siltstone, and sandstone of the Raglan Mudstone Formation) through any made ground overlaying the bedrock.

Ecosystem Pathways

17.16 Consideration of risks posed to any flora (from phytotoxic compounds) or fauna (direct contact including ingestion of flora) may be required if observed/recorded at the site.

Revised Quantitative Environmental Risk Assessment

17.17 From the combination of the information collated within this report thus far, a quantitative assessment of the potential geo-environmental risk is provided in **Table 16.1**. Where indicated, these risks may need to be considered for any future redevelopment of the land.

TABLE 16.1 REVISED CONCEPTUAL SITE MODEL					
Source	**Pathway**	**Receptor**	**Risk**	**Commentary**	**Post-Mitigation Risk**
Human Health					
S-P-R Link #1 **<u>Onsite</u>** • Tank • Made ground	• Dermal contact with contaminated soil and shallow groundwater • Ingestion/inhalation of soils and dust • Ingestion/inhalation of liquids and vapours from tank, the derelict pub structure and associated infrastructure.	Human health – Future Site Users (High receptor sensitivity)	Consequence: Medium Probability: Low Likelihood **Risk: Moderate/Low**	No visual or olfactory evidence of contamination surrounding the tank was recorded during the ground investigation works. Additionally, the geochemical testing of collected soil samples in WS5 identified no total petroleum or polycyclic aromatic hydrocarbons in exceedance of human health generic assessment criteria. However, elevated TPH concentrations were noted in the shallow made ground across the site. It is expected that the tank will be removed, by suitably qualified workers during the enabling works. A hardstanding and/or clean capping layer installed as part of the redevelopment would break the potential pollutant linkage for future site users.	Consequence: Medium Probability: Unlikely **Risk: Low**
		Human health – Construction workers (Low receptor sensitivity)	Consequence: Medium Probability: Likely **Risk: Moderate**	No visual or olfactory evidence of contamination surrounding the tank was recorded during the ground investigation works. Additionally, the geochemical testing of collected soil samples in WS5 identified no total petroleum or polycyclic aromatic hydrocarbons in exceedance of human health generic assessment criteria. However, elevated TPH concentrations were noted in the shallow made ground across the site. There remains the potential for unforeseen contamination to be present beneath the site and	Consequence: Medium Probability: Low Likelihood **Risk: Moderate**

TABLE 16.1 REVISED CONCEPTUAL SITE MODEL					
Source	**Pathway**	**Receptor**	**Risk**	**Commentary**	**Post-Mitigation Risk**
				associated with the tank. However, workers are expected to be provided with task-appropriate personal protection equipment (PPE) and significant contamination relating to the tank excavation is not expected.	
S-P-R Link #2 **<u>Onsite</u>** • Derelict Pub Structure (Asbestos)	• Inhalation of asbestos fibres. •	Human health - Future Site Users (High receptor sensitivity)	Consequence: Medium Probability: Unlikely **Risk: Low**	No asbestos containing materials were recorded during the ground investigation works or positively identified within collected soil samples via laboratory analysis. It is considered unlikely that future site users will come into contact with contamination associated with the current site building and infrastructure as all structures are expected to be demolished and removed by suitably qualified workers as part of the enabling works.	Consequence: Medium Probability: Unlikely **Risk: Low**
		Human health - Construction Workers (Low receptor sensitivity)	Consequence: Mild Probability: Likely **Risk: Moderate/Low**	No asbestos containing materials were recorded during the ground investigation works or positively identified within collected soil samples via laboratory analysis. It is recommended that an asbestos demolition survey of the site building is undertaken prior to any enabling works progressing on site. Any demolition works are expected to be undertaken by suitably qualified workers provided with task-appropriate PPE under safe working procedures to mitigate the contamination risk and therefore the consequence is considered mild.	Consequence: Mild Probability: Low Likelihood **Risk: Low**

TABLE 16.1
REVISED CONCEPTUAL SITE MODEL

Source	Pathway	Receptor	Risk	Commentary	Post-Mitigation Risk
S-P-R Link #3 **<u>Onsite</u>** • Made ground	• Generation and inhalation of ground gas	Human health – Future Site Users (High receptor sensitivity)	Consequence: Severe Probability: Low Likelihood **Risk:** Moderate	It is considered unlikely that future site users will come into contact with ground gas associated with made ground. Made ground has been identified beneath the site, the results of the 1no. environmental monitoring round indicate that special measures may be required as part of the proposed development. The made ground encountered at shallow depths during the construction works would be expected to be removed as part of the redevelopment. It is recommended that further ground gas monitoring works are undertaken to further define the associated ground gas risk and delineate areas requiring special measures	Consequence: Severe Probability: Unlikely **Risk:** Moderate/**Low**
		Human health – Construction workers (Low receptor sensitivity)	Consequence: Medium Probability: Low Likelihood **Risk: Moderate/Low**	Made ground has been identified at shallow depths across the majority of the site and at depth in TP5. Though environmental monitoring indicates minimal ground gas generation beneath the site, construction workers involved in any excavation works are considered likely to encounter ground gas. Construction workers working in excavations and trenches. However, it would be expected that task-appropriate PPE and/or RPE would be used during such work.	Consequence: Medium Probability: Unlikely **Risk: Low**

TABLE 16.1 REVISED CONCEPTUAL SITE MODEL					
Source	**Pathway**	**Receptor**	**Risk**	**Commentary**	**Post-Mitigation Risk**
Ecosystem					
S-P-R Link #4 **<u>Onsite</u>** • Derelict Pub Structure & Tank • Made ground	• Vertical and/or lateral migration of fuel, oils and leached contaminants into groundwaters, and the subsequent uptake by trees in the woodland.	Flora and Fauna Ancient Woodland southwest of the site.	Consequence: Mild Probability: Unlikely **Risk: Low**	There are woodlands to the southwest of the site where flora and fauna are located. Subsequently, the consequence of potential contamination reaching the woodlands has been considered as moderate. The findings of the ground investigation indicate no gross contamination of soils across the site, and limited potential for vertical migration of leached contaminants due to current hardstanding cover and low permeability of the Raglan Mudstone weathered zone. It is expected that the proposed redevelopment will incorporate an appropriately designed surface water drainage scheme to capture and collect any surface water run off thereby reducing the likelihood for leachate generation and off-site migration.	Consequence: Mild Probability: Unlikely **Risk: Low**

TABLE 16.1 REVISED CONCEPTUAL SITE MODEL					
Source	**Pathway**	**Receptor**	**Risk**	**Commentary**	**Post-Mitigation Risk**
Controlled Waters: Groundwater					
S-P-R Link #5 **<u>Onsite</u>** • Derelict Pub structure & Tank • Made ground	• Vertical migration of fuel, oils and leached contaminants into the underlying aquifer.	Controlled Waters (Bedrock-Secondary A).	Consequence: Medium Probability: Low LIkelihood **Risk: Moderate/Low**	There is potential for vertical migration of fuels/oils from the on-site tank and leached contaminants potentially present across the site leaching and dissolving into the groundwater within the Secondary A bedrock aquifer. The ground investigation returned no indication of gross contamination beneath the site and the failed soakaway test indicates the weathered zone of the Raglan Mudstone Formation to have very low permeability, thereby reducing the likelihood of vertical migration into the bedrock aquifer. It is expected that the tank will be removed, by suitably qualified workers, during the enabling works. It is expected that the proposed redevelopment will incorporate an appropriately designed surface water drainage scheme to capture and collect any surface water run off thereby reducing the likelihood for leachate generation and vertical migration.	Consequence: Medium Probability: Unlikely **Risk: Low**

TABLE 16.1 REVISED CONCEPTUAL SITE MODEL					
Source	**Pathway**	**Receptor**	**Risk**	**Commentary**	**Post-Mitigation Risk**
Controlled Waters: Surface Water					
S-P-R Link #6 **<u>Onsite</u>** • Derelict Pub structure & Tank • Made ground	• Contaminated surface water run-off flowing into surface water feature. • Conveying offsite of contamination waters via pipes, culverts and manifolds into surface water feature	Inland river, 12m southwest of the site.	Consequence: Medium Probability: Low Likelihood **Risk: Moderate/Low**	The ground investigation returned no indication of gross contamination associated with the tank or made ground beneath the site. It is expected that the tank will be removed, by suitably qualified workers, during the enabling works. It is expected that the proposed redevelopment will incorporate an appropriately designed surface water drainage scheme to capture and collect any surface water run off thereby reducing the likelihood for leachate generation and vertical migration.	Consequence: Medium Probability: Unlikely **Risk: Low**
Built Environment					
S-P-R Link #7 • Derelict Pub structure & Tank • Made ground	• Generation and migration of ground gas into buildings • Lateral migration of any gas generated off site. (Explosive Risk)	Built Environment (Structures)	Consequence: Severe Probability: Low Likelihood **Risk: Moderate**	Made ground has been identified beneath the site and generate ground gas and migrate through permeable ground and accumulate in buildings, subsequently posing a potential explosive risk. The results of the 1no. environmental monitoring round indicate that special measures may be required as part of the proposed development. The made ground encountered at shallow depths during the construction works would be expected to be removed as part of the redevelopment. It is recommended that further ground gas monitoring works are undertaken to further define the	Consequence: Medium Probability: Unlikely **Risk: Low**

TABLE 16.1 REVISED CONCEPTUAL SITE MODEL					
Source	**Pathway**	**Receptor**	**Risk**	**Commentary**	**Post-Mitigation Risk**
				associated ground gas risk and delineate areas requiring special measures.	
S-P-R Link #8 • Derelict Pub structure & Tank • Made ground	• Aggressive ground conditions	Built Environment	Consequence: Mild Probability: Low Likelihood **Risk: Low**	Aggressive ground conditions are common in made ground and result in chemical attack on sub-surface concrete structures. Collected soil samples were scheduled for specialised testing to allow for the classification of the site's potential for aggressive ground conditions. The testing indicated that no special concrete design needed to be considered for proposed sub-surface structures.	Consequence: Mild Probability: Unlikely **Risk: Very Low**

18 ENGINEERING CONSIDERATIONS

Site Constraints

18.1 Based upon the review of the available data discussed within this report and taking due consideration of the anticipated proposed development, the following geotechnical constraints have been identified:

- Variable thickness of made ground ranging in thickness from 0.2m to at least 1.3m.
- Shallow groundwater
- Ground gas

Site Preparation

18.2 It is understood that the current building will be demolished. All buried foundations and slabs will need to broken out and removed prior to construction of the proposed building.

18.3 All vegetation, including all roots, should be stripped beneath the development area(s).

18.4 All areas of hardstanding should be broken out from beneath the development area(s).

18.5 Allowances should be made for rerouting any buried services and the isolation and cutting back to the boundary of any non-essential or redundant services.

18.6 Reduced levels should be brought to the required levels with material classified in accordance with Series 600 SHW.

18.7 Technical Guidance WM3: Hazardous Waste: Interpretation of the definition and classification of hazardous waste provides guidance on the assessment and classification of hazardous waste based on the revised Waste Framework Directive definition of hazardous waste. For any material destined for offsite landfill disposal, the guidance should be used to identify the correct waste code for their waste and determine whether waste is hazardous or not based on its chemical composition.

18.8 In advance of detailed civil/earthworks design, the engineering recommendations and geotechnical considerations are preliminary in nature. The foundation and geotechnical recommendations should be reviewed at detailed design stage.

Foundations

18.9 A preliminary foundation assessment has been undertaken by WA based on the northern part of the site within the area in which the building is currently located. Light percussive dynamic windowless sampling boreholes have been completed within the area of the current proposed housing development. Should the proposed development change then the assessment should be revised accordingly.

18.10 Made ground deposits were encountered across the site and are unlikely to be a suitable bearing stratum for shallow foundations. The thickest made ground deposits were encountered in south of the existing building at a depth of 0.7m bgl (thickness 1.3m).

18.11 North of the site the made ground was thinner and weathered Raglan Mudstone was encountered at shallower depths.

18.12 Due to the thickness of the made ground in the south of the site it is unlikely that shallow foundations will be suitable in this area.

18.13 However, should the footprint of the building be contained to the northern part of the site then traditional shallow strip foundations may be feasible.

18.14 The anticipated loadings of the proposed development have not been provided or assessed as part of this report.

18.15 However, WA estimate that the weathered Raglan Musdtone has an approximate bearing capacity of 100kN/m^2 assuming a foundation width of 0.6m founded at 0.9m below formation level to ensure settlement does not exceed 25mm.

18.16 The bearing capacity of the made ground in the south of the site has not been estimated. However, should the footprint of the proposed building extend into this area then more specialist foundations may be required to accommodate for the thick made ground and variable ground conditions beneath the building.

18.17 Differential settlement will also need to be considered at the detailed design stage.

18.18 Soil plasticity testing determines that the deposits beneath the site have a typically low shrinkage potential, however medium shrinkage potential has also been noted. WA recommend that the foundation depth takes into consideration the VCP of the soil and deepened where necessary especially if cut or fill is required at the site.

18.19 It is also recommended that an arboricultural survey is undertaken where trees exist or are proposed such that foundation depths can be adopted in accordance with NHBC

guidance due to the medium (VCP) of the clay. Following a detailed arboricultural survey and investigation, it will be possible to refine the recommendations with regard to foundation type and depths.

18.20 It should be noted that deeper than quoted foundation depths may also be required due to the removal of historic foundations/floor slabs/other buried structures such as basements.

Floor slabs

18.21 Floor slabs should be designed and constructed as suspended with an appropriate void depth between the underside of the beam and the ground level.

Building Near Trees

18.22 In accordance with the NHBC Standards, Chapter 4.2, the minimum foundation depths are required to be assessed with regards to zones of existing, removed and new planting/trees.

18.23 The foundation depths may need to be greater due to the potential for volumetric change as trees, hedgerows or shrubs take moisture from the ground and, in cohesive soils such as clay, this can cause significant volume changes resulting in ground movement.

18.24 This has the potential to affect foundations and damage the supported structure. In order to minimise this risk, foundations should be designed to accommodate the movement or be taken to a depth where the likelihood of damaging movement is low.

18.25 Where a combination of existing, removed and proposed trees exists, the worst case deeper foundation depth should be selected for that plot.

18.26 Before the site is cleared, a tree survey should be undertaken to record the location, height and species of trees, hedgerows and shrubs on site.

Excavations

18.27 Shallow excavations should be possible with excavating machinery and hard standing areas and any buried obstructions requiring hydraulic attachments.

18.28 Excavations have the potential to encounter perched water within the made ground deposits and/or groundwater flows. It should be noted that during times of heavy rainfall a higher water table is likely to be encountered.

18.29 There is potential for excavations to become unstable due to the nature and combination of made ground deposits and the gravelly clays of the weathered zone.as demonstrated with the excavation of TP5. As a results, shoring excavations may require and dewatering of excavations cannot be discounted.

18.30 WA note the presence of shallow bedrock as referred to and discussed above.

Ground Gas

18.31 Surcharge of the ground due to upfilling may lead to an increase of ground gas release and migration. Ground has during construction should considered further through additional environmental monitoring before, during and post- construction and reassessment for the gas protection measures required.

19 CONCLUSIONS AND RECOMMENDATIONS

Current Land Use

19.1 The site is located off Circle Way West Road. The site covers an area of approximately 0.29 hectares and is centred at National Grid Reference 319872 E, 180522 N

19.2 The site comprises a derelict public house and is surrounded by residential properties. An above ground tank of unknown content located along the building's southern exterior wall..

19.3 The proposed redevelopment is understood to be residential end-use.

Geo-Environmental Background

19.4 The desk study identified that the site is not underlain by any artificial or superficial deposits, with Raglan Mudstone present as the bedrock formation.

19.5 No records of historical coal mining activities were identified beneath or within 250m of the site.

19.6 The Raglan Mudstone Formation bedrock underlying the entire site is classed as a Secondary A aquifer; however, no records of abstraction licences have been identified and the site is not located within a source protection zone.

19.7 The nearest surface water feature to the site is an unnamed "*Inland River*" located approximately 12m to the southwest of the site.

19.8 There are no records of historic pollution incidents or potentially contaminative processes occurring on site, except for the unspecified tank associated with the disused public house structure.

19.9 There are no records of any historical or active landfills or licenses waste facilities within 250m of the site.

19.10 No records of environmentally sensitive sites were identified within 250m of the site, with the exception an area designated as Ancient Woodland located approximately 10m to the southwest of the site.

19.11 A review of available BGS data as part of the desk study highlights that the risk to the site posed from geohazards such as compressible and collapsible ground, running sand, landslides and soluble ground are considered to be negligible to low.

Ground Investigation Works

19.12 Intrusive ground investigation works were commenced and completed on the 13th June 2022 and comprised 5no. windowless sampler boreholes, 5no. trial pits, 3no. soakaway tests, and 10no. TRL-Dynamic Cone Penetration tests.

19.13 As part of the ground investigation works, a total of 20no. soil samples were collected and scheduled for a range of contaminant testing, and a total of 7no. bulk samples were collected and scheduled for a range of geotechnical parameter testing.

19.14 A round of environmental monitoring was undertaken following the ground investigation works in order to record groundwater level across the site, where present; and to measure and record the presence, chemical composition and flow rate of any recorded ground gas.

Ground Conditions

19.15 The ground investigation works encountered a thin horizon of made ground deposits immediately beneath the hardstanding present across the site area to the north of the site building. The made ground was recorded from 0.05m bgl to a maximum depth of 0.30m bgl (at WS4), with a maximum encountered thickness of 0.25m. The deposits were described predominantly as a brown to light grey gravel.

19.16 Across the grassed site area, to the south of the existing site building, topsoil was encountered from ground level to a maximum depth of 0.20m bgl (TP5). The topsoil was recorded as a firm orangish brown slightly sandy, slightly gravelly clay with rootlets.

19.17 Beneath the topsoil in the south of the site, a thickness of reworked or impacted natural ground was encountered (0.15m in WS5 and 0.50m in TP5) as a sandy gravelly clay containing fragments of anthropogenic materials such as brick and glass.

19.18 Deeper made ground was encountered in TP5 and was recorded from 0.70m bgl to 2.0m bgl. This deeper made ground was of a different composition to those identified within the exploratory positions to the north of the site building. The made ground was recorded as soft, grey-brown clay with minor constituents of sand and gravel, and occasional cobbles. The gravel and cobbles were fine to coarse, angular to sub-rounded clasts of mudstone, and fragments of glass, metal sheeting, metal rebar, plastic, tile and wood. The base of the made ground materials encountered in TP5 was not observed due to instability of the trial pit excavation.

19.19 Based on anecdotal evidence, provided by a local resident of the area, it is understood that the grassed area to the south of the site building was part of a larger area which was used to bury/retain waste soils. This material originated from the construction of the adjacent residential properties surrounding the site.

19.20 A clay-dominant soil horizon was encountered underlying the topsoil and made ground layers in all exploratory holes except for TP5. This clay-dominant soil horizon has been interpreted as the weathered zone of the Raglan Mudstone Formation and was recorded from 0.15m bgl (WS5) down to 2.95m bgl (WS3), with a maximum recorded thickness of 2.75m (WS3). The soil horizon was recorded as a predominantly soft becoming firm with depth, reddish brown clay with minor constituents of silt, sand and gravel.

19.21 The bedrock of the Raglan Mudstone Formation was observed in the base of all exploratory holes, except for TP5. The bedrock was recorded from a minimum depth of 0.95m bgl (WS1) with a maximum observed thickness of 0.20m (TP3). The Ragland Mudstone was observed as an extremely to very weak, pale pink to reddish brown distinctly weathered mudstone. In the trial pit excavations, the bedrock was commonly excavated as a slightly clayey sandy gravel with cobbles.

19.22 No groundwater was encountered during the investigatory works.

19.23 The only visual or olfactory sign of contamination recorded during the ground investigation works was a slight hydrocarbon malodour within the made ground deposits of TP5, laboratory testing of this material returned a Total TPH C6-C40 concentration of 180mg/kg and lower than laboratory detection limits for PAHs. Additionally, no asbestos containing materials were identified.

Contamination Considerations

19.24 A total of 20no. soil samples were collected from a range of locations and depths across the site and scheduled for a range of commonly occurring contaminants such as asbestos, toxic metals, TPH and PAHs. The results of the geochemical testing were then assessed for the potential risk to human health and environmental receptors (using relevant generic assessment criteria) within the context of a proposed residential development. The testing and assessment identified no exceedances across the site, indicating that there is no risk to construction works or future site users. However, it should be noted that elevated concentrations of total petroleum hydrocarbon (maximum 590mg/kg) were recorded across the site.

19.25 In order to protect construction workers during any intrusive works during redevelopment it is recommended that task appropriate personal protection equipment is utilised.

19.26 Future site users are not expected to come into contact with any potentially contaminated materials, as hardstanding and/or a clean capping layer are expected to break the completed pollutant linkage.

Ground Gas

19.27 The 1no. environmental monitoring visit, undertaken on the 3no. monitoring wells installed across the site, indicates that ground gas generation is low (Characteristic Scenario 1) and that ground gas remedial measures are unlikely to be required within 2no. boreholes (WS1 & WS5). The monitoring of borehole WS3 returned elevated concentrations of Methane and Carbon Dioxide resulting in a classification of Characteristic Scenario 3, which would require special remedial measures in order to minimise the risk to the future site users and the built environment from ground gas beneath the site. It is recommended to undertake additional ground gas monitoring rounds to provide additional data in order to progress a more detailed ground gas risk assessment.

Geotechnical Considerations

19.28 Geochemical testing on soil samples collected during the intrusive works allowed for the classification of the aggressive ground conditions (AC-1s) and concrete design class (DS-1) for any proposed sub-surface structures.

19.29 The soakaway testing undertaken as part of the ground investigation works failed due to the low permeability of the Raglan Mudstone Formation and its weathered zone. Therefore, conventional soakaways are not recommended as part of a drainage scheme for the redevelopment.

19.30 The made ground deposits encountered during the ground investigation works beneath the site may be suitable for retention and reuse below a clean cover system or beneath areas of hardstanding.

19.31 The extent of the made ground encountered in TP5 is unknown and there may be a significant volume of material unsuitable for founding at this location. The subsurface material at this location may also possess undesirable geotechnical properties for earthworks.

19.32 Providing foundations are placed within areas where Made Ground is minimal and upon the weathered Raglan Mudstone i.e the northern part of the site then traditional shallow strip foundations may be suitable. Should the footprint of the proposed building extend to the south and above the areas of thick Made Ground then more specialist foundations may be required to mitigate against total and /or differential settlement beneath the building.

1.1.1 The foundation recommendations, particularly with regards to earthworks, tree planting, influence on foundation levels and changes to the proposed building footprint, should be reassessed at the detailed design stage.

19.33 If the proposed redevelopment necessitates site levels to be raised, due consideration should be given to feasibility of re-use of site won materials, placement and compaction of the materials in accordance with Series 600 of the Specification for Highway Works (SHW) and the anticipated loads associated with any imported materials applied to the underlying ground.

19.34 Additionally, any retention and reuse or import of material to site as part of the redevelopment should be undertaken in accordance with a Materials Management Plan (MMP) that has been declared at CL:AIRE by a Qualified Person in accordance with the Definition of Waste Code of Practice (DoWCoP).

Appendix A

Standard Terms and Conditions and Limitation to Report

Appendix I

Standard Terms and Conditions

STANDARD TERMS AND CONDITIONS AND LIMITATIONS TO REPORTS

This Report is provided for the stated purpose and for the sole use of the client in accordance with the Terms and Conditions of Appointment under which the services were performed. The Report is confidential to the client and no other warranty, expressed or implied, is made as to the professional advice included in the Report or any other services provided by Wardell Armstrong LLP. This Report may not be disclosed by the Client nor relied upon by any other party without the prior and express written agreement of Wardell Armstrong LLP.

Should any third party wish to use or rely upon the contents of this report, written approval must be sought and a charge may be levied accordingly.

Wardell Armstrong LLP accepts no responsibility or liability for the consequences of this document being used:

a. For any purpose or project other than for which it was commissioned, and
b. By any third party with whom an agreement has not been executed.

The conclusions and recommendations contained in this Report are based upon information provided by others including details supplied by the client and/or professional advisors on the assumption that all relevant information from whom it has been requested and/or supplied is accurate. Information so provided and/or supplied has not been verified independently by Wardell Armstrong LLP, unless otherwise stated in the Report.

The information has been accepted and used in good faith and unless otherwise stated, no attempt has been made to verify the information supplied. Should any of these factors or information change then the conclusions of the report may need to be amended.

The methodology adopted and the sources of information used by Wardell Armstrong LLP in providing the services are outlined in this Report. The work described in this Report is based on the conditions and information as stated at the date the Report was completed. The scope of this Report and the services are accordingly limited by these circumstances. The findings outlined in the Report together with any opinions expressed and recommendations made are considered to be valid and appropriate at the time of preparation and for the specific purpose or purposes intended.

