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WEPCo | Cardiff and Vale Colleges (CAVC)

Cardiff and Vale College - Barry Waterfront Campus (BWC)

Land Contamination Assessment Report

Reference: VG0201-ARP-ZZ-ZZ-RP-G-00002

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Contents

Tables

Drawings

Appendices

Executive Summary

Site description	The Barry Waterfront Campus (BWC) development site (National Grid Reference ST 11137 67414) is located immediately west of Barry Docks along the Ffordd Y Mileniwm, Barry, South Wales. The site covers an area of approximately 1.15ha and comprises impermeable hardstanding in the West, an existing private road along the Northern boundary, and a graded grassed area in the East to facilitate future development. The site is currently a brownfield bounded on all sides by built development, with the Barry Docks to the East and a railway line to the North and West.
Proposed development	The proposed development comprises the design of a new college campus including two three-storey connected buildings and a car parking area, site landscape and civil design for the proposed structures. The design is subject to ongoing development and detailed design through subsequent project stages.
Ground investigation	Ground investigations have been undertaken for the development of the proposed site and its surroundings. The recent site investigation was designed and scheduled by Arup and undertaken by HSP Consulting in September to October 2023 followed by groundwater and ground gas monitoring. The investigation included cable percussion boreholes with rotary core drilling follow-on and trial pits with soil and groundwater lab testing.
Ground conditions	The ground conditions encountered during the intrusive investigations on site are generally consistent with those of the published geology and detailed in the desk study, comprising Made Ground overlying Tidal Flat Deposits (predominantly silt with the presence of clays and sand in the centre and the east of the site) in turn overlying the Penarth Group bedrock (interbedded limestone and mudstone). Made Ground deposits were encountered throughout the entirety of the site are associated with the site history of extensive land reclamation including the diversion of the Cadoxton River to the east to allow for Barry Docks development. More recently the site was graded in preparation for the site development. No evidence of significant ground contamination has been encountered. The Tidal Flat Deposits are variable in thickness and increase towards the south towards the historical land reclamation area. The notable variations in the rockhead level and increased depths to the Penarth Group should be considered when evaluating design options.
Groundwater	Groundwater and seepages were encountered during the drilling and pitting works of the investigation between 3 and 5m bgl (4.2 to 5.9mOD) in both Made Ground and Tidal Flat Deposits strata. A rapid groundwater ingress was encountered within the limestone bedrock in BH01 at 16m bgl (-7.09 OD) and BH06 at 21m bgl (-11.82 mOD) during the advancement of the core drilling. During post fieldwork monitoring groundwater was recorded at depths between 1.9 to 2.5mbgl (6.9 to 6.3mOD). Due to the variability of the Made Ground materials and cohesive nature of the Tidal Flat Deposits, localised and discontinuous lenses of perched groundwater may be present within the site.
Geo-environmental considerations	<u>Human health</u> Asbestos was identified in multiple samples of Made Ground across site albeit in very low concentrations (at or below the laboratory level of detect of 0.001% w/w). Amosite, Chrysotile and Crocidolite asbestos containing material (ACM) was identified in one sample of Made Ground at a concentration of 0.2%w/w during the previous investigation of 2020. It is plausible that asbestos is encountered elsewhere on site in areas not previously investigated considering the presence of Made Ground across the site and the site history. The presence of asbestos may pose a risk to end site users and therefore remediation measures are required e.g. placement of clean capping with a demarcation layer in the landscaped areas Locally elevated concentrations of beryllium, lead, nickel and PAH were also recorded above the applied assessment criteria for construction and maintenance workers within the Made Ground. Appropriate measures should be incorporated into construction risk assessments and method statement to mitigate risks associated with these contaminants of concern. Liaison with an asbestos specialist contractor is recommended. Unexpected contamination may be encountered during construction. Watching brief is recommended. It is considered that soils that exhibit visual or olfactory evidence of contamination will not be suitable for reuse at the site unless a site specific risk assessment demonstrates no significant risks. <u>Groundwater</u> The majority of the soil leachate exceedances were identified in the area of the proposed car park, where based on the currently proposed drainage strategy, no significant infiltration into the ground would occur. Groundwater testing did not identify significant contamination within the site area. In addition, the low permeability TFD underlying the Made Ground would prevent vertical migration of contamination towards the bedrock aquifer. On this basis, the risk of contamination to groundwater is considered low. However, the proposed piling may create preferential flowpaths and will require a foundations works risk assessment. <u>Ground gas</u> The site has been classified as falling into a Characteristic Situation 1 (CS1), therefore no gas protection measures are considered necessary in the construction of onsite buildings. Radon protective measures are not required.

1. Introduction

Ove Arup and Partners Limited ('Arup') have been commissioned by WEPCo, Cardiff and Vale Colleges (the Client) to provide multidisciplinary engineering services for Barry Waterfront Campus (BWC) a proposed development of a new college facilities located approximately 0.30 km southeast of Barry town centre in South Wales. Site location is shown on Drawing 1.

HSP Consulting produced a Phase I Geo-environmental desk study (HSP Consulting, 07/2020) and subsequent Phase II geo-environmental assessment report in 2020 (HSP Consulting, 11/2020), which covered a wider area with the current site comprising the western and central parts of that area.

As part of a previous appointment at the feasibility stage, Arup have produced a geotechnical and geo-environmental desk study for the site in 2023 (Arup, 2023), to identify ground related constraints which may impact on the proposed development. The desk study recommended a site-specific ground investigation to be carried out to confirm the ground conditions and the extent of any contamination at the site. The desk study was an addendum report to the HSP Consulting Phase I Geo-environmental desk study report.

HSP Consulting undertook an intrusive ground investigation (as designed by Arup) between 18th September and 20th October 2023, followed by a period of post works monitoring. This report summarises the findings of these investigations and provides land contamination risk assessments to support planning.

1.1 Planning conditions

As part of the pre- application information submitted for the proposed development (ref: CAS-247394-X0B7), a number of conditions have been proposed with respect to the development at the site with the following condition pertaining to land contamination:

Condition 2 - No development, of land known to be / suspected of contamination, shall commence until the following components of a scheme to deal with the risks associated with contamination at the site, has been submitted to and approved in writing by the Local Planning Authority.

1. A preliminary risk assessment which has identified:

i. all previous uses

ii. potential contaminants associated with those uses

iii. a conceptual model of the site indicating sources, pathways and receptors

iv. potentially unacceptable risks arising from contamination at the site

2. A site investigation scheme, based on (1) to provide information for a detailed assessment of the risk to all receptors that may be affected, including those off site.

3. The results of the site investigation and the detailed risk assessment referred to in (2) and, based on these, an options appraisal and remediation strategy giving full details of the remediation measures required and how they are to be undertaken.

4. A verification plan providing details of the data that will be collected in order to demonstrate that the works set out in the remediation strategy in (3) are complete and identifying any requirements for longer-term monitoring of pollutant linkages, maintenance and arrangements for contingency action.

The remediation strategy and its relevant components shall be carried out in accordance with the approved details.

Justification: To ensure the risks associated with contamination at the site have been fully considered prior to commencement of development as controlled waters are of high environmental sensitivity; and where necessary remediation measures and long-term monitoring are implemented to prevent unacceptable risks from contamination.

1.2 Scope

This report summarises the findings of these investigations and provides interpretation of the factual information to support the design of the proposed development including a geo-environmental assessment to inform of risks to human health and controlled waters during construction and during operation of the proposed scheme and an assessment to inform suitability of materials for re-use. The intention is to submit this report in order to inform Sub-part 2 of Condition 2 (ground investigation informed by the desk study, followed by risk assessments). The desk study prepared by HSP in 2020 and the addendum desk study prepared by Arup in 2023 inform Sub-part 1.

1.3 Limitations

This report is prepared for and on behalf of WEPCo, Cardiff and Vale Colleges in response to their particular instructions and requirements. The information in this report is not intended for and should not be relied upon by any third party. Any other party using this information for any purpose does so at their own risk and any duty to that party is excluded.

2. The site

The site information is presented in detail in the HSP Phase I Geo-environmental desk study (HSP Consulting, 07/2020) and Arup Addendum desk study (Arup, 2023). The following sections provide a summary of key information.

2.1 Site location and description

The Barry Waterfront Campus (BWC) development site is in the vicinity of the docks along the Ffordd Y Mileniwm, approximately 0.30 km southeast of Barry town centre, in South Wales. The site is centred around National Grid Reference ST 11137 67414 and covers an area of approximately 1.2 hectares. Its location is shown on Drawing 1.

The site is generally bounded on all sides by built development including:

the Ffordd Y Mileniwm (Millennium Way) to the Southeast, with a supermarket and residential properties beyond;
a rail siding to the North and commercial development beyond;
a road junction to the East with Barry Docks beyond;
A primary school (Ysgol Gymraeg Sant Baruc) to the South with residential properties beyond;
and to the West by a railway line with residential properties beyond.

The site is accessed via a gated road from Ffordd Y Mileniwm along the south-eastern boundary of the site.

The site is currently a brownfield area comprising of impermeable hardstanding on the west, an existing private road along the northern boundary, and a graded grassed area in the east to facilitate future development. A sea culvert crosses the site as shown on Drawing 2.

Topographical surveys taken place on site indicate the site has been generally graded in preparation for development. The eastern grassed area has a high point at approximately +9.5mOD, which slopes to +9.15mOD at the southern boundary, +9.0mOD at the eastern boundary and +8.5mOD along the northern boundary and in the western hardstanding area.

2.2 Site history

The HSP Phase I Geo-environmental desk study (HSP Consulting, 07/2020) review indicated the site to had been part of tidal flats of the Cadoxton River estuary with a small tributary present in the north east of the site (1878). From 1898 the river, tributary and tidal flats were presumably reclaimed, which led to creation of West Pond. The West Pond was gradually infilled, as shown on Drawing 2, and the site formed part of the docks with associated rail sidings, tanks and coal yards. The site southern edge may encroach on the infilled

West Pond area, including the area of historical West pond landfill. By the early 2000s, the site and a wider area were unused, prior to more recent redevelopment of the dock area. The surrounding land use is recorded as predominantly, industrial and residential.

The site is currently a temporary compound with car park, offices and storage area for construction work being undertaken to the north of the site. The carpark is a mixture of concrete hardstanding weathered tarmacadam surface. The area to the south of the fenced construction compound comprises undulating scrubland, with several stockpiles of a topsoil like material and construction debris remnant from the nearby current construction works.

2.3 Geology

Geology mapping published by the British Geological Survey (BGS) indicates the following geological sequence of natural deposits at the site:

Superficial geology comprising Tidal Flat Deposits (predominantly silt with the presence of clays and sands) expected from the centre of the site with increasing thickness to the south-east.

Bedrock geology comprising interbedded mudstone and limestone of the Penarth Group and St. Mary's Well Bay Member.

Due to the site history, Made Ground deposits are anticipated to be encountered throughout the entirety of the site with different but potentially significant thicknesses, associated with historical land reclamation campaigns and the diversion of the Cadoxton River to the east, and recently grading in preparation for the site development.

Reviewing the available borehole records, the bedrock geology can be seen to dip in a north-west to south-east direction beneath the site and surrounding area, described below:

to the north of the site, bedrock is near surface and comprises interbedded limestone and mudstone, with ground elevation in the order of +16mOD at a distance of 65m from the site;

to the south of the site in the reclaimed West Pond area, bedrock dips steeply beneath the reclaimed Cadoxton River channel, with Tidal Flat Deposits extending to approximately -16mOD. Ground levels here are approximately +8mOD;

beneath the BWC site, the thickness of Tidal Flat Deposits is expected to be 3-5m thick in the north and increasing rapidly to >18m the south.

2.4 Hydrogeology

The Tidal Flat Deposits are designated as Secondary Undifferentiated aquifer and the Penarth Group as Secondary B aquifer. The groundwater vulnerability throughout most part of the site is assessed as high, pertaining to areas that provide protection from pollution, mainly associated with the mudstones and limestones of the Penarth Group encountered on site.

The available information for the site indicates that groundwater can be present between 2.0 to 4.0m below ground level, which represents the aquifer in the Tidal Flat Deposits. Groundwater within the bedrock is likely to be in hydraulic continuity with the overlying superficial deposits.

Based on the topography of the site and surrounding area and the nearby surface water features it is anticipated that the groundwater flow direction on site is to the south and east of the site, towards the Barry Docks.

2.5 Hydrology and flooding

The site is located 150m west of the Barry Docks, a facility that serves the South Wales chemical industry by handling cargo comprising timber, steel, coal, cement, aggregates, and specialist liquid bulks. The water level in Barry Docks is held at an average height of 10 metres however on spring tides predicted to exceed a

height of 13.70 metres the docks become tidal and water levels may rise to 12 metres or greater at high water.[1] The typical level of the Barry dock water is at approximately 5mOD.

Flood risk of site has been considered at Stage 3 and the site levels do not require significant change. For further details refer to other civils documents.

2.6 Radon

The HP Phase I Geo-environmental desk study (HSP Consulting, 07/2020) reported the findings of a detailed radon report provided as part of the Groundsure report (also enclosed in the desk study). This showed the east of the site, where the proposed building is located, is not recorded to be within a Radon Affected Area as between 1% and 3% of the properties are above the Action Level, therefore within this area of the site radon protective measures are not required. The west of the site has a Radon Affected Area, between 5% and 10% of the properties above the Action Level. This area has been designated carparking therefore not requiring any protective measures.

2.7 Unexploded ordnance (UXO)

Arup Addendum Desk Study (Arup, 2023) recommended that a detailed UXO desk study and risk assessment is undertaken for the site to assess the risk and mitigation strategy for the proposed works.

3. Proposed development

The proposed development is for the design of a new college campus including multi-storey buildings and at-grade car parking areas, civil engineering site design and landscaping throughout. The masterplan is presented on Drawing VG0201-ALA-00-XX-DR-L-00001 (Drawing 3 of this report).

Based on the encountered ground conditions and loads of the proposed structure, the college building is likely to require piled foundations. Currently preferred piling method for the site is Continuous Flights Auger (CFA). The foundations options and strategy will be presented in the separate geotechnical report.

Based on the currently proposed drainage strategy, Sustainable Drainage Systems (SuDS) will be utilised for the surface water management. There is insufficient space on the development site for a detention basin or other surface storage feature to be a viable solution. As such, attenuation is proposed to be provided via a below ground cellular storage system located between the building and the main area of soft landscaping, porous paving and vortex flow controls (subject to approval by the Vale of Glamorgan). Permeable paving will be used in the car park in areas where there are no existing below ground utilities. Due historical land use and the presence of potential for contamination on site, the proposed drainage strategy requires all proposed SuDS components including all permeable paving to be lined.

4. Previous land contamination assessments

HSP have undertaken land contamination risk assessments informed by the 2020 ground investigations. These are presented in their Phase I Geo-environmental desk study (HSP Consulting, 07/2020) and subsequent Phase II geo-environmental assessment report (HSP Consulting, 11/2020). These were supplemented by Arup Addendum desk study (Arup, 2023). The completed assessments are summarised in the following sections.

4.1 HSP Preliminary Risk Assessment (2020)

The Preliminary Risk Assessment (PRA) was undertaken by HSP and presented in their Phase I Geo-environmental Desk Study report (HSP Consulting, 07/2020). The PRA indicated that any Made Ground on

[1] ABP South Wales, https://www.southwalesports.co.uk/

site related to its historical end use, may contain elevated concentrations of potentially harmful contaminants, which may present a risk to the receptors identified including end users, adjacent residential/commercial properties, construction workers or controlled waters. The risk from contamination was considered to be moderate. Sources of ground gas were also identified within a 250m radius of the site, which related to the potential for Made Ground upon the site.

4.2 HSP Ground Investigation (2020)

The ground investigation was scoped and carried out on site in June 2020 by HSP. This comprised 12No. windowless sample boreholes with a good distribution across the site, including dry weight soil testing on 10No Made Ground samples for metals, speciated petroleum hydrocarbons, PAHs, and asbestos.

Ground gas monitoring of 3No installations was also carried out as part of the GI with response zones targeting the Made Ground (3No rounds were undertaken in July and 1No in October 2020).

The results are presented in the HSP Factual report, included as part of the HSP Phase II Geo-environmental Report (HSP Consulting, 11/2020).

The ground conditions encountered generally comprised hardstanding or topsoil, overlying Made Ground deposits of fill, with natural Tidal Flat Deposits encountered within four locations across the site underlying the Made Ground. No evidence of significant contamination was encountered however Made Ground materials were recorded to contain clicker, ash, and slag. The thickness of Made Ground was proven in the western site area only, at between 0.8 and 3.5m bgl. The remainder of the window samples were undertaken in the raised land area occupying the eastern site area, where they terminated within the Made Ground at between 1 and 3m bgl.

Perched groundwater was encountered within Made Ground deposits in four exploratory locations during the intrusive works. The depth of encounters ranged between 2.50m and 2.60m bgl. Groundwater levels have been monitored on three of four occasions during the ground gas monitoring visits. Groundwater levels associated with the main aquifer were encountered at depths between 1.80 and 2.94m bgl.

4.3 HSP Risk Assessments (2020)

The geo-environmental assessments carried out by HSP were presented in the Phase II Geo-environmental Report (HSP Consulting, 11/2020), which indicated the following:

Human Health: The results of the laboratory analysis were screeded against GACs including the Defra Category 4 Screening Levels (C4SL) and LQM and CIEH S4ULs for a residential without homegrown produce. There was a single exceedance of lead (510mg/kg) in the western part of the site (WS02 at 0.6m bgl; refer to Drawing 2 for hole location.
Asbestos of Spray coated Chrysotile, Crocidolite and Amosite were also identified in the same sample (asbestos quantification testing indicated 0.20%).

Waste classification: The same sample (WS02 at 0.6m bgl) was also characterised as containing hazardous properties on account of TPH at 1200 mg/kg. Description of materials encountered in that location is similar to materials across the site.

Ground gas: Gas concentrations were monitored on four occasions (3No. boreholes installed, response zones within the Made Ground). The results indicated that methane was not recorded above the monitor limit of detection (<0.1%vol). Carbon dioxide was recorded at a maximum concentration of 16.3% vol in air in WS01. Steady state gas flows were recorded during the monitoring visits. The ground gas assessment carried out by HSP in accordance with CIRIA C665 indicated that the site falls in a Characteristic Situation 2 (gas protection measures required for the proposed development).

Water Supply: The chemical results showed exceedances of the threshold values for PE and PVC pipes. It was therefore considered that specialist materials were likely to be required for water supply pipes at the site. Confirmation of supply pipes should always be sought from utility providers.

No sampling and testing of leachate and groundwater was carried out as part of the 2020 GI and by extension no quantitative controlled waters risk assessment was completed.

4.4 Arup geo-environmental review of land condition and remediation (2023)

The geo-environmental review carried out by Arup as part of the desk study addendum in 2023 (Arup, 2023) indicated the following:

> It was unclear whether the site itself had been subject to remediation since the removal/demolition of the dock related infrastructure. Historical infrastructure may still be in place and form preferential flow paths for contamination.
>
> The 2020 ground investigation did not fully penetrate Made Ground deposits and therefore there was a risk that unidentified contamination may be present at the base of the Made Ground, particularly in the eastern site area, where ground level has been raised.
>
> The 2020 human health risk assessment was inconclusive with respect to potential risks associated with lead and asbestos. This would require undertaking statistical analysis on available and any new data obtained from the site.
>
> Historical plans indicate that the site may be encroaching on the early 1900s tipping operations. The extent of these operations was unknown and may have extended further into the site than indicated by historical plans.
>
> No quantitative controlled waters risk assessment was completed as part of the 2020 risk assessment and the site conceptual model had not been adequately developed. No groundwater quality monitoring or soil leachate analysis had been undertaken as part of the 2020 investigations. Risks to controlled waters require appropriate assessment.
>
> Understanding of groundwater regime in the site area was limited, particularly in the eastern site area. The presence of perched water in the eastern area had not been confirmed. Based on previous work within the area, the low permeability of TFD soils is unlikely to reflect changes in dock water level as changes in groundwater level for the purpose of contaminant migration.
>
> Ground gas monitoring concluded a very low risk but due to two elevated CO_2 readings in WS01 the risk level was increased to Characteristic Situation 2 (CS2). The GI carried out as part of the Primary School site directly southwest off-site has also indicated a CS2.
>
> There had been extensive development and remediation of the land in vicinity to site, which rendered it suitable for its intended uses (residential and commercial development). It is considered that there has been sufficient investigation within the West Pond to assess the degree of contamination present; and appropriate mitigation works were completed. It is anticipated that the potential for any remaining contamination related to the land in vicinity to the site is low.
> It as recommended that further investigations and assessments are carried out to inform the identified gaps.

5. Ground investigations

This section describes the recent and relevant historical ground investigations undertaken in the vicinity of the site.

5.1 Historical ground investigations

Extensive ground investigations have been undertaken throughout the West Pond area located immediately south of the site, which appears to have been infilled from 1936 onwards with the addition of buildings and sidings. In 2008, intrusive ground investigations and assessments were carried out in the West Pond regarding the construction of a housing development extending all the way to the South Quay. The findings

from these investigations indicate the bedrock level depths greater than 20mbgl. These are detailed in the Arup Addendum desk study (Arup, 2023).

In 2012 a ground investigation was commissioned by the Vale of Glamorgan Council to propose the redevelopment of the Barry Waterfront, comprising No.3 boreholes and No.10 trial pits across an area that includes the current proposed site and immediately southwest an area intended for educational end-use, where the Ysgol Gymraeg Sant Baruc Primary School is being constructed at the time of writing. A summary of the ground conditions encountered across the site is presented below in Table 1.

