



AECOM Ltd

CISM, Swansea University Bay Campus, Swansea

Interpretative Geotechnical Report

Project no. 314617 R02 (00)

MARCH 2020





RSK GENERAL NOTES

Project No.: 314617 R01 (00)

Title: Interpretative Geotechnical Report: CISM, Swansea University Bay Campus, Swansea

Client: AECOM Ltd, 3rd Floor Portwall Place, Portwall Lane, Bristol, BS1 6NA

Date: March 2020

Office: RSK Environment Ltd, The Old school, Stillhouse Lane, Bedminster, Bristol, BS3 4EB
Tel: 0117 947 1006

Status: Final

Author	<u>Craig Lewis</u>	Technical reviewer	<u>Jonathon Bailey/J R Pulsford</u>
Signature		Signature	
Date:	<u>March 2020</u>	Date:	<u>March 2020</u>
Project manager	<u>Craig Lewis</u>	Quality reviewer	<u>Stacey Brown</u>
Signature			
Date:	<u>March 2020</u>		<u>March 2020</u>

RSK Environment Limited (RSK) has prepared this report for the sole use of the client, showing reasonable skill and care, for the intended purposes as stated in the agreement under which this work was completed. The report may not be relied upon by any other party without the express agreement of the client and RSK. No other warranty, expressed or implied, is made as to the professional advice included in this report.

Where any data supplied by the client or from other sources have been used, it has been assumed that the information is correct. No responsibility can be accepted by RSK for inaccuracies in the data supplied by any other party. The conclusions and recommendations in this report are based on the assumption that all relevant information has been supplied by those bodies from whom it was requested.

No part of this report may be copied or duplicated without the express permission of RSK and the party for whom it was prepared.

Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK Environment Ltd.

CONTENTS

1	INTRODUCTION.....	3
1.1	Objective	3
1.2	Existing reports	3
1.3	Limitations	3
2	THE SITE	5
2.1	Site location and description	5
2.2	Site walkover.....	5
2.3	History of site and surrounding area	6
2.4	Proposed development	7
2.5	Ground conditions.....	8
2.5.1	Geology.....	8
2.5.2	Mining, quarrying and ground workings	8
2.5.3	Landfilling and land reclamation	9
2.6	Hydrogeology	9
2.6.1	Aquifer characteristics.....	9
3	PRELIMINARY GEOTECHNICAL HAZARDS.....	11
3.1	Preliminary geotechnical hazards assessment.....	11
3.2	Design class.....	13
4	SITE INVESTIGATION STRATEGY & METHODOLOGY	14
4.1	Introduction	14
4.2	Objectives	14
4.3	Selection of investigation methods	14
4.4	Investigation strategy	14
4.4.1	Implementation of investigation works.....	16
4.5	Monitoring programme.....	16
4.5.1	Groundwater monitoring and sampling	16
4.6	Laboratory testing	16
5	SITE INVESTIGATION FACTUAL FINDINGS.....	18
5.1	Ground conditions encountered.....	18
5.1.1	Made ground	18
5.1.2	Blown Sand	19
5.1.3	Glacial Till.....	19
5.1.4	Coal Measures Bedrock.....	20
5.1.5	Visual/olfactory evidence of soil contamination	20
5.2	Groundwater and surface water	20
5.2.1	Groundwater encountered during intrusive works	20
5.2.2	Groundwater encountered during monitoring	20
5.2.3	Visual/olfactory evidence of groundwater contamination	21
5.3	Constraints and Limitations.....	21
6	GEOTECHNICAL ASSESSMENT.....	22
6.1	Proposed development	22

6.2	Key geotechnical hazards / development constraints	22
6.3	Foundations	22
6.3.1	Foundation options	22
6.3.2	Piled foundations	23
6.3.3	Foundation works risk assessment.....	26
6.4	Floor slabs.....	26
6.5	Roads and hardstanding.....	26
6.6	Excavations for foundations and services	27
6.7	Chemical attack on buried concrete	27
6.8	Infiltration drainage	28
6.9	Temporary working platform	28
7	CONCLUSIONS AND RECOMMENDATIONS	29
	BIBLIOGRAPHY	30

FIGURES

Figure 1	Site location plan
Figure 2	Exploratory Hole Location Plan
Figure 3	SPT 'N' values vs depth

APPENDICES

Appendix A	Service constraints
Appendix B	Site photographs
Appendix C	Exploratory Hole Logs
Appendix D	Monitoring Data
Appendix E	Infiltration Test Results
Appendix F	Laboratory Test Results

1 INTRODUCTION

RSK Environment Limited (RSK) was commissioned by AECOM Ltd (the 'Client') to carry out a geo-environmental and geotechnical assessment of the proposed Centre for Integrative Semiconductor Materials (CISM), Swansea University Bay Campus, Swansea.