The findings and recommendations are considered to be valid and appropriate at the time of preparation and for the specific purpose or purposes intended. Wardell Armstrong LLP will not be liable if any findings are used by third parties, without written agreement of the company, or if an interpretation is made and action taken without further consultation.

Wardell Armstrong LLP disclaim any undertaking or obligation to advise any person of any change in any matter affecting the Report which may come or be brought to Wardell Armstrong LLP's attention after the date of the Report. Unless otherwise stated in this Report, the assessments made assume that the site will continue to be used for their current purpose without significant changes.

Where site observations have been carried out, these have been restricted to a level of detail required to meet the stated objectives of the services. The results from any site observations made may vary and further confirmatory work should be made after the issuance of this Report. Wardell Armstrong LLP does not guarantee or warrant any estimates or projections contained in this Report.

The executive summary forms part of the overall report and should not be considered in isolation.

The findings within this report are based on limited borehole locations, machine excavated trial pits, and in-situ tests. The results from this site assessment are indicative of the ground conditions encountered at the positions the boreholes were drilled and/or where the trial pits were excavated. Whilst reasonable inferences have been made between the site investigation locations, ground conditions can and may vary between exploratory locations.

The scope of the investigation was selected on the basis of the Client's specific development proposal and may be inappropriate to any other form of development or scheme that may be considered at the site in the future.

The risk assessment(s) and opinion(s) provided are based on current guidance; no liability can be accepted for the retrospective effects of any future changes or amendments that may be relevant in the future.

Appendix B

Site Walkover Record

SITE VISIT RECORD	
Date of visit	8/06/22
Weather	Sunny, Clear
Client	Cardiff Council.
Enquiry/Job No.	CA12409
Site name	New Penn
Drawings / photographs attached?	Yes
Visited by	Bethan Hallett and Sunny Saikumar
Site contact details	
Access details	Access off Circle West Way Road.
Site area (Ha)	0.29

Observations	**Comments**	**Further action required?**
General Site Details		
Relevant Identification *(names of buildings, roads etc)*	New Penn Pub, off Circle West Way Road	
Present Land Use	Unfunctional Pub	
Adjacent Land Use	Residential Properties	
Adjacent public highways, roads leading to /crossing/servicing the site	Circle Way West Road and Brynfedw	
Site Access (*main access points, dimensions, by rig/excavator etc, footpaths)*	Main access through the west of the site off Circle Way West Road.	
Site Boundary *(walls, hedges and fences open etc)*	Open boundaries.	
Topography *(general site setting, land gradients, slopes etc)*	Generally flat, sloping to the south-east.	
Evidence of land use		
Archaeology	N/A	

Observations	Comments	Further action required?
(old buildings, monuments, mounds, ditches, artefacts in soil, pottery/glass)		
Site Relics *(evidence of past land use, building remains, roads, humps, bumps, hollows etc)*	N/A	
Buildings *(general condition/construction; eg brick/ steel framed, asbestos, pits/basement, use)*	Unfunctional Pub, possible brick made with a cellar entrance at the rear for possible storage of alcohol.	
Storage Facilities *(eg: tanks/drums/chemicals/capacity /condition/bunding/containment)*	Potential Generator tank for storage of hydrocarbons observed towards the south-east. Blue waste bins observed close to the western entrance to building.	
Activities/processes on site *(past and present)*	Past site activity is notably that of the New Penn pub.	
Observable Environment *(noise/dust/odours/emissions)*	N/A	
Waste Management *(fly tipping/ waste disposal/fires)*	No fly tipping noted on site. Waste bins noted on the western entrance of the pub.	
Underground Services *(evidence of manholes, grates, culverts, water supply, telephone)*	Included in utility plans. No observable evidence on site.	
Overhead Services *(overhead cables/pipes)*	Overhead power lines noted near outdoor seating.	
Evidence of ground conditions		
Vegetation *(description and condition, tree, frequency and age, bare patches, saplings, new growth)*	Mature trees noted on the western and southern boundaries of site, along with grassy banks to the east of the pub building.	
Ecology *(woodland, trees, hedges, ponds, running water, water loving plants, wildflowers, wildlife)*	N/A	
Soil Cover *(vegetated, unvegetated, soil/made ground/hardstanding/ condition/cracks/staining)*	Potential made ground in the form of gravel, and hardstanding concrete noted on site.	
Evidence of Geological Setting *(made ground, natural superficials and underlying rock)*	Made ground noted on site. Western side is noted to be laden with hardstanding concrete and gravel.	S.I recommended

Observations	Comments	Further action required?
Groundwater and Drainage *(ponding, streams, springs, wells, marshes, tides, rivers etc)*	N/A	
Subsidence *(fissures, abrupt changes in slope, collapse, tilting tree/posts, property damage)*	N/A	
Evidence of Mining *(surface features, shafts, trenches, tunnels, caves, wells, boreholes, gas etc)*	N/A	
Hazards identified		
(e.g. contamination, mine entries, ground fissures, sharps etc)	Hydrocarbon tank noted at the rear of the pub. Intrusive S.I recommended.	S.I recommended.
Anecdotal information		
Local knowledge		
Interview with residents/staff		
Further observations		
Additional remarks		
	Interior of pub not examined. Potential for Asbestos. Requires thorough examination.	

Originator: Sunny Saikumar **Date: 15/06/22**

Checked & Approved: Bethan Hallett **Date:**

Appendix C

Site Walkover Photographs

Appendix D

Zetica UXO Pre-Desk Study Assessment

Pre-Desk Study Assessment

Site:	West Way Road, New Penn, Cardiff, Wales
Client:	Wardell Armstrong
Contact:	Sunny Saikumar
Date:	16th June 2022
Pre-WWI Military Activity on or Affecting the Site	None identified.
WWI Military Activity on or Affecting the Site	None identified.
WWI Strategic Targets (within 5km of Site)	The following strategic targets were located in the vicinity of the Site: ■ Cardiff Docks. ■ Transport infrastructure and public utilities. ■ Industries important to the war effort, including chemical, engineering and metal works.
WWI Bombing	None identified on the Site.
Interwar Military Activity on or Affecting the Site	None identified.
WWII Military Activity on or Affecting the Site	None identified.
WWII Strategic Targets (within 5km of Site)	The following strategic targets were located in the vicinity of the Site: ■ Cardiff Docks. ■ Transport infrastructure and public utilities. ■ Industries important to the war effort, including munitions factories, chemical, engineering and metal works. ■ Royal Air Force (RAF) Pengam Moors. ■ Military barracks, camps and training areas. ■ Anti-aircraft (AA) and anti-invasion defences.
WWII Bombing Decoys (within 5km of Site)	None.
WWII Bombing	During WWII the Site was located in the Rural District (RD) of Cardiff which officially recorded 502No. High Explosive (HE) bombs with a bombing density of 8.4 bombs per 405 hectares (ha). No readily available records have been found to indicate that the Site was bombed.
Post-WWII Military Activity on or Affecting the Site	None identified.
Recommendation	A detailed desk study, whilst always prudent, is not considered essential in this instance.
Further information	For information about Zetica's detailed UXO desk studies and other UXO services, please visit our website: www.zeticauxo.com.

	Details and downloadable resources covering the most common sources of UXO hazard affecting sites in the UK can be found **here**. If you have any further queries, please don't hesitate to get in contact with us at uxo@zetica.com or 01993 886 682.

This summary is based on a cursory review of readily available records. Caution is advised if you plan to action work based on this summary.

It should be noted that where a potentially significant source of UXO hazard has been identified on the Site, the requirement for a detailed desk study and risk assessment has been confirmed and no further research will be undertaken at this stage. It is possible that further in-depth research as part of a detailed UXO desk study and risk assessment may identify other potential sources of UXO hazard on the Site.

Appendix E

Risk Assessment Matrix

Guidance on Contaminated Land Risk Assessment

In the UK, contaminated land is regulated by the planning and development control system and the contaminated land regime set out in Part 2A of the Environmental Protection Act (EPA) 1990.

When considering an application for development, the potential for the land to be contaminated is a material consideration, and the local planning authority should satisfy itself that any contamination is properly assessed and adequately remediated, based on a suitable for use approach. This is to ensure that the land is made suitable for its proposed new use.

Guidance on the investigation of contamination is contained in British Standard 10175: 2011 (+A2-2017) "Investigation of potentially contaminated sites - Code of Practice". It involves an identification of risks due to the presence of contaminants, and an assessment of those risks based on the:

- possible sources of contamination;
- identification of who or what may be affected by the contaminants (the receptors);
- possible pathways by which contaminants may migrate to one or more of the receptors.

A conceptual site model is a representation of the environmental processes that occur on and in the vicinity of the site and its purpose is to identify the potential contamination linkages that exist on the site. The assessment of the significance of these contamination linkages can then be carried out through the risk assessment process.

Since the conceptual site model underpins each stage of contaminated land management, BS10175: 2011 (+A2-2017) suggests that such a model should be developed for every site. Accordingly, the results of the desk study research on the site have been used to identify the source- pathway-receptor relationships that exist on the site before and during redevelopment works.

A conceptual site model is a representation of the environmental processes that occur on and in the vicinity of the site and its purpose is to identify the potential contamination linkages that exist on the site. The assessment of the significance of these contamination linkages can then be carried out through the risk assessment process.

Environmental Risk Assessment Methodology

In line with EA guidance LCRM, plausible source, pathway and receptor linkages have been identified through the Conceptual Site Model (CSM). The information gathered in the CSM can now be used to carry out a Qualitative Risk Assessment (QRA).

The LCRM outlines that for each tier of Risk Assessment the following steps must be taken:

1. Identify the hazard - establish contaminant sources.
2. Assess the hazard - use a source-pathway-receptor (S-P-R) linkage approach to find out if there is the potential for unacceptable risk.
3. Estimate the risk - predict what degree of harm or pollution might result and how likely it is to occur by using the tiered approach to risk assessment.
4. Evaluate the risk - decide whether a risk is unacceptable.

The LCRM states that the assessment must be based on the potential severity that the risk poses to the receptors against the likelihood of it happening. Subsequently, it is necessary to employ a risk assessment matrix, the CIRIA document Contaminated Land Risk Assessment – a guide to good practice C552, 2001 provides a good example of a suitable risk assessment matrices.

In the CIRIA methodology, the sensitivity assessment considers the contaminant-pathway-receptor in conjunction with the contamination linkage concept (described below). This information is then used to classify consequences and the probability of a contamination linkage occurring, affording the level of sensitivity of a given receptor to be established.

Contamination Linkage Concept

In forming a risk assessment for land contamination, there are three essential elements to be given consideration collectively known as a ‘contaminant linkage’:

- A contaminant/source – A substance that is in, on or under the land and has potential to cause harm or to cause pollution of controlled waters.

- A receptor – in general terms, something that could be adversely affected by a contaminant, these can include people, an ecological system, property or a water body; and

- A pathway – a route or means by which a receptor can be exposed to or affected by a contaminant.

Each of these elements can exist independently, but they create a risk where they are linked together, so that a particular contaminant affects a particular receptor through a particular pathway. This kind of linked combination of contaminant-pathway-receptor is described as a contaminant linkage.

Sensitivity Assessment Criteria

By considering the contaminant, pathways and receptors, an assessment of the environmental risk is made with reference to the degree of sensitivity of the receptor to a contaminant.

The qualitative sensitivity assessment is conducted by determining the severity of the potential consequences, taking into account the probability of risk and by considering the sensitivity of the receptor based on the categories below. It follows CIRIA documents C552 terminology and methodology as summarised:

Potential Consequences	x	Probability of Risk	=	Sensitivity
(Table 1)	x	(Table 2)	=	(Table 3)

Table 1 presents the consequences to the receptor of the contaminant linkage being realised. It has four categories, with severe being the most serious and minor being the least serious consequences:

Table 1 – Consequence of Risk Being Realised			
Classification	**Category**	**Definition**	**Examples (Not necessarily specific to this site)**
Severe short-term (acute) risks only	Humans	Short-term (acute) risk to human health likely to result in "significant harm" as defined by the Environment Protection Act 1990, Part 2A.	High concentrations of cyanide on the surface of an informal recreation area.
	Controlled Waters	Short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource.	Major spillage of contaminants from site into controlled water.
	Property	Catastrophic damage to buildings/property.	Explosion causing building collapse (can also equate to a short-term human health risk if buildings are occupied.
	Ecological System	A short-term risk to a particular ecosystem, or organism forming part of such ecosystem.	
Medium chronic (long term) risks; "significant harm"	Humans	Chronic damage to Human Health ("significant harm" as defined in Defra 2006).	Concentrations of a contaminant from site exceed the generic, or site-specific assessment criteria
	Controlled Waters	Pollution of sensitive water resources (note: Water Resources Act contains no scope for considering significance of pollution).	Leaching of contaminants from a site into a major or minor aquifer.
	Ecological System	A significant change in a particular ecosystem	Death of a species within a designated nature reserve.
Mild chronic (long term) risks; fewer sensitive receptors	Controlled Waters	Pollution of non-sensitive water resources.	Pollution of non-classified groundwater
	Property	Significant damage to buildings, structures and services ("significant harm" as defined in Circular on Contaminated Land, Defra, 2006). Damage to sensitive buildings/structures/services	Damage to building rendering it unsafe to occupy (e.g., foundation damage resulting in instability)
	Ecological System	Significant damage to crops. Damage to the environment.	
Minor chronic (long term) risks; mild	Financial / project	Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve.	
	Humans	Non-permanent health effects to human health (easily prevented by means such as personal protective clothing, etc).	The presence of contaminants at such concentrations that protective equipment is required during site works.
	Property	Easily repairable effects of damage to buildings, structures and services	The loss of plants in a landscaping scheme. Discolouration of concrete.

The likelihood of the pollution linkage being realised must take into account the presence of the source and position of the receptor as well as the pathway that connects them. Table 2 overleaf defines the likelihood of the pollution linkage occurring.

TABLE 2: Probability of Risk Being Realised	
Classification	**Definition**
High Likelihood	There is a contaminant linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a contaminant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a contaminant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place and is less likely in the shorter term.
Unlikely	There is a contaminant linkage, but circumstances are such that it is improbable that an event would occur even in the very long term.

The potential consequences and the probability of the risk occurring are combined to form the classification of sensitivity matrix, as presented in Table 3a below. It provides a sensitivity category for potential receptors if a pollution linkage exists, allowing the level of sensitivity of a receptor in a particular circumstance can be determined.

TABLE 3a: Risk Classification Matrix					
		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High Likelihood**	Very High	High	Moderate	Moderate/Low
	Likely	High	Moderate	Moderate/Low	Low
	Low Likelihood	Moderate	Moderate/Low	Low	Very Low
	Unlikely	Moderate/Low	Low	Very Low	Very Low

TABLE 3b: Risk Classification Definitions	
Very High	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term.
Moderate	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Moderate / Low	A notable balance between moderate and low categorisation. The moderate/low interface.
Low	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Under each of the contaminant linkage categories, the identified environmental risks have been assessed with regard to a wide range of topics including (where appropriate):

- the 'source-pathway-receptor' concept;
- the behaviour of potential contaminants within the environment;
- environmental processes;
- industrial operations and best practice;
- current environmental legislation;
- the views and practices of the environmental regulators;
- the likelihood of environmental notices, orders or other enforcement action;
- any requirements to remove waste, contaminated or hazardous materials;
- the health and safety of occupiers or neighbours;
- any redevelopment plans for the site; and
- effects on the fabric of buildings caused by contamination.

Appendix F

Soils Geochemical Laboratory Certificates

Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

2183

Final Report

Report No.:	22-22154-1
Initial Date of Issue:	20-Jun-2022
Client	Wardell Armstrong LLP
Client Address:	Tudor House 16 Cathedral Road Cardiff Cardiff CF11 9LJ
Contact(s):	Patrick Moore Sam Folarin
Project	CA12409 New Penn Pub
Quotation No.:	Q22-26577
Order No.:	CA10630
No. of Samples:	20
Turnaround (Wkdays):	5
Date Approved:	20-Jun-2022
Approved By:	
Details:	Stuart Henderson, Technical Manager

Date Received:	15-Jun-2022
Date Instructed:	15-Jun-2022
Results Due:	21-Jun-2022

Results - Soil

Project: CA12409 New Penn Pub

Client: Wardell Armstrong LLP					**Chemtest Job No.:**	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154
Quotation No.: Q22-26577					**Chemtest Sample ID.:**	1448173	1448174	1448175	1448176	1448177	1448178	1448179	1448180	1448181
Order No.: CA10630					Client Sample Ref.:	ES1	ES2	ES1	ES2	ES1	ES2	ES1	ES2	ES1
					Sample Location:	TP1	TP1	TP2	TP2	TP3	TP3	TP4	TP4	TP5
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.1	1.2	0.25	1.0	0.25	1.0	0.25	1.0	0
					Bottom Depth (m):	0.3	1.5	1.0	1.2	0.5	1.3	0.5	1.3	0.3
					Date Sampled:	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022
					Asbestos Lab:	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
ACM Type	U	2192		N/A		-	-	-	-	-	-	-	-	-
Asbestos Identification	U	2192		N/A		No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020		6.2	12	8.6	9.5	8.7	9.3	19	8.3	7.3
pH	U	2010		4.0		8.6	8.2	8.1	8.4	7.4	7.7	8.0	7.6	7.6
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40		< 0.40	0.47	< 0.40	< 0.40	< 0.40	< 0.40	0.70	< 0.40	< 0.40
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010		0.042	0.047	0.020	0.017	0.023	0.025	0.068	0.020	0.020
Cyanide (Complex)	U	2300	mg/kg	0.50		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Cyanide (Free)	U	2300	mg/kg	0.50		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Cyanide (Total)	U	2300	mg/kg	0.50		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Thiocyanate	U	2300	mg/kg	5.0		< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Sulphate (Acid Soluble)	U	2430	%	0.010		0.029	0.011	< 0.010	< 0.010	< 0.010	< 0.010	0.010	< 0.010	< 0.010
Arsenic	U	2455	mg/kg	0.5		2.7	1.4	0.5	< 0.5	< 0.5	< 0.5	1.8	1.1	1.0
Cadmium	U	2455	mg/kg	0.10		0.24	< 0.10	0.19	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chromium	U	2455	mg/kg	0.5		12	12	13	11	11	13	13	19	16
Copper	U	2455	mg/kg	0.50		6.3	5.7	4.1	3.1	2.8	3.5	5.5	5.7	5.1
Mercury	U	2455	mg/kg	0.05		0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nickel	U	2455	mg/kg	0.50		5.7	14	17	13	13	17	16	24	21
Lead	U	2455	mg/kg	0.50		20	8.0	7.9	5.6	5.2	6.3	7.9	10	8.9
Selenium	U	2455	mg/kg	0.25		0.40	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	0.32	0.28
Zinc	U	2455	mg/kg	0.50		45	23	26	17	17	20	24	41	32
Chromium (Trivalent)	N	2490	mg/kg	1.0		12	12	13	11	11	13	13	19	16
Chromium (Hexavalent)	N	2490	mg/kg	0.50		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Organic Matter	U	2625	%	0.40		11	1.1	1.1	0.78	0.47	0.41	0.81	0.60	0.60
Total TPH >C6-C40	U	2670	mg/kg	10		270	< 10	37	< 10	< 10	< 10	< 10	< 10	< 10
Naphthalene	U	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	U	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	U	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	U	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	U	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	U	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Pyrene	U	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	U	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	U	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	U	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

Results - Soil

Project: CA12409 New Penn Pub

Client: Wardell Armstrong LLP			**Chemtest Job No.:**		22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154
Quotation No.: Q22-26577			**Chemtest Sample ID.:**		1448173	1448174	1448175	1448176	1448177	1448178	1448179	1448180	1448181
Order No.: CA10630			Client Sample Ref.:		ES1	ES2	ES1	ES2	ES1	ES2	ES1	ES2	ES1
			Sample Location:		TP1	TP1	TP2	TP2	TP3	TP3	TP4	TP4	TP5
			Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		0.1	1.2	0.25	1.0	0.25	1.0	0.25	1.0	0
			Bottom Depth (m):		0.3	1.5	1.0	1.2	0.5	1.3	0.5	1.3	0.3
			Date Sampled:		13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022
			Asbestos Lab:		DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
Benzo[k]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	N	2800	mg/kg	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Total Phenols	U	2920	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

Results - Soil

Project: CA12409 New Penn Pub

Client: Wardell Armstrong LLP				**Chemtest Job No.:**	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154
Quotation No.: Q22-26577				**Chemtest Sample ID.:**	1448182	1448183	1448184	1448185	1448186	1448187	1448188	1448189	1448190
Order No.: CA10630				Client Sample Ref.:	ES2	ES1	ES2	ES1	ES2	ES1	ES2	ES1	ES2
				Sample Location:	TP5	WS1	WS1	WS2	WS2	WS3	WS3	WS4	WS4
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	0.7	0.2	1.5	0.2	0.8	0.05	2.0	0.1	0.8
				Bottom Depth (m):	1.5	0.5	1.7	0.4	1.0	0.25	2.5	0.3	1.0
				Date Sampled:	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022
				Asbestos Lab:	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
ACM Type	U	2192		N/A	-	-	-	-	-	-	-	-	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020	17	18	9.0	19	9.4	6.8	9.2	6.7	17
pH	U	2010		4.0	8.2	8.2	7.6	7.8	7.5	8.4	8.2	9.2	8.6
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	0.66	0.70	< 0.40	< 0.40	< 0.40	0.41	< 0.40	1.7	< 0.40
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.061	0.063	0.016	0.021	0.013	0.055	0.011	0.21	0.012
Cyanide (Complex)	U	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Cyanide (Free)	U	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Thiocyanate	U	2300	mg/kg	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Sulphate (Acid Soluble)	U	2430	%	0.010	0.014	0.016	< 0.010	< 0.010	< 0.010	0.043	< 0.010	0.20	< 0.010
Arsenic	U	2455	mg/kg	0.5	1.9	2.4	0.6	0.8	0.7	6.8	0.7	1.0	0.7
Cadmium	U	2455	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.40	< 0.10	0.51	< 0.10
Chromium	U	2455	mg/kg	0.5	14	15	12	12	13	6.0	21	8.9	14
Copper	U	2455	mg/kg	0.50	5.8	6.1	3.3	3.8	3.3	4.0	7.2	3.1	5.3
Mercury	U	2455	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05	< 0.05	< 0.05	0.05
Nickel	U	2455	mg/kg	0.50	18	18	15	14	15	5.6	24	2.2	15
Lead	U	2455	mg/kg	0.50	8.5	9.5	6.3	7.8	7.2	24	9.2	14	7.4
Selenium	U	2455	mg/kg	0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	0.35	0.25	0.87	0.28
Zinc	U	2455	mg/kg	0.50	27	28	17	17	18	61	38	70	23
Chromium (Trivalent)	N	2490	mg/kg	1.0	14	15	12	12	13	6.0	21	8.9	14
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Organic Matter	U	2625	%	0.40	0.90	0.72	< 0.40	0.78	< 0.40	5.0	< 0.40	17	1.1
Total TPH >C6-C40	U	2670	mg/kg	10	180	< 10	< 10	< 10	< 10	160	< 10	590	< 10
Naphthalene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

Results - Soil

Project: CA12409 New Penn Pub

Client: Wardell Armstrong LLP			**Chemtest Job No.:**		22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154
Quotation No.: Q22-26577			**Chemtest Sample ID.:**		1448182	1448183	1448184	1448185	1448186	1448187	1448188	1448189	1448190
Order No.: CA10630			Client Sample Ref.:		ES2	ES1	ES2	ES1	ES2	ES1	ES2	ES1	ES2
			Sample Location:		TP5	WS1	WS1	WS2	WS2	WS3	WS3	WS4	WS4
			Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		0.7	0.2	1.5	0.2	0.8	0.05	2.0	0.1	0.8
			Bottom Depth (m):		1.5	0.5	1.7	0.4	1.0	0.25	2.5	0.3	1.0
			Date Sampled:		13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022
			Asbestos Lab:		DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
Benzo[k]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	N	2800	mg/kg	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Total Phenols	U	2920	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

Results - Soil

Project: CA12409 New Penn Pub

Client: Wardell Armstrong LLP		**Chemtest Job No.:**			22-22154	22-22154
Quotation No.: Q22-26577		**Chemtest Sample ID.:**			1448191	1448192
Order No.: CA10630		Client Sample Ref.:			ES1	ES2
		Sample Location:			WS5	WS5
		Sample Type:			SOIL	SOIL
		Top Depth (m):			0.15	0.30
		Bottom Depth (m):			0.30	1.0
		Date Sampled:			13-Jun-2022	13-Jun-2022
		Asbestos Lab:			DURHAM	DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**		
ACM Type	U	2192		N/A	-	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020	9.5	7.0
pH	U	2010		4.0	8.4	8.5
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	< 0.40	< 0.40
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.017	0.013
Cyanide (Complex)	U	2300	mg/kg	0.50	< 0.50	< 0.50
Cyanide (Free)	U	2300	mg/kg	0.50	< 0.50	< 0.50
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50	< 0.50
Thiocyanate	U	2300	mg/kg	5.0	< 5.0	< 5.0
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	< 0.50	< 0.50
Sulphate (Acid Soluble)	U	2430	%	0.010	0.013	< 0.010
Arsenic	U	2455	mg/kg	0.5	3.8	0.6
Cadmium	U	2455	mg/kg	0.10	0.16	< 0.10
Chromium	U	2455	mg/kg	0.5	8.6	13
Copper	U	2455	mg/kg	0.50	5.4	5.5
Mercury	U	2455	mg/kg	0.05	< 0.05	< 0.05
Nickel	U	2455	mg/kg	0.50	9.7	14
Lead	U	2455	mg/kg	0.50	14	7.5
Selenium	U	2455	mg/kg	0.25	0.25	< 0.25
Zinc	U	2455	mg/kg	0.50	39	30
Chromium (Trivalent)	N	2490	mg/kg	1.0	8.6	13
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50
Organic Matter	U	2625	%	0.40	2.1	0.55
Total TPH >C6-C40	U	2670	mg/kg	10	< 10	< 10
Naphthalene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10	< 0.10
Acenaphthene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Fluorene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Phenanthrene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Anthracene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Benzo[a]anthracene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Chrysene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10

Results - Soil

Project: CA12409 New Penn Pub

Client: Wardell Armstrong LLP			**Chemtest Job No.:**		22-22154	22-22154
Quotation No.: Q22-26577			**Chemtest Sample ID.:**		1448191	1448192
Order No.: CA10630			Client Sample Ref.:		ES1	ES2
			Sample Location:		WS5	WS5
			Sample Type:		SOIL	SOIL
			Top Depth (m):		0.15	0.30
			Bottom Depth (m):		0.30	1.0
			Date Sampled:		13-Jun-2022	13-Jun-2022
			Asbestos Lab:		DURHAM	DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**		
Benzo[k]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Benzo[a]pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	U	2800	mg/kg	0.10	< 0.10	< 0.10
Total Of 16 PAH's	N	2800	mg/kg	2.0	< 2.0	< 2.0
Total Phenols	U	2920	mg/kg	0.10	< 0.10	< 0.10

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2325	Sulphide in Soils	Sulphide	Steam distillation with sulphuric acid / analysis by 'Aquakem 600' Discrete Analyser, using N,N–dimethyl-p-phenylenediamine.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenz[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.