Table 1 – Summary of ground conditions encountered across the site in the 2012 GI

Stratum	Top of stratum [mbgl]	Typical base depth [mbgl]
Made Ground	GL	2.6-4.0
Silty CLAY and/or sandy gravelly SILT, occasional pockets of loose sandy gravel.	2.6-4.0	11.0-11.8
Gravelly SAND with occasional cobbles of sandstone and mudstone	11.0-11.8	11.4-12.4
Weathered MUDSTONE	11.4-12.4	>12.9

The most recent historical intrusive ground investigation was carried out in 2018 approximately 50m north of the site along the Hood Road to inform the proposed development of commercial and residential units. The Made Ground and superficial deposits encountered in this investigation reached a maximum thickness of 10m.

A site specific UXO risk assessment carried out by SafeLane Global in 2020 indicated that the west and southwest zones of the site sit at medium risk of UXO contamination, with the remaining of the site at low risk. The following risk mitigation measures have been recommended by this UXO risk assessment:

site specific safety instructions (SSSI);
explosive ordnance disposal (EOD) Engineer for on-site support;
explosive ordnance disposal (EOD) Engineer to support site investigation works;
site specific explosive ordnance safety and awareness briefings (UXO toolbox briefing) to all personnel conducting intrusive works;
intrusive magnetometer survey of all pile locations across the medium risk zone down to the maximum bomb penetration depth (between 10 and 12mbgl).

In 2020 HSP ground investigation was carried out on site in June 2020 and comprised 12No. windowless sample boreholes with a good distribution across the site. The factual data is presented in their Phase II report (HSP Consulting, 11/2020). The scope of the GI included the following:

Dry weight soil testing completed on 10No Made Ground samples for the following determinands: metals, speciated petroleum hydrocarbons, PAHs, and asbestos.

Ground gas monitoring of 3No installations with response zones targeting the Made Ground (3No rounds were undertaken in July and 1No in October 2020).

The ground conditions encountered generally comprised hardstanding or topsoil, overlying Made Ground deposits of fill, with natural Tidal Flat Deposits encountered within four locations across the site underlying the Made Ground. No evidence of significant contamination was encountered however Made Ground materials were recorded to contain clicker, ash, and slag. The thickness of Made Ground was proven in the western site area only, at between 0.8 and 3.5m bgl. The remainder of the window samples were undertaken in the raised land area occupying the eastern site area, where they terminated within the Made Ground at between 1 and 3m bgl.

Perched groundwater was encountered within Made Ground deposits in four exploratory locations during the intrusive works. The depth of encounters ranged between 2.50m and 2.60m bgl. Groundwater levels have been monitored on three of four occasions during the ground gas monitoring visits. Groundwater levels were encountered at depths between 1.80 and 2.94m bgl.

The findings from the historical ground investigations indicate that the bedrock level is dipping steeply to the south-east beneath the site, with indicative depths between 5mbgl in the north and greater than 20mbgl outside the southern site boundary.

Refer to the Desk Study conducted by Arup in 2023 (Arup, 2023) for further findings from these historical investigations.

5.2 Arup investigation 2023

Following from the review presented in Arup 2023 desk study addendum (Arup, 2023), further investigations have been scoped. The site investigation designed and scheduled by Arup was undertaken by HSP Consulting between 18th September and 20th October 2023. A summary of the investigation is provided in the following sections. The factual report of this investigation is included as Appendix A to this report.

5.2.1 Scope of works

The purpose of the investigation was to provide geotechnical and geo-environmental information to supplement previous ground investigations and inform the design of the proposed development. The initial investigation specification comprised exploratory holes that were omitted from the ground investigation carried out due to limiting factors, primarily access and utilities.

The intrusive ground investigation works on site comprised the following geo-environmental scope of works:

- No.8 machine excavated trial pits across the site to a maximum of 4.10mbgl to confirm the ground conditions and groundwater level, and collect soil samples for laboratory analysis;
- No.5 cable percussion boreholes conducted to a maximum depth of 20.15mbgl with rotary core drilling follow-on to a maximum depth of 34.50mbgl distributed across the site;
- No.10 static penetration tests with piezocone to a maximum depth of 20m bgl to confirm ground conditions and groundwater level;
- Soil and groundwater sampling and associated laboratory testing for geo-environmental purposes, including soil leachate testing.

The locations of exploratory holes are displayed in Drawing 2. The investigations also include geotechnical scope such as CPTs, and in-situ and laboratory testing. This will be reported and assessed in a separate report.

5.2.2 Limitations on investigation

The intrusive ground investigation encountered limiting factors, which affected the location of exploratory holes and the ability to capture investigation data. The presence of an existing sea culvert that runs inside the site parallel to the northern and southwest boundaries prevented any exploratory holes to be located within its easement zone, as well as the numerous public and private buried utilities in all parts of the site identified during the non-intrusive utility survey. The areas that were not investigated present data gaps that have been managed by interpolation and inference of the ground conditions.

Refer to the Desk Study conducted by Arup in 2023 (Arup, 2023) for the detailed site constraints and the presence of existing structures and obstructions within the ground.

5.2.3 Laboratory testing

Geo-environmental testing have been undertaken by a UKAS accredited laboratory as part of the works at the site. The suite of geo-environmental analyses undertaken on selected soil and groundwater samples are summarised in Table 2 below.

Table 2 – Geo-environmental laboratory testing schedule

Geo-environmental tests	No. of tests
Soils	
General suite (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, antimony, beryllium, vanadium, cyanide, pH, boron, phenols, total organic carbon)	26
Asbestos screen	21
Asbestos quantification (where asbestos was detected)	4
TPHCWG	26
PAH and BTEX	26
VOCs and SVOCs	1
PCBs	15
Hexavalent chromium	9
Waste Acceptance Criteria	4
Leachate	
Leachability	5
Leachable general suite	5
Leachable PAH and BTEX	5
Groundwater	
General suite (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, antimony, beryllium, vanadium, cyanide, pH, calcium, chloride, boron, beryllium, ammoniacal nitrogen, phenols, dissolved organic carbon, total hardness as $CACO_3$)	9
TPHCWG	9
PAH and BTEX	9
VOCs and SVOCs	9
PCBs	6

5.2.4 Monitoring installations

During the ground investigation, dual use gas and groundwater monitoring installations were constructed within 4No. of the boreholes across the site to allow for post site works monitoring. Every installation was constructed with 50mm diameter HDPE pipes and raised round lockable stopcock covers. The installation details are provided in Table 3 below.

Table 3 – Groundwater and ground gas monitoring installations details

Exploratory hole	Installation type	Response zone (m bgl)	Response zone (mOD)	Targeted geological formation
BH1	SP	1.0 to 5.0	+7.91 to +3.91	Made Ground / Tidal Flat Deposits
BH2	SP	3.0 to 10.0	+6.05 to -0.95	Tidal Flat Deposits
BH3A	SP	3.0 to 6.0	+5.87 to +2.87	Tidal Flat Deposits
BH3B	Gas	1.0 to 2.0	+7.87 to +6.87	Made Ground
BH4	SP	1.0 to 5.0	+7.62 to +3.62	Made Ground / Tidal Flat Deposits (silt)

The groundwater levels as well as ground gas concentrations and flow rates have been recorded over three rounds, detailed in Sections 6.1.1 and 10, respectively.

6. Ground conditions

This section provides a summary of the ground model developed for the site. The detailed ground model and geotechnical parameters will be presented within a separate report.

The ground conditions encountered during the intrusive investigations on site are generally consistent with those of the published geology and detailed in the desk study comprising Tidal Flat Deposits (predominantly silt with the presence of clays and sand in the centre and the east of the site) overlying the Penarth Group (interbedded limestone and mudstone).

6.1 Summary of stratigraphy

The characteristic levels listed in Table 4 represent a generalised sitewide stratigraphy. However, it should be noted that there is variation in strata levels encountered across the site.

Table 4 – Summary of the site stratigraphyt

Stratum	Range of top levels encountered [m bgl]	Maximum thickness [m]	Description
Made Ground	GL	0.15	Hardstanding: Asphalt concrete in places (encountered in TP03 and TP09).
	GL to 0.15	0.3	Sub base: Reddish sub base material (Type 1). Recovered as a gravel. Gravel is fine to coarse sub angular limestone (encountered in TP03, TP04, TP8 and TP09).
	GL	0.35	Scrub overlying brown sandy slightly gravelly clayey topsoil. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of brick fragments, concrete, asphalt concrete, sandstone and mudstone (encountered in TP05, TP06, TP07, and TP10).
	GL to 4.0	4.0	Black, brown slightly gravelly clay fill with cobbles of brick and concrete and clayey sand and gravel fill. Gravels are of brick, coal, clinker, concrete, ceramics, plastic, timber, and occasional fabric.
	0.4 to 3.0	3.3	Reworked ground: Blue to brown to grey sandy gravelly CLAY. Sand is fine to medium. Gravel is fine to medium angular to sub angular of mudstone, siltstone and limestone (encountered in BH04, TP03, TP04 and TP09).
Tidal Flat Deposits	1.9 to 4.0	17.0	Very soft to stiff grey, blue and brown SILT and bands of medium dense grey and brown gravelly COBBLES of limestone.
Penarth Group	8.0 to 21.0	Not proven	Very weak and weathered LIMESTONE at lower depths to competent and strong LIMESTONE.

6.1.1 Evidence of contamination

The Made Ground included anthropogenic material such as brick, concrete, ceramics, timber, and occasional fabric. Some of these include construction materials and based on this and the site history, it was considered that there is potential that asbestos could be encountered. Asphalt and clinker were also recorded within the Made Ground, and these are potential sources of hydrocarbons.

Slight hydrocarbon odour and staining was recorded within the reworked ground in one location in the western part of the site (TP03 between 3.2 and 3.6m bgl).

The completed investigations encountered heterogeneous made ground materials across the site, as anticipated based on the site history including reclamation. However, no significant variations in materials nature have been observed in the southern part of the site, where based on the area infilling history, as shown on Drawing 2, West Pond infill materials may have been present. No evidence of landfill refuse materials present within the site boundary has been encountered.

6.2 Groundwater observations and monitoring

Groundwater strikes have been recorded during the 2023 ground investigation works as summarised in Table 5. Seepages and groundwater strikes were typically recorded within between 3 and 5m bgl (4.2 to 5.9mOD) in both made ground and TFD. A groundwater strike was also recorded in BH04 at 6.9mbgl (1.7mOD) in TFD. A rapid groundwater ingress was encountered within the limestone bedrock in BH01 at 16m bgl (-7.09 OD) and BH06 at 21m bgl (-11.82 mOD) during the advancement of the core drilling.

Table 5 – Groundwater strikes recorded during the 2023 investigation

Hole	Depth [mbgl]	Depth [mOD]	Stratum	Observation
TP03	3.6	4.74	Made Ground (gravelly clay fill)	Seepage
BH01	3.0	5.91	Made Ground (gravelly clay fill)	Seepage
TP04	3.9	4.61	Clayey SAND and gravel	Seepage
BH02	3.5	5.55	Stiff blue grey SILT	Steady flow (wet from 3.6m bgl)
BH03	3.9	4.97	Very soft wet grey brown SILT	Steady flow
BH06	5.0	4.18	Very soft wet grey brown SILT	Steady flow
BH04	6.9	1.72	Stiff blue grey SILT with gravels of Limestone	Steady flow
BH01	16.0	-7.09	Very weak weathered grey LIMESTONE	Extremely rapid flow
BH06	from 21 to 34.5	-11.82	LIMESTONE	Extremely rapid flow (from 21m bgl to bottom of borehole)

Groundwater level monitoring was undertaken over three fortnightly rounds of manual dipping. The types and locations of groundwater monitoring installations are shown in Section 5.2.4. The location of boreholes are shown on Drawing 2. The range of groundwater rest levels measured across the site is summarised in Table 6. The monitoring results indicate the general groundwater level at approximately 1.9 to 2.5mbgl (6.9 to 6.3mOD). Due to the variability of the made ground materials and cohesive nature of the TFD, localised and discontinuous lenses of perched groundwater may be present within the site.

Table 6 – Groundwater levels measured across the site during the monitoring period post-GI

Borehole ID	Monitored stratum	Monitored groundwater level range [m bgl]	Monitored groundwater level range [mOD]
BH02	TFD	3.1 – 3.9	5.9 to 5.1
BH03B	Made Ground	1.9 - 2.0	6.9 to 6.8
BH03A	TFD	2.2. – 2.5	6.5 to 6.3
BH04	Made Ground/ TFD	1.8 – 2.0	6.8 to 6.6

6.3 Ground aggressivity

Concrete classification was completed by HSP and reported in their Phase II report. Their recommendation was to apply DS-1 AC-1 for made ground and DS-2 AC-1 for natural ground. However, some anomalous results obtained from made ground were indicative of much more aggressive environment requiring DS-4 AC-4 class concrete. It was recommended that further testing is undertaken to confirm the concrete class. The further assessment of ground aggressivity in relation to concrete will be undertaken as part of the geotechnical interpretation and will be presented in a separate report.

7. Conceptual Site Model

The 2023 ground investigation has provided supplementary data allowing for confirmation of the level of risk concluded by previously completed risk assessments, as summarised in Section 4. The scope of the investigation is presented in Section 5.2.1.

A conceptual site model (CSM) describes the scenario in which the risks to human health and the environment (posed by contaminated land) are assessed. The preliminary CSM is presented within the Phase I Desk Study for the site and updated CSM – in the Phase II assessment report, which is based on desk study information and the findings from the 2020 GI. This is summarised below, reviewed and updated with the findings of the 2023 investigation.

7.1 Sources of Contamination

Table 7 presents the potential sources of contamination on the site based on the site historical setting and land use and information gathered through completed ground investigations.

Table 7 – Potential sources of contamination

Potential source	Potential Contaminants
Onsite	
Historical and Contemporary land use: Railway – tracks/sidings, Coal Yard, Unknown Tanks, Made Ground (Infilled land)	Inorganic and organic contaminants including heavy metals, metalloids, acids/alkalis, TPH, PAHs, sulphate, asbestos and ground gases. *HSP 2020 assessments identified asbestos and lead as main contaminants of concern.*
Offsite	
Historical and Contemporary land use: Barry Docks (east), Locomotive Repair Works, Railway – lines/sidings (north and north west), historic Landfill (south), Coal Handling/Yard (north) and Oil Storage Terminal (south east). *Land surrounding the site has been remediated to allow for land development, and therefore off site sources potentially posing significant risk to sensitive receptors are considered to have been removed.*	Inorganic and organic contaminants including heavy metals, metalloids, acids/alkalis, TPH, PAHs, sulphate, asbestos and ground gases.

7.2 Potential Receptors

The receptors considered to be relevant to the potential sources of contamination are identified as follows:

Construction phase:

Construction workers involved in the development;
Site neighbours (residents and commercial workers);
Controlled waters, i.e. onsite Secondary (Undifferentiated) aquifer (Tidal Flat Deposits), Secondary B aquifer (Penarth Group Mudstone and Limestone), Secondary A aquifer (St Mary's Well Bay Member – Limestone and Mudstone), offsite surface waters (Barry dock approximately 150m east and by extension Bristol Channel).

Operational phase:

Site end users (staff and students of the Educational Facilities);
Site maintenance workers post development;
Building materials used in the proposed development (concrete, potable water pipes);
Site neighbours (residents and commercial workers);
Controlled water, i.e., onsite aquifers, offsite surface waters.

7.3 Potential Pathways

For a risk to exist the source and receptor must be connected by a viable pathway. Potential pathways by which human and environmental receptors may be impacted upon are as identified below:

Ingestion of contaminated soils and dust: During construction of the proposed development, site workers who are dealing closely with excavated soils may come into contact with contaminants through ingestion of soils and dust. Occupants of the adjacent areas (residents and commercial workers) may be impacted by the ingestion of soils and dust created during development in the construction phase. This risk of dust ingestion is however considered to be low on the basis that construction works will involve suitable dust suppression in accordance with good construction practice measures. It is not anticipated that the ingestion pathway will be active during the operational phase due to the site soils being covered with either vegetation or hardstanding or building footprint. There may be a risk through the ingestion pathway should site soils be left at surface within areas of soft landscaping.

Dermal contact with soils, dust and groundwater: During site development, site workers who are engaged in ground works and handling of excavated soils/earthworks materials may come into skin contact with potentially impacted soils and groundwater. Following redevelopment, maintenance workers may also come into direct skin contact with shallow soils and groundwater during any intrusive works. It is not anticipated that the dermal pathway will be active during the operational phase due to the site soils being covered with either vegetation or hardstanding or building footprint. There may however be a dermal pathway linkage should site soils be present at surface in areas of soft landscaping.

Inhalation of vapours, dust (including asbestos fibres) and gases: Volatilisation of hydrocarbon products may occur within the subsurface from impacted soils and perched/groundwaters and be present in indoor air (particularly where organic contamination is present), which has the potential to build up and impact site end users within confined spaces within the building. Ground gas, potentially generated by any Made Ground beneath the site may migrate into confined spaces within the proposed building (ground gas assessment carried out by HSP indicated that the site falls in a Characteristic Situation 2 - gas protection measures required for the proposed development). However, based on the nature of encountered Made Ground (consisting of asphalt, concrete, brick, plastic, wood, metal, fabric and clinker) and the absence of putrescible materials or significant levels of biodegradable materials, the Made Ground is considered to be of a low gas generation potential. In addition, no peat or other organic deposits have been encountered withing the TFD. Generation of dust through excavation works may impact construction workers and site neighbours during the construction phase. Good construction practice would reduce the risk however specific mitigation measures would be required with respect to asbestos fibres. There may also be dust generation in areas of soft landscaping should site soils be present at surface in these areas.

Lateral and vertical migration of contaminants: As detailed in Section 6.1.1, groundwater monitoring indicated groundwater rest levels typically between 1.9 and 2.5m bgl (6.9 to 6.3mOD), withing the Made Ground. Lenses of shallower perched groundwater within the Made ground may also be encountered. Based on existing information, the level of the Barry dock water typically varies between 4.9 and 5.3mOD. The groundwater is likely to be in hydraulic continuity with the docks and flow towards the docks. Contaminants mobilised from the ground from impacted Made Ground may migrate vertically or laterally through the underlying strata. However, based on the GI findings the Made Ground is underlain with around 3m thick silt/clay (low permeability deposits) thus reducing the migration potential. The proposed foundations for the building are piles. Therefore, there is potential for preferential contamination pathways created through piling as well as service trenches. However, the currently preferred piling method is CFA piling and therefore the risk of creating new pathways for contamination migration is considered to be very low.

Leachate generation and migration: There is potential for the generation and migration of leachate from impacted soils, which may enter and migrate within underlying groundwater bodies and preferential pathways as identified above. Generally, the exiting site drainage comprises of a single drainage catchment split into two sub-catchments. The eastern development plot forms the one sub-catchment and is a grassed area with no positive drainage. It is assumed that the rainfall locally

infiltrates into the ground in this grassed area and there is potential for leaching as surface waters are not being controlled and can freely percolate through the Made Ground. Where infiltration does not occur, the overland flow path is either to the internal road network, Ffordd y Mileniwm, or Hood Road. The western plot is an impermeable area served by a positive drainage system. Rainwater is assumed to be collected by gullies and directed into the storm drainage pipe network. The internal roads have a kerb and gully arrangement and again are served by a positive drainage network.

As detailed in Section 3, the currently proposed drainage strategy all proposed SuDS components including all permeable paving will be lined, thus reducing the potential contamination risk through leachate migration.

8. Human health risk assessment

The conceptual model identified a potential plausible pollutant linkage between soil potentially impacted by contamination and the end use receptors.

On this basis soil testing was undertaken as part of the 2023 investigation on site to assess the contaminative nature of the site soils and the risk potential.

Results of the chemical analysis undertaken on soil samples obtained from 2023 investigations have been reviewed and complied in Appendix B of this report. The assessment in relation to human health for the end site user is presented below.

8.1 Methodology

In order to facilitate the most appropriate assessment of the chemical analyses, consideration is required with regards to the end use of the site and the exposure pathways identified as part of the CSM.

The current development proposals for the new college campus include mainly hardstanding surface in the form of multi-storey buildings and at-grade car parking areas, and some soft landscaping (eastern and southern parts of the site).

Site end users will comprise collage aged students (aged 16+) and workers, forming teachers and other day time staff. There is not considered to be any children using the site, or overnight stays or working.

The CSM indicates that a large proportion of the site is to be covered by hardstanding, forming either car parking or building footprint, however landscaped areas with picnic tables will be formed on the fringes of the site around the perimeter of the site. Therefore, there will be a potential for the end users to be exposed to the soils via the dermal, ingestion inhalation (dusts) pathways, particularly should site soils are left exposed at the surface.

Ground gas will be freely venting within the car parking and soft landscaping areas, however gases can build up in the proposed school building and may pose a risk to the end user.

Based on the proposed development, it is considered a commercial end use scenario is suitable for the assessment of risk to the end site user from the site soils, as it considers a female adult (16+) worker, representative of both the students and staff within the assumed exposure scenario. The proposed development also largely aligns with the generic scenario elements with respect to the type of building and presence of limited landscaped areas.

The risk from exposure to the soils during construction to the construction workers and site neighbours has been assessed by application of a residential without plant uptake end use scenario. The applied scenario is considered to be conservative however it allows for a similar direct exposure to soils as a residential end use scenario. The assessment provides an indication to potential contaminants of concern, which would need to be managed appropriately during construction through a health and safety management system.

8.2 Averaging Areas

On account of the likely difference in chemical nature between the Made Ground soils and the underlying natural soils, these strata will be assessed in isolation. This will help identify whether contamination within the Made Ground has impacted the natural soils below and/or if there are any natural background concentrations of contaminants within the natural soils. The following averaging areas were considered as part of the assessment:

Made Ground 1: Soils which recorded anthropogenic inclusions (black, brown slightly gravelly clay fill with cobbles of brick and concrete and clayey sand and gravel fill. Gravels are of brick, asphalt, clinker, concrete, ceramics, plastic, timber, and occasional fabric).