Report Information

Key

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

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis

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

For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

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

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

Results - Soil

Project: CA12409 New Penn Pub

Client: Wardell Armstrong LLP					Chemtest Job No.:	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	22-22154	
Quotation No.: Q22-26577					Chemtest Sample ID.:	1448173	1448174	1448175	1448176	1448177	1448178	1448179	1448180	1448181	1448182	1448183	1448184	1448185	1448186	1448187	1448188	1448189	1448190	1448191	1448192	
Order No.: CA10630					Client Sample Ref.:	ES1	ES2	ES1	ES2	ES1	ES2	ES1	ES2	ES1	ES2	ES1	ES2	ES1	ES2	ES1	ES2	ES1	ES2	ES1	ES2	
					Sample Location:	TP1	TP1	TP2	TP2	TP3	TP3	TP4	TP4	TP5	TP5	WS1	WS1	WS2	WS2	WS3	WS3	WS4	WS4	WS5	WS5	
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
					Top Depth (m):	0.1	1.2	0.25	1.0	0.25	1.0	0.25	1.0	0	0.7	0.2	1.5	0.2	0.8	0.05	2.0	0.1	0.8	0.15	0.30	
					Bottom Depth (m):	0.3	1.5	1.0	1.2	0.5	1.3	0.5	1.3	0.3	1.5	0.5	1.7	0.4	1.0	0.25	2.5	0.3	1.0	0.30	1.0	
					Date Sampled:	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	13-Jun-2022	
					Asbestos Lab:	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	MIN
Determinand	**Accred.**	**SOP**	**Units**	**LOD**																						
Organic Matter	U	2625	%	0.40	11	1.1	1.1	0.78	0.47	0.41	0.81	0.60	0.60	0.90	0.72	< 0.40	0.78	< 0.40	5.0	< 0.40	17	1.1	2.1	0.55	0.41
ACM Type	U	2192		N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Asbestos Identification	U	2192		N/A	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	0
Moisture	N	2030	%	0.020	6.2	12	8.6	9.5	8.7	9.3	19	8.3	7.3	17	18	9.0	19	9.4	6.8	9.2	6.7	17	9.5	7.0	6
pH	U	2010		4.0	8.6	8.2	8.1	8.4	7.4	7.7	8.0	7.6	7.6	8.2	8.2	7.6	7.8	7.5	8.4	8.2	9.2	8.6	8.4	8.5	7.40
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	< 0.40	0.47	< 0.40	< 0.40	< 0.40	< 0.40	0.70	< 0.40	< 0.40	0.66	0.70	< 0.40	< 0.40	< 0.40	0.41	< 0.40	1.7	< 0.40	< 0.40	< 0.40	0
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.042	0.047	0.020	0.017	0.023	0.025	0.068	0.020	0.020	0.061	0.063	0.016	0.021	0.013	0.055	0.011	0.21	0.012	0.017	0.013	0.011
Cyanide (Complex)	U	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0
Cyanide (Free)	U	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0
Thiocyanate	U	2300	mg/kg	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	0
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0
Sulphate (Acid Soluble)	U	2430	%	0.010	0.029	0.011	< 0.010	< 0.010	< 0.010	< 0.010	0.010	< 0.010	< 0.010	0.014	0.016	< 0.010	< 0.010	< 0.010	0.043	< 0.010	0.20	< 0.010	0.013	< 0.010	0
Arsenic	U	2455	mg/kg	0.5	2.7	1.40	0.5	< 0.5	< 0.5	< 0.5	1.80	1.1	1	1.90	2.40	0.6	0.8	0.7	6.80	0.7	1.0	0.7	3.8	0.6	0.50
Cadmium	U	2455	mg/kg	0.10	0.24	< 0.10	0.19	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.40	< 0.10	0.5	< 0.10	0.16	< 0.10	0.16
Chromium	U	2455	mg/kg	0.5	12	12.00	13	11	11	13	13.00	19	16	14.00	15.00	12	12	13	6.00	21	8.9	14	8.6	13	6.00
Copper	U	2455	mg/kg	0.50	6.3	5.70	4.1	3.1	2.8	3.5	5.50	5.7	5.1	5.80	6.10	3.3	3.8	3.3	4.00	7.2	3.1	5.3	5.4	5.5	2.8
Mercury	U	2455	mg/kg	0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05	< 0.05	< 0.05	0.05	< 0.05	< 0.05	0
Nickel	U	2455	mg/kg	0.50	5.7	14.00	17	13	13	17	16.00	24	21	18.00	18.00	15	14	15	5.60	24	2.2	15	9.7	14	2.2
Lead	U	2455	mg/kg	0.50	20	8.00	7.9	5.6	5.2	6.3	7.90	10	8.9	8.50	9.50	6.3	7.8	7.2	24.00	9.2	14.0	7.4	14	7.5	5.20
Selenium	U	2455	mg/kg	0.25	0.4	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	0.32	0.28	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	0.35	0.25	0.9	0.28	0.25	< 0.25	0.25
Zinc	U	2455	mg/kg	0.50	45	23.00	26	17	17	20	24.00	41	32	27.00	28.00	17	17	18	61.00	38	70.0	23	39	30	17.0
Chromium (Trivalent)	N	2490	mg/kg	1.0	12	12.00	13	11	11	13	13.00	19	16	14.00	15.00	12	12	13	6.00	21	8.9	14	8.6	13	6
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0
Total TPH >C6-C40	U	2670	mg/kg	10	270	< 10	37	< 10	< 10	< 10	< 10	< 10	< 10	180	< 10	< 10	< 10	< 10	160	< 10	590	< 10	< 10	< 10	37
Naphthalene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Acenaphthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Fluorene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Phenanthrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Anthracene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Benzo[a]anthracene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Chrysene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Benzo[b]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Benzo[k]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Benzo[a]pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Benzo[g,h,i]perylene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0
Total Of 16 PAH's	N	2800	mg/kg	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	0
Total Phenols	U	2920	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0

Results - Soil

Project: CA12409 New Penn Pub

Client: Wardell Armstrong LLP	Chemtest Job No.:
Quotation No.: Q22-26577	Chemtest Sample ID.:
Order No.: CA10630	Client Sample Ref.:
	Sample Location:
	Sample Type:
	Top Depth (m):
	Bottom Depth (m):
	Date Sampled:
	Asbestos Lab:

Determinand	Accred.	SOP	Units	LOD	MAX	AVG	S4UL (LQM/CIEH 2014) mg/kg 1% SOM	S4UL (LQM/CIEH 2014) mg/kg 2.5% SOM	S4UL (LQM/CIEH 2014) mg/kg 6% SOM
Organic Matter	U	2625	%	0.40	17.00	2.65		-	
ACM Type	U	2192		N/A	0	#DIV/0!		-	
Asbestos Identification	U	2192		N/A	0	#DIV/0!		-	
Moisture	N	2030	%	0.020	19.00	11		-	
pH	U	2010		4.0	9.20	8.11		-	
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	1.70	1		290	
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.21	0		-	
Cyanide (Complex)	U	2300	mg/kg	0.50	0.00	#DIV/0!		-	
Cyanide (Free)	U	2300	mg/kg	0.50	0.00	#DIV/0!		-	
Cyanide (Total)	U	2300	mg/kg	0.50	0.00	#DIV/0!		-	
Thiocyanate	U	2300	mg/kg	5.0	0.00	#DIV/0!		-	
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	0.00	#DIV/0!		-	
Sulphate (Acid Soluble)	U	2430	%	0.010	0.20	0		-	
Arsenic	U	2455	mg/kg	0.5	6.80	2		37	
Cadmium	U	2455	mg/kg	0.10	0.51	0		11	
Chromium	U	2455	mg/kg	0.5	21.00	13		910	
Copper	U	2455	mg/kg	0.50	7.20	5		2400	
Mercury	U	2455	mg/kg	0.05	0.05	0		1.2	
Nickel	U	2455	mg/kg	0.50	24.00	15		130	
Lead	U	2455	mg/kg	0.50	24.00	10		200	
Selenium	U	2455	mg/kg	0.25	0.87	0		250	
Zinc	U	2455	mg/kg	0.50	70.00	31		3700	
Chromium (Trivalent)	N	2490	mg/kg	1.0	21.00	13		910	
Chromium (Hexavalent)	N	2490	mg/kg	0.50	0.00	#DIV/0!		6	
Total TPH >C6-C40	U	2670	mg/kg	10	590	247		-	
Naphthalene	U	2800	mg/kg	0.10	0.00	#DIV/0!		5.6	
Acenaphthylene	N	2800	mg/kg	0.10	0.00	#DIV/0!		420	
Acenaphthene	U	2800	mg/kg	0.10	0.00	#DIV/0!		510	
Fluorene	U	2800	mg/kg	0.10	0.00	#DIV/0!		400	
Phenanthrene	U	2800	mg/kg	0.10	0.00	#DIV/0!		220	
Anthracene	U	2800	mg/kg	0.10	0.00	#DIV/0!		5400	
Fluoranthene	U	2800	mg/kg	0.10	0.00	#DIV/0!		560	
Pyrene	U	2800	mg/kg	0.10	0.00	#DIV/0!		1200	
Benzo[a]anthracene	U	2800	mg/kg	0.10	0.00	#DIV/0!		11	
Chrysene	U	2800	mg/kg	0.10	0.00	#DIV/0!		22	
Benzo[b]fluoranthene	U	2800	mg/kg	0.10	0.00	#DIV/0!		3.3	
Benzo[k]fluoranthene	U	2800	mg/kg	0.10	0.00	#DIV/0!		93	
Benzo[a]pyrene	U	2800	mg/kg	0.10	0.00	#DIV/0!		2.7	
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.10	0.00	#DIV/0!		36	
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	0.00	#DIV/0!		0.28	
Benzo[g,h,i]perylene	U	2800	mg/kg	0.10	0.00	#DIV/0!		340	
Total Of 16 PAH's	N	2800	mg/kg	2.0	0	#DIV/0!		-	
Total Phenols	U	2920	mg/kg	0.10	0	#DIV/0!		-	

Appendix G

Soils Geotechnical Laboratory Certificates

Laboratory Report

UKAS TESTING 2788

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES A PHENNA GROUP COMPANY

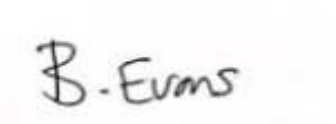
Contract Number: 59999

Client Ref: **CA12409**
Client PO: **CA10636**

Date Received: **16-06-2022**
Date Completed: **06-07-2022**
Report Date: **06-07-2022**

Client: **Wardell Armstrong**
Tudor House
16 Cathedral Road
Cardiff
CF11 9LJ

This report has been checked and approved by:



Brendan Evans
Office Administrator

Contract Title: **CA12409 New Penn Pub**
For the attention of: **Patrick Moore**

Test Description	Qty
Samples Received - @ Non Accredited Test	7
Moisture Content BS 1377:1990 - Part 2 : 3.2 - * UKAS	7
4 Point Liquid & Plastic Limit BS 1377:1990 - Part 2 : 4.3 & 5.3 - * UKAS	7
PSD Wet Sieve method BS 1377:1990 - Part 2 : 9.2 - * UKAS	7
PSD: Sedimentation by pipette carried out with Wet Sieve (Wet Sieve must also be selected) BS 1377:1990 - Part 2 : 9.4 - * UKAS	7
BRE Suite D Brownfield Site (pyrite present) **includes pH, water & acid soluble sulphate, total sulphur, magnesium, chloride and nitrate** Sub-contracted Test - @ Non Accredited Test	7
Dry Den/MC (2.5kg Rammer Method 1 litre mould/CBR Mould) BS 1377:1990 - Part 4 : 3.4 - * UKAS	3
Disposal of samples for job	1

Notes: **Observations and Interpretations are outside the UKAS Accreditation**
*** - denotes test included in laboratory scope of accreditation**
 # - denotes test carried out by approved contractor
@ - denotes non accredited tests

Approved Signatories:
Brendan Evans (Office Administrator) - Emma Sharp (Business Support Manager) - Paul Evans (Director)
Richard John (Quality/Technical Manager) - Shaun Jones (Laboratory manager) - Shaun Thomas (Site Manager)
Wayne Honey (Health and Safety Coordinator/ Quality Assistant)

GEO Site & Testing Services Ltd
Units 3-4, Heol Aur, Dafen, Llanelli, Carmarthenshire, Wales SA14 8QN
Tel: 01554 784040 Fax: 01554 784041 info@gstl.co.uk gstl.co.uk

GSTL
GEOTECHNICAL SITE & TESTING LABORATORIES

Summary of Soil Descriptions

Contract Number	59999	
Site Name	CA12409 New Penn Pub	
Client Reference		

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Descriptions
WS1	B1	BULK	0.60	-	1.00	Brown fine to medium gravelly fine to coarse sandy silty CLAY
WS2	B1	BULK	0.50	-	1.00	Brown slightly sandy fine to coarse gravelly silty CLAY
WS3	B1	BULK	1.00	-	2.00	Brown slightly gravelly fine to coarse sandy silty CLAY
WS4	B1	BULK	1.00	-	1.50	Brown fine to coarse sandy fine to coarse gravelly silty CLAY
TP1	B1	BULK	1.20	-	1.50	Brown slightly gravelly fine to coarse sandy silty CLAY
TP2	B1	BULK	1.30	-	1.50	Brown slightly gravelly silty CLAY
TP3	B1	BULK	1.00	-	1.40	Brown slightly silty fine to coarse sandy clayey fine to coarse GRAVEL
				-		
				-		
				-		
				-		
				-		
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GSTL
GEOTECHNICAL SITE & TESTING LABORATORIES

NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX
(BS 1377:1990 - Part 2 : 4.3 & 5.3)

Contract Number	59999
Project Location	CA12409 New Penn Pub
Date Tested	02/07/2022

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity index %	Passing 0.425mm %	Remarks
WS1	B1	BULK	0.60	-	1.00	12	43	20	23	60	CI Intermediate Plasticity
WS2	B1	BULK	0.50	-	1.00	20	48	23	25	76	CI Intermediate Plasticity
WS3	B1	BULK	1.00	-	2.00	14	41	17	24	81	CI Intermediate Plasticity
WS4	B1	BULK	1.00	-	1.50	7.0	24	14	10	58	CL Low Plasticity
TP1	B1	BULK	1.20	-	1.50	18	40	20	20	73	CI Intermediate Plasticity
TP2	B1	BULK	1.30	-	1.50	16	45	20	25	92	CI Intermediate Plasticity
TP3	B1	BULK	1.00	-	1.40	6.0		NP		39	
				-							
				-							
				-							
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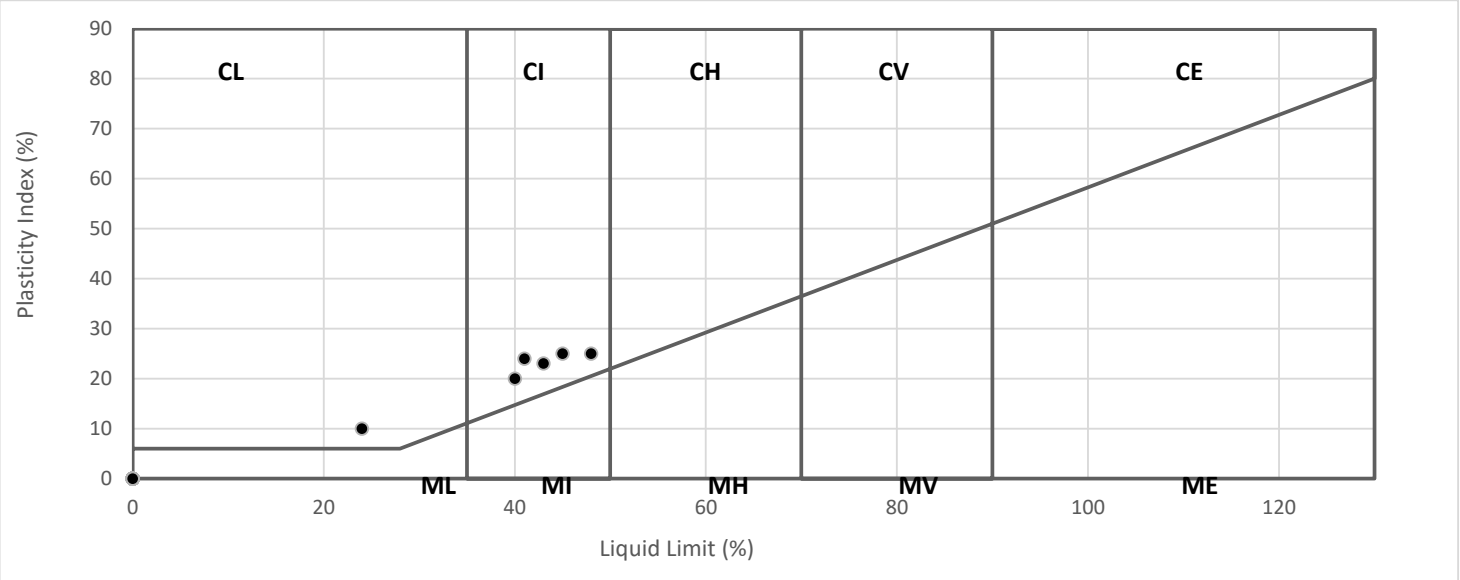
				-							

Symbols: NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved

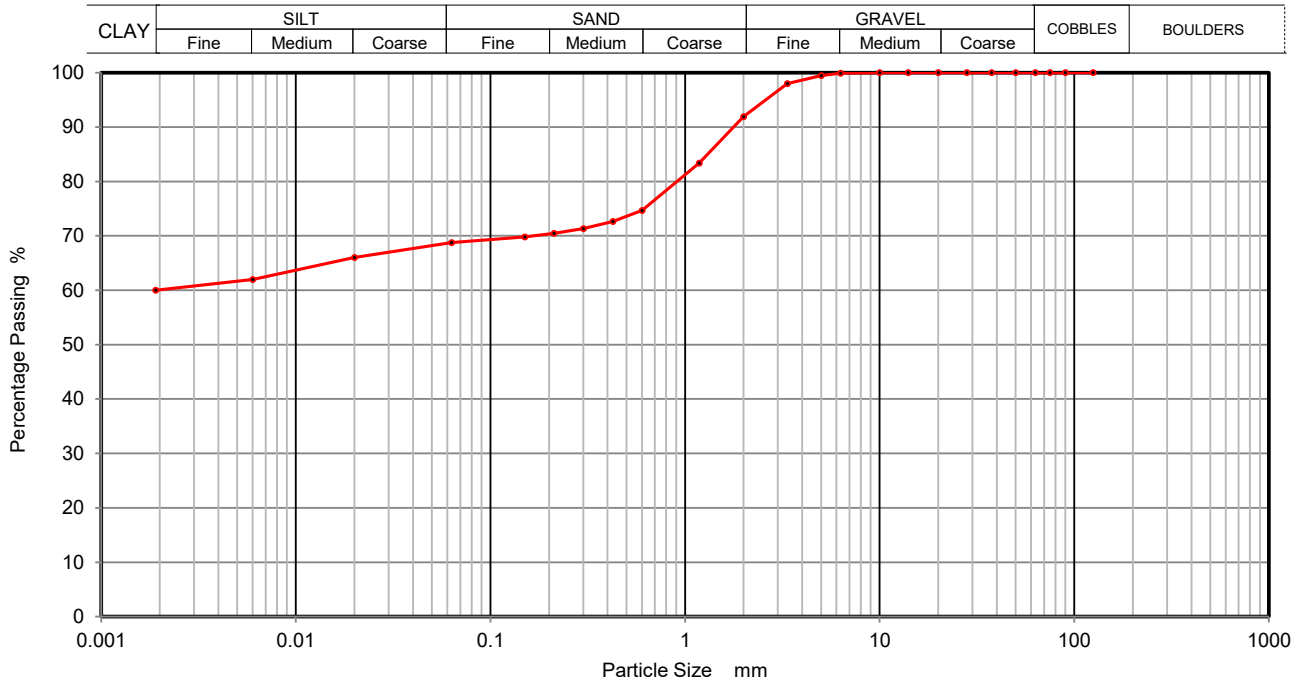
PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION
BS 5930:1999+A2:2010



Operators			
Darcy Etheridge			

UKAS TESTING
2788

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**PARTICLE SIZE DISTRIBUTION** **BS 1377 Part 2:1990** **Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4**	Contract Number	59999
		Borehole/Pit No.	TP1
Site Name	CA12409 New Penn Pub	Sample No.	B1
Soil Description	*See sample description sheet	Depth Top	1.20
		Depth Base	1.50
Date Tested	02/07/2022	Sample Type	BULK



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	66
90	100	0.0060	62
75	100	0.0020	60
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	99		
3.35	98		
2	92		
1.18	83		
0.6	75		
0.425	73		
0.3	71		
0.212	70		
0.15	70		
0.063	69		

Sample Proportions	% dry mass
Cobbles	0
Gravel	8
Sand	23
Silt	9
Clay	60

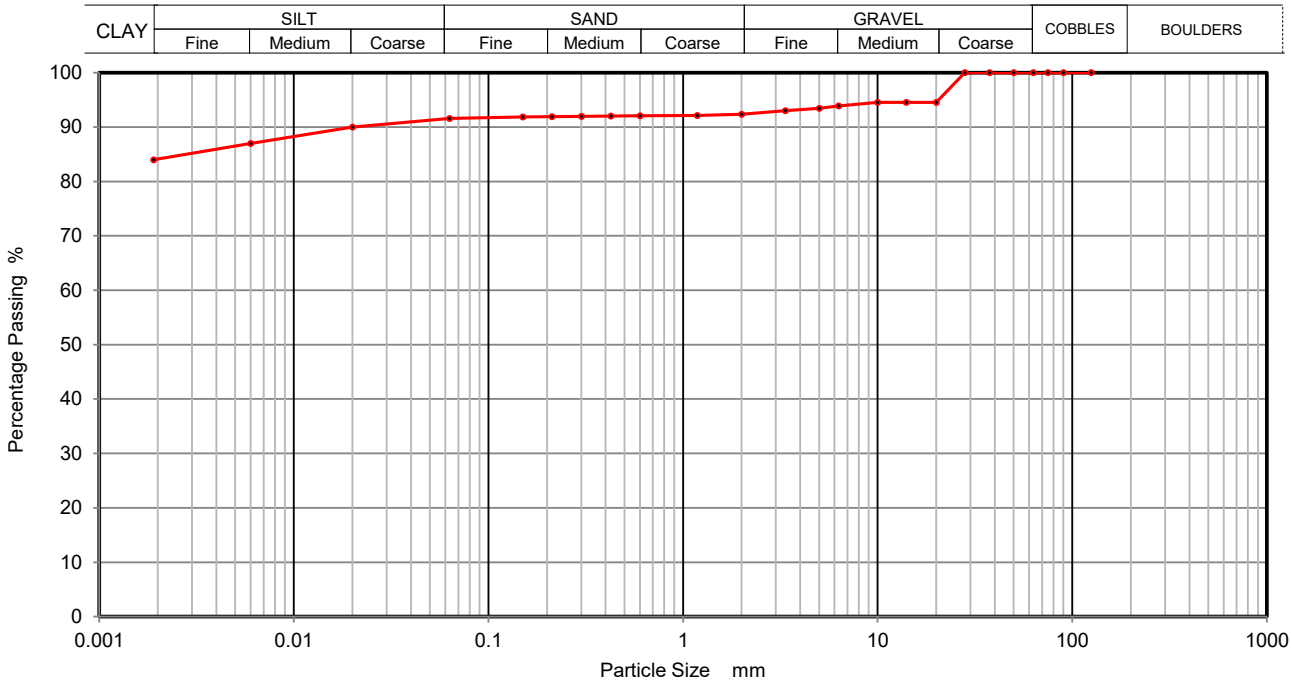
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator				
David Edwards				