Made Ground 2: Reworked natural ground encountered in BH04, TP03, TP04 and TP09 (blue to brown to grey sandy gravelly clay. Sand is fine to medium. Gravel is fine to medium angular to sub angular of mudstone, siltstone and limestone).

Natural ground: Tidal Flat Deposits (grey, blue and brown silt and bands of medium dense grey and brown gravelly cobles of limestone).

8.3 Asbestos

17No samples taken from Made Ground 1 and 4No samples taken from Made Ground 2 were tested for the presence of asbestos. Asbestos was identified in 4No of the Made Ground 1 samples tested. The following table summarizes the samples where asbestos was identified as part of the GI.

Table 8: Summary of Asbestos test results

GI area	Sample where asbestos was identified (depth in mBGL)	Asbestos Type	Asbestos Quantification (%)
Graded grassed area in the east	TP05 (1.1 – 1.2)	Amosite (fibres/clumps)	0.001
Graded grassed area in the east	TP06 (1 – 1.20)	Chrysotile (fibres/clumps)	0.001
Graded grassed area in the east	TP07 (1.2 – 1.4)	Chrysotile (fibres/clumps)	<0.001
Area of impermeable hardstanding in the west	TP08 (2.1 – 2.3)	Chrysotile (fibres/clumps)	0.001

The HSP 2020 investigations identified asbestos containing material (ACM) in one of the tested sample (WS02 at 0.6m). ACM was described as sprayed coating containing Amosite, Chrysotile and Crocidolite at total asbestos content of 0.2%.

Based on the available asbestos test results, asbestos was identified within Made Ground 1 in the central and western parts of the site. There is potential for asbestos to be encountered elsewhere on site in areas not previously investigated considering the presence of Made Ground across the site and the site's history.

8.4 Results of Tier 1 Soil Screen

Construction workers & site neighbours (construction phase) and maintenance workers (operational phase)

The following assessment is based on the applied residential without plant uptake end use scenario for the assessment of risk to construction workers and sit neighbours.

26No soil samples were tested for heavy metals, TPHs and PAHs (17No samples taken from Made Ground 1, 4No samples taken from Made Ground 2 and 5No samples taken from natural ground). One sample taken from Made Ground 2 was tested for VOCs and SVOCs and selected samples from Made Ground 1 and Made Ground 2 were tested for PCBs. The results of the chemical screen are presented in Appendix B.

The soil test results were screened against the relevant assessment criteria and are presented within the chemical results tables appended as Appendix B. The exceedances of the applied criteria are summarised in the below table and discussed in detail in Section 7.2.5.

The HSP 2020 also identified elevated concentration of lead in one sample, WS02 at 0.6m, where it was measured at 510mg/kg. No other exceedances of the residential without plant uptake end use scenario were reported however the review of the factual data identifies similar exceedances in made ground to those presented in Table 9, with Dibenz(a,h)Anthracene measured 0.41 to 1.4mg/kg, Benzo[a]pyrene 1.3 to 4.6 mg/kg and Benzo[b]fluoranthene 1.6 to 5.4mg/kg.

Table 9 – Tier 1 soil exceedances (relevant to construction workers, site neighbours and maintenance workers)

Determinant (µg/l)	Screening Criteria (mg/kg) Notes 1 and 2	Measured concentrations in mg/kg (No of exceedances / No of samples)	
		Made Ground 1	Natural ground
Beryllium	1.7 (AGAC/S4UL)	5.5 (1 / 17)	-
Lead	310 (C4SL)	1300 (1 / 17)	-
Nickel	181.4 (AGAC)	260 (1 / 17)	-
Dibenz(a,h)Anthracene	0.32 (AGAC/S4UL)	0.57 to 1.1 (7 / 17)	0.39, 0.53 (2 / 5)
Benzo[a]pyrene	3.23 (AGAC/S4UL)	3.3 to 7.4 (6 / 17)	-
Benzo[b]fluoranthene	4.06 (AGAC)	4.1 to 9.1 (7 / 17)	-

Notes:

1. Screening criteria for a Residential with no uptake end use, relevant to construction workers, site neighbours and maintenance workers.
2. Arup GACs (AGACs) have usually been developed using the same chemical and toxicological assumptions as the LQM S4ULs. Typically, where AGACs differ from S4ULs this is because LQM rounded the S4ULs to two significant figures, whereas AGACs have not.

Site end users (operational phase)

The following assessment is based on the applied 'commercial' criteria for the assessment of risk to site end users through reuse of onsite materials.

No exceedances of the applied assessment criteria have been identified. The review of the HSP 2020 results have not identified exceedances of the end use scenario adopted for the proposed development.

Asbestos was detected in tested Made Ground samples as already detailed in section 8.3.

8.5 Potential Contaminants of Concern – Construction Workers and Site Neighbours

Asbestos

Asbestos was identified within Made Ground 1 across site in a 5No samples of made ground at detectable albeit very low concentrations of at or below the laboratory level of detect of 0.001% w/w. The asbestos was identified as clumps or loose fibres primarily of Chrysotile but also Amosite. The HSP 2020 investigations identified ACM in one of the tested samples of Made Ground comprising as sprayed coating containing Amosite, Chrysotile and Crocidolite at total asbestos content of 0.2%.

The completed testing strongly indicates that the Made Ground present across the site is likely to be impacted by asbestos and contain both fibres and ACMs. Therefore, there is increased probability for asbestos to be encountered elsewhere on site in areas not previously investigated. On this basis, the management of made ground materials on site should be assumed the contain Asbestos and appropriate measures should be incorporated into construction risk assessments and method statement. This could include visual inspections to confirm the absence of asbestos containing materials by a suitably qualified and experienced person (with relevant training such as asbestos awareness and identification) prior to their processing for re-use in the earthworks.

The services of a specialist asbestos contractor should be sought to confirm the required mitigation measures, which shall include, but not be limited to sufficient hygiene units, decontamination units, welfare facilities and PPE provided by the Contractor for the duration of the works, prevention of dust generation by damping

down, appointment of suitably qualified asbestos specialist /personnel to supervise works on site and brief staff of the hazards and correct working methods etc.

Metals

Metal such as beryllium, lead and nickel were measured above the applied assessment criteria relevant to construction workers and site neighbours (during construction) and maintenance workers (during operation). The exceedances were recorded in the sample taken from TP07 at 1.2 and 1.4m bgl. Following a review of the log descriptions of the Made Ground in the location where elevated beryllium, lead and nickel were recorded (*dark brown sandy gravelly clay with occasional cobbles. Sand is fine to coarse. Gravel is fine to medium angular to sub angular of bricks, concrete. Cobbles are angular of concrete and brick*), these are similar to descriptions of the Made Ground in other areas of the site. There was no obvious source related to the locally elevated concentrations. Elevated lead concentrations were also measured in WS02 at 0.6m of material described as *dark brown and black mottled sandy gravel. Gravel is fine to coarse and angular of mixed lithology clinker, slag and brick.* To manage the risk, made ground martials on site should assume the presence of elevated concentrations of metals particularly lead and appropriate health and safety measures should be incorporated into construction risk assessments and method statements. The health and safety measures may include adequate PPE, dust suppression etc. which would allow mitigation of the risk. The contractor should undertake their own assessment to confirm the appropriate level of health and safety measures.

PAH

PAH exceedances were recorded in Made Ground 1 samples taken from the graded grassed area in the east. The 2020 HSP identified elevated PAHs, particularly Dibenz(a,h)Anthracene. Based on the log descriptions, the recorded PAH are likely related to the asphalt and clinker inclusions within the Made Ground. PAH exceedances (dibenz(a.h)anthracene) were also locally recorded in the natural ground in the southernmost part of the site near the road (BH01 at 3 – 3.1m bgl also recorded in the sample taken from the Made Ground in the location) and in the western part of the site near the railway sidings (TP09 at 1.1 – 1.3m bgl).

Despite the above recorded concentrations, it is considered that the risk presented to construction workers and site neighbours during construction, and maintenance workers involved in excavations during operation is low. For the purpose of managing the risk, it should be assumed that made ground materials on site contain elevated concentrations of PAHs and appropriate health and safety measures should be incorporated into construction risk assessments and method statements. The health and safety measures may include adequate PPE, dust suppression etc. which would allow mitigation of the risk. The contractor should undertake their own assessment to confirm the appropriate level of health and safety measures.

8.6 Potential Contaminants of Concern –Maintenance Workers

The above recommendations with respect to managing risk during construction works also apply to any intrusive maintenance works. Information regarding the asbestos, elevated beryllium, lead, nickel and PAHs should be included within the health and safety file for the development.

8.7 Potential Contaminants of Concern – Site End Users

Asbestos

Based on current development proposals, the main area of soft landscaping will be formed by removing up to 0.6m of Made Ground. However, asbestos was detected at depths of around 1 – 2m bgl. Therefore, there is a risk posed to site end users from Made Ground containing asbestos, would be exposed at surface.

It is understood that the proposed soft landscaping areas will comprise clean soil cover (clean topsoil and subsoil), which would mitigate any risk to site end users. However, due to the risk of asbestos impacted soils being exposed at surface due to future activities on site associated with landscaped areas maintenance or to prevent burrowing animals bringing the impacted materials to surface, it is proposed that an engineered capping is incorporated into the landscaping design allowing for a demarcation layer e.g. a brightly colour geotextile underlying a minimum of 300mm of clean materials in grassed areas and minimum of 600mm of clean materials in areas of planting. This will be detailed in the remediation strategy developed for the site.

8.8 Conclusion and Recommendations

The completed human health risk assessment has indicated the following:

Locally elevated concentrations of beryllium, lead, nickel and PAH were recorded above the applied assessment criteria for construction and maintenance workers within the Made Ground. Asbestos in the form of chrysotile and amosite fibres was also identified within the Made Ground. There is potential for asbestos to be encountered within the Made Ground soils in areas not previously investigated. Appropriate measures should be incorporated into construction risk assessments and method statement to mitigate risks associated with these contaminants of concern. The services of a specialist asbestos contractor should be sought to confirm the required mitigation measures. The contractor should undertake their own assessment to confirm the appropriate level of health and safety measures (including asbestos health and safety measures).

Materials management should assume the presence of asbestos impacted soils (fibres and ACM) and incorporate appropriate measures with respect to watching brief, materials storge, transport and reuse. Manual sorting may be required to remove ACMs and allow for reuse won materials on site (beneath hardstanding, buildings or engineered capping layer – see below), or disposal of site. Materials containing ACM would be considered mixed asbestos waste and require disposal at a hazardous waste facility. Processing and sorting of materials prior to disposal would allow reduction in volume of hazardous waste.

There is a risk present to site end users in the proposed soft landscaping areas on account of asbestos detected in the Made Ground. Clean soil capping layer (minimum 300mm in grassed areas or 600mm in areas of planting) with an underlying demarcation layer in areas of soft landscaping should be incorporated into the design to break the pathways for identified asbestos within Made Ground soils and mitigate the risk. This will be detailed in the remediation strategy developed for the site.

It is considered that soils that exhibit visual or olfactory evidence of contamination will not be suitable for reuse at the site unless a site specific risk assessment demonstrates no significant risks.

9. Controlled waters risk assessment

The conceptual model identified a potential plausible pollutant linkage between potentially mobile soil contamination and the underlying groundwater bodies, and between onsite groundwater bodies and nearby surface water receptor. Based on the proposed development infiltration will be possible within h soft landscaped areas only.

On this basis leachate analysis and groundwater testing was undertaken as part of the 2023 investigation on site to assess the contaminative nature of the site soils and the potential for leaching.

Results of the soil leachate and groundwater testing obtained from the 2023 investigations have been reviewed and compiled in Appendix C to this report. The assessment in relation to controlled waters is presented below.

9.1 Methodology

Groundwater contained within the Secondary aquifers at the site is considered to be of low potential as a drinking water resource as there are no historical or current abstraction licences in site proximity. In addition, the presence of the off-site sources of contamination listed in Section 7.1 may have had an impact on the background water quality. However, based on the fact that extensive development and remediation of the land was undertaken in vicinity to site which has rendered it suitable for its intended use, it is anticipated that the potential for any remaining contamination related to the land in vicinity to the site is low.

The primary controlled waters receptor is considered to be the Secondary aquifers beneath the site and surface water course (Barry Dock). Based on the recorded groundwater levels as part of the GI, it is likely that groundwater under the site is in hydraulic continuity with Barry Dock in the site vicinity to the east. On

this basis, Freshwater Environmental Quality Standards (FEQS) screening criteria are considered to be the most suitable to assess the risk. Where no FEQS are available for certain analytes, the UK Drinking Water Standard (DWS) assessment criteria have been used.

EQS values are typically subject to bioavailability using data from the receiving waters. These are used to predict the potential risk posed by metals in the aquatic environment. As no data is currently available from the receiving waters, data obtained from groundwater testing has been used to provide an indicative assessment.

9.2 Results of Tier 1 Leachate Screen

Nine soil samples were subject to leachate testing including seven of Made Ground 1, one of Made Ground 2 and one from natural. Soil leachate was tested for metals (all samples), PAHs and BTEX (5No samples).

The 2:1 L/S leachate results were screened against the relevant assessment criteria and are presented within the chemical results tables appended as Appendix C. The exceedances of the applied criteria are summarised in the below table.

Table 10 – Tier 1 leachate exceedances

Determinant (µg/l)	Screening Criteria	Measured concentrations(µg/l) (No of exceedances / No of samples)	
		Made Ground 1	Made Ground 2
Antimony	5 (DWS)	8.7 (1 / 7)	9.6 (1 /1)
Chromium	4.7 (EQS)	None	5.8 (1 / 1)
Mercury	1 (DWS)	1.3 (1 / 7)	None
Zinc	12.3 (EQS)	25 (1 /7)	None
Ammoniacal Nitrogen	300 (EQS)	1800 (1 / 7)	None
Fluoranthene	0.0063 (EQS)	10 (1 / 4)	None
Anthracene	0.01 (EQS)	1.3 (1 / 4)	None

9.3 Results of Tier 1 Groundwater Screen

Nine groundwater samples were recovered over monitoring period. The samples were subject to laboratory testing for metals, PAHs, speciated TPH, BTEX, PCBs, sVOCs and VOCs.

The groundwater results were screened against the relevant assessment criteria and are presented within the chemical results tables appended as Appendix C. The exceedances of the applied criteria are summarised in the below table.

Table 11 – Tier 1 groundwater exceedances

Determinant (mg/l)	Screening Criteria	Measured concentrations (mg/l) (No of exceedances / No of samples per borehole)	
		TFD	MG (perched)
Chloride	250	BH01 3200 – 5900 (3 / 3) BH03 none (0 / 3)	BH04 87 – 910 (2 /3)
Ammoniacal Nitrogen	0.3	BH01 0.35 – 0.59 (3 / 3) BH03 0.068 – 0.93 (2 / 3)	BH04 0.34 – 2.6 (3 /3)
Sulphates	400	BH01 540 - 1400 (3 / 3) BH03 none (0 / 3)	BH04 none (0 /3)

9.4 Potential Contaminants of Concern – Controlled Waters

Metals

The soil leachate assessment has identified isolated exceedances of applied criteria for antimony, chromium, zinc and mercury within Made Ground 1 and 2. Following a review of the log descriptions, the recorded concentration is likely related to clinker and metal inclusions within the Made Ground.

The elevated concentration of Mercury was recorded in a sample obtained from TP08 at 2.1-2.m bgl. The exploratory hole log for this sample location describes the encountered materials (0.9m to at least 3m) as *yellowish grey brown sandy gravelly clay with occasional cobble content. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of bricks, brick fragments, concrete, timber fragments, metal sheeting, sandstone and mudstone with occasional limestone. Cobbles are angular of concrete.* The source of leachable mercury in this location is not apparent. No Mercury was detected in the analysed groundwater samples including the nearest BH04 monitoring perched groundwater in made ground. This is indicative of a localised issue.

The recorded concentrations of leachable metals are unlikely to pose a significant risk to the controlled water receptors.

Chloride and sulphates

Elevated concentrations of chlorides and sulphates in BH01 and BH04 indicates brackish nature of the underlying groundwater likely as a result of estuary water intrusion into the site area. Borehole BH01 encountered granular TFD, where main groundwater flows are anticipated, and which may be in continuity with the estuary via the Cadoxton River former channel system. Chloride and sulphates are unlikely to pose a significant risk to controlled waters as these represent the background hydrogeological setting of the site.

Ammoniacal Nitrogen

Ammoniacal nitrogen was recorded above the applied criteria within Made Ground 1 (TP10 at 0.25 – 0.45m bgl). Ammonia is often found in landfill leachate and in waste products, such as sewage and other liquid organic waste products. However, there was no indication of landfill extents on site based on the nature of the Made Ground encountered in the location of the recorded exceedance and no significant sources of ammoniacal nitrogen have been identified within the site area.

The screening of groundwater results identified elevated concentrations of ammoniacal nitrogen in groundwater, both in TFD and perched water in Made ground, with highest concentrations measured in the perched groundwater. The recorded single exceedance of the applied assessment criterion is unlikely to be indicative of a source of ammoniacal nitrogen on site posing a significant risk to controlled water receptors. Therefore, the quality of groundwater on site may have been impacted by off-site sources.

Hydrocarbons

PAH were locally recorded above the applied assessment criteria within soil leachate sample obtained from Made Ground 1 (on sample obtained from TP08 at 2.1 – 2.3). Based on the log description (presented in 'Metals' subsection above) there is no obvious source for the recorded PAH.

Completed ground investigations have not encountered evidence of significant hydrocarbon contamination. Slight hydrocarbon odour and staining was recorded within the reworked ground in one location in the western part of the site (TP03 between 3.2 and 3.6m bgl). The subsequent testing did not indicate significantly elevated concentrations of TPHs. No petroleum hydrocarbons, semi-volatile or volatile organic compounds or PAHs have been detected in the analysed groundwater samples. Therefore, the site is not considered to pose a significant risk to controlled waters with respect to hydrocarbons.

9.5 Conclusion and Recommendations

The completed controlled waters risk assessment indicated that the majority of the soil leachate exceedances were noted in TP09 and TP08, which are located in the area of the proposed car park, where based on currently proposed drainage strategy, no significant infiltration into the ground would occur. In addition, the low permeability TFD underlying the Made Ground would prevent vertical migration of contamination towards the bedrock aquifer, which is of low sensitivity. On this basis the contamination identified in the leachate analysis is not considered to pose a significant risk to controlled waters.

Other identified exceedances are not considered significant and no evidence of significant contamination has been encountered. No significant contamination has been identified within the underlying groundwater. Groundwater testing indicated potential brackish nature of the underlying groundwater further reducing its potential as a potable resource. The proposed development will generally reduce rainwater infiltration by

introduction of a building in the eastern site area, resulting in a potential betterment. A vegetated capping in the proposed landscaped areas will further reduce the potential risks.

A foundation works risk assessment will be required to confirm the potential risk from creating new preferential pathways for vertical migration of contamination towards the groundwater through piling related to the proposed building. The currently preferred piling technique - CFA is considered to pose a very low risk due to the nature of construction of CFA piles (direct injection of concrete into the ground). In addition, the completed assessments did not identify significant contamination on site with low risk from perched groundwater and soils.

It is considered that site-won soils are likely to be suitable for reuse at the site within the currently proposed design that incorporates below hardstanding, lined drainage, or the clean soil capping in areas of soft landscaping. If the design changes substantially, further detailed site specific risk assessments may be required.

10. Ground gas risk assessment

The revised CSM identified the underlying Made Ground as potential source of ground gas. Generated ground gas may migrate into the building and accumulate in confined spaces potentially impacting end site users.

Three rounds of fortnightly gas monitoring from boreholes BH02, BH03(A), BH03(B) and BH04 were undertaken between November and December 2023 as part of the recently completed 2023 Arup GI, as detailed in Table 3. The results are presented in the HSP Factual Report, Appendix A, and summarised in the tables below. All boreholes are located within the footprint or vicinity of the proposed building.

In 2020 HSP completed three rounds of ground gas monitoring within Made ground in three installations, WS01, WS09 and WS11, with WS09 and WS11 located within the area of the proposed building. WS01 is located in the western end of the site, area of the proposed car park. The results of the HSP monitoring have been considered within the assessment.

10.1 Monitoring results

10.1.1 Atmospheric Pressure

The 2023 monitoring has been undertaken during periods of rising and falling atmospheric pressure, as summarised in the table below.

Table 12 – Monitoring dates and recorded atmospheric pressure conditions

Monitoring date	Monitoring round	Atmospheric pressure trend
06/11/2023	1	Steady (1000mbar)
21/11/2023	2	Steady (1033mbar)
12/12/2023	3	Steady (994mbar)

10.1.2 Groundwater Levels

As mentioned in Section 6.2, the onsite groundwater levels ranged between 1.8 to 3.9 (approximately 5.1 to 6.9 mOD), with response zones within some of the monitored boreholes flooded during some of the monitoring rounds. In this scenario, the standpipe will provide a pathway for dissolved gases to reach the surface only and may result in gas accumulation in the plain section of the standpipe resulting in monitored levels not representative of the ground atmosphere. Therefore, the results obtained from the flooded standpipes will not be applied into the assessment.

All HSP monitoring was undertaken in unsaturated zone and therefore are considered representative of the soil ground gas conditions.

10.1.3 Gas Monitoring Results

On each monitoring visit to a given standpipe 21No gas readings were taken over a five-minute period. The final reading (steady) has been taken to represent the stable gas conditions, as there is potential that gases may have accumulated within the capped standpipe. The steady readings obtained from not flooded response zones have been applied within the assessment, as summarised in the table below.

The 2020 HSP monitoring was undertaken in three monitoring installations, WS01, WS09 and WS11, all equipped with response zones within the made ground. The results of the 2020 HSP monitoring are discussed in the sections below.