UKAS TESTING
2788

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**PARTICLE SIZE DISTRIBUTION** **BS 1377 Part 2:1990** **Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4**	Contract Number	59999
		Borehole/Pit No.	TP2
Site Name	CA12409 New Penn Pub	Sample No.	B1
Soil Description	*See sample description sheet	Depth Top	1.30
		Depth Base	1.50
Date Tested	02/07/2022	Sample Type	BULK



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	90
90	100	0.0060	87
75	100	0.0020	84
63	100		
50	100		
37.5	100		
28	100		
20	95		
14	95		
10	95		
6.3	94		
5	93		
3.35	93		
2	92		
1.18	92		
0.6	92		
0.425	92		
0.3	92		
0.212	92		
0.15	92		
0.063	92		

Sample Proportions	% dry mass
Cobbles	0
Gravel	8
Sand	0
Silt	8
Clay	84

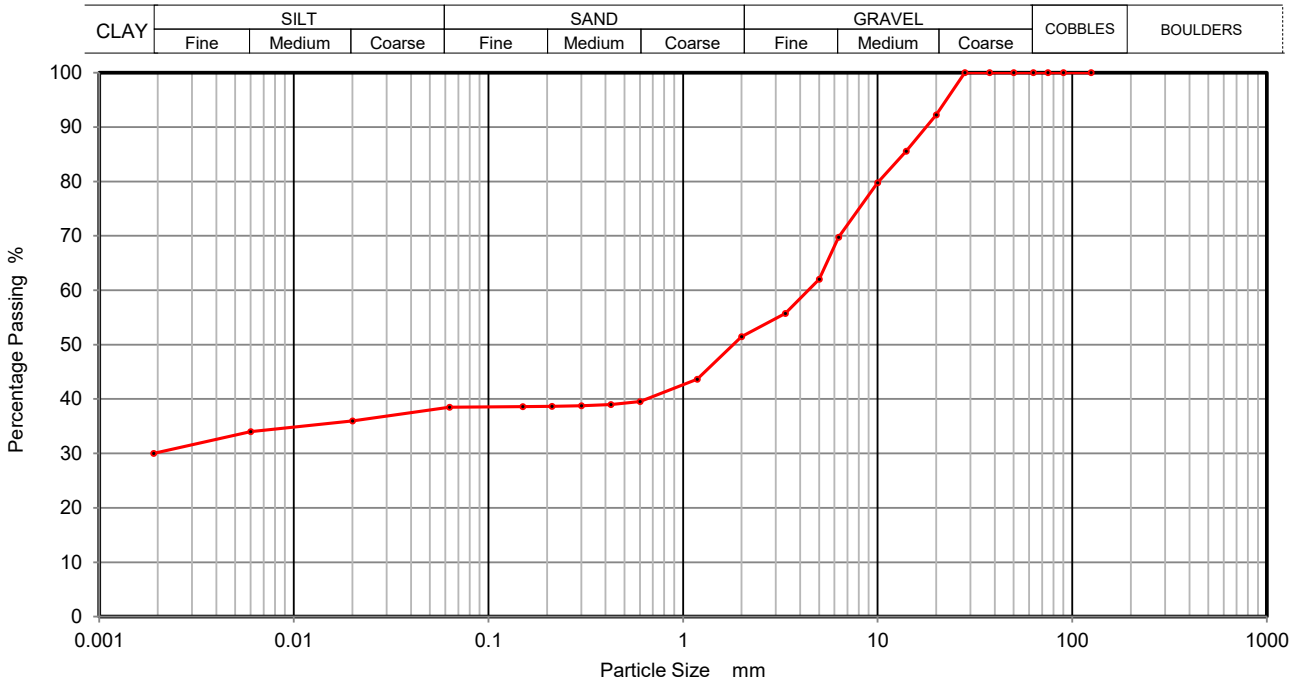
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator				
David Edwards				

UKAS TESTING
2788

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**PARTICLE SIZE DISTRIBUTION** **BS 1377 Part 2:1990** **Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4**	Contract Number	59999
		Borehole/Pit No.	TP3
Site Name	CA12409 New Penn Pub	Sample No.	B1
Soil Description	*See sample description sheet	Depth Top	1.00
		Depth Base	1.40
Date Tested	02/07/2022	Sample Type	BULK



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	36
90	100	0.0060	34
75	100	0.0020	30
63	100		
50	100		
37.5	100		
28	100		
20	92		
14	86		
10	80		
6.3	70		
5	62		
3.35	56		
2	51		
1.18	44		
0.6	40		
0.425	39		
0.3	39		
0.212	39		
0.15	39		
0.063	38		

Sample Proportions	% dry mass
Cobbles	0
Gravel	49
Sand	13
Silt	8
Clay	30

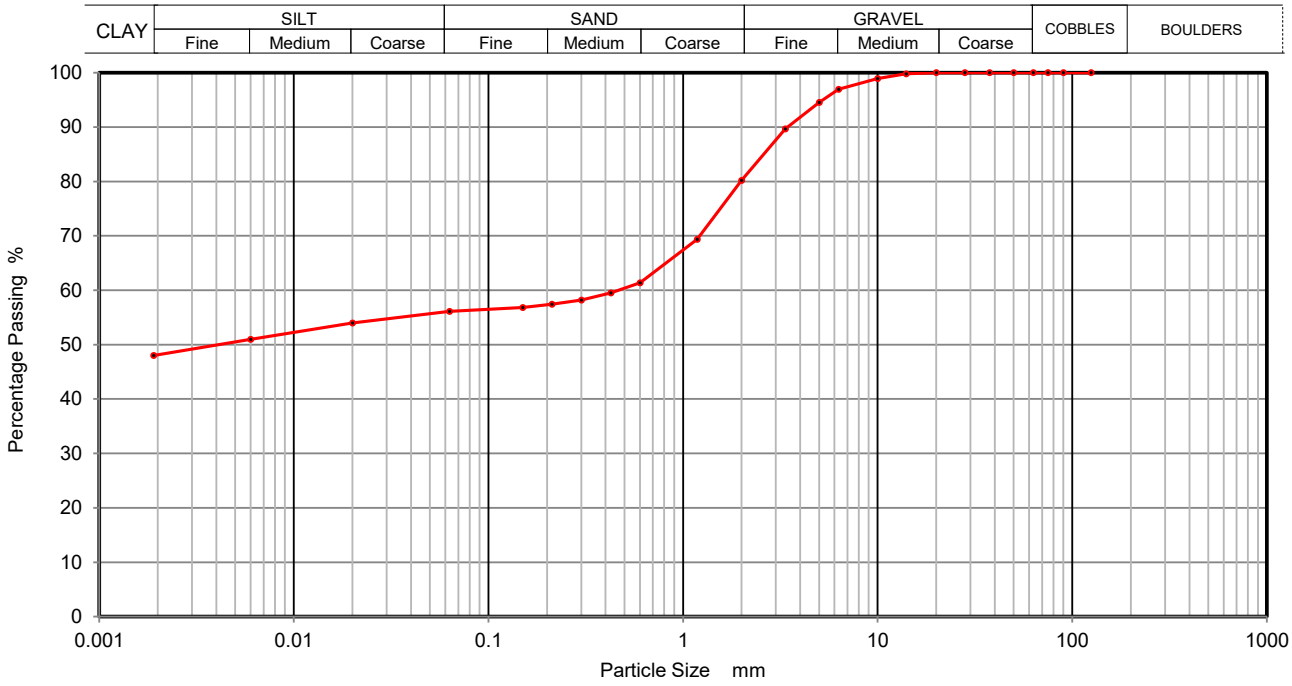
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator				
David Edwards				

UKAS TESTING
2788

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**PARTICLE SIZE DISTRIBUTION** **BS 1377 Part 2:1990** **Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4**	Contract Number	59999
		Borehole/Pit No.	WS1
Site Name	CA12409 New Penn Pub	Sample No.	B1
Soil Description	*See sample description sheet	Depth Top	0.60
		Depth Base	1.00
Date Tested	02/07/2022	Sample Type	BULK



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	54
90	100	0.0060	51
75	100	0.0020	48
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	99		
6.3	97		
5	95		
3.35	90		
2	80		
1.18	69		
0.6	61		
0.425	60		
0.3	58		
0.212	57		
0.15	57		
0.063	56		

Sample Proportions	% dry mass
Cobbles	0
Gravel	20
Sand	24
Silt	8
Clay	48

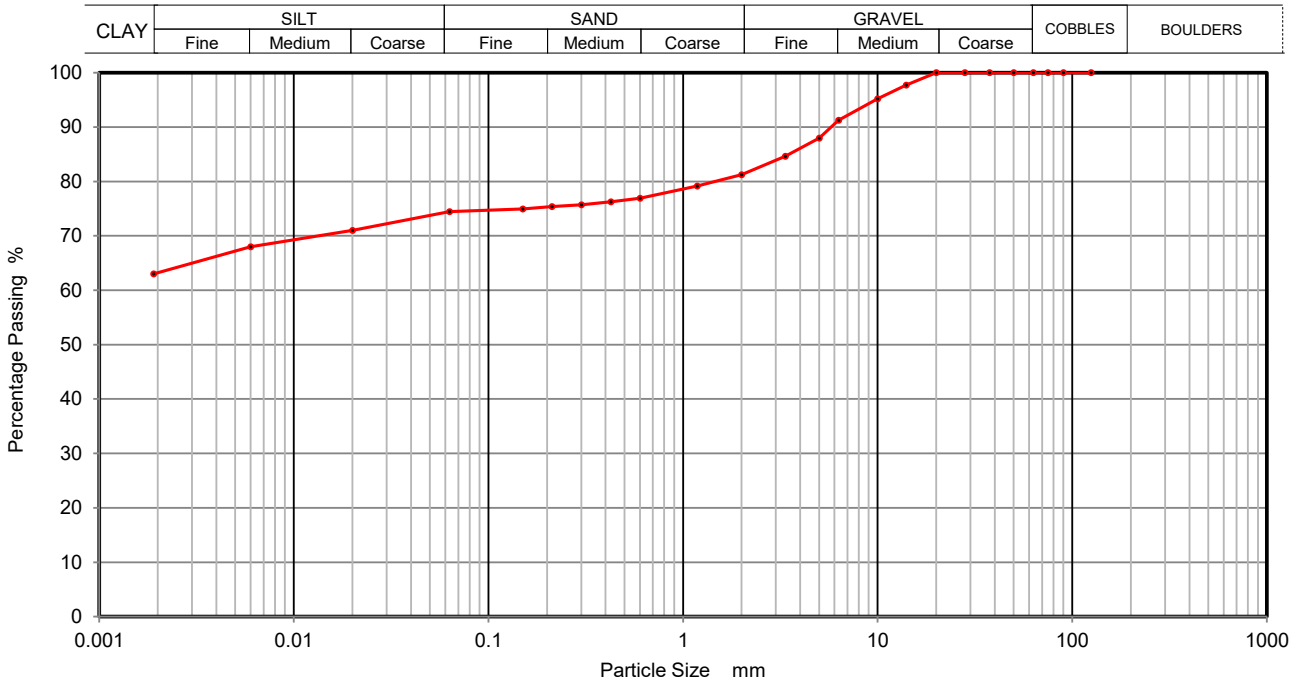
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator				
David Edwards				

UKAS TESTING
2788

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**PARTICLE SIZE DISTRIBUTION** **BS 1377 Part 2:1990** **Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4**	Contract Number	59999
		Borehole/Pit No.	WS2
Site Name	CA12409 New Penn Pub	Sample No.	B1
Soil Description	*See sample description sheet	Depth Top	0.50
		Depth Base	1.00
Date Tested	02/07/2022	Sample Type	BULK



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	71
90	100	0.0060	68
75	100	0.0020	63
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	98		
10	95		
6.3	91		
5	88		
3.35	85		
2	81		
1.18	79		
0.6	77		
0.425	76		
0.3	76		
0.212	75		
0.15	75		
0.063	74		

Sample Proportions	% dry mass
Cobbles	0
Gravel	19
Sand	7
Silt	11
Clay	63

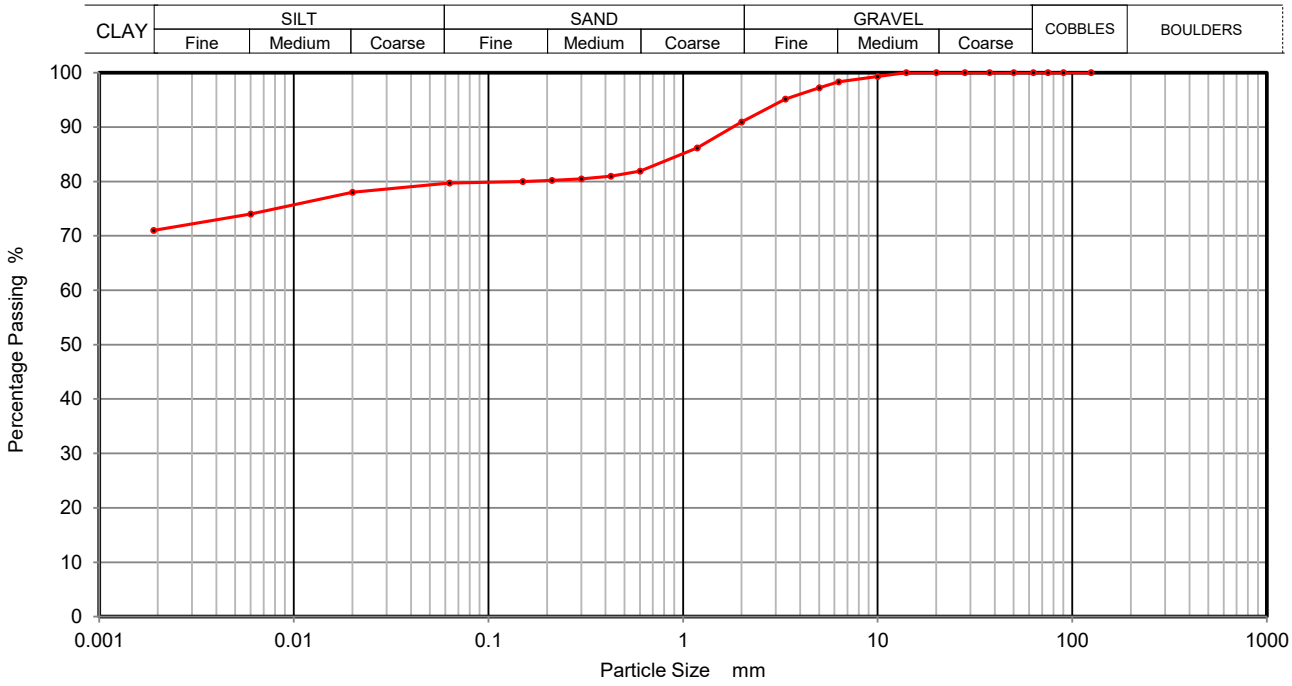
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator				
David Edwards				

UKAS TESTING
2788

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**PARTICLE SIZE DISTRIBUTION** **BS 1377 Part 2:1990** **Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4**	Contract Number	59999
		Borehole/Pit No.	WS3
Site Name	CA12409 New Penn Pub	Sample No.	B1
Soil Description	*See sample description sheet	Depth Top	1.00
		Depth Base	2.00
Date Tested	02/07/2022	Sample Type	BULK



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	78
90	100	0.0060	74
75	100	0.0020	71
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	99		
6.3	98		
5	97		
3.35	95		
2	91		
1.18	86		
0.6	82		
0.425	81		
0.3	80		
0.212	80		
0.15	80		
0.063	80		

Sample Proportions	% dry mass
Cobbles	0
Gravel	9
Sand	11
Silt	9
Clay	71

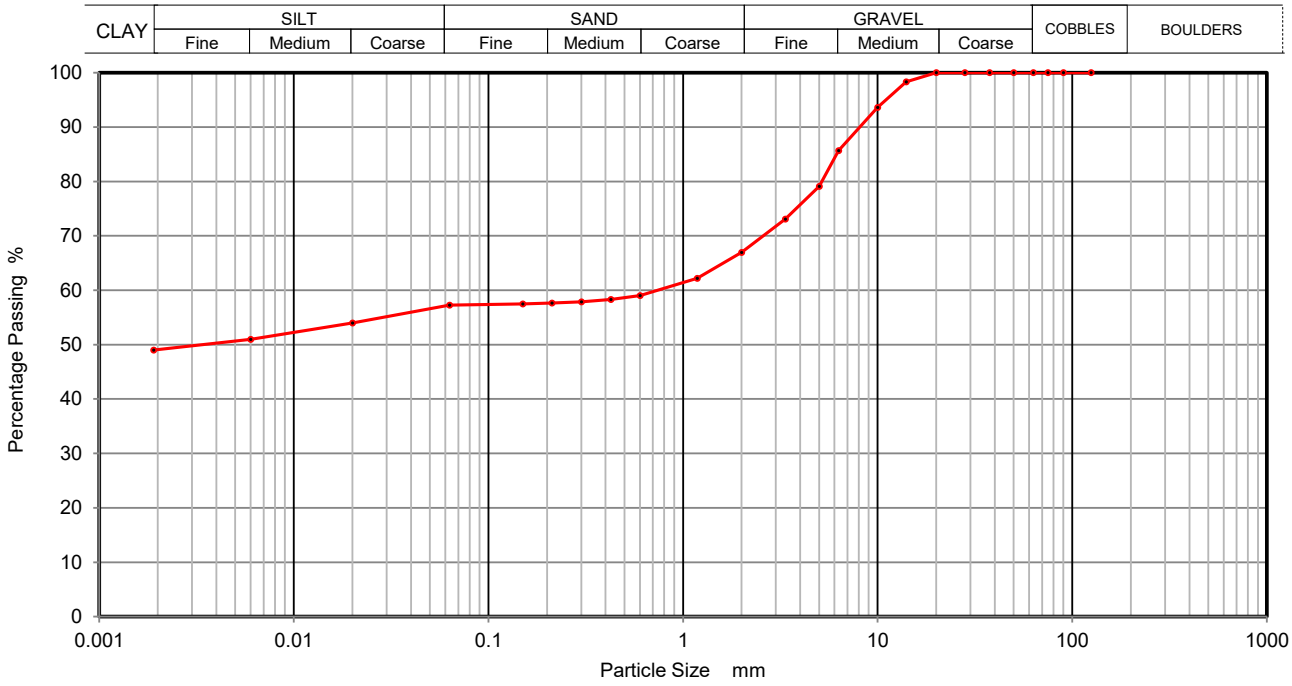
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator				
David Edwards				

UKAS TESTING
2788

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**PARTICLE SIZE DISTRIBUTION** **BS 1377 Part 2:1990** **Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4**	Contract Number	59999
		Borehole/Pit No.	WS4
Site Name	CA12409 New Penn Pub	Sample No.	B1
Soil Description	*See sample description sheet	Depth Top	1.00
		Depth Base	1.50
Date Tested	02/07/2022	Sample Type	BULK



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	54
90	100	0.0060	51
75	100	0.0020	49
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	98		
10	94		
6.3	86		
5	79		
3.35	73		
2	67		
1.18	62		
0.6	59		
0.425	58		
0.3	58		
0.212	58		
0.15	57		
0.063	57		

Sample Proportions	% dry mass
Cobbles	0
Gravel	33
Sand	10
Silt	8
Clay	49

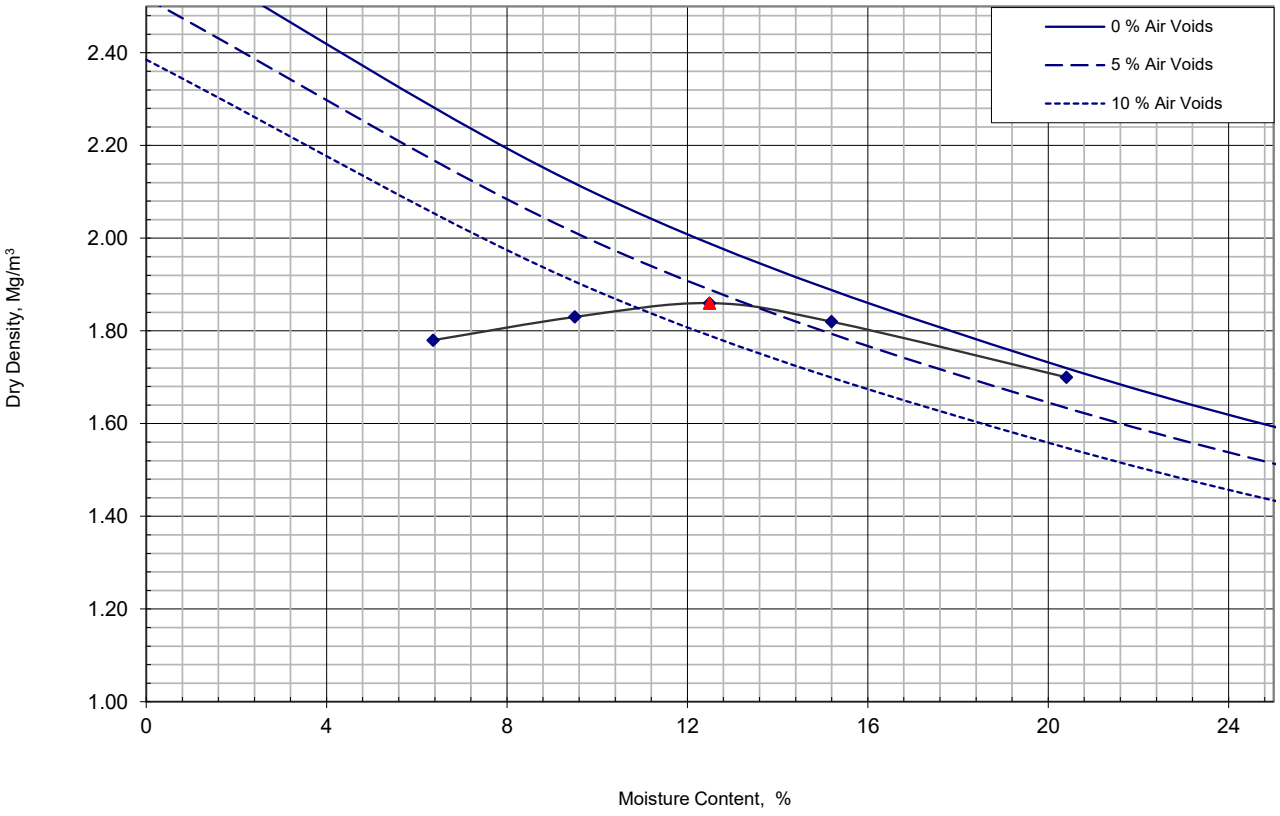
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator				
David Edwards				

UKAS TESTING
2788

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**Dry Density / Moisture Content Relationship BS 1377:Part 4:1990**	Contract Number	59999
		Borehole / Pit No	WS2
Project Location	CA12409 New Penn Pub	Sample No	B1
Date Tested	02/07/2022	Depth Top	0.50
Compaction Method	2.5 Kg Rammer	Depth Base	1.00
Compaction Clause	BS1377:Part 4:1990, Clause 3.3	Sample Type	BULK
Sample Description	*See Sample Description Sheet		