Table 13 – Summary of ground gas monitoring results

Monitoring data	BH02	BH03(B)	BH04
Response zone depth	3.0 to 10	1.0 to 2.0	1.0 to 5.0
Stratigraphy	TFD	MG	MG/TFD
Water level (mbgl)	3.12 to 3.91	1.95 to 2.05	1.8 to 1.97
Carbon Dioxide (%)	0.8 to 2.7	2.1 to 2.6	0.2 to 0.7
Methane (%)	<0.1	<0.1	<0.1
Oxygen (%)	15 to 17	0 to 0.6	18.6 to 19.8
Hydrogen sulphide (ppm)	<1.0	<1.0	<1.0
Carbon monoxide (ppm)	<1.0	<1.0	<1.0
Gas flow (ltr/hr)	0.1	0.1	0.1

Carbon dioxide

Steady concentrations of carbon dioxide were recorded between 0.2 and 2.7% v/v during the 2023 monitoring.

HSP monitoring within the proposed building area recorded similar carbon dioxide concentrations of between <0.1 and 1.8% v/v. However, the installation located in the western end of the site, in the area of the proposed car park, measured carbon dioxide between 1.6 and 16.3% v/v, with concentrations above 5% measured on two occasions. It is no considered that these readings are representative of proposed building area. The review of the WS11 exploratory hole log did not identify potential sources of carbon dioxide with the recorded materials primarily comprising of mineral material. The review of the exploratory hole logs for locations in the area between WS11 and the proposed building, indicates the presence of reworked natural ground comprising mainly cohesive materials, which would inhibit any significant migration of the ground gas towards the building.

Methane

Methane was not measured above the detection level of 0.1%v/v in the monitored installations.

HSP 2020 monitoring also did not detect methane within the monitored locations.

Oxygen

Depleted levels of oxygen were recorded in one installation (BH03(B)) ranging between 0% and 0.6%, which is well below the typical atmospheric oxygen concentrations of approximately 21%. This may be measuring equipment error.

Carbon monoxide

Carbon monoxide was not detected in any of the gas monitoring rounds.

HSP 2020 monitoring detected carbon monoxide on one monitoring occasion in WS11 at the detection level of 1ppm. This is not considered significant or posing a significant risk to end site users.

Hydrogen Sulphide

No hydrogen sulphide was detected in any of the monitoring installations.

HSP 2020 monitoring detected Hydrogen Sulphide on one monitoring occasion in WS11 at the detection level of 1ppm. This is no considered significant or posing a significant risk to end site users.

Flow

Gas flow rate was consistently recorded in all installations at 0.1 l/hr.

HSP 2020 monitoring measured the flow rate consistently below the level of detection of 0.1 l/hr.

10.2 Gas Screening Value

Gas screening values (GSV) for the site have been calculated for methane and carbon dioxide using the maximum representative encountered concentrations during the 2023 as reported in Table 14 below.

Table 14 – Gas screening values

Ground gas	Max Concentration (% Vol)	Flow Rate (l/hr)	Gas Screening Value GSV (l/hr)	Characteristic Situation (CIRIA 665)
Methane	0.1	0.1	0.0001	1
Carbon dioxide	2.7	0.1	0.0027	1

10.3 Conclusions and Recommendations

The site has been classified for gas protection measures in accordance with both CIRIA 665 guidance and BS8485:2015, using the ground gas monitoring results obtained from the completed gas monitoring.

The calculated GSVs for the proposed development area falls within the threshold for Characteristic Situation 1, which means that there is a very low risk from ground gas. This is consistent with the HSP 2020 monitoring undertaken in the area of the proposed building. The carbon dioxide concentrations measured in WS11 in 2020 is not considered to be representative of the area of the proposed building.

In line with the guidance provided in CIRIA C665, no gas protection will be required for the new building.

As discussed in Section 2.6, no radon protection measures are required for the proposed building.

11. Geo-environmental considerations

The conceptual site model identified a number of plausible contaminant linkages. These have been further investigated and assessed. Table 15 below presents the summary and conclusions of the assessments with recommended remediation measures.

The assessments have identified a moderate/low risk from made ground to construction workers and site neighbours primarily due to asbestos as well as elevated concentrations of metals. This risk can be managed by implementation of appropriate health and safety and materials management during construction. It is recommended that as a minimum Ciria 765 ‘Asbestos in soil and made ground good practice site guide’ is followed. Due to the presence of asbestos and an increased risk of encountering asbestos during the works, liaison with a specialist asbestos contractor is recommended.

Watching brief will be required to identify unexpected contamination that may be encountered during construction. This will also allow for identification of ACM and appropriate management of materials designated for reuse or disposal. No materials containing ACM would be suitable for reuse. The presence of ACM in materials designated for off-site disposal would result in asbestos mixed waste classification and hazardous disposal.

Materials exhibiting evidence of hydrocarbon contamination, if encountered, would require a separate appropriate management during construction and further assessments to determine potential risks with respect to reuse or disposal.

The assessment has also identified moderate/low risk with respect to the end site users, also on account of asbestos. It is proposed that clean capping is placed in landscaped areas (minimum 300mm or 600mm

depending on planting proposals), which would incorporate a demarcation layer e.g. a brightly coloured geotextile. This would lower the risk of impacted soils being brought to the surface as a result of maintenance works or activities of burrowing animals.

The soils are considered to be suitable for reuse subject to implementation of the above mentioned remediation measures.

The presence of the identified contaminants of concern should be included in the health and safety file for the site.

The assessments have identified a low risk to controlled waters. No sources of significant contamination have been identified. In addition, the drainage strategy adopted for the site allows for a lined system with minimum infiltration into the ground. However, a foundation works risk assessment will be required to confirm the risk from the piled foundations.

The ground gas risk assessment characterised the site as Characteristic Situation 1, meaning a very low risk and therefore no protection measures are required. The site is not located in a radon impacted area, and therefore no radon protection measures are required.

A remediation strategy, implementation and verification plan for the above mentioned remediation measures will be prepared and presented in a separate document.

Table 15 – Summary of risk assessment and proposed mitigation measures

Identified contaminant of concern	Potential pathway	Receptor	Consequence	Likelihood	Risk	Proposed remediation measures
Asbestos, Metals (lead, beryllium and nickel), PAHs in Made Ground	Exposure to soils and soil dust/fibres	Construction workers Maintenance workers Residents and workers of adjacent land	Medium	Low likelihood	Moderate / low risk	Construction health and safety management in liaison with advice from an asbestos specialist contractor. Application of Ciria 765 'Asbestos in soil and made ground good practice site guide' Materials management including watching brief, sorting of materials to remove ACMs, appropriate storage and handling of made ground materials assuming asbestos is present.
Asbestos in made Ground	Exposure to soil dust/fibres	End site users	Medium	Low likelihood	Moderate / low risk	Clean capping placed in landscaped areas (minimum 300mm or 600mm depending on planting proposals) incorporating a demarcation layer.
Leachable Metals (antimony, chromium, zinc and mercury) and PAHs in Made Ground	Leaching in areas of landscaping to underlying perched water and lateral migration	Surface water: The docks	Mild	Low likelihood	Low risk	No specific measures are required.
	Vertical migration along piles	Groundwater: Secondary aquifers	Medium	Unlikely	Low risk	Foundation works risk assessment to confirm the risk.

Identified contaminant of concern	Potential pathway	Receptor	Consequence	Likelihood	Risk	Proposed remediation measures
Ground gas generated by Made ground associated with historical infilling and land use. Radon	Migration and accumulation in enclosed spaces. Inhalation	End site users	Medium	Unlikely	Low risk	No specific measures are required.
Made ground associated with historical infilling and land use.	Direct contact	Concrete elements	Minor	Unlikely	Low risk	Concrete classification will be undertaken as part of the design and appropriate class applied.

ARUP

WEPCo | Cardiff and Vale Colleges (CAVC)
Barry Waterfront Campus (BWC)
Contamination Assessment Report

Drawing 1 - Site location plan
Scale at A3 1:5,000
03/2024

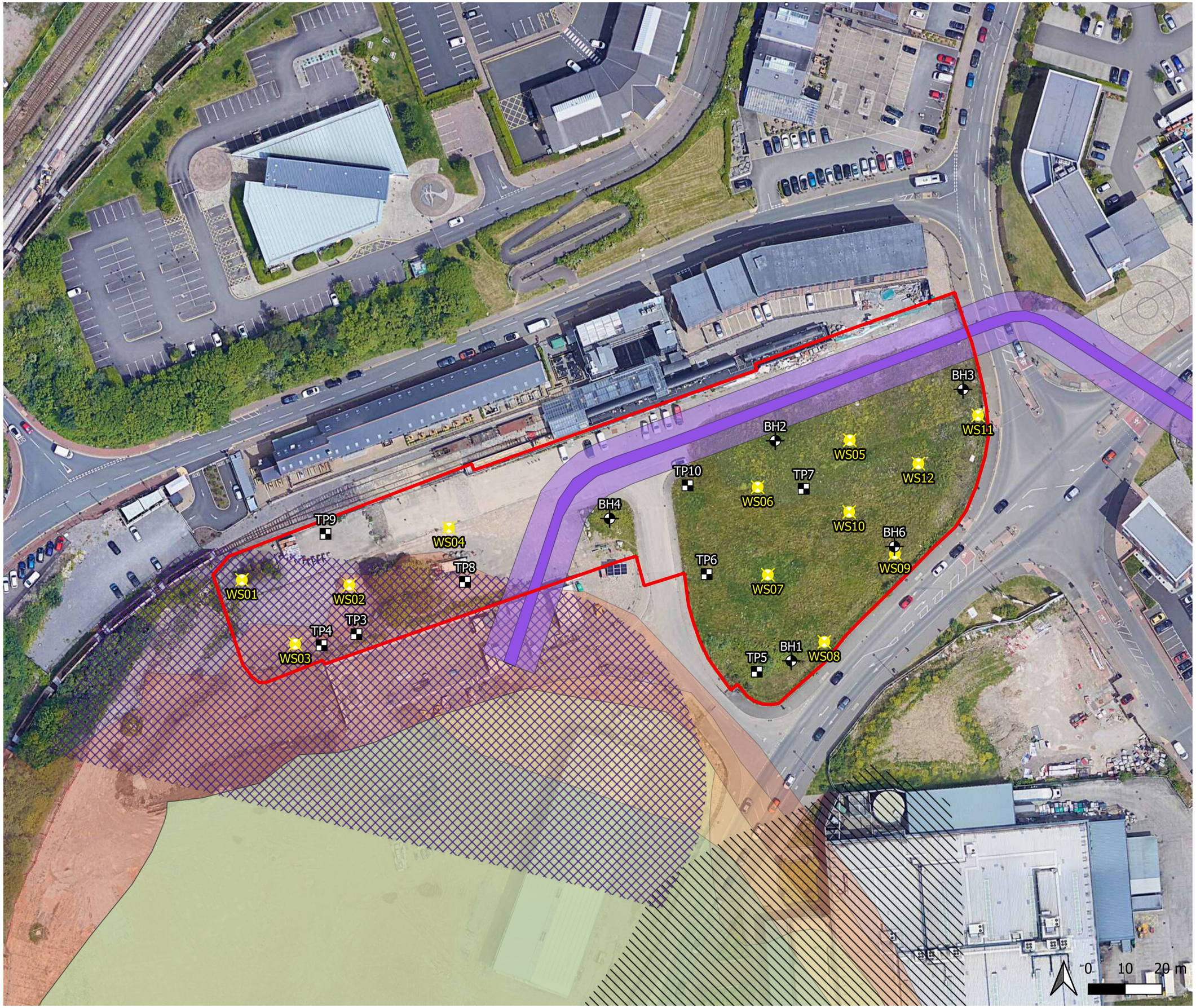
0 50 100 m

Site boundary

ARUP

WEPCo | Cardiff and Vale Colleges (CAVC)
Barry Waterfront Campus (BWC)
Contamination Assessment Report

Drawing 2 - Constraints plan and completed GI
Scale at A3 1:1,500
03/2024



Site boundary

Ground investigation 2023:

Borehole

Trial pit

Ground investigation 2020:

Windowless sample borehole

Existing culvert:

Structure

Easement

Historical infilling areas:

Historical landfill

Area not capped

Tipping

1900

1915

1920

1927-1936

1950

1980-1990

L01 Terrace Illustrative Masterplan SCALE 1:250

HOOD ROAD

ESS

FFORDD Y MILENIWM

SEE INSET

WIP

Note

1. Do not scale from this drawing
2. To be read in conjunction with Project Risk Register REF: XXX
3. To be read in conjunction with all other Landscape Architect's drawings

KEY

- A ENTRANCE PLAZA
- B BIN STORE
- C DOUBLE STACKED CYCLE STORAGE
  Number of spaces: 160 long stay, 10 short stay
- D CAR PARK ACCESS
  Automatic barrier with intercom to reception and double gate to enable site to be secured when needed
- E OUTDOOR DINING
- F FEATURE TREES & RAIN GARDEN
- G GRASS LAWN
  For socialising and outdoor learning
- H DROP OFF ZONE
- I AIR SOURCE HEAT PUMP
- J CARPARK
  93 spaces (inc. 8no. EVCPs and 4 Accessible Bays)
- K SPINKLER & PUMP HOUSE
- L ACCESS ROUTE
  For refuse, maintenace and kitchen deliveries only
- M L01 ILS TERRACE
  Including shed, greenhouse, Horticulture planting, canopy and external seating
- N PV CANOPY
- O SITE EGRESS
  For refuse, maintenace and kitchen deliveries only
- P HEDGE
- Q MOTORCYCLE PARKING
  3no. spaces
- R GAS KIOSK
- S EDIBLE GARDEN
- T BATTERY
- U STORAGE SHED
- V GENERATOR

ID	RISK	MITIGATION	DATE MITIGATED

RESIDUAL PROJECT RISKS

DATE	REV	DESCRIPTION OF REVISION	DRAWN BY	APPROVED BY
07/03/2024	C05	1.Site boundary along eastern and southern boundary updated to align with back of footpath 2.Entrance plaza design updated to respond to building geometry and relocated canopy 3.Planters added along Ffordd Y Milenium to continue plaza 4.Maintenance access pathway switched with planting along Ffordd Y Milenium to continue plaza 5.Northen access road re-aligned to avoid clash with lampost outside of boundary 6.Rear plaza design updated to respond to building geometry, tree locations moved to suit around social lawn 7.Drop off area changed to tarmac 8.MUGA Removed from strategy and replaced with parking spaces (additional 31 spaces) and rain garden. 9.Bollards added along building frontage as part of the security requirements. 10. Battery and Storage shed added to plan	MDS	MH

REVISIONS

STATUS
S4 - *Stage 4*

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CLIENT :
Cardiff and Vale College

PROJECT TITLE :
Barry Waterfront Campus

DRAWING TITLE :
Landscape Illustrative Masterplan

DRAWING SCALE :	DRAWN BY :	DRAWN DATE :
1:250	HS	15/06/2022
PAPER SIZE :	APPROVED BY :	ALA PROJECT CODE:
A1	HT	ALA724

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VG0201-ALA-00-XX-DR-L-00001 S4 C05

Appendix A

HSP Consulting Factual Ground Investigation Report, 2023

INTRUSIVE GEO-ENVIRONMENTAL FACTUAL REPORT

FINAL

Cardiff and Vale College – Barry Waterfront Campus (BWC)

February 2024

HSP2023-C3297-G-GFPII-1948

REV B

hsp consulting

CIVIL | STRUCTURAL | GEOTECHNICAL & ENVIRONMENTAL | TRAFFIC AND TRANSPORT

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Cardiff and Vale College - Barry Waterfront Campus (BWC)

Ground Investigation Factual Report

This report was produced by HSP Consulting Engineers Ltd for WEPCo on behalf of Cardiff and Vale College as the Factual Supplementary Ground Investigation Report for a proposed college development on land off Ffordd Y Mileniwm, Barry.

This report may not be used by any person other than WEPCo on behalf of Cardiff and Vale College and must not be relied upon by any other party without the explicit written permission of HSP Consulting Engineers Ltd. In any event, HSP Consulting Engineers Ltd accepts no liability for any costs, liabilities or losses arising as a result of the use or reliance upon the contents of this report by any person other than WEPCo on behalf of the Cardiff and Vale College.

All parties to this report do not intend any of the terms of the Contracts (Rights of Third Party Act 1999) to apply to this report. Please note that this report does not purport to provide definitive legal advice.

Issue & Revision History

Revision	Status	Originated	Checked	Approved	Date
-	INTERIM	L.Jones B.Sc (Hons) FGS, MIEnvSci	K. Murray BSc (Hons), MSc FGS, MIMMM	H.Pratt B.Eng (Hons), C.Eng, F.Cons.E, M.I.C.E, MI Mgt.	05.12.2023
A	INTERIM	L.Jones B.Sc (Hons) FGS, MIEnvSci	K. Murray BSc (Hons), MSc FGS, MIMMM	H.Pratt B.Eng (Hons), C.Eng, F.Cons.E, M.I.C.E, MI Mgt.	22.12.2023
B	FINAL	L.Jones B.Sc (Hons) FGS, MIEnvSci	K. Murray BSc (Hons), MSc FGS, MIMMM	H.Pratt B.Eng (Hons), C.Eng, F.Cons.E, M.I.C.E, MI Mgt.	08.02.2024
Project Number: C3297				**Document Reference:** HSP2023-C3297-G-GFPII-1948	

This document is available electronically please contact the author to obtain a copy.

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Contents

Appendices

Executive Summary

HSP Consulting Engineers Ltd has been commissioned by WEPCo on behalf of Cardiff and Vale College to undertake an intrusive ground investigation at the site to investigate the existing ground conditions, identify any buried obstructions or fuel tanks and provide information on likely constraints to the development.

The site is located off Ffordd Y Mileniwm, approximately 0.30 km south east of Barry town centre. The approximate National Grid Reference for the centre of the site is (NGR) 311115, 167399.

The physical methods of investigation employed were 8No mechanically excavated trial pits to a maximum depth of 4.10m begl, 5No. cable percussion boreholes with rotary core follow on to depths in the range of 25.15m begl and 34.50m begl and 10No. static cone penetration tests to a maximum depth of 10.00m begl. In-situ plate load testing and infiltration testing was conducted within the trial pits. The scope of works has been prepared by Ove Arup & Partners Limited ref: VG0201-ARP-ZZ-ZZ-SP-G-00001, 23rd June 2023.

The ground conditions encountered on site generally comprised grass or hardstanding over Made Ground deposits which were encountered to a maximum depth of 4.00m begl. Underlying the Made Ground, Tidal Flat Deposits consisting of very soft to stiff grey blue brown SILT and bands of medium dense grey brown gravelly COBBLES of Limestone to a maximum depth of 20.00m begl. Weathered deposits of the Penarth Group were encountered from a minimum depth of 8.00m begl and comprised very weak weathered LIMESTONE. Competent strong LIMESTONE was encountered from a minimum depth of 15.00m begl. Rapid groundwater ingress was encountered within BH01 at 16.00m begl and BH06 at 21.00m begl during the advancement of the core drilling.

Thirty seven soil samples were scheduled for chemical analysis. In addition, disturbed, bulk and undisturbed samples were scheduled for geotechnical testing from the development area. Testing schedules were prepared by the design engineers Ove Arup and Partners. Three rounds of ground gas and water monitoring has been completed at the site. Ground water samples were collected during each monitoring visit and submitted for chemical analysis.

The executive summary contains an overview of key findings. However, no reliance should be placed on the executive summary until the whole of the report has been read. Other sections of the report may contain information which puts into context the findings noted within the executive summary.

1. Introduction

1.1 Background

WEPCo on behalf of Cardiff and Vale College propose to construct a new college campus including multi-storey buildings, car park, access roads and areas of landscaping and attenuation.

This investigation forms a supplementary ground investigation and the scope of works has been prepared by Arup Ref: VG0201-ARP-ZZ-ZZ-SP-G-00001, 23rd June 2023. (Ref 9).

1.2 Client Brief & Scope

HSP Consulting Engineers Ltd has been commissioned by WEPCo on behalf of the Vale of Glamorgan Council to undertake an intrusive ground investigation at the site to investigate the existing ground conditions and geoenvironmental setting. The scope of the investigation was provided by Arup, the clients engineer.

The ground investigation scope included the following:

- 8No. Machine excavated trial pits to a maximum of 4m begl. This is to confirm the ground conditions and groundwater level, and collect soil samples for laboratory analysis;
- 5No. exploratory holes to a depth of between 25m and 35m using a combination of cable percussion and rotary drilling methods, to confirm ground conditions and groundwater level, and collect soil samples for laboratory analysis;
- 7No. cone penetration tests with piezocone to confirm ground conditions and groundwater level;
- In situ strength and stiffness testing such as Standard Penetration tests and Plate Load tests;
- In situ infiltration testing in 3No. trial pits;
- Geotechnical laboratory testing to inform the design process, including unconfined compression strength test;
- BRE SD1 classification of all strata encountered;
- Sampling and geochemical testing of Made Ground and suspected contaminated materials where encountered;
- Monitoring of groundwater if encountered;
- Sampling and contamination testing of groundwater if encountered;
- Ground gas monitoring;
- Dry weight and waste acceptance criteria (WAC) of soil samples to inform disposal options;

The report presents the following information:

- details of the ground investigation undertaken and the ground conditions encountered,
- details and results of the environmental analysis and geotechnical testing.

- results of ground gas and groundwater monitoring.

Where applicable, the fieldwork was undertaken in accordance with BS5930:2015+A1:2020 Code of Practice for Site Investigations and BS10175:2011+A2:2017 Investigation of Potentially Contaminated Sites.

1.3 Limitations

The recommendations made in this report are based on the findings of the intrusive ground investigation undertaken by HSP Consulting Engineers Ltd from the 18th September to the 20th October 2023.

1.4 Previous Reports

HSP Consulting Engineers Ltd has produced the following reports for the site:

- HSP Consulting Engineers Limited – Cardiff and Vale College Site - BWF - Phase I Geo-Environmental Desk Study Report, July 2020, Ref: C3297/PI. (Ref 1).
- HSP Consulting Engineers Limited – Cardiff and Vale College Site – BWF - Phase II Geo-Environmental Assessment Report, November 2020, Ref C3297/PII. (Ref 2).

The following third party reports are also available for the site:

- Barry Waterfront Campus Proposed Site Plan [VG0210-SRA-ZZ-ZZ-DR-A-00101-P02-Sheppard Robson – 05/2022]. (Ref 3).
- Barry Waterfront Campus Desk Study Addendum [VG0201-ARP-ZZ-ZZ-RP-G-00001, Arup]. (Ref 4).

2. Review of Existing Information & Geoenvironmental Setting

2.1 The Site

2.1.1 Location

The site is located off Ffordd Y Mileniwm, approximately 0.30 km south east of Barry town centre. The approximate National Grid Reference for the centre of the site is (NGR) 311115, 167399. A Site Location Plan is included in Appendix I.

2.1.2 2020 Description

The site is irregular in shape and is approximately 1.15Ha in area. The site is accessed via a gated road off Ffordd Y Mileniwm to the south of the site.

The majority of the site is a mixture of concrete hardstanding and weathered tarmacadam surface. Directly south of the fenced temporary compound is an area of undulating scrubland which has been used for stockpiling topsoil like materials and construction debris.

The site is bounded by a mixture of Heras and Palisade fencing with the temporary site compound in the east of the site bounded by further Heras Fencing. The sites topography is generally level in the west, centre and north east of the site. With the eastern scrubland at a higher elevation, approximately 1.5m compared to the rest of the site.

2.1.3 Surrounding Land Use

The main features of interest identified are:

North:	Mixed use, heritage rail line and station, commercial, retail and leisure use with residential properties beyond.
East:	Barry Docks.
South:	Supermarket and residential properties.
West:	Railway Lines and residential properties beyond.

2.1.4 Site Access

The site was accessed via a turning head off Ffordd Y Mileniwm along the southern boundary of the site or via a gated entrance from Hood Road on the eastern boundary.

2.1.5 Proposed End Use

WEPCo on behalf of Cardiff and Vale College propose to construct a new college campus including multi-storey buildings, car park, access roads and areas of landscaping and attenuation. A site development plan is presented in Appendix II.

2.2 Geology

2.2.1 Made Ground

The BGS mapping indicates that Made Ground (Undivided) is present across the site, this is described as an area where the land surface (natural or artificial) has been extensively

remodelled, but where it is impractical or impossible to delineate separate zones of made ground, worked ground or disturbed ground of variable composition.

2.2.2 Superficial Deposits

The BGS mapping indicates the site is underlain by superficial deposits of Tidal Flats in the centre and east of the site, which comprise sands, gravels, silts and clays. Described by the BGS as '*Tidal flat deposits, including mud flat and sand flat deposits, are deposited on extensive nearly horizontal marshy land in the intertidal zone that is alternately covered and uncovered by the rise and fall of the tide. They consist of unconsolidated sediment, mainly mud and/or sand. They may form the top surface of a deltaic deposit. Normally a consolidated soft silty clay, with layers of sand, gravel and peat. Characteristically low relief*.' Superficial deposits are not expected in the west of the site.

2.2.3 Bedrock Geology

BGS bedrock mapping indicates the majority of the site is underlain by mudstone and interbedded limestones of the Penarth Group Mudstone and Limestone, Interbedded of the Triassic Period, described by the BGS as '*Grey to black mudstones with subordinate limestones and sandstones; predominantly marine in origin.'*

With the St Mary's Well Bay Member – Limestone and Mudstone, Interbedded of the Triassic and Jurassic Periods indicated in the extreme west of the site. A detailed description of this unit is not available from the BGS.

2.3 Pertinent Site Sensitivity Information

Based on the information collated for the desk study, the geo-environmental setting of the site is summarised as follows:

- The site is shown from earliest mapping (1878) to be part of tidal flats of the *Cadoxton River*. The site and surrounding area is shown as reclaimed from the 1898 mapping forming part of the Barry Docks, a large industrial area with associated railways, tracks, tanks and coal yards until the late 1990's where the site is disused.
- The surrounding land use is recorded as predominantly, industrial and residential. The town of Barry is located to the east of the site. Rapid industrial development in the early 1900s reaching its peak towards the 1970s, with a steady decline to present day. Recent developments include residential and commercial development to the north and south of the site.
- Superficial deposits comprising Tidal Flats with bedrock geology of the Penarth Group and St Mary's Well Bay Member are expected on site.
- Made Ground materials are expected across the site area as the site and surrounding area are recorded on the BGS mapping as Infilled Land
- The superficial geology of the Tidal Flats is designated as Secondary Undifferentiated with bedrock geologies of the Penarth Group and St Mary's Well Bay Member are designated as a Secondary (B) Aquifer and Secondary (A) Aquifer respectively.

Based on the above, the environmental sensitivity of the site can be considered to be Moderate at this stage.

2.4 HSP 2020 Intrusive Site Investigation Summary

The ground investigation comprised 12No window sample boreholes to a maximum depth of 4.00m begl. The ground conditions encountered generally comprised hardstanding or topsoil, overlying made ground deposits to a maximum depth of 3.50m begl. Natural Tidal Flats deposits were encountered within four locations across the site.

Due to variable and deep made ground (greater than 3.00m depth) and low strength Tidal Flat deposits, a traditional solution is unlikely to be feasible. Therefore, an alternate foundation solution in the form of piling is recommended. This should be designed and warranted by a specialist contractor. It is recommended that deeper rotary boreholes are advanced within the proposed building footprint on site to determine the depth of competent strata and provide information for initial pile design.

The screening process for on-site human health receptors show that the relevant GACs, were exceeded for lead and asbestos. Mitigation measures in the form of a clean cover system within all soft landscaping areas will be required. Alternatively, the area of the lead exceedance and asbestos detection could be subject to delineation and removal off site to a suitable waste disposal facility.

At this stage, it is considered appropriate to adopt a basic Design Sulphate Class of DS-1 together with and Aggressive Chemical Environment for Concrete (ACEC) of AC-1 within the made ground across the site and a basic Design Sulphate Class of DS-2 together with and Aggressive Chemical Environment for Concrete (ACEC) of AC-1s within the natural soils. An atypical result was encountered within WS02 at 2.80m which would be classified as DS- 4 with ACEC of AC - 4, further testing is recommended to confirm the above concrete classification.

Ground gas concentrations have been monitored on four occasions. Comparison of the results with Table 8.5 of the CIRIA document indicates the site falls in a Characteristic Situation 2 and therefore gas protection measures will be required for the proposed development.

3. Fieldwork & Factual Information

Site work was carried out between the 18th September and 20th October 2023. Where applicable, the fieldwork was undertaken in accordance with BS5930:2015+A1:2020 Code of Practice for Site Investigations (Ref. 7) and BS10175:2011+A2:2017 Investigation of Potentially Contaminated Sites (Ref. 8).

3.1 Exploratory Methods

The physical methods of investigation employed were:

- 8No mechanically excavated trial pits to a maximum depth of 4.10m begl,
- 3No. of the trial pits were utilised for soakaway infiltration testing,
- 4No. plate load tests were also undertaken within 4No. trial pit locations,
- 5No. cable percussion boreholes were conducted to a maximum depth of 20.15m begl with rotary core follow on to 34.50m begl and
- 10No. Static Cone Penetration Tests were conducted to a maximum depth of 20m begl with dissipation testing.

The exploratory holes were logged and sampled by an engineer from HSP Consulting Engineers Ltd. The exploratory hole logs are presented in Appendix III. The exploratory hole locations are shown on the Ground Investigation Layout Plan presented in Appendix IV. Photographs of the site and rotary cores are presented within Appendix X.

Fragmentary bulk and disturbed samples were recovered from materials revealed within all of the exploratory holes. Rock cores were extruded in plastic liners and placed in suitable core boxes for geotechnical testing. Geo-environmental samples, placed in plastic tubs and glass jars supplied by the laboratory, were also obtained specifically for chemical analysis. The samples were taken to UKAS accredited laboratories for further examination and testing.

3.2 In-situ Testing

3.2.1 Standard Penetration Tests

Standard Penetration Tests (SPTs) were carried out within the cable percussion and rotary cored boreholes to 22.50m depth. The SPTs were undertaken in accordance with EN ISO 22476-2 2005: A1 2011 and the results are included on the appended borehole logs (Appendix III).

3.2.2 Soil Infiltration Tests

Soil Infiltration Tests were conducted within TP05, TP06 and TP9. The tests were undertaken in accordance with BRE Digest 365 Soakaway Design. The results are included within Appendix VII.

3.2.3 In-situ Plate Load Tests

In-situ plate load tests were conducted within TP07, TP08, TP09 and TP10 in accordance with BS 1377-9 Section 4.1 using a 300mm diameter plate. The results are presented in Appendix VIII.

3.2.4 Dissipation Tests

Dissipation Tests were conducted within four of the static cone penetration test locations. The dissipation test was carried out where there was excess porewater pressure. The results are included in the CPT report presented within Appendix XI.

3.3 Laboratory Testing

The laboratory testing schedules were prepared by Arup, the Clients Engineer.

3.3.1 Geotechnical Testing

Geotechnical testing has been undertaken by a UKAS accredited laboratory as part of the works at the site:

- 35 No. Particle Size Distributions (Wet Sieving)
- 5 No. Compaction using 2.5kg rammer
- 21 No. Natural Moisture Contents
- 25 No. Atterberg Limits
- 21 No. Sedimentation by Pipette
- 9 No. Organic Matter
- 8 No. Recompacted CBR Testing
- 6 No. Shear Strength 60mm x 60mm
- 9 No. Uniaxial Compressive Strength (rock)
- 5 No. Point Load Strength Index (rock)

The laboratory testing has been carried out by Apex Testing Solutions (ATS) (UKAS accredited, laboratory No. 7771), Professional Soils Laboratories (PSL) (UKAS accredited, laboratory No. 4043) and KIWA CMT (UKAS accredited, laboratory No. 0529) in accordance with BS1377:1990 using calibrated equipment specifically for the British Standard and in accordance with the methodology within the ISRM suggested methods for Rock Testing for UCS and Point Load (ref. 10). The results are presented in Appendix VI.

3.3.2 Chemical Analysis

The geo-environmental samples retained specifically for chemical analysis were stored in cooled containers until delivery to the laboratory by courier.

Thirty-seven samples were analysed by the laboratory for the presence of a selected suite of potential contaminants as outlined in the table below. Please refer to the Arup specification (presented in Appendix V) for further details regarding the specifics of each suite:

Table 1 – Chemical Analysis

Exploratory Hole Location & Depth	Sample Description	Exploratory Hole Location & Depth	Sample Description
TP03, 1.20 – 1.40m	Made Ground[1,2,3,4,8,9,10]	TP08, 2.10 – 2.30m	Made Ground[1,2,3,4,11,12]
TP03, 2.20 – 2.40m	Made Ground[13]	TP09, 1.10 – 1.30m	Made Ground[1,2,3,4,6,9,10,11,12]
TP03, 3.00 – 3.20m	Made Ground[1,2,3,5,7]	TP09, 2.00 – 2.20m	Made Ground[13]
TP04, 1.00 – 1.20m	Made Ground[13]	TP09, 2.10 – 2.30m	Made Ground[1,3,4,7]
TP04, 1.00 – 1.40m	Made Ground[1,2,3,4]	TP10, 0.25 – 0.45m	Made Ground[1,2,3,4,6,11,12]
TP05, 0.15 – 0.20m	Made Ground[1,2,3,4,6,7,8,9,10]	TP10, 1.15 – 1.35m	Made Ground[13]
TP05, 0.90 – 1.00m	Made Ground[13]	TP10, 2.20 – 2.40m	Made Ground[1,2,3,4,6,7,8]
TP05, 1.10 – 1.20m	Made Ground[1,2,3,4,6,11,12]	TP10, 2.90 – 3.00m	CLAY[1,3,4]
TP05, 2.20 – 2.30m	CLAY[1,3,4]	BH01, 0.80 – 1.00m	Made Ground[1,2,3,4]
TP05, 3.10 – 3.20m	CLAY[13]	BH01, 3.00 – 3.10m	Made Ground[1,3,4]
TP06, 0.25 – 0.35m	Made Ground[1,2,3,4,6]	BH02, 0.10 – 0.30m	Made Ground[1,2,3,4,6]
TP06, 1.00 – 1.20m	Made Ground[1,2,3,4,7,8,9,10]	BH02, 1.00 – 1.20m	Made Ground[1,2,3,4]
TP06, 1.10 – 1.30m	Made Ground[13]	BH03, 0.10 – 0.30m	Made Ground[1,2,3,4,6,7,8,9,10]
TP06, 2.00 – 2.20m	Made Ground[1,2,3,4,6,11,12]	BH03, 1.80 – 2.00m	Made Ground[1,2,3,4]
TP07, 1.00 – 1.20m	Made Ground[13]	BH04, 1.00 – 1.20m	Made Ground[1,2,3,4,6]
TP07, 1.20 – 1.40m	Made Ground[1,2,3,4,7,8,9,10]	*BH04, 1.80 – 2.00m*	*Made Ground[1,2,3,4,6]**
TP07, 2.00 – 1.40m	CLAY[1,3,4]	BH06, 0.10 – 0.30m	Made Ground[1,2,3,4,6]
TP07, 2.90 – 3.00m	CLAY[13]	BH06, 1.80 – 2.00m	Made Ground[1,2,3,4]
TP08, 1.00 – 1.20m	Made Ground[13]		

[1] Suite E1 – Soil, [2] Suite E2 – Asbestos, [3] Suite E3 - TPHCWG + BTEX, [4] Suite E4 – PAH, [5] Suite E5 – VOC and SVOC, [6] Suite E6 – PCB, [7] Suite E9 – Hexavalent Chromium, [8] Suite E16 - Other (Loss on Ignition), [9] Suite H - WAC soils, [10] Suite I – WAC leachability, [11] Suite J1 – Leachability General, [12] Suite J2 Leachability PAH / BTEX [13] Suite D BRE (Greenfield site – pyrite present)

**This samples were misplaced by the courier / testing laboratory and therefore the requested testing has not been completed.*

The contamination analysis was carried out by Chemtest Environmental Ltd (UKAS accredited, laboratory No. 2183) during the period 21st September to 3rd November 2023. The results are presented in Appendix V.

3.3.3 Chemical Analysis – Groundwaters

The groundwater samples were extracted using low-flow techniques and retained specifically for chemical analysis. The samples were stored in cooled containers until delivery to the laboratory by courier. The samples were delivered to the laboratory with 24 hours of abstraction.

Three rounds of ground water monitoring were undertaken between the 15th December 2023 and the 23rd January 2024.

Prior to extraction each borehole was purged for three times the well volume and given ample time to recharge prior to extraction via low flow.

The groundwater samples were analysed by the laboratory for the presence of a selected suite of potential contaminants. Please refer to the Arup specification (presented in Appendix XII) for further details regarding the specifics of each suite.

The contamination analysis was carried out by Chemtest Environmental Ltd (UKAS accredited, laboratory No. 2183) during the period 15th December 2023 to 31st January 2024. The results along with low flow data are presented in Appendix XII.

3.4 Ground Conditions

3.4.1 Published Geology

The published geology indicates the site is expected to be underlain by Made Ground up to 3.00m in depth and superficial Tidal Flat deposits as described in section 2.2.1 and 2.2.2 The site is underlain by the bedrock geology of the Penarth Group– Limestone and Mudstone, described in section 2.2.3 above.

3.4.2 Ground Conditions on site or General Geology & Revealed Strata

The exploratory hole data does conform with the published information, the strata across the site generally comprises:

Table 2 – Encountered Ground Conditions

Strata		Depth (m begl)	Thickness (m)	Description
Anthropogenic	MADE GROUND	G.L. – 3.00	3.00	MADE GROUND comprising black, brown slightly gravelly clay fill with cobbles of brick and concrete.
		2.00 – 2.80	0.80	MADE GROUND comprising black, clayey sand and gravel fill. Gravels are of coal, clinker and concrete.
		2.80 – 4.00	1.20	MADE GROUND comprising grey, brown very gravelly clay fill. Gravels are of brick, concrete, ceramics and occasional fabric.
		3.00 – 4.00	1.00	POSSIBLE MADE GROUND comprising reworked blue grey sandy CLAY. (BH04 only).
Superficial	TIDAL FLAT DEPOSITS	4.00 – 12.00	8.00	Medium dense light brown sandy clayey gravelly COBBLES. (BH01 only).
		12.00 – 15.00	3.00	Dense red brown clayey SAND and GRAVEL. (BH01 only).
		2.80 – 6.50	3.70	Soft to firm blue grey brown SILT.
		6.50 – 9.70	3.20	Medium dense grey brown gravelly COBBLES of Limestone.
		9.70 – 16.40	6.70	Soft blue grey SILT.
		11.00 – 15.00	2.00	Dense slightly clayey sandy GRAVELS of Mudstone and Limestone.
		16.40 – 20.00	3.60	Soft to stiff blue grey SILT with cobbles of Limestone.
Bedrock	PENARTH GROUP – MUDSTONE AND LIMESTONE	8.00 – 9.00	1.00	Very weak weathered LIMESTONE. (BH04 only).
		9.00 – 15.00	3.00	Very strong grey LIMESTONE with yellowish brown staining. (BH04 only).
		15.00 – 21.00	6.00	Very weak to strong greenish grey LIMESTONE.
		21.00 – 21.10	0.10	Very strong white CALCITE.
		21.10 – 34.50	13.40	Very strong reddish brown and bluish grey banded LIMESTONE.

3.5 Ground Gas and Groundwater Monitoring

Dual use gas and groundwater monitoring installations were constructed within four of the boreholes at the site during ground investigation (BH01, BH02, BH03 and BH04). Each well has been constructed using 50mm diameter HDPE pipe. All of the borehole installations have a 6mm pea gravel surround to the slotted pipe with a bentonite seal above and a gas tap. The covers are raised round lockable stopcock covers.

HSP Consulting uses a GFM 436 Gas Analyser. Prior to its use a calibration check can be performed against gas readings in air. It is recommended that this check is undertaken once on each day the analyser is used. Annual calibration is undertaken on the unit and a copy of this certificate has been included within Appendix IX.

Three rounds of ground gas and ground water monitoring have been completed on the site. The results are presented within IX.

3.6 Groundwater Levels

Groundwater was encountered during the advancement of the exploratory holes. Table 3 below provides further information:

Table 3 – Groundwater during Drilling

Exploratory Hole Location	Depth of Groundwater (m begl)	Depth of Groundwater (m AOD)	Notes
TP03	3.60	4.74	Seepage.
TP04	3.90	4.61	Seepage.
BH01	3.00	3.91	Seepage.
BH01	16.00	-7.09	Extremely rapid flow.
BH02	3.50	5.55	Steady flow.
BH03	3.90	4.97	Steady flow.
BH04	6.90	1.72	Steady flow.
BH06	5.00	4.18	Steady flow.
BH06	21.00	-11.82	Extremely rapid flow.

Groundwater levels were recorded on three occasions. The results are presented in Table 4 below.