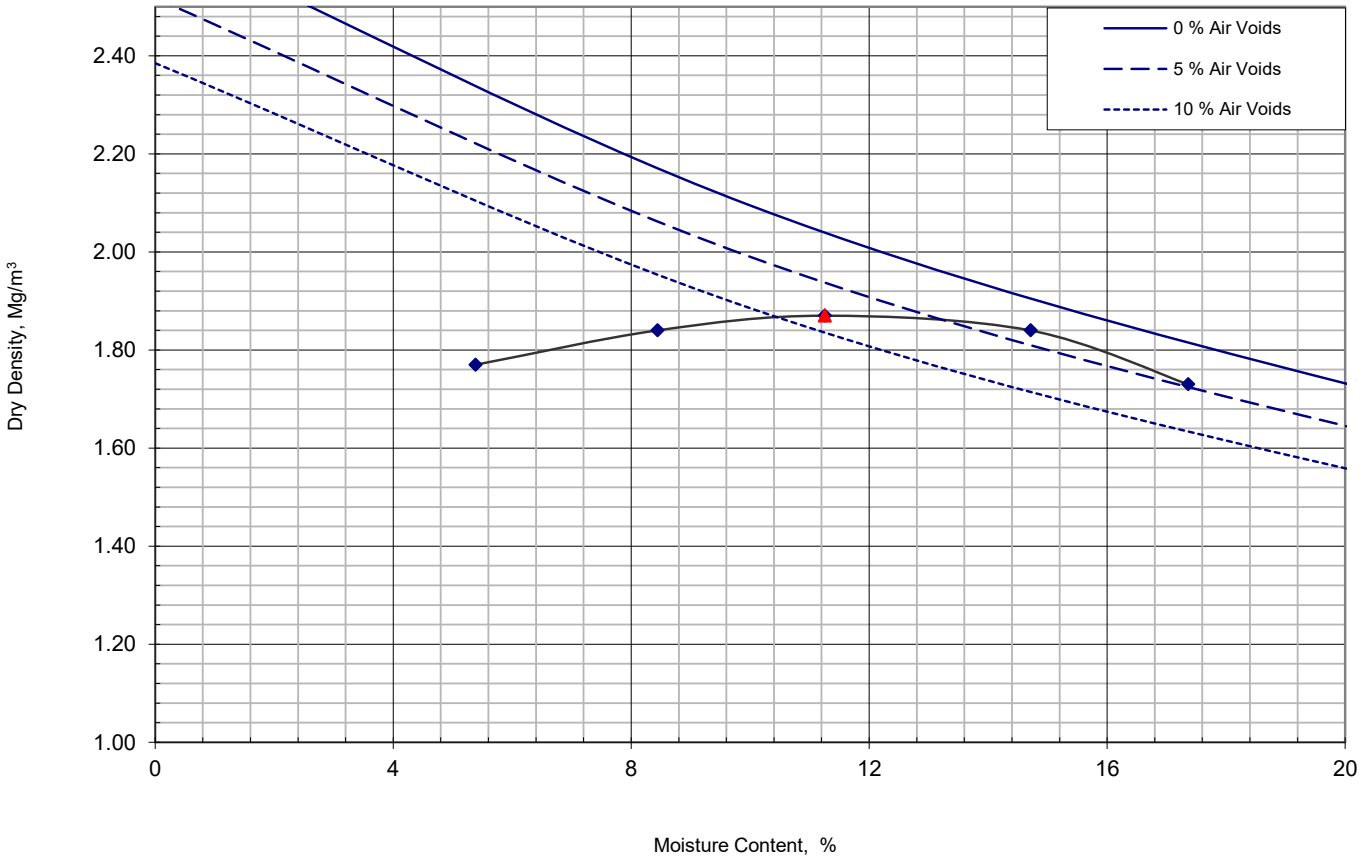
Compaction Point	1	2	3	4	5							
Moisture Content	6.4	9.5	12	15	20							
Bulk Density	1.89	2.00	2.09	2.10	2.05							
Dry Density	1.78	1.83	1.86	1.82	1.70							

Initial Moisture Content	20	%
Maximum Dry Density	1.86	Mg/m3
Optimum Moisture Content	12	%
Particle Density	2.65 Assumed	Mg/m3
Material Retained 37.5mm	0	%
Material Retained 20mm	0	%

Operator				
Conor				

UKAS TESTING
2788

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**Dry Density / Moisture Content Relationship BS 1377:Part 4:1990**	Contract Number	59999
		Borehole / Pit No	WS3
Project Location	CA12409 New Penn Pub	Sample No	B1
Date Tested	02/07/2022	Depth Top	1.00
Compaction Method	2.5 Kg Rammer	Depth Base	2.00
Compaction Clause	BS1377:Part 4:1990, Clause 3.3	Sample Type	BULK
Sample Description	*See Sample Description Sheet		



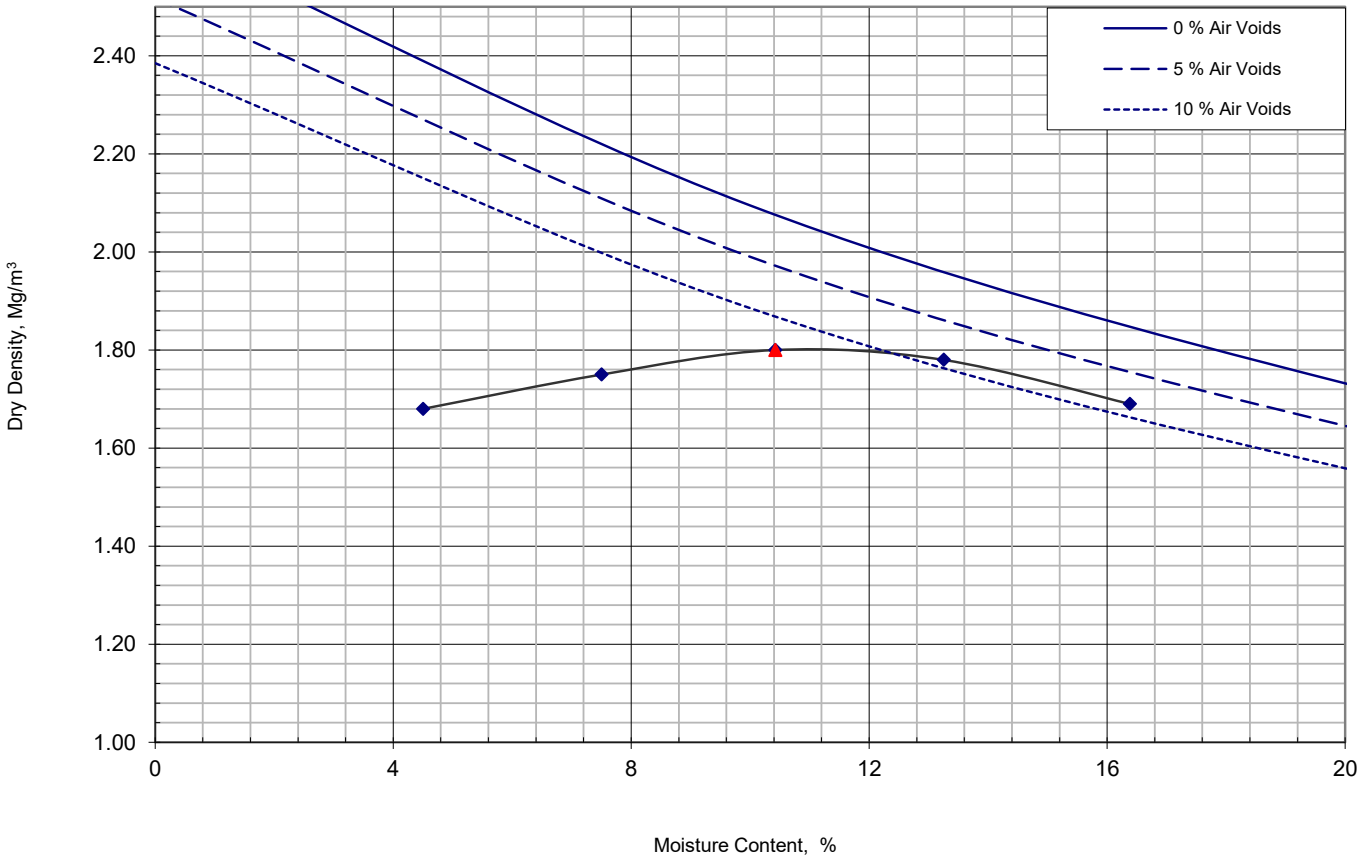
Compaction Point	1	2	3	4	5							
Moisture Content	5.4	8.4	11	15	17							
Bulk Density	1.87	2.00	2.08	2.11	2.03							
Dry Density	1.77	1.84	1.87	1.84	1.73							

Initial Moisture Content	15	%
Maximum Dry Density	1.87	Mg/m3
Optimum Moisture Content	11	%
Particle Density	2.65 Assumed	Mg/m3
Material Retained 37.5mm	0	%
Material Retained 20mm	0	%

Operator				
Conor				

UKAS TESTING
2788

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**Dry Density / Moisture Content Relationship BS 1377:Part 4:1990**	Contract Number	59999
		Borehole / Pit No	WS4
Project Location	CA12409 New Penn Pub	Sample No	B1
Date Tested	02/07/2022	Depth Top	1.00
Compaction Method	2.5 Kg Rammer	Depth Base	1.50
Compaction Clause	BS1377:Part 4:1990, Clause 3.3	Sample Type	BULK
Sample Description	*See Sample Description Sheet		



Compaction Point	1	2	3	4	5							
Moisture Content	4.5	7.5	10	13	16							
Bulk Density	1.76	1.88	1.99	2.02	1.97							
Dry Density	1.68	1.75	1.80	1.78	1.69							

Initial Moisture Content	7.5	%
Maximum Dry Density	1.80	Mg/m3
Optimum Moisture Content	10	%
Particle Density	2.65 Assumed	Mg/m3
Material Retained 37.5mm	0	%
Material Retained 20mm	0	%

Operator				
Conor				

UKAS TESTING
2788

2531

ANALYTICAL TEST REPORT

Contract no: 110578

Contract name: New Penn Pub

Client reference: CS12409

Clients name: Geo Site & Testing Services

Clients address: Unit 3 and 4 Heol Aur
Dafen Industrial Estate, Dafen
Llanelli, Carmarthenshire
SA14 8QN

Samples received: 20 June 2022

Analysis started: 20 June 2022

Analysis completed: 27 June 2022

Report issued: 27 June 2022

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
N/S	Sample not suitable for testing

Approved by:

Will Fardon

Technical Director

Chemtech Environmental Limited

SOILS

Lab number			110578-1	110578-2	110578-3	110578-4	110578-5	110578-6
Sample id			TP1	TP2	TP3	WS1	WS2	WS3
Depth (m)			1.20-1.50	1.30-1.50	1.00-1.40	0.60-1.00	0.50-1.00	1.00-2.00
Sample Type			B	B	B	B	B	B
Date sampled			-	-	-	-	-	-
Test	**Method**	**Units**						
pH	CE004 [U]	units	8.4	7.6	6.8	7.8	7.5	7.1
Magnesium (2:1 water soluble)	CE061	mg/l Mg	8.7	8.5	8.8	5.7	7.0	3.2
Chloride (2:1 water soluble)	CE049 [U]	mg/l Cl	3.5	2.3	2.1	2.7	1.6	3.7
Nitrate (2:1 water soluble)	CE049 [U]	mg/l NO_3	2.8	3.8	2.7	2.4	2.6	2.6
Sulphate (2:1 water soluble)	CE061 [U]	mg/l SO_4	40	14	48	40	24	16
Sulphate (total)	CE062 [U]	mg/kg SO_4	112.27	<100	164.29	145.94	<100	<100
Sulphate (total)	CE062 [U]	% w/w SO_4	0.01	<0.01	0.02	0.01	<0.01	<0.01
Sulphur (total)	CE119	mg/kg S	181	106	141	133	<100	<100
Sulphur (total)	CE119	% w/w S	0.02	0.01	0.01	0.01	<0.01	<0.01

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SOILS

Lab number			110578-7
Sample id			WS4
Depth (m)			1.00-1.50
Sample Type			B
Date sampled			-
Test	**Method**	**Units**	
pH	CE004 [U]	units	6.5
Magnesium (2:1 water soluble)	CE061	mg/l Mg	11
Chloride (2:1 water soluble)	CE049 [U]	mg/l Cl	1.4
Nitrate (2:1 water soluble)	CE049 [U]	mg/l NO_3	2.4
Sulphate (2:1 water soluble)	CE061 [U]	mg/l SO_4	18
Sulphate (total)	CE062 [U]	mg/kg SO_4	<100
Sulphate (total)	CE062 [U]	% w/w SO_4	<0.01
Sulphur (total)	CE119	mg/kg S	<100
Sulphur (total)	CE119	% w/w S	<0.01

Chemtech Environmental Limited

METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE004	pH	Based on BS 1377, pH Meter	As received	U	-	units
CE061	Magnesium (2:1 water soluble)	Aqueous extraction, ICP-OES	Dry		1	mg/l Mg
CE049	Chloride (2:1 water soluble)	Aqueous extraction, IC-COND	Dry	U	1	mg/l Cl
CE049	Nitrate (2:1 water soluble)	Aqueous extraction, IC-COND	Dry	U	1	mg/l NO_3
CE061	Sulphate (2:1 water soluble)	Aqueous extraction, ICP-OES	Dry	U	10	mg/l SO_4
CE062	Sulphate (total)	Acid extraction, ICP-OES	Dry	U	100	mg/kg SO_4
CE062	Sulphate (total)	Acid extraction, ICP-OES	Dry	U	0.01	% w/w SO_4
CE119	Sulphur (total)	Acid extraction, ICP-OES	Dry		100	mg/kg S
CE119	Sulphur (total)	Acid extraction, ICP-OES	Dry		0.01	% w/w S

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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

N	No (not deviating sample)
Y	Yes (deviating sample)
NSD	Sampling date not provided
NST	Sampling time not provided (waters only)
EHT	Sample exceeded holding time(s)
IC	Sample not received in appropriate containers
HP	Headspace present in sample container
NCF	Sample not chemically fixed (where appropriate)
OR	Other (specify)

Lab ref	Sample id	Depth (m)	Deviating	Tests (Reason for deviation)
110578-1	TP1	1.20-1.50	Y	All (NSD)
110578-2	TP2	1.30-1.50	Y	All (NSD)
110578-3	TP3	1.00-1.40	Y	All (NSD)
110578-4	WS1	0.60-1.00	Y	All (NSD)
110578-5	WS2	0.50-1.00	Y	All (NSD)
110578-6	WS3	1.00-2.00	Y	All (NSD)
110578-7	WS4	1.00-1.50	Y	All (NSD)

Chemtech Environmental Limited

ADDITIONAL INFORMATION

Notes

Opinions and interpretations expressed herein are outside the UKAS accreditation scope.
Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling.
All testing carried out at Unit 6 Parkhead, Stanley, DH9 7YB, except for subcontracted testing.
Methods, procedures and performance data are available on request.
Results reported herein relate only to the material supplied to the laboratory.
This report shall not be reproduced except in full, without prior written approval.
Samples will be disposed of 4 weeks from initial receipt unless otherwise instructed.
For soils and solids, all results are reported on a dry basis. Samples dried at no more than 30°C in a drying cabinet.
Analytical results are inclusive of stones, where applicable.

Appendix H

Exploratory Hole Logs

Windowless Sample Borehole Log

BOREHOLE REFERENCE
WS1
Sheet 1 of 1

Project Name: New Penn Pub	Client: Cardiff City Council	Date: 13/06/2022
Location: Cardiff	Contractor: OAKLAND SI	Co-ords: E319860.00 N180535.00
Project No. : CA12409	Drilling Equipment: DANDO TERRIER	Level :

Logged By	Checked By	Approved By	SPT Energy Ratio	Final Depth
PM			74.61%	2.00

Install. / Backfill	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description	Scale
					0.05			Tarmacadam	
		0.20 – 0.50	ES		0.20			Loose brown-grey sandy slightly clayey angular to sub-angular fine to coarse GRAVEL of mixed lithologies with cobbles. [Made Ground]	
								Soft reddish brown mottled grey slightly sandy silty CLAY. [Raglan Mudstone Formation - Weathered Zone]	
		0.60 – 1.00	B		0.60			Soft to firm reddish brown mottled grey slightly gravelly sandy silty CLAY. Gravel is fine to coarse, angular to sub-rounded clasts of mudstone. [Raglan Mudstone Formation - Weathered Zone]	
		1.00	SPT(S)	N=25 (4,4/6,5,7,7)					1
		1.50 – 1.70	ES						
					1.95				
		2.00	SPT(S)	N=61 (8,10/13,15,15,18)	2.00			Weak pinkish brown calcareous MUDSTONE. Recovered as sandy slightly clayey angular to sub-angular fine to coarse GRAVEL with cobbles. [Raglan Mudstone Formation]	2
								End of Borehole at 2.00m	
									3

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Installation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Top	Base	Inclination	Orientation	Top	Base	Pipe Type	Diameter
												0.00m 1.00m	1.00m 2.00m	PLAIN SLOTTED	50mm 50mm

Remarks

Log printed on 23/08/2022 at 12:08

Windowless Sample Borehole Log

BOREHOLE REFERENCE
WS2
Sheet 1 of 1

Project Name: New Penn Pub	Client: Cardiff City Council	Date: 13/06/2022
Location: Cardiff	Contractor: OAKLAND SI	Co-ords: E319852.00 N180522.00
Project No. : CA12409	Drilling Equipment: DANDO TERRIER	Level :

Logged By	Checked By	Approved By	SPT Energy Ratio	Final Depth
PM			74.61%	1.45

Install. / Backfill	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results					
					0.05			Tarmac	
		0.20 – 0.40	ES		0.20			Loose brown-grey sandy slightly clayey angular to sub-angular fine to coarse GRAVEL of mixed lithologies with cobbles. [Made Ground]	
					0.40			Soft reddish brown mottled grey slightly sandy silty CLAY. [Raglan Mudstone Formation - Weathered Zone]	
		0.50 – 1.00	B					Soft to firm reddish brown mottled grey slightly gravelly sandy silty CLAY. Gravel is fine to coarse, angular to sub-rounded clasts of mudstone. [Raglan Mudstone Formation - Weathered Zone]	
		0.80 – 1.00	ES						
		1.00	SPT(S)	N=65 (7,8/11,17,17,20)					1
					1.20			Weak pinkish brown calcareous MUDSTONE. Recovered as sandy slightly clayey angular to sub-angular fine to coarse GRAVEL with cobbles. [Raglan Mudstone Formation]	
					1.45			End of Borehole at 1.45m	2
									3

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Installation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Top	Base	Inclination	Orientation	Top	Base	Pipe Type	Diameter

Remarks

Log printed on 23/08/2022 at 12:08

Windowless Sample Borehole Log

BOREHOLE REFERENCE
WS3
Sheet 1 of 1

Project Name: New Penn Pub	Client: Cardiff City Council	Date: 13/06/2022
Location: Cardiff	Contractor: OAKLAND SI	Co-ords: E319867.00 N180512.00
Project No. : CA12409	Drilling Equipment: DANDO TERRIER	Level :

Logged By	Checked By	Approved By	SPT Energy Ratio	Final Depth
PM			74.61%	3.00

Install. / Backfill	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description	Scale
		0.05 – 0.25	ES		0.05			Tarmacadam	
								Loose brown-grey sandy slightly clayey angular to sub-angular fine to coarse GRAVEL of mixed lithologies with cobbles. [Made Ground]	
					0.20			Soft reddish brown mottled grey slightly sandy silty CLAY. [Raglan Mudstone Formation - Weathered Zone]	
		0.50 – 1.00	B						
		1.00	SPT(S)	N=17 (3,3/3,4,5,5)	1.00			Soft to firm reddish brown mottled grey slightly gravelly sandy silty CLAY. Gravel is fine to coarse, angular to sub-rounded clasts of mudstone. [Raglan Mudstone Formation - Weathered Zone]	1
		2.00 – 2.50	ES						
		2.00	SPT(S)	N=16 (4,3/4,4,4,4)					2
					2.95			Weak pale reddish brown calcareous MUDSTONE. Recovered as sandy slightly clayey angular to sub-angular fine to coarse GRAVEL with cobbles. [Raglan Mudstone Formation]	
		3.00	SPT(S)	N=53 (3,8/11,10,15,17)	3.00			End of Borehole at 3.00m	3

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Installation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Top	Base	Inclination	Orientation	Top	Base	Pipe Type	Diameter
												0.00m 1.00m	1.00m 3.00m	PLAIN SLOTTED	50mm 50mm

Remarks

Log printed on 23/08/2022 at 12:08

Windowless Sample Borehole Log

BOREHOLE REFERENCE
WS4
Sheet 1 of 1

Project Name: New Penn Pub	Client: Cardiff City Council	Date: 13/06/2022
Location: Cardiff	Contractor: OAKLAND SI	Co-ords: E319889.00 N180542.00
Project No. : CA12409	Drilling Equipment: DANDO TERRIER	Level :

Logged By	Checked By	Approved By	SPT Energy Ratio	Final Depth
PM			74.61%	1.50

Install. / Backfill	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results					
		0.10 – 0.30	ES		0.10			GRAVEL over fabric reference layer	
								Loose dark grey slightly clayey fine to coarse SAND and angular to sub-rounded fine to coarse GRAVEL of mixed lithologies with cobbles. [Made Ground]	
					0.30			Soft reddish brown mottled grey slightly sandy CLAY. [Raglan Mudstone Formation - Weathered Zone]	
		0.80 – 1.00	ES						
		1.00 – 1.50	B		1.00			Soft to firm reddish brown mottled grey gravelly slightly sandy CLAY. Gravel is fine to coarse, angular to sub-rounded clasts of mudstone. [Raglan Mudstone Formation - Weathered Zone]	1
		1.00	SPT(S)	N=37 (2,4/4,5,11,17)					
		1.50	SPT(S)	50 (12,15/50 for 65mm,0,0,0)	1.50			Weak pinkish brown calcareous MUDSTONE. Recovered as sandy slightly clayey angular to sub-angular fine to coarse GRAVEL with cobbles. [Raglan Mudstone Formation]	
					1.65			End of Borehole at 1.50m	2
									3

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Installation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Top	Base	Inclination	Orientation	Top	Base	Pipe Type	Diameter

Remarks

Log printed on 23/08/2022 at 12:08

Windowless Sample Borehole Log

BOREHOLE REFERENCE
WS5
Sheet 1 of 1

Project Name: New Penn Pub	Client: Cardiff City Council	Date: 13/06/2022
Location: Cardiff	Contractor: OAKLAND SI	Co-ords: E319881.00 N180500.00
Project No. : CA12409	Drilling Equipment: DANDO TERRIER	Level :

Logged By	Checked By	Approved By	SPT Energy Ratio	Final Depth
PM			74.61%	1.00

Install. / Backfill	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	Scale
		Depth (m)	Type	Results					
		0.15 – 0.30	ES		0.15			Firm orangish brown slightly gravelly slightly sandy CLAY with occasional rootlets. Gravel is fine to medium angular to rounded clasts of mudstone. [Topsoil]	
		0.30 – 1.00	ES					Soft brown gravelly sandy CLAY with common rootlets. Gravel is fine to medium, angular to sub-angular clasts of mudstone, brick and glass fragments.	
		1.00	SPT(S)	N=65 (8,14/15,15,18,17)	0.95 1.00			Weak pale reddish brown calcareous MUDSTONE. Recovered as sandy slightly clayey angular to sub-angular fine to coarse GRAVEL with cobbles. [Raglan Mudstone Formation]	1 2 3
								End of Borehole at 1.00m	

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Installation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Top	Base	Inclination	Orientation	Top	Base	Pipe Type	Diameter
												0.00m 0.50m	0.50m 1.00m	PLAIN SLOTTED	50mm

Remarks

Log printed on 23/08/2022 at 12:08

Trial Pit Log

TRIAL PIT REFERENCE
TP1
Sheet 1 of 1

Project Name: New Penn Pub	Client: Cardiff City Council	Date: 13/06/2022
Location: Cardiff	Contractor: OAKLAND SI	Co-ords: E319864.00 N180524.00
Project No. : CA12409	Excavator: JCB-3CX	Dimensions : 1.50m × 0.70m; Final Depth: 1.60m
Logged By: PM	Checked By	Approved By	Level	Orientation: °

Backfill	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description	Scale
		0.10 – 0.30	ES		0.05			Tarmacadam	
								Loose brown-grey sandy slightly clayey angular to sub-angular fine to coarse GRAVEL of mixed lithologies with cobbles. [Made Ground]	
					0.30			Soft reddish brown mottled grey-green slightly sandy CLAY. [Raglan Mudstone Formation - Weathered Zone]	
					0.60			Soft to firm reddish brown mottled grey slightly gravelly sandy CLAY. Gravel is fine to coarse angular to sub-rounded clasts of calcareous mudstone. [Raglan Mudstone Formation - Weathered Zone]	1
		1.20 – 1.50 1.20 – 1.50	B ES						
					1.50			Extremely weak reddish brown distinctly weathered calcareous MUDSTONE. Excavated as sandy slightly clayey angular to sub-angular fine to coarse GRAVEL with cobbles. [Raglan Mudstone Formation]	2
					1.60			Base of Excavation at 1.60m	3