Table 4 – Groundwater Levels

	Round 1 (06.11.2023)		Round 2 (21.11.2023)		Round 3 (12.12.2024)	
Exploratory Location	Depth (m begl)	Depth (m AOD)	Depth (m begl)	Depth (m AOD)	Depth (m begl)	Depth (m AOD)
BH02	3.12	5.93	3.48	5.57	3.91	5.14
BH03 (A)	2.21	6.66	2.43	6.44	2.55	6.32
BH03 (B)	-		1.95	6.92	2.05	6.82
BH04	1.80	6.82	1.97	6.65	1.93	6.69

4. References

1. HSP Consulting Engineers Limited – Cardiff and Vale College Site - BWF - Phase I Geo-Environmental Desk Study Report, July 2020, Ref: C3297/PI.
2. HSP Consulting Engineers Limited – Cardiff and Vale College Site – BWF - Phase II Geo-Environmental Assessment Report, November 2020, Ref C3297/PII.
3. Barry Waterfront Campus Proposed Site Plan [VG0210-SRA-ZZ-ZZ-DR-A-00101-P02-Sheppard Robson – 05/2022].
4. Barry Waterfront Campus Desk Study Addendum [VG0201-ARP-ZZ-ZZ-RP-G-00001, Arup].
5. BRITISH GEOLOGICAL SURVEY. 1996. Cardiff. England and Wales Sheet 263. Solid and Drift. 1:50 000 (Keyworth, Nottingham: British geological Survey).
6. British Geological Survey Lexicon Search - http://www.bgs.ac.uk/lexicon/
7. BS5930:2015+A1:2020 Code of Practice for Site Investigations
8. BS10175:2011 +A2:2017 Investigation of Potentially Contaminated Sites - Code of Practice.
9. Ove Arup & Partners Limited ref: VG0201-ARP-ZZ-ZZ-SP-G-00001, 23rd June 2023.
10. ISRM (1985)., Suggested method for determining point load strength, International Journal of Rock Mechanics and Mining Sciences and Geomechanics Abstract., Vol 22, Issue 2

Appendix I

DO NOT SCALE

NOTES:

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Lawrence House, Meadowbank Way,
Eastwood, Nottingham, NG16 3SB
Tel: 01773 535 555 Fax: 0870 600 6091
www.hspconsulting.com

CLIENT:
WEPCo

PROJECT:
Barry Waterfront Campus

TITLE:
Site Location Plan

SCALE@SIZE :	ISSUE:
NTS	FINAL
DESIGN/DRAWN: LEJ	DATE: Dec 2023
PROJECT No: C3297	DRAWING No: 502

Appendix II

L01 Terrace Illustrative Masterplan SCALE 1:250

HOOD ROAD

ESS

MILENIWM

SEE INSET

FFORDD Y MILENIWM

MINIBUS

MINIBUS

KEY

- A ENTRANCE PLAZA
- B BIN STORE
- C DOUBLE STACKED CYCLE STORAGE
  Number of spaces: 160 long stay, 10 short stay
- D CAR PARK ACCESS
  Automatic barrier with intercom to reception and double gate to enable site to be secured when needed
- E OUTDOOR DINING
- F FEATURE TREES & RAIN GARDEN
- G GRASS LAWN
  For socialising and outdoor learning
- H DROP OFF ZONE
- I AIR SOURCE HEAT PUMP
- J CARPARK
  93 spaces (inc. 10no. EVCPs and 4 Accessible Bays)
  2 x Minibus Parking
- K SPINKLER & PUMP HOUSE
- L ACCESS ROUTE
  For refuse, maintenace and kitchen deliveries only
- M L01 ILS TERRACE
  Including shed, greenhouse, Horticulture planting, canopy and external seating
- N PV CANOPY
- O SITE EGRESS
  For refuse, maintenace and kitchen deliveries only
- P HEDGE
- Q MOTORCYCLE PARKING
  3no. spaces
- R GAS KIOSK
- S EDIBLE GARDEN
- T BATTERY
- U STORAGE SHED
- V GENERATOR

Note

1. Do not scale from this drawing
2. To be read in conjunction with Project Risk Register REF: VG0201-ALA-00-XX-RG-L-00001
3. To be read in conjunction with all other Landscape Architect's drawings

ID	RISK	MITIGATION	DATE MITIGATED

RESIDUAL PROJECT RISKS

DATE	REV	DESCRIPTION OF REVISION	DRAWN BY	APPROVED BY
20/03/2024	P05	Issued for Planning	MDS	MH

REVISIONS

STATUS
A2 - ***Authorized and Accepted as Planning Application Submission***

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CLIENT :
Cardiff and Vale College

PROJECT TITLE :
Barry Waterfront Campus

DRAWING TITLE :
Landscape Illustrative Masterplan

DRAWING SCALE :	DRAWN BY :	DRAWN DATE :
1:250	HS	15/06/2022
PAPER SIZE :	APPROVED BY :	ALA PROJECT CODE:
A1	HT	ALA724

DRAWING NUMBER : **VG0201-ALA-00-XX-DR-L-00001** STATUS : **A2** REVISION : **P05**

Appendix III

Borehole Log

Borehole No. **BH01**

Sheet 1 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311148.00 - 167363.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 8.91	Scale 1:50
Client: WEPCO		Dates: 04/10/2023 - 10/10/2023	Logged By LH+LJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		1.20 1.20 - 1.65	B	N=21 (4,4/4,5,6,6)				MADE GROUND comprising black brown slightly gravelly clayey fill with cobbles of brick and concrete. Sand is fine to coarse, gravel is fine to coarse subangular brick and concrete.
		2.00 2.00 - 2.45	B	N=20 (3,2/2,6,6,6)				
	▼	3.00 3.00 - 3.45	B	N=31 (5,5/7,8,8,8)	2.80	6.11		MADE GROUND comprising grey brown very gravelly clay fill. Gravels are fine to coarse angular to subangular brick, concrete, ceramics and occasional fabric pieces.
		4.00 4.00 - 4.45	B	N=33 (4,6/8,9,8,8)	4.00	4.91		Wet medium dense light brown clayey gravelly COBBLES. Gravels are fine to coarse, angular to subrounded mudstone, limestone and flint.
		5.00 5.00 - 5.45	B	N=35 (5,7/7,10,9,9)				
		6.00 6.00 - 6.45	B	N=34 (7,7/10,8,7,9)				
		7.00 7.00 - 7.45	B	N=38 (6,6/11,9,9,9)				
		8.00 8.00 - 8.45	B	N=35 (10,7/6,9,10,10)	8.00	0.91		Wet medium dense light brown sandy clayey gravelly COBBLES. Sand is fine to coarse. Gravels are fine to coarse, angular to subrounded mudstone, limestone and flint.
		9.00 9.00 - 9.45	B	N=38 (7,7/8,10,9,11)				
		10.00		N=39 (4,8/10,9,9,11)				

Continued on next sheet

Remarks

1. Cable Percussion to 16m with Rotary Core to 34.50m begl. 2.Extremely rapid groundwater encountered whilst coring from 16m begl.

Borehole Log

Borehole No. **BH01**

Sheet 2 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311148.00 - 167363.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 8.91	Scale 1:50
Client: WEPCO		Dates: 04/10/2023 - 10/10/2023	Logged By LH+LJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.00 - 10.45	B						
		11.00		N=34 (6,6/6,7,10,11)					11
		11.00 - 11.45	B						
		12.00		N=38 (10,11/11,9,9,9)	12.00	-3.09			12
		12.00 - 12.45	B					Dense wet red brown clayey SAND and GRAVEL. Sand is fine to coarse, gravels are fine to coarse, angular to subangular mudstone and limestone.	
		13.00		N=42 (8,8/12,11,9,10)					13
		13.00 - 13.45	B						
		14.00		N=49 (10,11/10,11,14,14)					14
		14.00 - 14.45	B						
		15.00		50 (10,12/50 for 295mm)	15.00	-6.09			15
		15.00 - 15.45	B					Very weak weathered grey LIMESTONE. Recovered as gravels and cobbles. Gravels and cobbles are fine to coarse angular to subangular.	
	▼	16.00 - 16.50	C						16
		16.50		50 (25 for 120mm/50 for 295mm)					
		16.50 - 17.25	C						17
		17.25 - 18.00	C						
		18.00		50 (8 for 110mm/50 for 249mm)	18.00	-9.09			18
		18.00 - 19.50	C					Strong greenish grey LIMESTONE recovered as non-intact	
									19
		19.50 - 21.00	C		19.40	-10.49		Strong grey LIMESTONE with orange staining	
					19.80	-10.89		Very strong greenish grey and grey banded LIMESTONE with orange staining and occasional 5mm bands of calcite.	20
								Continued on next sheet	

Remarks

1. Cable Percussion to 16m with Rotary Core to 34.50m begl. 2.Extremely rapid groundwater encountered whilst coring from 16m begl.

Borehole Log

Borehole No. **BH01**

Sheet 3 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311148.00 - 167363.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 8.91	Scale 1:50
Client: WEPCO		Dates: 04/10/2023 - 10/10/2023	Logged By LH+LJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Band of non-intact mudstone.
		21.00 - 22.50	C		21.00 21.10	-12.09 -12.19		Very strong white CALCITE Very strong reddish brown and bluish grey banded LIMESTONE with regular 5-15mm bands of non-intact LIMESTONE and orangish brown staining. Fractures very closely to widely spaced 0-30° rough planar and 70-90° rough vertical.
		22.50 - 24.00	C					
					23.55	-14.64		Very strong reddish brown and bluish grey LIMESTONE with orange brown staining. Fractures closely spaced 0-20° rough planar.
		24.00 - 25.50	C		24.00	-15.09		Very strong dark grey with orange staining and very frequent bands of non-intact limestone. Fractures closely spaced 0-20° rough planar and 80-90° rough closed undulating.
								Band of white calcite.
		25.50 - 27.00	C					
					25.90	-16.99		Very strong and bluish grey mottled LIMESTONE with dark orange staining and frequent 5mm veins of calcite from 27.95m bgl. Fractures 0-20° very closely so closely spaced rough closed planar and very widely spaced 50-60° rough undulating.
		27.00 - 28.50	C					
		28.50 - 30.00	C					*Band of white calcite*
					29.55	-20.64		Very strong brown and bluish grey banded LIMESTONE. Fractures are closely to widely spaced 0-25° smooth to rough planar and very widely spaced 50-70° rough undulating.
		30.00 - 31.50	C					

Continued on next sheet

Remarks

1. Cable Percussion to 16m with Rotary Core to 34.50m begl. 2.Extremely rapid groundwater encountered whilst coring from 16m begl.

Borehole Log

Borehole No. **BH01**

Sheet 4 of 4

Project Name:	Barry Waterfront	Project No. C3297	Co-ords: 311148.00 - 167363.00	Hole Type CP
Location:	Ffordd Y Mileniwm, Barry		Level: 8.91	Scale 1:50
Client:	WEPCO		Dates: 04/10/2023 - 10/10/2023	Logged By LH+LJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		31.50 - 33.00	C					
		33.00 - 34.50	C					
					33.15	-24.24		Very strong reddish brown and bluish grey banded LIMESTONE with occasional 5mm veins of calcite and orange staining. Fractures very closely to widely spaced 0-20° smooth to rough closed planar and very widely spaced 40-60° rough undulating.
					34.50	-25.59		End of borehole at 34.50 m

31 32 33 34 35 36 37 38 39 40

Remarks

1. Cable Percussion to 16m with Rotary Core to 34.50m begl. 2.Extremely rapid groundwater encountered whilst coring from 16m begl.

Rotary Core Log

Borehole No. **BH01**

Sheet 1 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311148.00 - 167363.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 8.91	Scale 1:50
Client: WEPCO		Dates: 04/10/2023 - 10/10/2023	Logged By LH+LJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		1.20 - 1.65	B							MADE GROUND comprising black brown slightly gravelly clayey fill with cobbles of brick and concrete. Sand is fine to coarse, gravel is fine to coarse subangular brick and concrete.
		2.00 - 2.45	B							
	▼	3.00 - 3.45	B				2.80	6.11		MADE GROUND comprising grey brown very gravelly clay fill. Gravels are fine to coarse angular to subangular brick, concrete, ceramics and occasional fabric pieces.
		4.00 - 4.45	B				4.00	4.91		Wet medium dense light brown clayey gravelly COBBLES. Gravels are fine to coarse, angular to subrounded mudstone, limestone and flint.
		5.00 - 5.45	B							
		6.00 - 6.45	B							
		7.00 - 7.45	B							
		8.00 - 8.45	B				8.00	0.91		Wet medium dense light brown sandy clayey gravelly COBBLES. Sand is fine to coarse. Gravels are fine to coarse, angular to subrounded mudstone, limestone and flint.
		9.00 - 9.45	B							
		10.00 - 10.45	B							

Continued on next sheet

Remarks

1. Cable Percussion to 16m with Rotary Core to 34.50m begl. 2.Extremely rapid groundwater encountered whilst coring from 16m begl.

Rotary Core Log

Borehole No. **BH01**

Sheet 2 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311148.00 - 167363.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 8.91	Scale 1:50
Client: WEPCO		Dates: 04/10/2023 - 10/10/2023	Logged By LH+LJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		11.00 - 11.45	B							
		12.00 - 12.45	B				12.00	-3.09		Dense wet red brown clayey SAND and GRAVEL. Sand is fine to coarse, gravels are fine to coarse, angular to subangular mudstone and limestone.
		13.00 - 13.45	B							
		14.00 - 14.45	B							
		15.00 - 15.45	B				15.00	-6.09		Very weak weathered grey LIMESTONE. Recovered as gravels and cobbles. Gravels and cobbles are fine to coarse angular to subangular.
	▼	16.00 - 16.50	C							
		16.50 - 17.25	C							
		17.25 - 18.00	C							
		~~18.00 - 19.50~~	C				18.00	-9.09		Strong greenish grey LIMESTONE recovered as non-intact
		18.00 - 19.50		53	9	0				
		~~19.50 - 21.00~~	C				19.40	-10.49		Strong grey LIMESTONE with orange staining
							19.80	-10.89		Very strong greenish grey and grey banded LIMESTONE with orange staining and occasional 5mm bands of calcite.

Continued on next sheet

Remarks

1. Cable Percussion to 16m with Rotary Core to 34.50m begl. 2.Extremely rapid groundwater encountered whilst coring from 16m begl.

Rotary Core Log

Borehole No. **BH01**

Sheet 3 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311148.00 - 167363.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 8.91	Scale 1:50
Client: WEPCO		Dates: 04/10/2023 - 10/10/2023	Logged By LH+LJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		19.50 - 21.00		53	34	24				*Band of non-intact mudstone.*
		~~21.00 - 22.50~~	C				21.00	-12.09		Very strong white CALCITE
							21.10	-12.19		Very strong reddish brown and bluish grey banded LIMESTONE with regular 5-15mm bands of non-intact LIMESTONE and orangish brown staining. Fractures very closely to widely spaced 0-30° rough planar and 70-90° rough vertical.
		21.00 - 22.50		94	52	15				
		~~22.50 - 24.00~~	C							
		22.50 - 24.00		87	81	36				
							23.55	-14.64		Very strong reddish brown and bluish grey LIMESTONE with orange brown staining. Fractures closely spaced 0-20° rough planar.
		~~24.00 - 25.50~~	C				24.00	-15.09		Very strong dark grey with orange staining and very frequent bands of non-intact limestone. Fractures closely spaced 0-20° rough planar and 80-90° rough closed undulating.
		24.00 - 25.50		97	28	10				
										Band of white calcite.
		~~25.50 - 27.00~~	C							
							25.90	-16.99		Very strong and bluish grey mottled LIMESTONE with dark orange staining and frequent 5mm veins of calcite from 27.95m bgl. Fractures 0-20° very closely so closely spaced rough closed planar and very widely spaced 50-60° rough undulating.
		25.50 - 27.00		97	91	30				
		~~27.00 - 28.50~~	C							
		27.00 - 28.50		100	95	57				
		~~28.50 - 30.00~~	C							*Band of white calcite*
		28.50 - 30.00		89	81	41				
							29.55	-20.64		Very strong brown and bluish grey banded LIMESTONE. Fractures are closely to widely spaced 0-25° smooth to rough planar and very widely spaced 50-70° rough undulating.
		~~30.00 - 31.50~~	C							

Continued on next sheet

Remarks

1. Cable Percussion to 16m with Rotary Core to 34.50m begl. 2.Extremely rapid groundwater encountered whilst coring from 16m begl.

Rotary Core Log

Borehole No. **BH01**

Sheet 4 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311148.00 - 167363.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 8.91	Scale 1:50
Client: WEPCO		Dates: 04/10/2023 - 10/10/2023	Logged By LH+LJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		30.00 - 31.50		88	87	87				
		~~31.50 - 33.00~~	C							
		31.50 - 33.00		100	100	89				
		~~33.00 - 34.50~~	C				33.15	-24.24		Very strong reddish brown and bluish grey banded LIMESTONE with occasional 5mm veins of calcite and orange staining. Fractures very closely to widely spaced 0-20° smooth to rough closed planar and very widely spaced 40-60° rough undulating.
		33.00 - 34.50		100	100	65				
							34.50	-25.59		End of borehole at 34.50 m

31 32 33 34 35 36 37 38 39 40

Remarks

1. Cable Percussion to 16m with Rotary Core to 34.50m begl. 2.Extremely rapid groundwater encountered whilst coring from 16m begl.

Borehole Log

hsp consulting			Borehole No. **BH02** Sheet 1 of 3
Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311145.00 - 167423.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 9.05	Scale 1:50
Client: WEPCO		Dates: 16/10/2023 - 18/10/2023	Logged By LH+LEJ

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		1.20 1.20 - 1.65	B	N=31 (3,4/6,6,9,10)				MADE GROUND comprising black brown sandy gravelly clay fill. Sand is fine to coarse, gravel is fine to coarse angular to sub angular brick, concrete, mudstone and limestone.
		2.00 2.00 - 2.45	B	N=16 (3,4/4,4,4,4)	2.00	7.05		MADE GROUND comprising black clayey sand and gravel fill. Sand is fine to coarse, gravel is fie to coarse angular to subangular coal, clinker and concrete.
		3.00 3.00 - 3.45	B	N=22 (4,4/6,6,6,4)	2.80	6.25		Stiff blue grey SILT.
	▼							*....Wet from 3.60m.*
		4.00 4.00 - 4.45	B	N=22 (3,4/6,5,5,6)				
		5.00 5.00 - 5.45	B	N=21 (4,3/3,5,6,7)				
		6.00 6.00 - 6.45	B	N=22 (4,5/5,6,5,6)				
		7.00 7.00 - 7.45	B	N=29 (6,5/4,7,9,9)	6.50	2.55		Wet medium dense grey brown COBBLES oF Limestone. Cobbles are fine to coarse angular to subangular.
		8.00 8.00 - 8.45	B	N=37 (4,6/9,9,10,9)	7.60	1.45		Wet medium dense grey brown sandy COBBLES oF Limestone. Sand is fine to coarse, cobbles are fine to coarse angular to subangular.
		9.00 9.00 - 9.45	B	N=33 (7,7/7,8,9,9)	8.80	0.25		Wet medium dense grey brown clayey GRAVELS and COBBLES oF Limestone. Gravels and cobbles are fine to coarse angular to subangular.
		10.00		N=3 (0,0/0,1,1,1)	9.70	-0.65		Very soft wet blue grey SILT.
								Continued on next sheet

Remarks
1. Cable Percussion to 18m with Rotary Core to 25.5m begl.

AGS

Borehole Log

Borehole No. **BH02**

Sheet 2 of 3

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311145.00 - 167423.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 9.05	Scale 1:50
Client: WEPCO		Dates: 16/10/2023 - 18/10/2023	Logged By LH+LEJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.00 - 10.45	B						
		11.00		N=3 (0,0/0,1,1,1)					11
		11.00 - 11.45	B						
		12.00		N=2 (1,0/0,1,0,1)					12
		12.00 - 12.45	B						
		13.00		N=3 (1,0/0,1,1,1)					13
		13.00 - 13.45	B						
		14.00		N=4 (1,0/1,1,1,1)					14
		14.00 - 14.45	B						
		15.00		N=4 (0,0/0,1,1,2)					15
		15.00 - 15.45	B						
		16.00		N=36 (5,6/5,10,9,12)					16
		16.00 - 16.45	B						
					16.40	-7.35		Stiff wet blue grey SILT with cobbles of Limestone. Cobbles are fine to coarse angular to subangular.	
		17.00		N=50 (8,9/10,11,14,15)					17
		17.00 - 17.45	B						
		18.00		50 (25 for 145mm/50 for 265mm)	18.00	-8.95		Very strong bluish grey LIMESTONE - Recovered as non-intact	18
		18.00 - 19.50	C						
									19
		19.50		50 (25 for 95mm/50 for 245mm)	19.50	-10.45		Very strong bluish grey and yellowish brown mottled LIMESTONE with orangish brown staining and occasional 15mm nodular of calcite. Fractures closely spaced 10-30° rough planar and 60-70° very widely spaced smooth open planar.	
		19.50 - 21.00	C						20

Continued on next sheet

Remarks

1. Cable Percussion to 18m with Rotary Core to 25.5m begl.

Borehole Log

Borehole No. **BH02**

Sheet 3 of 3

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311145.00 - 167423.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 9.05	Scale 1:50
Client: WEPCO		Dates: 16/10/2023 - 18/10/2023	Logged By LH+LEJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		21.00 - 22.50	C					*Band of reddish brown mudstone - recovered as non-intact.*
					21.20	-12.15		Very strong reddish brown and grey banded LIMESTONE with occasional orange staining. Fractures 0-20° very closely to widely spaced rough open to closed planar and 80-90° vertical smooth undulating.
		22.50 - 24.00	C					
		24.00 - 25.50	C		24.00	-14.95		Very strong grey mottled reddish brown LIMESTONE with very frequent bands of yellowish brown moderately strong mudstone and dark orange staining. Fractures 0-20° extremely closely to closely spaced rough planar and 70-80° vertical smooth planar.
								Band of pinkish white calcite.
					25.30	-16.25		End of borehole at 25.50 m

Remarks

1. Cable Percussion to 18m with Rotary Core to 25.5m begl.

Rotary Core Log

Borehole No. **BH02**

Sheet 1 of 3

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311145.00 - 167423.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 9.05	Scale 1:50
Client: WEPCO		Dates: 16/10/2023 - 18/10/2023	Logged By LH+LEJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		1.20 - 1.65	B							MADE GROUND comprising black brown sandy gravelly clay fill. Sand is fine to coarse, gravel is fine to coarse angular to sub angular brick, concrete, mudstone and limestone.
		2.00 - 2.45	B				2.00	7.05		MADE GROUND comprising black clayey sand and gravel fill. Sand is fine to coarse, gravel is fie to coarse angular to subangular coal, clinker and concrete.
		3.00 - 3.45	B				2.80	6.25		Stiff blue grey SILT.
	▼									....Wet from 3.60m.
		4.00 - 4.45	B							
		5.00 - 5.45	B							
		6.00 - 6.45	B							
		7.00 - 7.45	B				6.50	2.55		Wet medium dense grey brown COBBLES oF Limestone. Cobbles are fine to coarse angular to subangular.
		8.00 - 8.45	B				7.60	1.45		Wet medium dense grey brown sandy COBBLES oF Limestone. Sand is fine to coarse, cobbles are fine to coarse angular to subangular.
		9.00 - 9.45	B				8.80	0.25		Wet medium dense grey brown clayey GRAVELS and COBBLES oF Limestone. Gravels and cobbles are fine to coarse angular to subangular.
		10.00 - 10.45	B				9.70	-0.65		Very soft wet blue grey SILT.
										Continued on next sheet

Remarks

1. Cable Percussion to 18m with Rotary Core to 25.5m begl.

Rotary Core Log

Borehole No. **BH02**

Sheet 2 of 3

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311145.00 - 167423.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 9.05	Scale 1:50
Client: WEPCO		Dates: 16/10/2023 - 18/10/2023	Logged By LH+LEJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description	
		11.00 - 11.45	B								11
		12.00 - 12.45	B								12
		13.00 - 13.45	B								13
		14.00 - 14.45	B								14
		15.00 - 15.45	B								15
		16.00 - 16.45	B								16
							16.40	-7.35		Stiff wet blue grey SILT with cobbles of Limestone. Cobbles are fine to coarse angular to subangular.	
		17.00 - 17.45	B								17
		~~18.00 - 19.50~~	C				18.00	-8.95		Very strong bluish grey LIMESTONE - Recovered as non-intact	18
		18.00 - 19.50		50	50	7					19
		~~19.50 - 21.00~~	C				19.50	-10.45		Very strong bluish grey and yellowish brown mottled LIMESTONE with orangish brown staining and occasional 15mm nodular of calcite. Fractures closely spaced 10-30° rough planar and 60-70° very widely spaced smooth open planar.	20

Continued on next sheet

Remarks

1. Cable Percussion to 18m with Rotary Core to 25.5m begl.

Rotary Core Log

Borehole No. **BH02**

Sheet 3 of 3

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311145.00 - 167423.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 9.05	Scale 1:50
Client: WEPCO		Dates: 16/10/2023 - 18/10/2023	Logged By LH+LEJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		19.50 - 21.00		97	73	8				*Band of reddish brown mudstone - recovered as non-intact.*
		~~21.00 - 22.50~~	~~C~~				21.20	-12.15		
		21.00 - 22.50	5.3	100	100	63				Very strong reddish brown and grey banded LIMESTONE with occasional orange staining. Fractures 0-20° very closely to widely spaced rough open to closed planar and 80-90° vertical smooth undulating.
		~~22.50 - 24.00~~	~~C~~							
		22.50 - 24.00	6.7	87	87	49				
		~~24.00 - 25.50~~	~~C~~				24.00	-14.95		Very strong grey mottled reddish brown LIMESTONE with very frequent bands of yellowish brown moderately strong mudstone and dark orange staining. Fractures 0-20° extremely closely to closely spaced rough planar and 70-80° vertical smooth planar.
		24.00 - 25.50	9.3	99	93	20				*Band of pinkish white calcite.*
							25.30	-16.25		End of borehole at 25.50 m

Remarks

1. Cable Percussion to 18m with Rotary Core to 25.5m begl.

Borehole Log

Borehole No. **BH03**

Sheet 1 of 3

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311196.00 - 167435.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 8.87	Scale 1:50
Client: WEPCO		Dates: 12/10/2023 - 17/10/2023	Logged By LEJ+LH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		1.20 1.20 - 1.65	B	N=13 (3,3/4,3,3,3)				MADE GROUND comprising black brown sand gravelly clayey fill. Sand is fine to coarse, gravels are fine to coarse angular to subrounded brick, concrete, flint, mudstone and limestone.
G		2.00 2.00 - 2.45	B	N=20 (4,4/6,4,5,5)				
W		3.00 3.00 - 3.45	B	N=9 (1,1/2,3,2,2)	3.00	5.87		Very soft wet grey brown SILT.
	▼	4.00 4.00 - 4.45	B	N=4 (1,1/1,1,1,1)				
		5.00 5.00 - 5.45	B	N=8 (2,2/2,2,2,2)				
		6.00 6.00 - 6.45	B	N=4 (1,1/1,1,1,1)	6.00	2.87		Very soft wet grey brown SILT with occasional cobbles and gravels of LIMESTONE. Gravels and cobbles are fine to coarse, angular to subangular.
		7.00 7.00 - 7.45	B	N=3 (1,0/1,0,1,1)	7.00	1.87		Very soft wet grey brown SILT.
		8.00 8.00 - 8.45	B	N=6 (2,1/2,2,1,1)				
		9.00 9.00 - 9.45	B	N=4 (1,1/1,1,1,1)				
		10.00		N=7 (2,2/1,2,2,2)				

Continued on next sheet

Remarks

1. Cable Percussion to 15.5m with Rotary Core to 25.30m begl.

Borehole Log

Borehole No. **BH03**

Sheet 2 of 3

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311196.00 - 167435.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 8.87	Scale 1:50
Client: WEPCO		Dates: 12/10/2023 - 17/10/2023	Logged By LEJ+LH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.00 - 10.45	B						
		11.00		N=37 (8,9/9,9,9,10)	11.00	-2.13			11
		11.00 - 11.45	B					Dense wet slightly clayey sandy GRAVELS. Sand is fine to coarse, gravels are fine to coarse angular to subrounded flint, mudstone and limestone.	
		12.00		N=37 (9,10/9,10,9,9)					12
		12.00 - 12.45	B						
		13.00		N=34 (9,8/9,8,8,9)	13.00	-4.13			13
		13.00 - 13.45	B					Very weak weathered grey LIMESTONE. Recovered as gravels and cobbles of Limestone. Gravels and cobbles are fine to coarse, angular to subangular.	
		14.00		N=39 (7,10/9,9,10,11)					14
		14.00 - 14.45	B						
		15.00		N=50 (7,10/10,10,15,15)					15
		15.00 - 15.45	B						
		15.50 - 16.50	C		15.50	-6.63		Very strong dark grey LIMESTONE with yellowish brown staining. Fractures closely spaced 0-20° rough planar.	16
		16.50 - 18.00	C		16.50	-7.63		*Band of white calcite.* Very strong greenish grey LIMESTONE, recovered as non-intact	17
					17.20	-8.33		Very strong greenish grey mottled grey LIMESTONE with dark orange staining and frequent bands of non-intact limestone. Fractures are closely spaced 20-30° rough undulating and 70-80 smooth planar.	
		18.00		50 (25 for 115mm/50 for 245mm)					18
		18.00 - 19.50	C						19
		19.50 - 21.00	C						20

Continued on next sheet

Remarks

1. Cable Percussion to 15.5m with Rotary Core to 25.30m begl.

Borehole Log

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311196.00 - 167435.00	Borehole No. **BH03** Sheet 3 of 3
Location: Ffordd Y Mileniwm, Barry		Level: 8.87	Hole Type CP
Client: WEPCO		Dates: 12/10/2023 - 17/10/2023	Scale 1:50
			Logged By LEJ+LH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					20.20	-11.33		*Band of yellowish brown limestone.* *Band of pinkish white calcite.* Very strong grey and reddish brown mottled with dark orange staining and occasional 5mm calcite veins. Fractures very closely to closely 0-20° spaced smooth open planar and 70-90° smooth planar.
		21.00 - 22.50	C					
		22.50 - 24.00	C					
					23.60	-14.73		Very strong yellowish brown and grey LIMESTONE. Fractures extremely closely to closely spaced 0-20° smooth to rough planar and very widely spaced 50-60° rough planar.
		24.00 - 25.30	C		24.30	-15.43		*Band of white calcite.* *Band of pinkish white calcite.* Dark grey and dark bluish grey mottled LIMESTONE with dark orange and yellowish brown staining. Fractures closely 0-20° rough undulating and 70-90° vertical smooth undulating
					25.30	-16.43		End of borehole at 25.30 m

Remarks
1. Cable Percussion to 15.5m with Rotary Core to 25.30m begl.

Rotary Core Log

Borehole No. **BH03**

Sheet 1 of 3

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311196.00 - 167435.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 8.87	Scale 1:50
Client: WEPCO		Dates: 12/10/2023 - 17/10/2023	Logged By LEJ+LH

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		1.20 - 1.65	B							MADE GROUND comprising black brown sand gravelly clayey fill. Sand is fine to coarse, gravels are fine to coarse angular to subrounded brick, concrete, flint, mudstone and limestone.
G		2.00 - 2.45	B							
W		3.00 - 3.45	B				3.00	5.87		
	▼	4.00 - 4.45	B							Very soft wet grey brown SILT.
		5.00 - 5.45	B							
		6.00 - 6.45	B				6.00	2.87		
		7.00 - 7.45	B				7.00	1.87		Very soft wet grey brown SILT with occasional cobbles and gravels of LIMESTONE. Gravels and cobbles are fine to coarse, angular to subangular.
		8.00 - 8.45	B							Very soft wet grey brown SILT.
		9.00 - 9.45	B							
		10.00 - 10.45	B							

Continued on next sheet

Remarks

1. Cable Percussion to 15.5m with Rotary Core to 25.30m begl.

Rotary Core Log

Borehole No. **BH03**

Sheet 2 of 3

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311196.00 - 167435.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 8.87	Scale 1:50
Client: WEPCO		Dates: 12/10/2023 - 17/10/2023	Logged By LEJ+LH

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		11.00 - 11.45	B				11.00	-2.13		Dense wet slightly clayey sandy GRAVELS. Sand is fine to coarse, gravels are fine to coarse angular to subrounded flint, mudstone and limestone.
		12.00 - 12.45	B							
		13.00 - 13.45	B				13.00	-4.13		Very weak weathered grey LIMESTONE. Recovered as gravels and cobbles of Limestone. Gravels and cobbles are fine to coarse, angular to subangular.
		14.00 - 14.45	B							
		15.00 - 15.45	B							
		~~15.50 - 16.50~~	C				15.50	-6.63		Very strong dark grey LIMESTONE with yellowish brown staining. Fractures closely spaced 0-20° rough planar.
		15.50 - 16.50	4	60	55	11				
		~~16.50 - 18.00~~	C				16.50	-7.63		*Band of white calcite.* Very strong greenish grey LIMESTONE, recovered as non-intact
		16.50 - 18.00		67	49	11	17.20	-8.33		Very strong greenish grey mottled grey LIMESTONE with dark orange staining and frequent bands of non-intact limestone. Fractures are closely spaced 20-30° rough undulating and 70-80 smooth planar.
		~~18.00 - 19.50~~	C							
		18.00 - 19.50	8	73	34	10				
		~~19.50 - 21.00~~	C							

Continued on next sheet

Remarks

1. Cable Percussion to 15.5m with Rotary Core to 25.30m begl.

AGS

Rotary Core Log

Borehole No. **BH03**

Sheet 3 of 3

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311196.00 - 167435.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 8.87	Scale 1:50
Client: WEPCO		Dates: 12/10/2023 - 17/10/2023	Logged By LEJ+LH

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							20.20	-11.33		*Band of yellowish brown limestone.* *Band of pinkish white calcite.* Very strong grey and reddish brown mottled with dark orange staining and occasional 5mm calcite veins. Fractures very closely to closely 0-20° spaced smooth open planar and 70-90° smooth planar.
		19.50 - 21.00	10	73	53	0				
		~~21.00 - 22.50~~	~~C~~							
		21.00 - 22.50	5	93	92	61				
		~~22.50 - 24.00~~	~~C~~							
		22.50 - 24.00	9	100	85	53				
		~~24.00 - 25.30~~	~~C~~				23.60	-14.73		Very strong yellowish brown and grey LIMESTONE. Fractures extremely closely to closely spaced 0-20° smooth to rough planar and very widely spaced 50-60° rough planar.
							24.30	-15.43		*Band of white calcite.* *Band of pinkish white calcite.* Dark grey and dark bluish grey mottled LIMESTONE with dark orange and yellowish brown staining. Fractures closely 0-20° rough undulating and 70-90° vertical smooth undulating
		24.00 - 25.30		100	85	8				
							25.30	-16.43		End of borehole at 25.30 m

Remarks

1. Cable Percussion to 15.5m with Rotary Core to 25.30m begl.

Borehole Log

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311099.00 - 167403.00	Borehole No. **BH04** Sheet 1 of 3
Location: Ffordd Y Mileniwm, Barry		Level: 8.62	Hole Type CP
Client: WEPCO		Dates: 18/10/2023 - 20/10/2023	Scale 1:50
			Logged By LH+LEJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		1.20 1.20 - 1.65	B	N=16 (2,4/4,4,4,4)				MADE GROUND comprising black brown sandy gravelly clayey fill. Sand is fine to coarse, gravel is fine to coarse subangular of brick, concrete, limestone, flint and mudstone.
		2.00 2.00 - 2.45	B	N=26 (2,4/6,6,7,7)				
		3.00 3.00 - 3.45	B	N=18 (4,3/3,4,6,5)	3.00	5.62		Possible MADE GROUND comprising reworked blue grey sandy CLAY. Sand is fine to coarse.
		4.00 4.00 - 4.45	B	N=4 (1,1/1,1,1,1)	4.00	4.62		Very soft blue grey SILT with occasional organic partings.
		5.00 5.00 - 5.45	B	N=2 (1,0/1,0,0,1)				
		6.00 6.00 - 6.45	B	N=2 (1,0/1,1,0,0)				
	▼	7.00 7.00 - 7.45	B	N=42 (6,9/9,9,10,14)	6.80	1.82		Stiff wet blue grey SILT with occasional gravels of Limestone. Gravels are fine to coarse, angular to subangular.
		8.00 8.00 - 8.45	B	N=50 (10,12/25,25,0,0)	8.00	0.62		Very weak weathered LIMESTONE. Recovered as gravels and cobbles which are fine to coarse, angular to subangular.
		9.00 9.00 - 10.50	C	N=50 (25,0/50,0,0,0)	9.00	-0.38		Very strong grey LIMESTONE with yellowish brown staining and frequent bands of non-intact limestone. Fractures 0-20° very closely to widely spaced rough open planar.
								Continued on next sheet

Remarks
1. Cable Percussion to 9.14m with Rotary Core to 25.50m begl.

Borehole Log

Borehole No. **BH04**

Sheet 2 of 3

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311099.00 - 167403.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 8.62	Scale 1:50
Client: WEPCO		Dates: 18/10/2023 - 20/10/2023	Logged By LH+LEJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.50		50 (25 for 105mm/50 for 275mm)				
		10.50 - 12.00	C					
		12.00 - 13.50	C		12.00	-3.38		Very strong yellowish brown and dark grey mottled with dark orange staining and occasional 5-15m veins of calcite. Fractures closely to widely spaced 10-30° rough open planar, *Band of pinkish white calcite.*
		13.50 - 15.00	C		13.50	-4.88		Very strong yellowish brown mottled dark grey LIMESTONE. Fractures 0-20° very closely to closely spaced rough open undulating/planar and 50-60° very widely spaced rough open planar. *Band of white calcite.* *Band of yellowish brown mudstone.*
		15.00		50 (25 for 85mm/50 for 245mm)				*Band of white calcite.*
		15.00 - 16.50	C					*Band of pinkish white calcite.*
		16.50 - 18.00	C		15.70	-7.08		Very strong dark grey LIMESTONE with yellowish brown staining and occasional 5-10mm veins of calcite. Fractures closely spaced 0-20° smooth planar and 80-90° vertical closed planar. *Band of dark grey mudstone.*
		18.00 - 19.50	C		17.10	-8.48		Very strong bluish grey LIMESTONE with dark orange staining and very frequent 5mm veins of calcite, becoming less frequent with depth. Fractures extremely closely to closely spaced 0-20° rough planar and widely 30-40° smooth undulating.
		19.50 - 21.00	C					

Continued on next sheet

Remarks

1. Cable Percussion to 9.14m with Rotary Core to 25.50m begl.

Borehole Log

Borehole No. **BH04**

Sheet 3 of 3

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311099.00 - 167403.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 8.62	Scale 1:50
Client: WEPCO		Dates: 18/10/2023 - 20/10/2023	Logged By LH+LEJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		21.00 - 22.50	C					*Band of reddish brown mudstone.*
								Band of pinkish white calcite.
								Band of yellowish brown mudstone with calcite nodules.
					21.20	-12.58		Very strong reddish brown and grey banded LIMESTONE with occasional 5mm veins of calcite and orange staining. Fractures closely to very widely spaced 10-20° rough open to closed planar and very widely spaced 30-40° smooth open planar.
		22.50 - 24.00	C					
								band of dark grey mudstone.
		24.00 - 25.50	C					
					24.20	-15.58		Very strong grey LIMESTONE with orange staining and occasional bands of pinkish white calcite and dark grey mudstone. Fractures 0-20° closely spaced smooth open planar
					25.50	-16.88		End of borehole at 25.50 m

21 22 23 24 25 26 27 28 29 30

Remarks

1. Cable Percussion to 9.14m with Rotary Core to 25.50m begl.

AGS

Rotary Core Log

Borehole No. **BH04**

Sheet 1 of 12

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311099.00 - 167403.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 8.62	Scale 1:50
Client: WEPCO		Dates: 18/10/2023 - 20/10/2023	Logged By LH+LEJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		1.20 - 1.65	B							MADE GROUND comprising black brown sandy gravelly clayey fill. Sand is fine to coarse, gravel is fine to coarse subangular of brick, concrete, limestone, flint and mudstone.
		2.00 - 2.45	B							
		3.00 - 3.45	B				3.00	5.62		
		4.00 - 4.45	B				4.00	4.62		Possible MADE GROUND comprising reworked blue grey sandy CLAY. Sand is fine to coarse.
		5.00 - 5.45	B							Very soft blue grey SILT with occasional organic partings.
		6.00 - 6.45	B							
	▼	7.00 - 7.45	B				6.80	1.82		Stiff wet blue grey SILT with occasional gravels of Limestone. Gravels are fine to coarse, angular to subangular.
		8.00 - 8.45	B				8.00	0.62		Very weak weathered LIMESTONE. Recovered as gravels and cobbles which are fine to coarse, angular to subangular.
		~~9.00 - 10.50~~	C				9.00	-0.38		Very strong grey LIMESTONE with yellowish brown staining and frequent bands of non-intact limestone. Fractures 0-20° very closely to widely spaced rough open planar.
		9.00 - 10.50		50	21	9				

Continued on next sheet

Remarks

1. Cable Percussion to 9.14m with Rotary Core to 25.50m begl.

Rotary Core Log

Borehole No. **BH04**

Sheet 2 of 12

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311099.00 - 167403.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 8.62	Scale 1:50
Client: WEPCO		Dates: 18/10/2023 - 20/10/2023	Logged By LH+LEJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		~~10.50 - 12.00~~	C							
		10.50 - 12.00		80	61	17				
		~~12.00 - 13.50~~	C				12.00	-3.38		Very strong yellowish brown and dark grey mottled with dark orange staining and occasional 5-15m veins of calcite. Fractures closely to widely spaced 10-30° rough open planar,
		12.00 - 13.50		88	87	28				*Band of pinkish white calcite.*
		~~13.50 - 15.00~~	C				13.50	-4.88		Very strong yellowish brown mottled dark grey LIMESTONE. Fractures 0-20° very closely to closely spaced rough open undulating/planar and 50-60° very widely spaced rough open planar.
		13.50 - 15.00		80	73	10				*Band of white calcite.* *Band of yellowish brown mudstone.*
		~~15.00 - 16.50~~	C							*Band of white calcite.*
		15.00 - 16.50		90	83	11	15.70	-7.08		*Band of pinkish white calcite.* Very strong dark grey LIMESTONE with yellowish brown staining and occasional 5-10mm veins of calcite. Fractures closely spaced 0-20° smooth planar and 80-90° vertical closed planar.
		~~16.50 - 18.00~~	C							*Band of dark grey mudstone.*
		16.50 - 18.00		90	67	33	17.10	-8.48		Very strong bluish grey LIMESTONE with dark orange staining and very frequent 5mm veins of calcite, becoming less frequent with depth. Fractures extremely closely to closely spaced 0-20° rough planar and widely 30-40° smooth undulating.
		~~18.00 - 19.50~~	C							
		18.00 - 19.50		97	93	15				
		~~19.50 - 21.00~~	C							

Continued on next sheet

Remarks

1. Cable Percussion to 9.14m with Rotary Core to 25.50m begl.

Rotary Core Log

Borehole No. **BH04**

Sheet 3 of 12

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311099.00 - 167403.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 8.62	Scale 1:50
Client: WEPCO		Dates: 18/10/2023 - 20/10/2023	Logged By LH+LEJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		19.50 - 21.00		94	80	36				*Band of reddish brown mudstone.*
		~~21.00 - 22.50~~	C							*Band of pinkish white calcite.*
		21.00 - 22.50		94	94	61				*Band of yellowish brown mudstone with calcite nodules.*
		~~22.50 - 24.00~~	C				21.20	-12.58		Very strong reddish brown and grey banded LIMESTONE with occasional 5mm veins of calcite and orange staining. Fractures closely to very widely spaced 10-20° rough open to closed planar and very widely spaced 30-40° smooth open planar.
		22.50 - 24.00		100	100	73				*band of dark grey mudstone.*
		~~24.00 - 25.50~~	C							
		24.00 - 25.50		97	65	37	24.20	-15.58		Very strong grey LIMESTONE with orange staining and occasional bands of pinkish white calcite and dark grey mudstone. Fractures 0-20° closely spaced smooth open planar
							25.50	-16.88		End of borehole at 25.50 m

21 22 23 24 25 26 27 28 29 30

Continued on next sheet

Remarks

1. Cable Percussion to 9.14m with Rotary Core to 25.50m begl.

AGS

Borehole Log

Borehole No. **BH06**

Sheet 1 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311177.00 - 167395.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 9.18	Scale 1:50
Client: WEPCO		Dates: 06/10/2023 - 13/10/2023	Logged By LH+LEJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		1.20 1.20 - 1.65	B	N=26 (3,4/6,6,7,7)				MADE GROUND comprising black brown sandy gravelly clayey fill. Sand is fine to coarse, gravel is fine to coarse angular to subangular brick, concrete, mudstone and limestone,	1
		2.00 2.00 - 2.45	B	N=25 (4,4/7,6,6,6)					2
		3.00 3.00 - 3.45	B	N=6 (1,1/2,2,1,1)	3.00	6.18		Wet very soft grey brown SILT with occasional organic partings.	3
		4.00 4.00 - 4.45	B	N=3 (1,1/1,0,1,1)					4
	▼	5.00 5.00 - 5.45	B	N=5 (2,2/2,1,1,1)					5
		6.00 6.00 - 6.45	B	N=8 (2,3/2,2,2,2)					6
		7.00 7.00 - 7.45	B	N=4 (1,1/1,1,1,1)					7
		8.00 8.00 - 8.45	B	N=10 (1,1/2,3,3,2)					8
		9.00 9.00 - 9.45	B	N=8 (2,2/2,2,2,2)					9
		10.00		N=15 (3,2/4,4,3,4)					10