Trench Support and Comment			Pumping Data		
Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
	NONE				

General Remarks

Log printed on 23/08/2022 at 12:08

Trial Pit Log

TRIAL PIT REFERENCE
TP2
Sheet 1 of 1

Project Name: New Penn Pub	Client: Cardiff City Council	Date: 13/06/2022
Location: Cardiff	Contractor: OAKLAND SI	Co-ords: E319873.50 N180536.50
Project No. : CA12409	Excavator: JCB-3CX	Dimensions : 1.60m x 0.70m / Final Depth: 1.50m
Logged By: PM	Checked By	Approved By	Level	Orientation: °

Backfill	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description	Scale
					0.05			Tarmacadam	
								Loose brown-grey sandy slightly clayey angular to sub-angular fine to coarse GRAVEL of mixed lithologies with cobbles. [Made Ground]	
		0.25 – 1.00	ES		0.25			Soft reddish brown mottled grey-green slightly sandy CLAY. [Raglan Mudstone Formation - Weathered Zone]	
					0.30			Soft to firm reddish brown mottled grey gravelly CLAY. Gravel is fine to coarse angular to sub-rounded clasts of mudstone. [Raglan Mudstone Formation - Weathered Zone]	
		1.00 – 1.20	ES						1
		1.30 – 1.50	B						
					1.40			Extremely weak reddish brown distinctly weathered calcareous MUDSTONE. Excavated as sandy slightly clayey angular to sub-angular fine to coarse GRAVEL with cobbles. [Raglan Mudstone Formation]	
					1.50			Base of Excavation at 1.50m	
									2
									3

Trench Support and Comment

Pit Stability	Shoring Used	Remarks
	NONE	

Pumping Data

Date	Rate	Remarks

General Remarks

Log printed on 23/08/2022 at 12:08

Trial Pit Log

TRIAL PIT REFERENCE
TP3
Sheet 1 of 1

Project Name: New Penn Pub	Client: Cardiff City Council	Date: 13/06/2022
Location: Cardiff	Contractor: Oakland SI	Co-ords: E319865.50 N180538.00
Project No. : CA12409	Excavator: JCB-3CX	Dimensions : 1.40m x 0.70m; Final Depth: 1.50m
Logged By: PM	Checked By	Approved By	Level	Orientation: °

Backfill	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description	Scale
					0.05			Tarmacadam	
								Loose brown-grey sandy slightly clayey angular to sub-angular fine to coarse GRAVEL of mixed lithologies with cobbles. [Made Ground]	
		0.25 – 0.50	ES		0.30			Soft reddish brown slightly gravelly CLAY. Gravel is fine to coarse angular to rounded clasts of calcareous mudstone. [Raglan Mudstone Formation - Weathered Zone]	
		1.00 – 1.30 1.00 – 1.40	ES B		1.00			Firm reddish brown gravelly CLAY. Gravel is fine to coarse, angular to sub-rounded clasts of calcareous mudstone. [Raglan Mudstone Formation - Weathered Zone]	1
					1.30			Extremely weak reddish brown distinctly weathered calcareous MUDSTONE. Excavated as slightly sandy clayey angular to sub-angular fine to coarse GRAVEL with cobbles. [Raglan Mudstone Formation]	
					1.50			Base of Excavation at 1.50m	2 3

Trench Support and Comment

Pit Stability	Shoring Used	Remarks
	NONE	

Pumping Data

Date	Rate	Remarks

General Remarks

Log printed on 23/08/2022 at 12:08

Trial Pit Log

TRIAL PIT REFERENCE
TP4
Sheet 1 of 1

Project Name: New Penn Pub	Client: Cardiff City Council	Date: 13/06/2022
Location: Cardiff	Contractor: OAKLAND SI	Co-ords: E319855.00 N180517.00
Project No. : CA12409	Excavator: JCB-3CX	Dimensions : m E m — Final Depth: 1.50m
Logged By: PM	Checked By	Approved By	Level	Orientation: °

Backfill	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description	Scale
					0.05			Tarmacadam	
								Loose brown-grey sandy slightly clayey angular to sub-angular fine to coarse GRAVEL of mixed lithologies with cobbles. [Made Ground]	
		0.25 – 0.50	ES		0.25			Soft to firm reddish brown mottled grey gravelly CLAY. Gravel is fine to coarse, angular to sub-rounded clasts of calcareous mudstone. [Raglan Mudstone Formation - Weathered Zone]	
		1.00 – 1.30	ES						1
					1.40			Extremely reddish brown distinctly weathered calcareous MUDSTONE. Excavated as sandy slightly clayey angular to sub-angular fine to coarse GRAVEL with cobbles. [Raglan Mudstone Formation]	
					1.50			Base of Excavation at 1.50m	
									2
									3

Trench Support and Comment			Pumping Data		
Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
	NONE				

General Remarks

Log printed on 23/08/2022 at 12:08

Trial Pit Log

TRIAL PIT REFERENCE
TP5
Sheet 1 of 1

Project Name: New Penn Pub	Client: Cardiff City Council	Date: 13/06/2022
Location: Cardiff	Contractor: OAKLAND SI	Co-ords: E319886.00 N180493.00
Project No. : CA12409	Excavator: JCB-3CX	Dimensions : 2.10m × 0.70m; Final Depth: 2.00m
Logged By: PM	Checked By	Approved By	Level	Orientation: °

Backfill	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description	Scale
		0.00 – 0.30	B		0.20			Firm orangish brown slightly gravelly slightly sandy CLAY with occasional rootlets. Gravel is fine to medium angular to rounded clasts of mudstone. [Topsoil]	
		0.70 – 1.50	ES		0.70			Soft to firm reddish brown mottled grey slightly gravelly slightly sandy CLAY. Gravel is fine to coarse angular to sub-rounded clasts of mudstone and fragments of glass and plastic.	
					2.00			Soft grey-brown gravelly slightly sandy CLAY with occasional cobbles. Gravel is fine to coarse angular to sub-rounded clasts of mudstone and fragments of glass, metal sheeting, metal rebar, plastic, tile and wood. Slight hydrocarbon odour. [Made Ground]	1
								Base of Excavation at 2.00m	2
									3

Trench Support and Comment

Pit Stability	Shoring Used	Remarks
	NONE	

Pumping Data

Date	Rate	Remarks

General Remarks

Log printed on 23/08/2022 at 12:08

Appendix I

Environmental Monitoring Sheet

Client:	CARDIFF CITY COUNCIL	**Job No:**	**CA12409**		
Site:	NEW PENN PUB	**Visit No:**	1	**of**	1
Date:	14/07/2022	**Operator:**	**PM**		

Monitoring Point	GAS CONCENTRATIONS								VOLATILES		FLOW DATA			WELL AND WATER DATA	Comments
	Methane (%v/v)		Carbon dioxide (%v/v)		Carbon monoxide (ppm)	Hydrogen sulphide (ppm)	Oxygen (%v/v)		PID Peak (ppm)	Product thickness (mm)	Flow rate (l/hr)		Differential borehole Pressure (Pa)	Water level (mbgl)	
	Peak	Steady	Peak	Steady	Peak	Peak	Minimum	Steady			Peak	Steady			
WS1	0.2	0.2	7.6	7.6	0	1	12.8	12.8			0.0	0.0	0.05	DRY	
WS3	7.0	5.1	14.1	14.1	2	1	1.2	2.9			0.2	0.0	-0.68	2.02	
WS5	0.5	0.1	0.7	0.7	1	1	19.6	19.6			0.0	0.0	0.1	DRY	
Max	**7.0**	**5.1**	**14.1**	**14.1**	**2**	**1**	**19.6**	**19.6**	**N/A**	**N/A**	**0.2**	**0.0**	**0.1**	**2.02**	
Min	**0.2**	**0.1**	**0.7**	**0.7**	**0**	**1**	**1.2**	**2.9**	**N/A**	**N/A**	**0.0**	**0.0**	**-0.68**	**2.02**	
GSV (l/hr)	**0.014**		**0.0282**												

METEOROLOGICAL AND SITE INFORMATION:

State of ground:	X	Dry		Wet		Snow		Frozen
Wind:	X	Calm		Moderate		Strong		
Cloud cover:	X	None		Cloudy		Overcast		
Preciptation:	X	None		Moderate		Heavy		
Barometric pressure (mbar):			1019	Before	1020	After		
Pressure trend:		Falling		Steady	X	Rising		

Ground gas meter: CA5000

Date of last calibration:

Appendix J

TRL-DCP Test Sheets

Dynamic Cone CBR Test

New Penn Pub, Llanedeyrn Test Refer

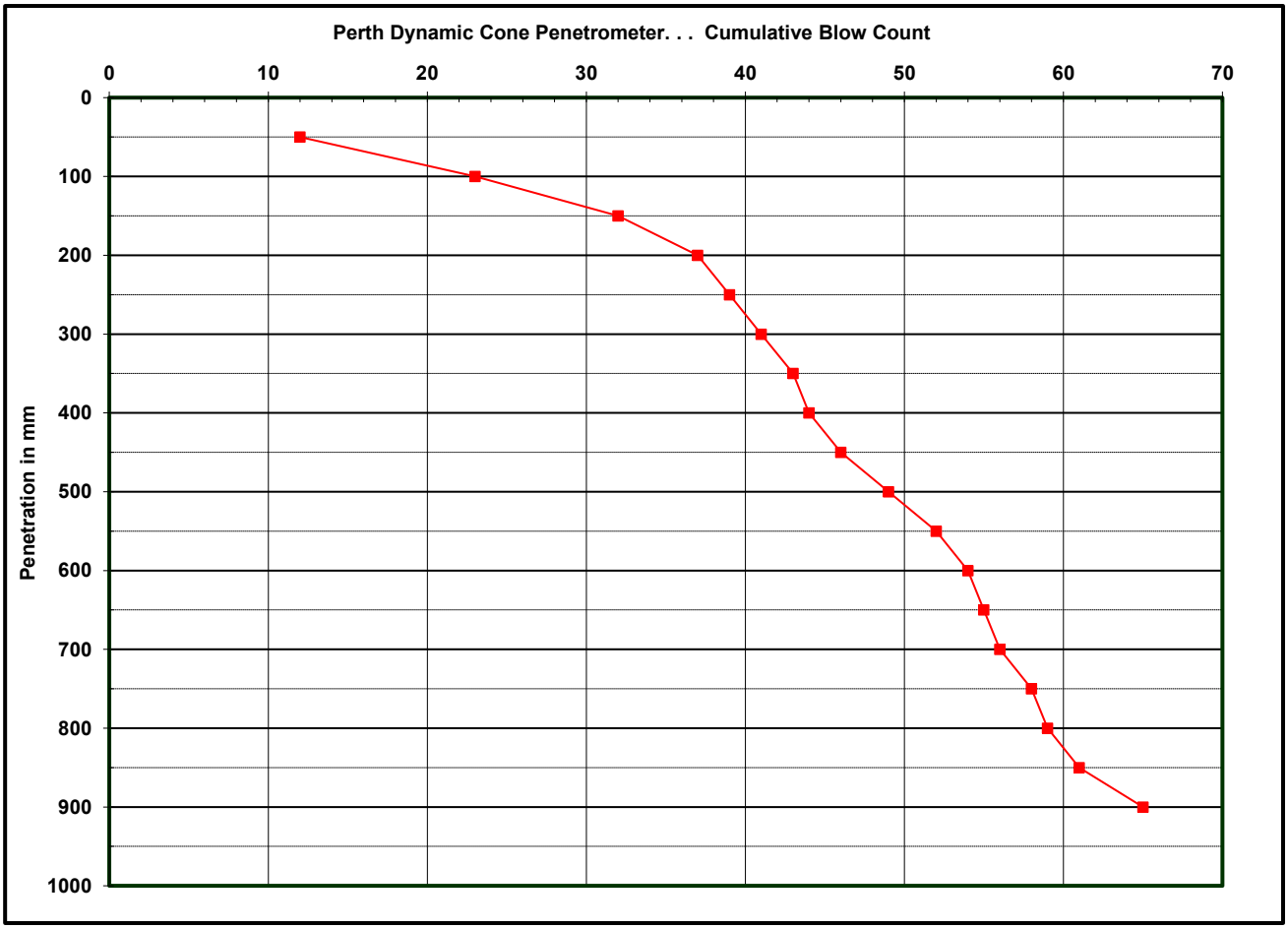
Date 13.06.2022

0

Nr Blows	S Blows	Penetration mm	S Pen. mm
12	12	50	50
11	23	50	100
9	32	50	150
5	37	50	200
2	39	50	250
2	41	50	300
2	43	50	350
1	44	50	400
2	46	50	450
3	49	50	500
3	52	50	550
2	54	50	600
1	55	50	650
1	56	50	700
2	58	50	750
1	59	50	800
2	61	50	850
4	65	50	900

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
50	150	12	32	5.0	55.1	54.6	**54.6**
200	350	37	43	25.0	10.1	7.0	**7.0**
350	500	43	49	25.0	10.1	7.0	**7.0**
500	600	49	54	20.0	12.7	9.3	**9.3**
600	800	54	59	40.0	6.1	3.8	**3.8**



Tested by	SB	Checked		Approved	

Site: New Penn Pub, Llanedeyrn	**Client:** Wardell Armstrong	**Date:** 13.06.2022
	Job No: 0	**Test No:** CBR 1

Dynamic Cone CBR Test

New Penn Pub, Llanedeyrn Test Refer

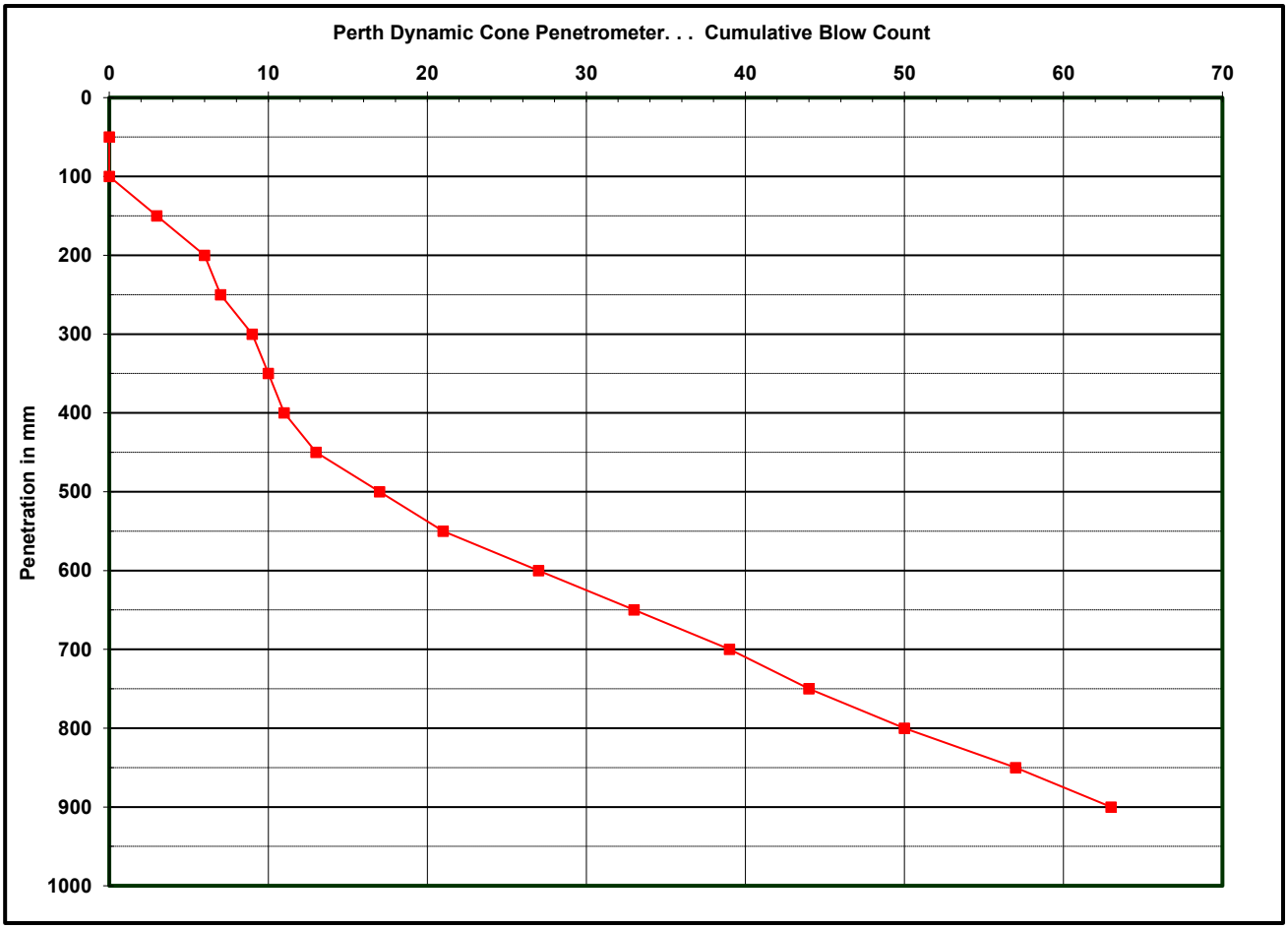
Date 13.06.2022

0

Nr Blows	S Blows	Penetration mm	S Pen. mm
	0	50	50
	0	50	100
3	3	50	150
3	6	50	200
1	7	50	250
2	9	50	300
1	10	50	350
1	11	50	400
2	13	50	450
4	17	50	500
4	21	50	550
6	27	50	600
6	33	50	650
6	39	50	700
5	44	50	750
6	50	50	800
7	57	50	850
6	63	50	900

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
150	200	3	6	16.7	15.4	11.7	**11.7**
200	450	6	13	35.7	6.9	4.4	**4.4**
450	650	13	33	10.0	26.5	22.5	**22.5**
650	900	33	63	8.3	32.1	28.4	**28.4**



Tested by	SB	Checked		Approved	

Site: New Penn Pub, Llanedeyrn	**Client:** Wardell Armstrong	**Date:** 13.06.2022
	Job No: 0	**Test No:** CBR 2

Dynamic Cone CBR Test

New Penn Pub, Llanedeyrn Test Refer

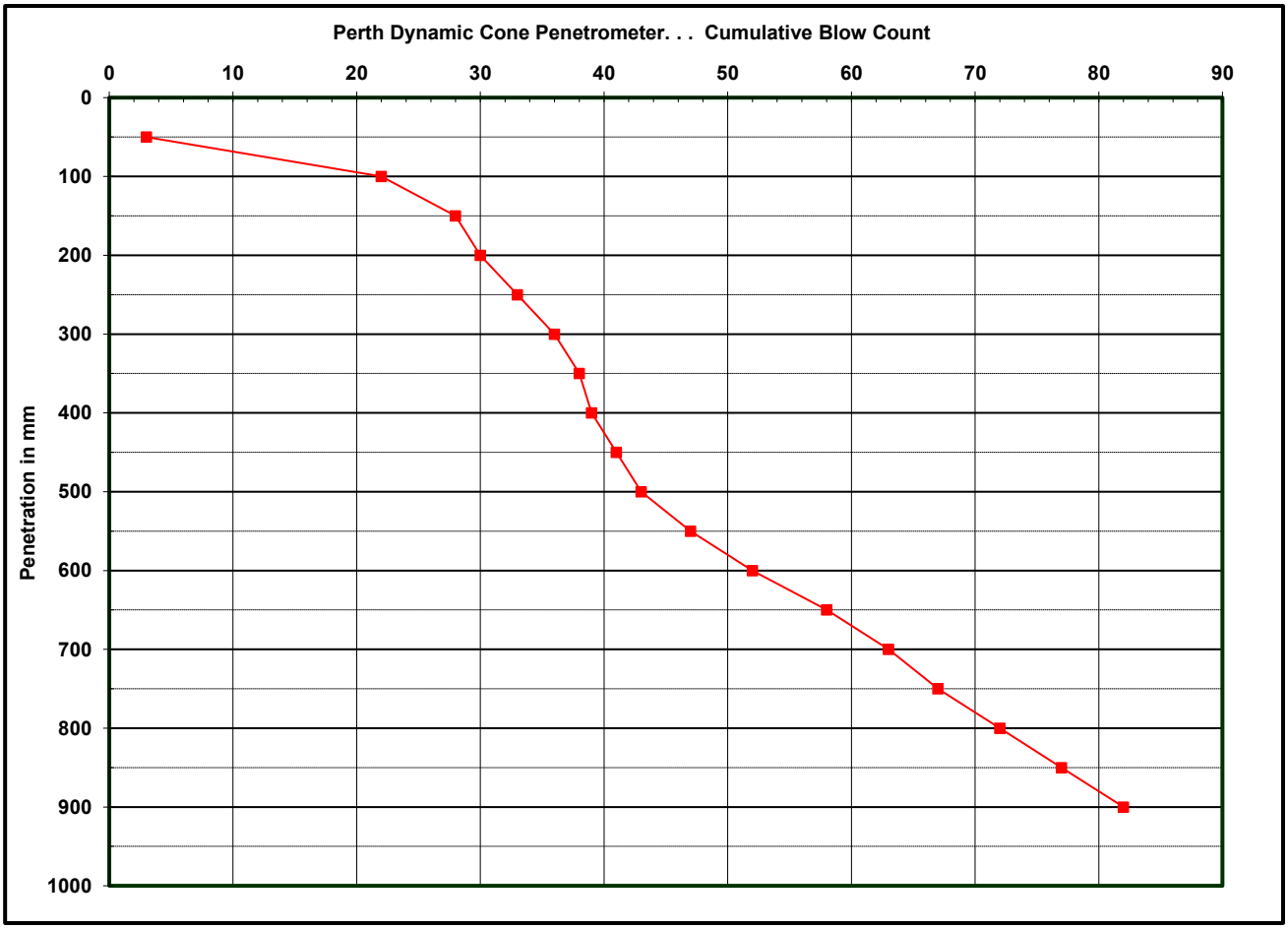
Date 13.06.2022

0

Nr Blows	S Blows	Penetration mm	S Pen. mm
3	3	50	50
19	22	50	100
6	28	50	150
2	30	50	200
3	33	50	250
3	36	50	300
2	38	50	350
1	39	50	400
2	41	50	450
2	43	50	500
4	47	50	550
5	52	50	600
6	58	50	650
5	63	50	700
4	67	50	750
5	72	50	800
5	77	50	850
5	82	50	900

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
150	350	28	38	20.0	12.7	9.3	**9.3**
350	500	38	43	30.0	8.3	5.5	**5.5**
500	900	43	82	10.3	25.8	21.8	**21.8**



Tested by	SB	Checked		Approved	

Site: New Penn Pub, Llanedeyrn	**Client:** Wardell Armstrong	**Date:** 13.06.2022
	Job No: 0	**Test No:** CBR 3

Dynamic Cone CBR Test

New Penn Pub, Llanedeyrn Test Refer

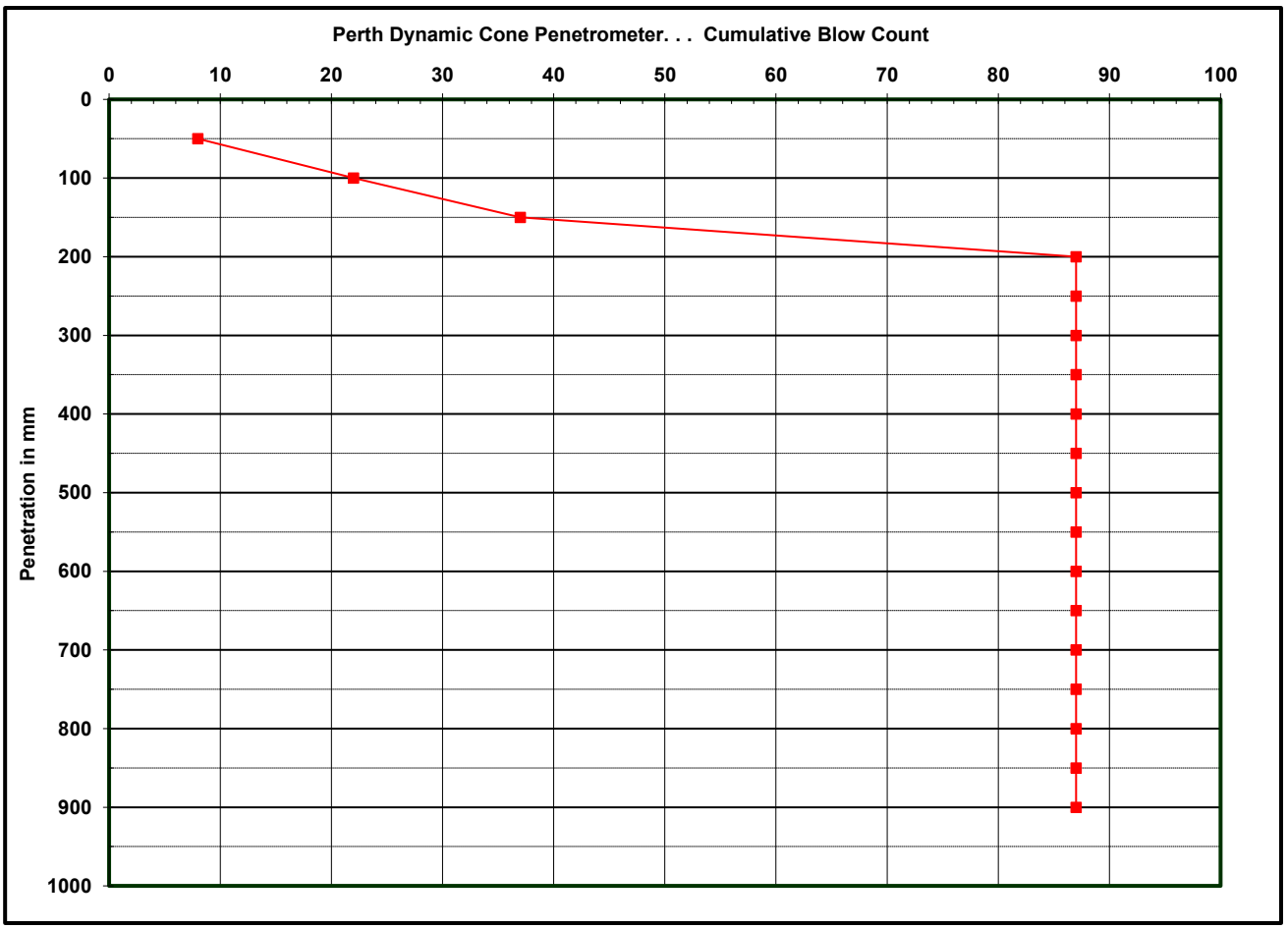
Date 13.06.2022

0

Nr Blows	S Blows	Penetration mm	S Pen. mm
8	8	50	50
14	22	50	100
15	37	50	150
50	87	50	200
	87	50	250
	87	50	300
	87	50	350
	87	50	400
	87	50	450
	87	50	500
	87	50	550
	87	50	600
	87	50	650
	87	50	700
	87	50	750
	87	50	800
	87	50	850
	87	50	900

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
50	150	8	37	3.4	81.6	87.9	**81.6**
150	200	37	87	1.0	302.0	428.5	**302.0**



Tested by	SB	Checked		Approved	

Site: New Penn Pub, Llanedeyrn	**Client:** Wardell Armstrong	**Date:** 13.06.2022
	Job No: 0	**Test No:** CBR 4

Dynamic Cone CBR Test

New Penn Pub, Llanedeyrn Test Refer

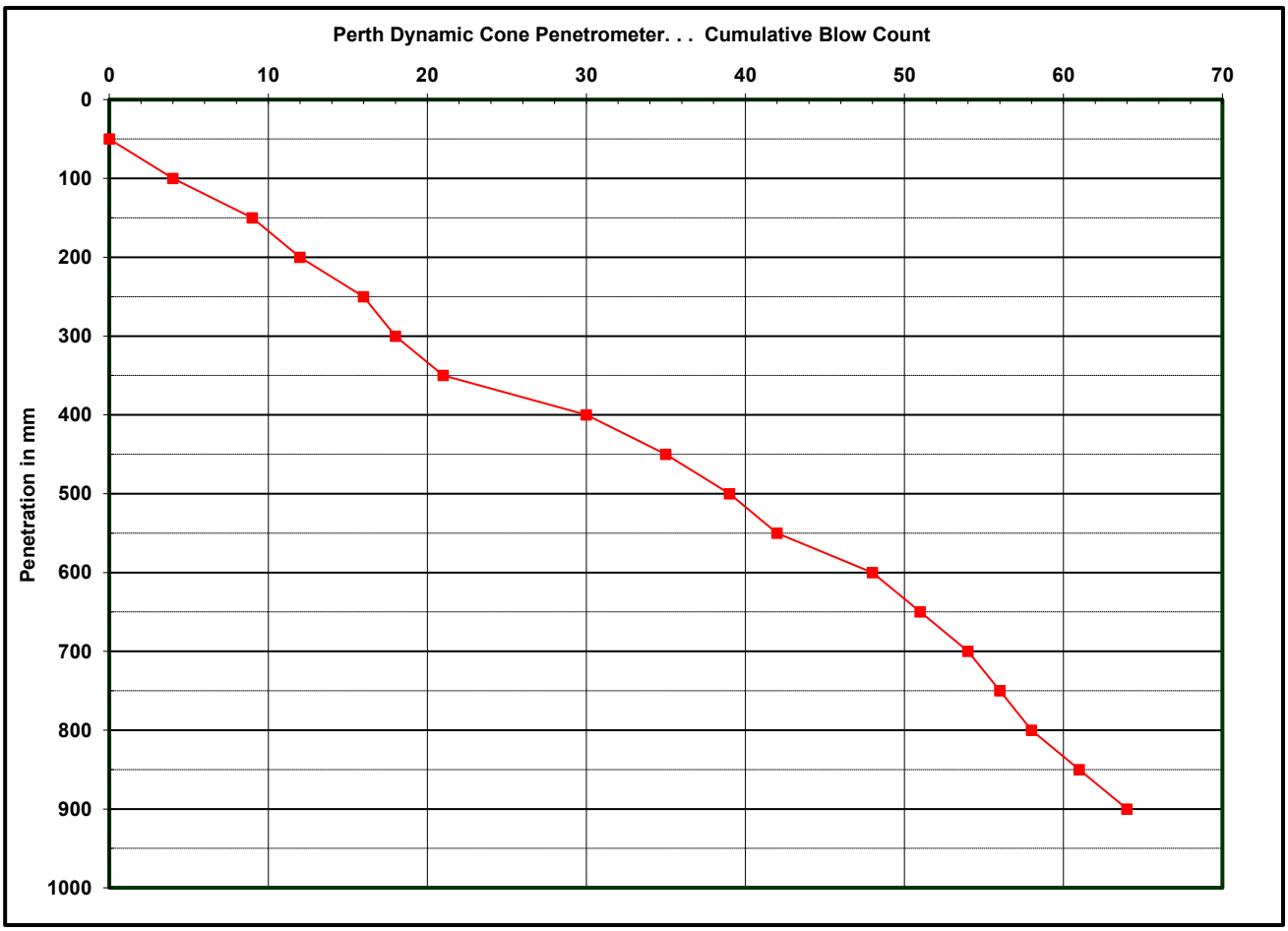
Date 13.06.2022

0

Nr Blows	S Blows	Penetration mm	S Pen. mm
	0	50	50
4	4	50	100
5	9	50	150
3	12	50	200
4	16	50	250
2	18	50	300
3	21	50	350
9	30	50	400
5	35	50	450
4	39	50	500
3	42	50	550
6	48	50	600
3	51	50	650
3	54	50	700
2	56	50	750
2	58	50	800
3	61	50	850
3	64	50	900

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
100	250	4	16	12.5	20.9	16.9	**16.9**
250	350	16	21	20.0	12.7	9.3	**9.3**
350	400	21	30	5.6	49.3	47.7	**47.7**
400	600	30	48	11.1	23.7	19.7	**19.7**
600	900	48	64	18.8	13.6	10.1	**10.1**



Tested by	SB	Checked		Approved	

Site: New Penn Pub, Llanedeyrn	**Client:** Wardell Armstrong	**Date:** 13.06.2022
	Job No: 0	**Test No:** CBR 5

Dynamic Cone CBR Test

New Penn Pub, Llanedeyrn Test Refer

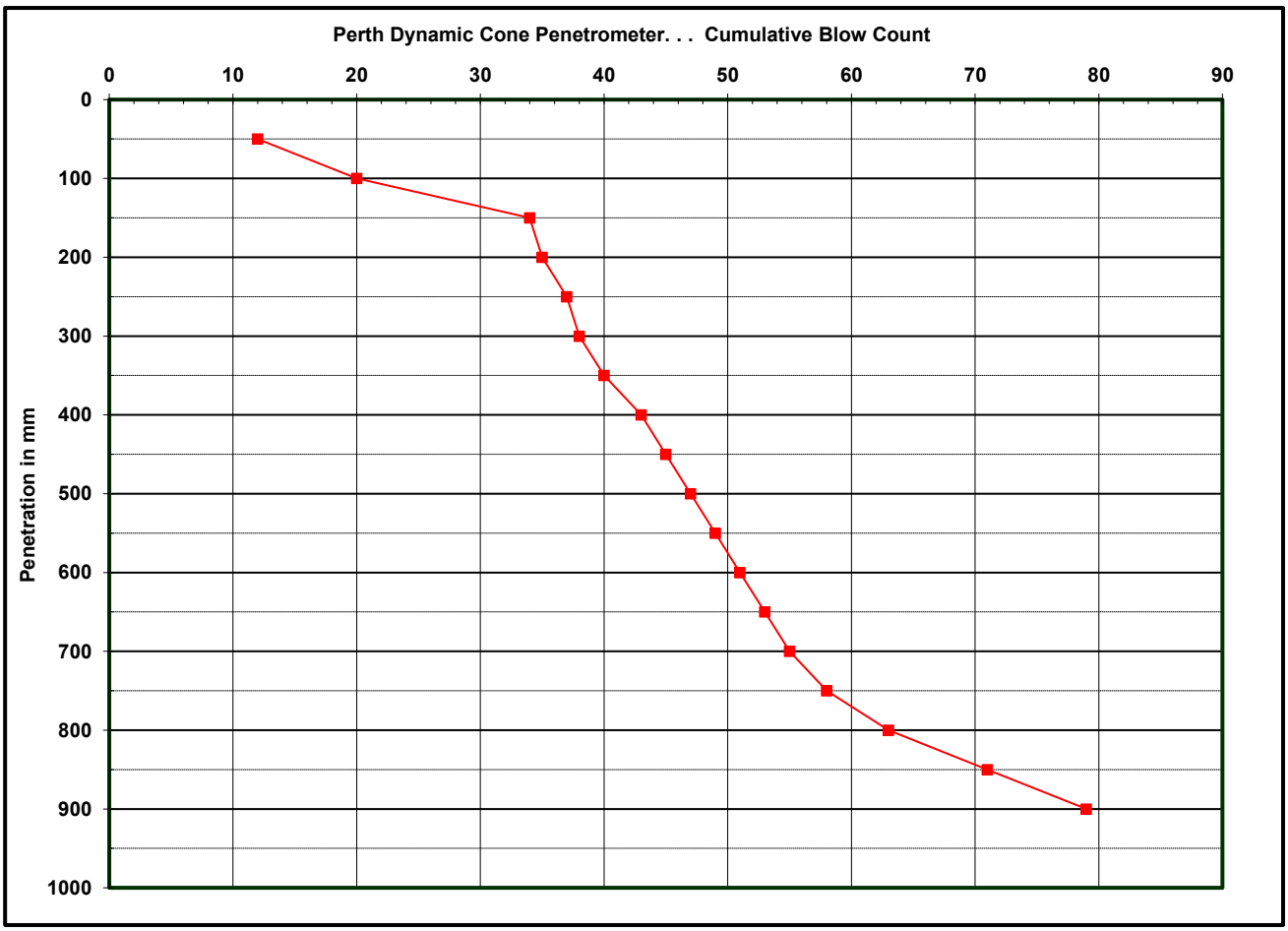
Date 13.06.2022

0

Nr Blows	S Blows	Penetration mm	S Pen. mm
12	12	50	50
8	20	50	100
14	34	50	150
1	35	50	200
2	37	50	250
1	38	50	300
2	40	50	350
3	43	50	400
2	45	50	450
2	47	50	500
2	49	50	550
2	51	50	600
2	53	50	650
2	55	50	700
3	58	50	750
5	63	50	800
8	71	50	850
8	79	50	900

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
150	350	34	40	33.3	7.4	4.8	**4.8**
350	400	40	43	16.7	15.4	11.7	**11.7**
400	750	43	58	23.3	10.8	7.6	**7.6**
750	900	58	79	7.1	37.8	34.6	**34.6**



Tested by	SB	Checked		Approved	

Site: New Penn Pub, Llanedeyrn	**Client:** Wardell Armstrong	**Date:** 13.06.2022
	Job No: 0	**Test No:** CBR 6

Dynamic Cone CBR Test

New Penn Pub, Llanedeyrn Test Refer

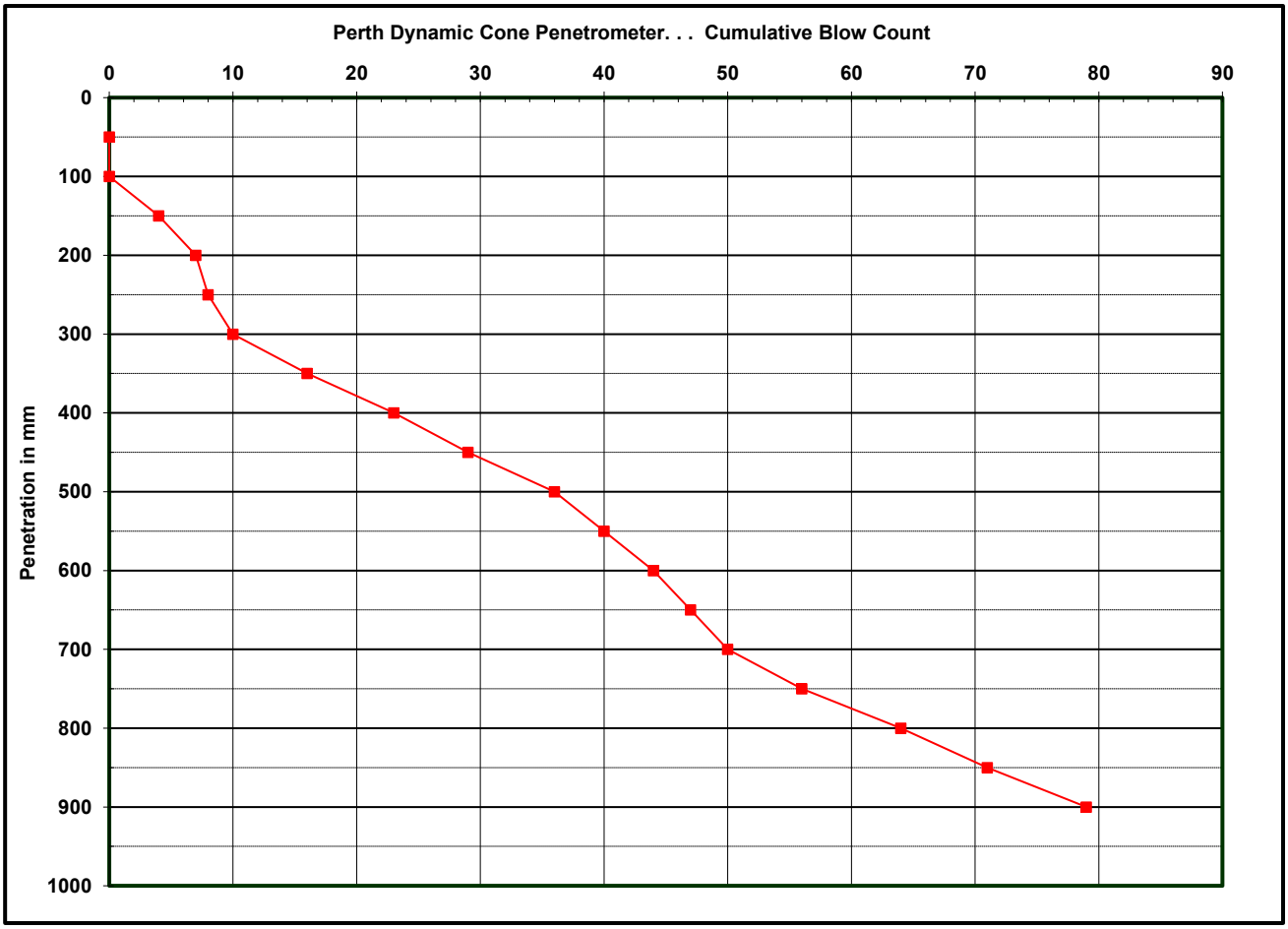
Date 13.06.2022

0

Nr Blows	S Blows	Penetration mm	S Pen. mm
0	0	50	50
0	0	50	100
4	4	50	150
3	7	50	200
1	8	50	250
2	10	50	300
6	16	50	350
7	23	50	400
6	29	50	450
7	36	50	500
4	40	50	550
4	44	50	600
3	47	50	650
3	50	50	700
6	56	50	750
8	64	50	800
7	71	50	850
8	79	50	900

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
150	300	4	10	25.0	10.1	7.0	**7.0**
300	500	10	36	7.7	34.9	31.5	**31.5**
500	700	36	50	14.3	18.2	14.2	**14.2**
700	900	50	79	6.9	39.2	36.2	**36.2**



Tested by	SB	Checked		Approved	

Site: New Penn Pub, Llanedeyrn	**Client:** Wardell Armstrong	**Date:** 13.06.2022
	Job No: 0	**Test No:** CBR 7

Dynamic Cone CBR Test

New Penn Pub, Llanedeyrn Test Refer

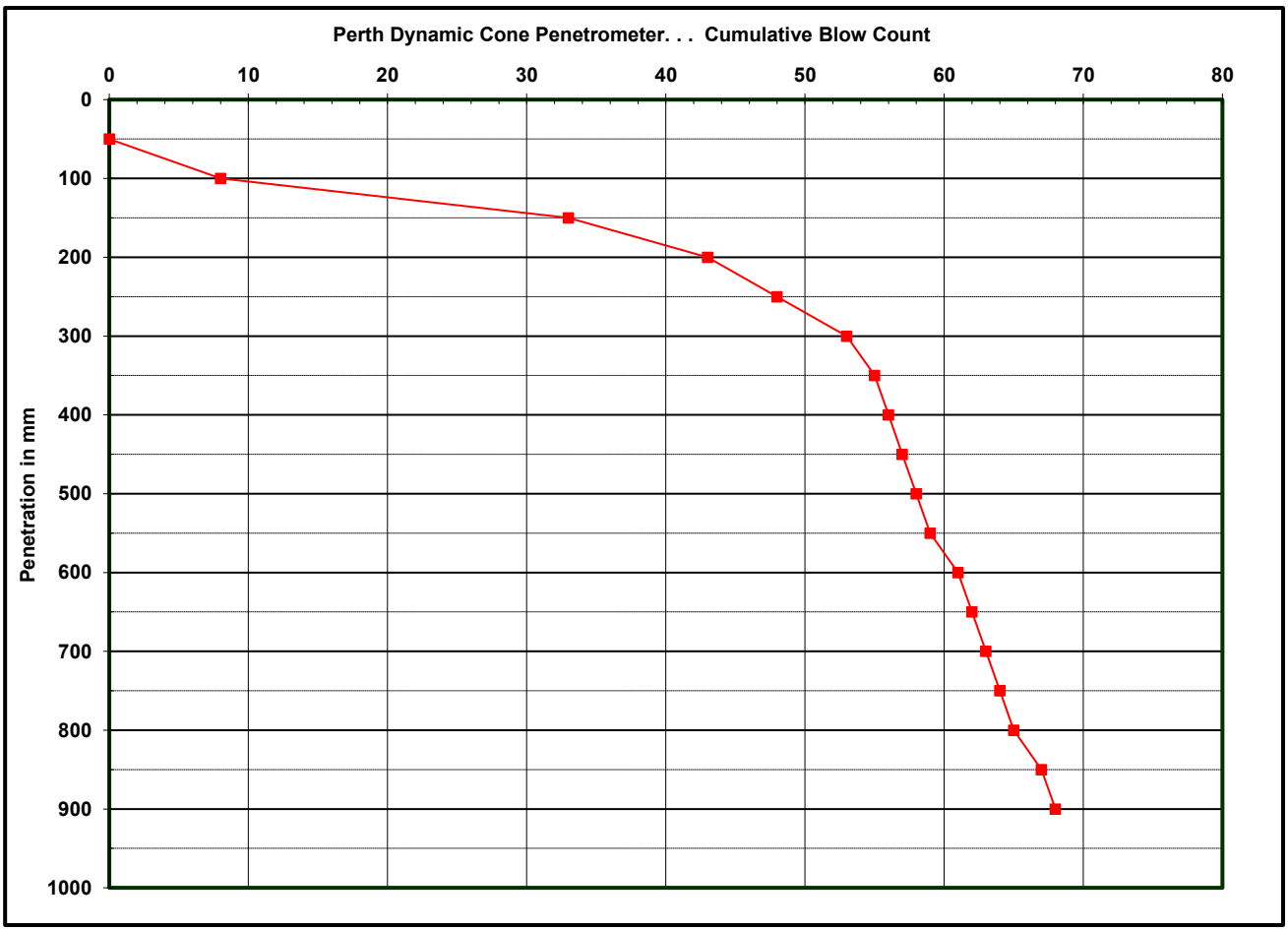
Date 13.06.2022

0

Nr Blows	S Blows	Penetration mm	S Pen. mm
0	0	50	50
8	8	50	100
25	33	50	150
10	43	50	200
5	48	50	250
5	53	50	300
2	55	50	350
1	56	50	400
1	57	50	450
1	58	50	500
1	59	50	550
2	61	50	600
1	62	50	650
1	63	50	700
1	64	50	750
1	65	50	800
2	67	50	850
1	68	50	900

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
100	150	8	33	2.0	145.1	176.5	**145.1**
150	300	33	53	7.5	35.9	32.5	**32.5**
300	550	53	59	41.7	5.9	3.6	**3.6**
550	900	59	68	38.9	6.3	4.0	**4.0**



Tested by	SB	Checked		Approved	

Site: New Penn Pub, Llanedeyrn	**Client:** Wardell Armstrong	**Date:** 13.06.2022
	Job No: 0	**Test No:** CBR 8

Dynamic Cone CBR Test

New Penn Pub, Llanedeyrn Test Refer

OAKLAND site investigation

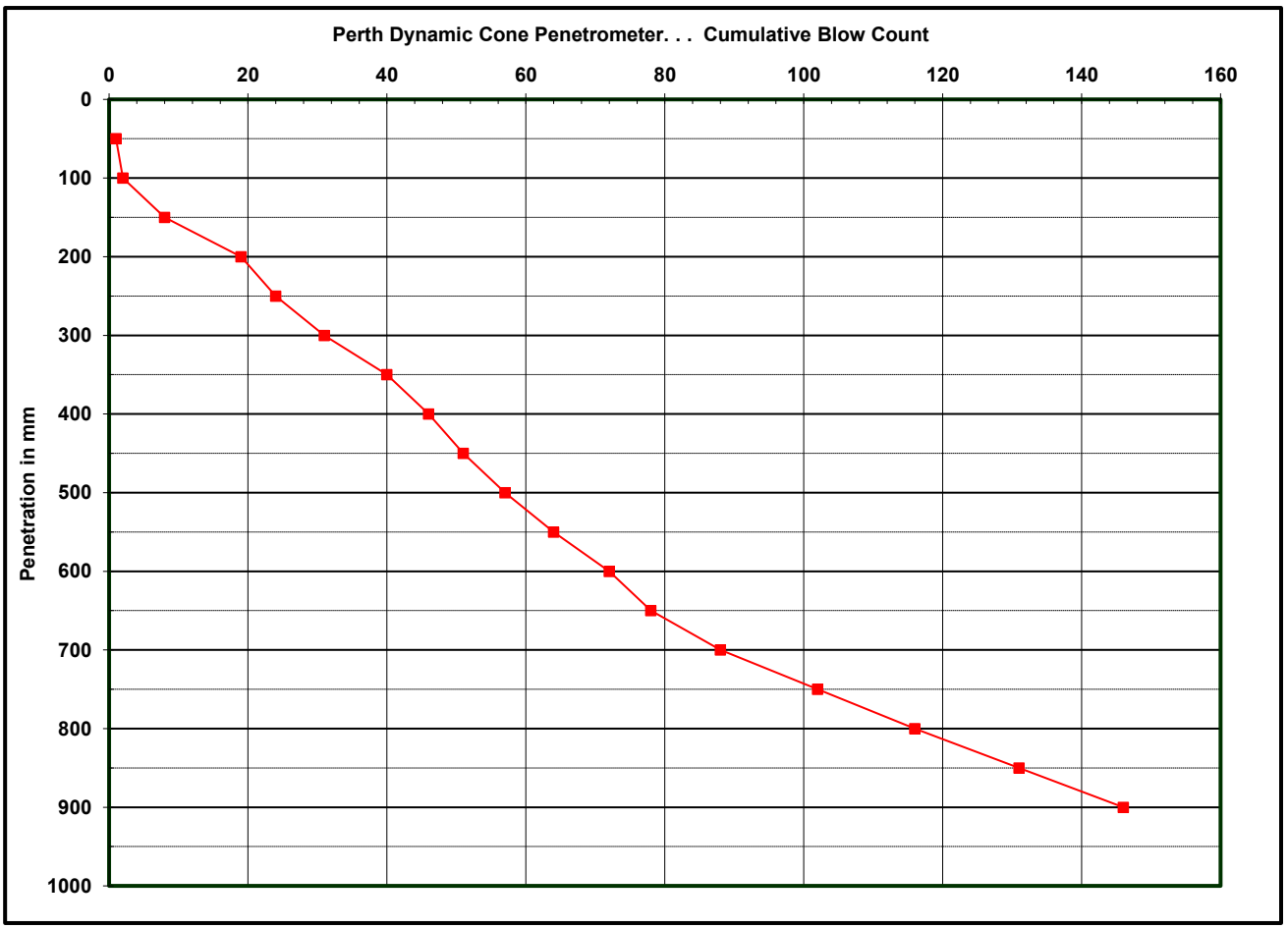
Date 13.06.2022

0

Nr Blows	S Blows	Penetration mm	S Pen. mm
1	1	50	50
1	2	50	100
6	8	50	150
11	19	50	200
5	24	50	250
7	31	50	300
9	40	50	350
6	46	50	400
5	51	50	450
6	57	50	500
7	64	50	550
8	72	50	600
6	78	50	650
10	88	50	700
14	102	50	750
14	116	50	800
15	131	50	850
15	146	50	900