Continued on next sheet

Remarks

1. Cable Percussion to 21.15m with Rotary Core to 34.5m begl. whilst coring from 21m to 34.5m

2. Extreme groundwater encountered

Borehole Log

Borehole No. **BH06**

Sheet 2 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311177.00 - 167395.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 9.18	Scale 1:50
Client: WEPCO		Dates: 06/10/2023 - 13/10/2023	Logged By LH+LEJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.00 - 10.45	B						
		11.00		N=14 (3,3/3,4,3,4)					11
		11.00 - 11.45	B						
					11.50	-2.32			
		12.00		N=8 (1,2/2,2,2,2)				Medium dense yellow brown SAND and GRAVELS. Sand is fine to coarse, gravel is fine to coarse angular to subangular flint, limestone and mudstone.	12
		12.00 - 12.45	B						
		13.00		N=16 (3,4/4,4,4,4)					13
		13.00 - 13.45	B						
		14.00		N=17 (4,6/5,4,4,4)					14
		14.00 - 14.45	B						
		15.00		N=4 (1,1/1,1,1,1)	15.00	-5.82			15
		15.00 - 15.45	B					Soft blue grey SILT.	
		16.00		N=4 (2,2/1,1,1,1)					16
		16.00 - 16.45	B						
		17.00		N=11 (1,2/2,3,3,3)					17
		17.00 - 17.45	B						
		18.00		N=10 (2,2/3,2,3,2)					18
		18.00 - 18.45	B						
		19.00		N=13 (2,2/3,3,4,3)					19
		19.00 - 19.45	B						
		20.00		50 (10,12/24,26,,)	20.00	-10.82			20

Continued on next sheet

Remarks

1. Cable Percussion to 21.15m with Rotary Core to 34.5m begl. whilst coring from 21m to 34.5m

2. Extreme groundwater encountered

Borehole Log

Borehole No. **BH06**

Sheet 3 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311177.00 - 167395.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 9.18	Scale 1:50
Client: WEPCO		Dates: 06/10/2023 - 13/10/2023	Logged By LH+LEJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		20.00 - 20.30	B					Very weak weathered LIMESTONE. Recovered as gravels and cobbles of Limestone. Gravels and Cobbles are fine to coarse, angular to subrounded.
	▼	21.00 - 21.75	C					
		22.50		50 (25 for 80mm/50 for 275mm)	22.50	-13.32		
		22.50 - 24.00	C					Very strong reddish brown mottled grey LIMESTONE with alternating bands of intact and non-intact limestone.
		24.00 - 25.50	C					
					24.50	-15.32		Very strong grey and reddish brown mottled LIMESTONE with orange staining. Fractures very closely to widely spaced 0-20° rough open planar and 70-80° rough open planar.
								Band of white calcite.
		25.50 - 27.00	C					
					26.10	-16.92		Very strong dark blue and dark grey mottled LIMESTONE with orange staining. Fractures widely spaced 0-20° smooth planar, 70-90° smooth planar and widely to very widely spaced 50-60° rough open undulating.
		27.00 - 28.50	C					
		27.75	C					
		28.50 - 30.00	C					
		30.00 - 31.50	C		30.00	-20.82		*Band of pinkish white calcite.*

Continued on next sheet

Remarks

1. Cable Percussion to 21.15m with Rotary Core to 34.5m begl. whilst coring from 21m to 34.5m

2. Extreme groundwater encountered

Borehole Log

Borehole No. **BH06**

Sheet 4 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311177.00 - 167395.00	Hole Type CP
Location: Ffordd Y Mileniwm, Barry		Level: 9.18	Scale 1:50
Client: WEPCO		Dates: 06/10/2023 - 13/10/2023	Logged By LH+LEJ

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		31.50 - 33.00	C					Very strong grey and reddish brown LIMESTONE. Fractures 0-20° very closely to widely spaced rough open to closed planar.
					32.40	-23.22		
		33.00 - 33.50	C					Very strong reddish brown mottled grey with occasional 5-15mm calcite veins. Fractures are very closely to widely spaced are 0-10° and very widely spaced 30-40° smooth undulating
					34.50	-25.32		End of borehole at 34.50 m

31 32 33 34 35 36 37 38 39 40

Remarks

1. Cable Percussion to 21.15m with Rotary Core to 34.5m begl. whilst coring from 21m to 34.5m

2. Extreme groundwater encountered

Rotary Core Log

Borehole No. **BH06**

Sheet 1 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311177.00 - 167395.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 9.18	Scale 1:50
Client: WEPCO		Dates: 06/10/2023 - 13/10/2023	Logged By LH+LEJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		1.20 - 1.65	B							MADE GROUND comprising black brown sandy gravelly clayey fill. Sand is fine to coarse, gravel is fine to coarse angular to subangular brick, concrete, mudstone and limestone,
		2.00 - 2.45	B							
		3.00 - 3.45	B				3.00	6.18		
		4.00 - 4.45	B							Wet very soft grey brown SILT with occasional organic partings.
	▼	5.00 - 5.45	B							
		6.00 - 6.45	B							
		7.00 - 7.45	B							
		8.00 - 8.45	B							
		9.00 - 9.45	B							
		10.00 - 10.45	B							

Continued on next sheet

Remarks

1. Cable Percussion to 21.15m with Rotary Core to 34.5m begl. whilst coring from 21m to 34.5m

2. Extreme groundwater encountered

Rotary Core Log

Borehole No. **BH06**

Sheet 2 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311177.00 - 167395.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 9.18	Scale 1:50
Client: WEPCO		Dates: 06/10/2023 - 13/10/2023	Logged By LH+LEJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		11.00 - 11.45	B							
							11.50	-2.32		
		12.00 - 12.45	B							Medium dense yellow brown SAND and GRAVELS. Sand is fine to coarse, gravel is fine to coarse angular to subangular flint, limestone and mudstone.
		13.00 - 13.45	B							
		14.00 - 14.45	B							
		15.00 - 15.45	B				15.00	-5.82		
		16.00 - 16.45	B							Soft blue grey SILT.
		17.00 - 17.45	B							
		18.00 - 18.45	B							
		19.00 - 19.45	B							
		20.00 - 20.30	B				20.00	-10.82		

Continued on next sheet

Remarks

1. Cable Percussion to 21.15m with Rotary Core to 34.5m begl. whilst coring from 21m to 34.5m

2. Extreme groundwater encountered

Rotary Core Log

Borehole No. **BH06**

Sheet 3 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311177.00 - 167395.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 9.18	Scale 1:50
Client: WEPCO		Dates: 06/10/2023 - 13/10/2023	Logged By LH+LEJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
	▼	21.00 - 21.75	C							Very weak weathered LIMESTONE. Recovered as gravels and cobbles of Limestone. Gravels and Cobbles are fine to coarse, angular to subrounded.
		~~22.50 - 24.00~~	C				22.50	-13.32		
		22.50 - 24.00		100	28	15				Very strong reddish brown mottled grey LIMESTONE with alternating bands of intact and non-intact limestone.
		~~24.00 - 25.50~~	C							
		24.00 - 25.50		60	55	8	24.50	-15.32		Very strong grey and reddish brown mottled LIMESTONE with orange staining. Fractures very closely to widely spaced 0-20° rough open planar and 70-80° rough open planar.
										Band of white calcite.
		~~25.50 - 27.00~~	C							
		25.50 - 27.00		60	57	7	26.10	-16.92		Very strong dark blue and dark grey mottled LIMESTONE with orange staining. Fractures widely spaced 0-20° smooth planar, 70-90° smooth planar and widely to very widely spaced 50-60° rough open undulating.
		~~27.00 - 28.50~~	C							
		27.00 - 28.50	6	97	90	42				
		~~28.50 - 30.00~~	C							
		28.50 - 30.00	7	98	75	25				
		~~30.00 - 31.50~~	C				30.00	-20.82		*Band of pinkish white calcite.*

Continued on next sheet

Remarks

1. Cable Percussion to 21.15m with Rotary Core to 34.5m begl. whilst coring from 21m to 34.5m

2. Extreme groundwater encountered

Rotary Core Log

Borehole No. **BH06**

Sheet 4 of 4

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311177.00 - 167395.00	Hole Type RC
Location: Ffordd Y Mileniwm, Barry		Level: 9.18	Scale 1:50
Client: WEPCO		Dates: 06/10/2023 - 13/10/2023	Logged By LH+LEJ

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		30.00 - 31.50	4	71	69	59				Very strong grey and reddish brown LIMESTONE. Fractures 0-20° very closely to widely spaced rough open to closed planar.
		~~31.50 - 33.00~~	~~C~~							
		31.50 - 33.00	2.6	100	100	85	32.40	-23.22		Very strong reddish brown mottled grey with occasional 5-15mm calcite veins. Fractures are very closely to widely spaced are 0-10° and very widely spaced 30-40° smooth undulating
		~~33.00 - 33.50~~	~~C~~							
		33.00 - 34.50	5	98	97	43				
							34.50	-25.32		End of borehole at 34.50 m

31 32 33 34 35 36 37 38 39 40

Remarks

1. Cable Percussion to 21.15m with Rotary Core to 34.5m begl. whilst coring from 21m to 34.5m

2. Extreme groundwater encountered

Trial Pit Log

Trialpit No **TP03** Sheet 1 of 1

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311035.00 - 167374.00 Level: 8.34	Date 20/09/2023
Location: Ffordd Y Mileniwm, Barry		Dimensions (m): Depth 4.00	Scale 1:25
Client: WEPCO			Logged LAB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.15 - 0.30	TJ		0.15	8.19		MADE GROUND - Asphalt concrete.
	0.15 - 0.30	TJV					
				0.30	8.04		MADE GROUND - Sub base material (Type 1).
	0.50 - 0.60	B					MADE GROUND - Dark brown sandy gravelly clay with occasional cobbles. Sand is fine to coarse. Gravel is fine to medium angular to sub angular of bricks, concrete. Cobbles are angular of concrete and brick.
	0.60 - 0.80	B					
	0.70 - 1.00	B		0.70	7.64		MADE GROUND - Brown sandy gravelly CLAY. Sand is fine to medium. Gravel is fine to medium angular to sub angular of mudstone, siltstone and limestone (Reworked).
	1.00 - 1.20	TJ					
	1.20 - 1.40	TJV					
	1.50 - 1.70	B					
	1.70 - 1.90	B					
	1.80 - 2.10	B					
	2.00 - 2.20	TJ					
	2.20 - 2.40	TJV					
	2.50 - 2.70	B					
	2.70 - 2.90	B					
	2.90 - 3.10	B					
	3.00 - 3.10	TJ					
	3.20	TJV					*...slight hydrocarbon odour and staining between 3.20m to 3.60m depth.*
▼	3.50 - 3.70	B					
	3.80 - 4.00	B					
	4.00 - 4.10	TJ		4.00	4.34		End of pit at 4.00 m
	4.00 - 4.10	TJV					

Remarks: 1. Slight groundwater was encountered at 3.60m depth during the excavation process.
2. Trial pit was terminated at 4.00m depth and backfilled with arisings.

Stability: Sides unstable within made ground.

Trial Pit Log

Trialpit No **TP04**

Sheet 1 of 1

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311021.00 - 167370.00 Level: 8.51	Date 20/09/2023
Location: Ffordd Y Mileniwm, Barry		Dimensions (m): Depth 4.00	Scale 1:25
Client: WEPCO			Logged LAB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.15 - 0.30	TJ		0.20	8.31		MADE GROUND - Sub base material (Type 1).
	0.15 - 0.30	TJV					MADE GROUND - Brown sandy gravelly clay. Sand is fine to coarse. Gravel is fine to coarse angular to sub angular of mudstone, siltstone and limestone.
	0.50 - 0.60	B					
	0.60 - 0.80	B					
	0.70 - 1.00	B					
	1.00 - 1.20	TJ					
	1.20 - 1.40	TJV					
	1.50 - 1.70	B					
	1.70 - 1.90	B					
	1.80 - 2.10	B		1.90	6.61		
	2.00 - 2.20	TJ					Soft to firm brown grey sandy gravelly CLAY. Sand is fine to medium. Gravel is fine to medium angular to sub angular of limestone, mudstone and siltstone.
	2.20 - 2.40	TJV					
	2.50 - 2.70	B					
	2.70 - 2.90	B					
	2.90 - 3.10	B					
	3.00 - 3.10	TJ					
	3.20	TJV					
	3.50 - 3.70	B		3.40	5.11		Medium dense black brown slightly clayey SAND and GRAVEL. Sand is fine to coarse. Gravel if fine to medium angular to sub angular mudstone and shale.
▼	3.80 - 4.00	B					
	4.00 - 4.10	TJ		4.00	4.51		End of pit at 4.00 m
	4.00 - 4.10	TJV					

Remarks: 1. Slight groundwater was encountered at 3.90m depth during the excavation process.
2. Trial pit was terminated at 4.00m depth and backfilled with arisings.

Stability: Sides unstable within made ground.

AGS

Trial Pit Log

Trialpit No **TP05** Sheet 1 of 1

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311139.00 - 167361.00 Level: 9.01	Date 18/09/2023
Location: Ffordd Y Mileniwm, Barry		Dimensions (m): Depth 3.10	Scale 1:25
Client: WEPCO			Logged DRS

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.15	TJV					MADE GROUND - scrub overlying brown sandy slightly gravelly clayey topsoil. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of brick fragments, concrete, asphalt concrete, sandstone and mudstone.
	0.25	TJ		0.35	8.66		
	0.50	B					MADE GROUND - dark brown sandy very gravelly clay with occasional cobble content. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of bricks, brick fragments, concrete, asphalt concrete, sandstone and mudstone. Cobbles are sub angular of concrete.
	0.60	B					
	0.70	B					
	1.00	TJ		1.00	8.01		MADE GROUND - black plastic membrane.
	1.10	TJV		1.01	8.00		MAADE GROUND - dark brown sandy gravelly clay with occasional cobble content. Sand is fine to coarse. Gravel is fine to coarse angular to sub angular of bricks, brick fragments, concrete, plastic, timber, asphalt concrete. Cobbles are sub angular of concrete.
	1.50	B					
	1.60	B					
	1.70	B					
	2.00	TJV		1.90	7.11		Soft brown mottled grey orange sandy gravelly CLAY. Sand is fine to coarse. Gravel is sub angular to sub rounded of mudstone and sandstone.
	2.20 - 2.30	TJ					
	2.50	B					
	2.60	B					
	2.70	B					
	3.00	TJV					
	3.10	TJ		3.10	5.91		End of pit at 3.10 m

Remarks: 1. No groundwater was encountered during the excavation process.
2. Trial pit was terminated at 3.10m depth and backfilled with arisings.

Stability: Sides unstable within made ground.

Trial Pit Log

Trialpit No **TP06**

Sheet 1 of 1

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311126.00 - 167387.00 Level: 9.39	Date 18/09/2023
Location: Ffordd Y Mileniwm, Barry		Dimensions (m): Depth 3.00	Scale 1:25
Client: WEPCO			Logged DRS

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.15	TJV		0.30	9.09		MADE GROUND - scrub overlying brown sandy slightly gravelly clayey topsoil. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of brick fragments, concrete, asphalt concrete, sandstone and mudstone.
	0.25	TJ					
	0.50	B					MADE GROUND - dark brown sandy gravelly clay with occasional cobble content. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of bricks, brick fragments, concrete, asphalt concrete, clinker. Cobbles are angular of bricks and concrete.
	0.60	B					
	0.70	B					
	1.00	TJV					
	1.10	TJ					
	1.50	B					
	1.60	B					
	1.70	B					
	2.00	TJV					
	2.10	TJ					
	2.50	B		2.50	6.89		Soft brown mottled yellowish grey brown sandy very gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of sandstone, mudstone and occasional limestone.
	2.60	B					
	2.70	B					
	2.80	B					
				3.00	6.39		End of pit at 3.00 m

Remarks: 1. No groundwater was encountered during the excavation process.
2. Trial pit was terminated at 3.00m depth and backfilled with arisings.

Stability: Sides unstable within made ground.

Trial Pit Log

Trialpit No **TP07**

Sheet 1 of 1

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311153.00 - 167410.00 Level: 9.13	Date 20/09/2023
Location: Ffordd Y Mileniwm, Barry		Dimensions (m): Depth 3.00	Scale 1:25
Client: WEPCO			Logged LAB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.15 - 0.30 0.20 - 0.30	TJV TJ		0.20	8.93		MADE GROUND - scrub overlying brown sandy slightly gravelly clayey topsoil. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of brick fragments, concrete, asphalt concrete, sandstone and mudstone.
	0.50 - 0.70 0.60 - 0.80 0.70 - 1.00	B B B					MADE GROUND - dark brown sandy gravelly clay with occasional cobbles. Sand is fine to coarse. Gravel is fine to medium angular to sub angular of bricks, concrete. Cobbles are angular of concrete and brick.
	1.00 - 1.20	TJ					
	1.20 - 1.40	TJV					
	1.50 - 1.70	B					
	1.70 - 1.90 1.80 - 2.10	B B					
	2.00 - 2.20	TJ					
	2.20 - 2.40	TJV		2.20	6.93		Firm brown yellow slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to medium rounded to sub rounded of sandstone and mudstone.
	2.50 - 2.70	B					
	2.70 - 2.90	B					
	2.90 - 3.10	B					
	3.00 - 3.10 3.00 - 3.20	TJ TJV		3.00	6.13		End of pit at 3.00 m

Remarks: 1. No groundwater was encountered during the excavation process.
2. Trial pit was terminated at 3.00m depth and backfilled with arisings.

Stability: Sides unstable within made ground.

Trial Pit Log

Trialpit No **TP08**

Sheet 1 of 1

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311062.00 - 167385.00 Level: 8.25	Date 20/09/2023
Location: Ffordd Y Mileniwm, Barry		Dimensions (m): Depth 3.00	Scale 1:25
Client: WEPCO			Logged DRS

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30	7.95		MADE GROUND - compacted layer of stone. Recovered as a gravel. Gravel is sub angular of limestone.
	0.50	B					MADE GROUND - reddish brown sandy gravelly clay with occasional cobble content. Sand is fine to coarse. Gravel is sub angular to sub rounded of bricks, brick fragments, concrete, sandstone and mudstone with occasional limestone. Cobbles are angular of brick and concrete.
	0.60	B					
	0.70	B					
				0.90	7.35		
	1.00	TJ					MADE GROUND - yellowish grey brown sandy gravelly clay with occasional cobble content. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of bricks, brick fragments, concrete, timber fragments, metal sheeting, sandstone and mudstone with occasional limestone. Cobbles are angular of concrete.
	1.20	TJV					
	1.60	B					
	1.70	B					
	1.80	B					
	2.10	TJ					
	2.20	TJV					
	2.50	B					
	2.60	B					
	2.70	B					
	2.90	TJ					
	3.00	TJV		3.00	5.25		End of pit at 3.00 m

Remarks: 1. No groundwater was encountered during the excavation process.
2. Trial pit was terminated at 3.00m depth and backfilled with arisings.

Stability: Sides unstable within made ground.

Trial Pit Log

Trialpit No **TP09** Sheet 1 of 1

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311028.00 - 167400.00 Level: 8.89	Date 19/09/2023
Location: Ffordd Y Mileniwm, Barry		Dimensions (m): Depth 3.00	Scale 1:25
Client: WEPCO			Logged DRS

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.15 0.20	TJ TJV		0.10	8.79		MADE GRROUND - asphalt concrete.
				0.40	8.49		MADE GROUND - reddish sub base material. Recovered as an gravel. Gravel is fine to coarse sub angular limestone.
	0.50 0.50 0.60 0.70	B C B B					MADE GROUND - light yellowish grey sandy gravelly CLAY with abundant cobble content. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of mudstone and sandstone with occasional limestone. Cobbles are sub rounded of mudstone and sandstone (Possible Reworked).
	1.00 1.10	TJ TJV					
	1.50 1.60	B B					
	2.00 2.10	TJ TJV		1.90	6.99		MADE GROUND - yellowish grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse of sandstone, mudstone, shale and flint.
	2.50 2.60	B B		2.50	6.39		Firm dark grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse sub angular of shale and flint.
	2.90 3.00	TJ TJV		3.00	5.89		End of pit at 3.00 m

Remarks: 1. No groundwater was encountered during the excavation process.
2. Trial pit was terminated at 3.00m depth and backfilled with arisings.

Stability: Sides unstable within the made ground.

Trial Pit Log

Trialpit No **TP10**

Sheet 1 of 1

Project Name: Barry Waterfront	Project No. C3297	Co-ords: 311119.00 - 167411.00 Level: 8.61	Date 19/09/2023
Location: Ffordd Y Mileniwm, Barry		Dimensions (m): Depth 3.00	Scale 1:25
Client: WEPCO			Logged DRS

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.15	TJ		0.10	8.51		MADE GROUND - scrub overlying brown sandy slightly gravelly clayey topsoil. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of brick fragments, concrete, asphalt concrete, sandstone and mudstone.
	0.25	TJV					
	0.50	B					MADE GROUND - dark brown sandy gravelly clay with occasional cobbles. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of bricks, brick fragments, concrete, asphalt concrete, plastic, fabric sandstone and mudstone. Cobbles are angular of brick and concrete.
	0.60	B					
	0.70	B					
	1.00	TJV					
	1.15	TJ		1.10	7.51		MADE GROUND - yellowish grey brown sandy gravelly clay with occasional cobble content. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of bricks, brick fragments, concrete, plastic, timber, sandstone and mudstone with occasional limestone.
	1.60	B					
	1.70	B					
	1.80	B					
	2.10	TJ					
	2.20	TJV					
	2.50	B		2.50	6.11		Soft brown mottled yellowish grey brown sandy very gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse sub angular to sub rounded of sandstone, mudstone and occasional limestone.
	2.60	B					
	2.70	B					
	2.90	TJ					
	3.00	TJV		3.00	5.61		End of pit at 3.00 m

Remarks: 1. No groundwater was encountered during the excavation process.
2. Trial pit was terminated at 3.00m depth and backfilled with arisings.

Stability: Sides unstable within made ground.

Appendix IV