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
150	200	8	19	4.5	60.9	61.7	**60.9**
200	350	19	40	7.1	37.8	34.6	**34.6**
350	500	40	57	8.8	30.2	26.4	**26.4**
500	650	57	78	7.1	37.8	34.6	**34.6**
650	900	78	146	3.7	76.3	81.0	**76.3**



Tested by	SB	Checked		Approved	

Site: New Penn Pub, Llanedeyrn	**Client:** Wardell Armstrong	**Date:** 13.06.2022
	Job No: 0	**Test No:** CBR 9

Dynamic Cone CBR Test

New Penn Pub, Llanedeyrn Test Refer

OAKLAND site investigation

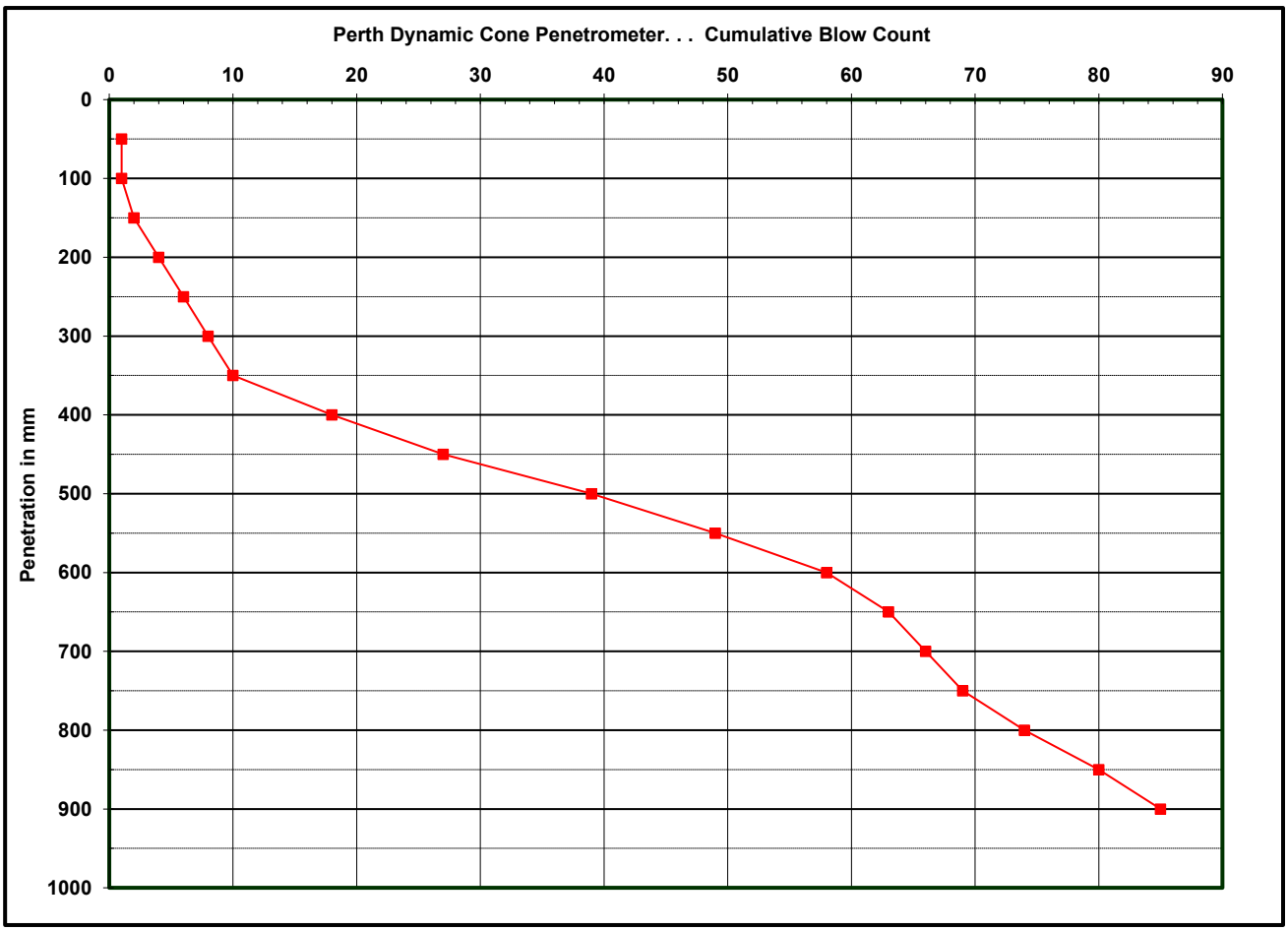
Date 13.06.2022

0

Nr Blows	S Blows	Penetration mm	S Pen. mm
1	1	50	50
0	1	50	100
1	2	50	150
2	4	50	200
2	6	50	250
2	8	50	300
2	10	50	350
8	18	50	400
9	27	50	450
12	39	50	500
10	49	50	550
9	58	50	600
5	63	50	650
3	66	50	700
3	69	50	750
5	74	50	800
6	80	50	850
5	85	50	900

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
150	350	2	10	25.0	10.1	7.0	**7.0**
350	600	10	58	5.2	52.8	51.8	**51.8**
600	750	58	69	13.6	19.1	15.1	**15.1**
750	900	69	85	9.4	28.4	24.4	**24.4**



Tested by	SB	Checked		Approved	

Site: New Penn Pub, Llanedeyrn	**Client:** Wardell Armstrong	**Date:** 13.06.2022
	Job No: 0	**Test No:** CBR 10

Appendix K

Soakaway Test Sheets

TP01		Length (m)	1.50
Date	13/06/2022	Width (m)	0.70
Site	New Penn Pub	Depth (m)	1.60
Job Number	CA12409	Groundwater Level (mbgl)	-

wardell armstrong

SOIL INFILTRATION RATE TEST

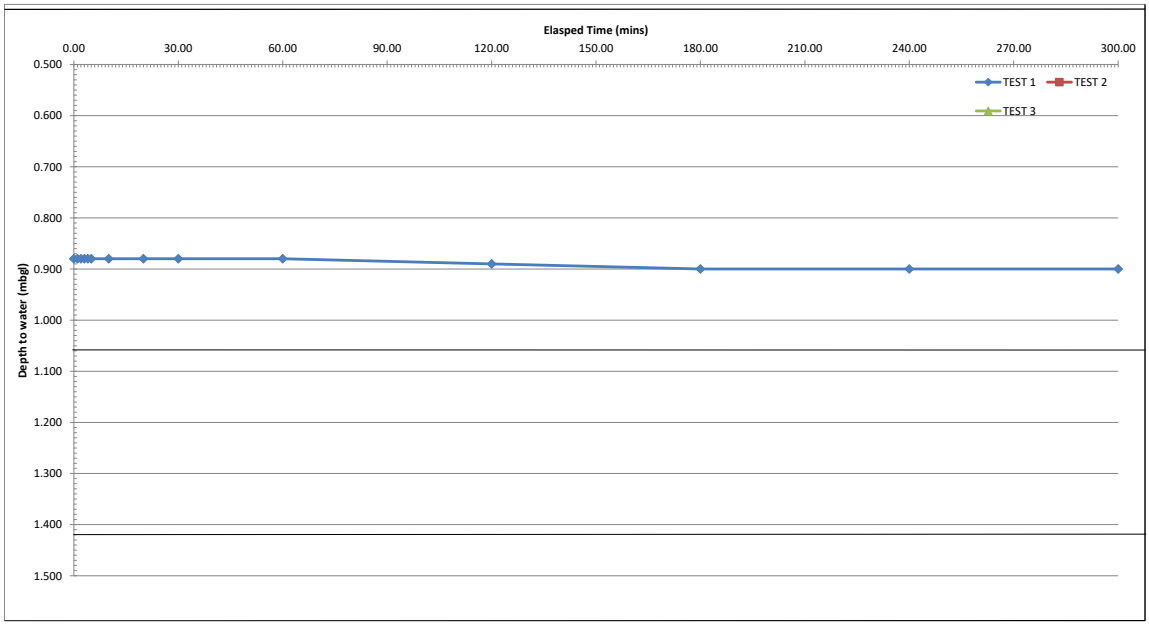
See B.R.E. Digest 365, 2016, Soakaway Design.

Remarks -

GROUND CONDITIONS ENCOUNTERED

TEST 1		TEST 2		TEST 3	
Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
0.00	0.880				
1.00	0.880				
2.00	0.880				
3.00	0.880				
4.00	0.880				
5.00	0.880				
10.00	0.880				
20.00	0.880				
30.00	0.880				
60.00	0.880				
120.00	0.890				
180.00	0.900				
240.00	0.900				
300.00	0.900				

		TEST 1	TEST 2	TEST 3
Effective Storage Depth	**m**	0.72	1.60	1.60
75% Effective Storage Depth	**m**	0.54	1.20	1.20
(i.e. depth below GL)	**m**	**1.060**	**0.400**	**0.400**
25% Effective Storage Depth	**m**	0.18	0.40	0.40
(i.e. depth below GL)	**m**	**1.420**	**1.200**	**1.200**
Effective Storage Depth 75%-25%	**m**	0.36	0.80	0.80
Time to fall to 75% effective depth	**mins**	0.00		
Time to fall to 25% effective depth	**mins**	0.00		
V (75%-25%)	**m^3**	0.3780	0.8400	0.8400
a (50%)	**m^2**	2.6340	4.5700	4.5700
t (75%-25%)	**mins**	0.0000	0.0000	0.0000
SOIL INFILTRATION RATE	**m/s**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**
DESIGN SOIL INFILTRATION RATE, f	**m/s**	**#DIV/0!**		

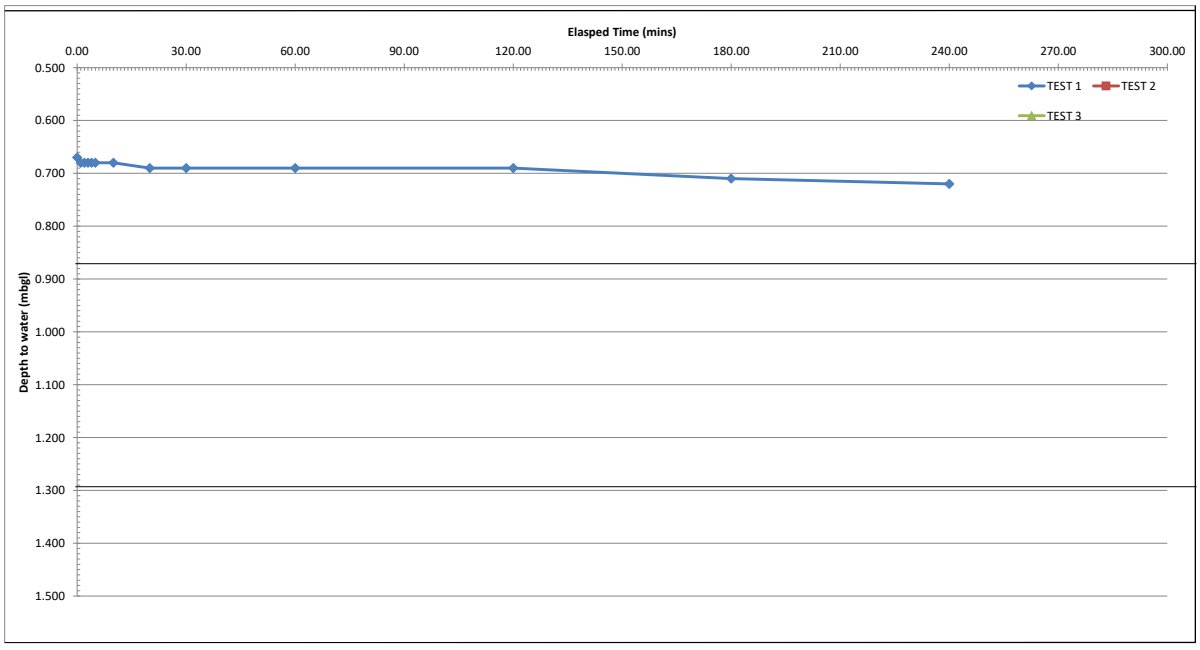


TP02		Length (m)	1.60	wardell armstrong
Date	13/06/2022	Width (m)	0.70	
Site	New Penn Pub	Depth (m)	1.50	SOIL INFILTRATION RATE TEST
Job Number	CA12409	Groundwater Level (mbgl)	-	See B.R.E. Digest 365, 2016, Soakaway Design.

Remarks -

TEST 1		TEST 2		TEST 3	
Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
0.00	0.670				
1.00	0.680				
2.00	0.680				
3.00	0.680				
4.00	0.680				
5.00	0.680				
10.00	0.680				
20.00	0.690				
30.00	0.690				
60.00	0.690				
120.00	0.690				
180.00	0.710				
240.00	0.720				

Effective Storage Depth	m	0.83	1.50	1.50
75% Effective Storage Depth	m	0.62	1.13	1.13
(i.e. depth below GL)	m	**0.878**	**0.375**	**0.375**
25% Effective Storage Depth	m	0.21	0.38	0.38
(i.e. depth below GL)	m	**1.293**	**1.125**	**1.125**
Effective Storage Depth 75%-25%	m	0.42	0.75	0.75
Time to fall to 75% effective depth	mins	0.00		
Time to fall to 25% effective depth	mins	0.00		
V (75%-25%)	m^3	0.4648	0.8400	0.8400
a (50%)	m^2	3.0290	4.5700	4.5700
t (75%-25%)	mins	0.0000	0.0000	0.0000
SOIL INFILTRATION RATE	m/s	#DIV/0!	#DIV/0!	#DIV/0!
DESIGN SOIL INFILTRATION RATE, f	m/s	#DIV/0!		

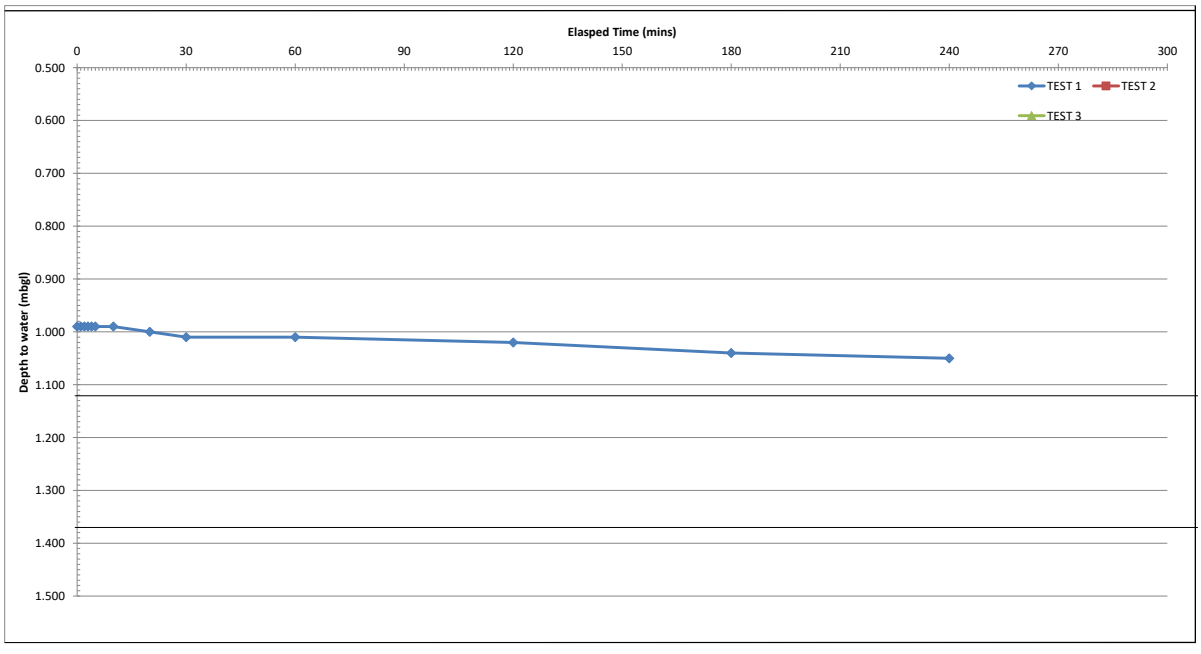


TP03		Length (m)	1.40	wardell armstrong
Date	13/06/2022	Width (m)	0.70	
Site	New Penn Pub	Depth (m)	1.50	SOIL INFILTRATION RATE TEST
Job Number	CA12409	Groundwater Level (mbgl)	-	See B.R.E. Digest 365, 2016, Soakaway Design.

Remarks -

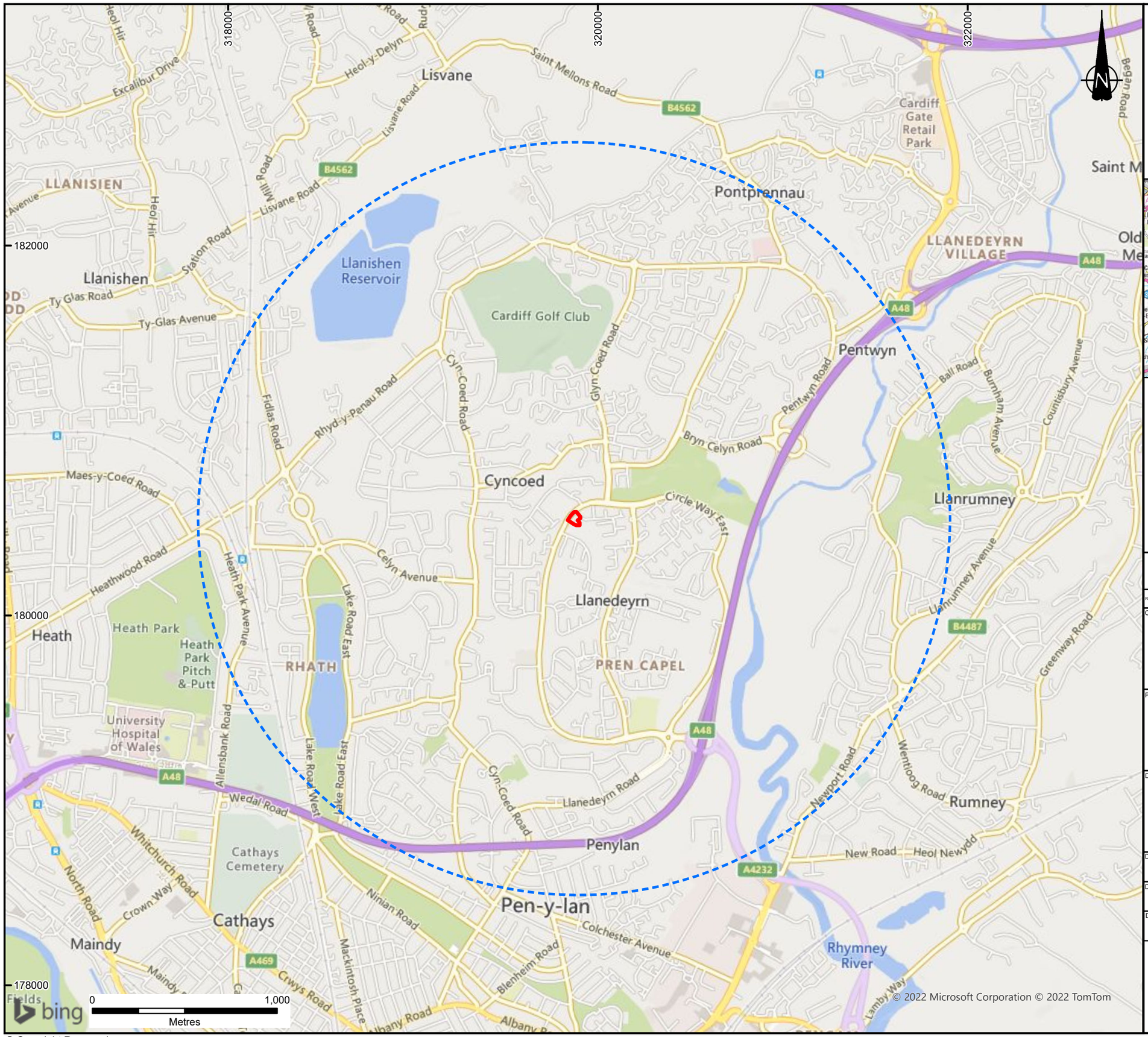
TEST 1		TEST 2		TEST 3	
Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
0	0.990				
1	0.990				
2	0.990				
3	0.990				
4	0.990				
5	0.990				
10	0.990				
20	1.000				
30	1.010				
60	1.010				
120	1.020				
180	1.040				
240	1.050				

Effective Storage Depth	m	0.51	1.50	1.50
75% Effective Storage Depth	m	0.38	1.13	1.13
(i.e. depth below GL)	m	**1.118**	**0.375**	**0.375**
25% Effective Storage Depth	m	0.13	0.38	0.38
(i.e. depth below GL)	m	**1.373**	**1.125**	**1.125**
Effective Storage Depth 75%-25%	m	0.26	0.75	0.75
Time to fall to 75% effective depth	mins	0.00		
Time to fall to 25% effective depth	mins	0.00		
V (75%-25%)	m^3	0.2499	0.7350	0.7350
a (50%)	m^2	2.0510	4.1300	4.1300
t (75%-25%)	mins	0.0000	0.0000	0.0000
SOIL INFILTRATION RATE	m/s	#DIV/0!	#DIV/0!	#DIV/0!
DESIGN SOIL INFILTRATION RATE, f	m/s	#DIV/0!		



Drawing CA12409-02A

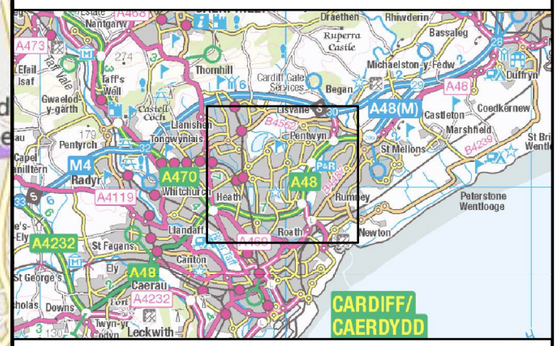
Site Location Plan



KEY

Site Boundary

2km Radius



Notes:

Boundaries are indicative.

Aerial imagery shown for context purposes only.

REVISION	DETAILS	DATE	DRAWN	CHKD	APPD
A	FIRST ISSUE	15/07/2022	EL	TS	JH

CLIENT

CARDIFF COUNCIL

PROJECT

NEW PENN, CARDIFF

DRAWING TITLE

SITE LOCATION PLAN

DRG No.	REV
CA12409-002	A

DRG SIZE	SCALE	DATE
A3	1:20,000	15/07/2022

DRAWN BY	CHECKED BY	APPROVED BY
EL	TS	JH

wardell armstrong

CA12409-006

Exploratory Hole Location Plan

DO NOT SCALE FROM THIS DRAWING

KEY

Indicative Site Boundary

Exploratory Hole Positions

- Windowless Sampler Borehole
- Trial Pit Excavation
- Trial Pit & Soakaway test
- TRL-Dynamic Cone Penetration test

REVISION	DETAILS	DATE	DR'N	CH'K'D	APP'D

CLIENT

CARDIFF COUNCIL

PROJECT

CA12409 - NEW PENN PUBLIC HOUSE

DRAWING TITLE

EXPLORATORY HOLE LOCATION PLAN

DRG No.	REV
CA12409-006	-

DRG SIZE	SCALE	DATE
A3	1:500	August 2022

DRAWN BY	CHECKED BY	APPROVED BY
PM	.	.

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