This report presents the findings of the geotechnical assessment and the geo-environmental assessment is covered separately in RSK Report Ref. 314617 R02 (00).

1.1 Objective

AECOM Ground Investigation Specification Project No: 60605215 October 2019 sets out the requirements for a Geotechnical report. In summary, these are as follows:

- Phase 1 desk study (contained within RSK 314617 R01(00))
- Site works. To include (but not limited to) the following:
 - Drive-in sampler boreholes
 - Cable percussion boreholes
 - Machine excavated trial pits
 - Hand dug inspection pits
 - Gas & groundwater monitoring boreholes & monitoring
 - In-situ testing –SPET, UT100, PID, hand vane tests, hand penetrometer tests
 - In-situ permeability –Soakaway tests
- Laboratory testing.
- Factual and interpretative report.

1.2 Existing reports

No site-specific reports have been provided.

1.3 Limitations

The comments given in this report and the opinions expressed are based on the site walkover, published third party information, the ground conditions encountered during

the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the walkover, published information or the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels may vary from those reported due to seasonal, or other, effects and the limitations stated in the data should be recognised.

This report is subject to the RSK service constraints given in **Appendix A**.

2 THE SITE

2.1 Site location and description

The site is located approximately 4.35 km to the east of Swansea city centre and is situated on the Swansea University Bay campus, Skewen, Swansea, SA1 8QB (nearest postcode) which comprises multiple buildings with soft and hard landscaping. The site is immediately bound by buildings to all sides, discussed further in Table 1. There is currently no vehicular access, however hardstanding and footpaths lead to Crymlyn Way road to the east and a service road leading to the A483 (Fabian Way) to the north.

The site occupies an area of circa 0.24ha. The site is currently occupied by 2no. structures along with soft and hard landscaping. One of the structures occupying the site is referred to as 'ORACLE II' and is the 'Outdoor Research and Community Learning Environment' building. It is described as a '8m x 6m outdoor classroom / pavilion' and was constructed by a company called 'Down to Earth' using ecologically low impact locally sourced materials utilising skills such as dry-stone walling and timber frame forming'. The other structure is the Green Roof Bike Shelter and was constructed opposite ORACLE II at the same time by Down to Earth using the same methods and materials (Swansea University Bay Campus Grounds Management Plan 2018-2019). The site is generally flat with the broader area sloping gently southward toward the Severn Estuary; neighbouring buildings are at a similar elevation.

Table 1 Site setting

To the north:	The site is bound by a foot pathway leading to the Energy Safety Research Institute (ESRI) building, beyond which lies car parking, a service road for the university campus and the A483 with further commercial premises.
To the east:	The site is bound by an area of hard landscaping with a foot pathway leading to the 'Active Office / Classroom' (SPECIFIC) building, beyond which lies Crymlyn Way road and the Crymlyn Burrows SSSI.
To the south:	The site is bound by an irregular shaped hedge leading to an area of hardstanding, presumed to be used as a goods / delivery loading area, beyond which lies the 'Engineering EAST' building and soft landscaping down to the Severn Estuary.
To the west:	The site is bound by a foot pathway leading to the ISM building, beyond which lies further buildings of the Swansea University Bay Campus.

2.2 Site walkover

The site walkover was undertaken on the 21st January 2020. Photographs are provided in **Appendix B**. A description of the site along with any potentially significant environmental and/ or geotechnical issues are summarised below.

The site is approximately square in shape and comprises a central foot pathway (intersecting the site in a north-south orientation), soft landscaping and the 'ORACLE 2' and 'Green Roof Bike Shelter'.

The site is bound by foot pathways, hard landscaping and buildings of the Swansea Bay University Campus.

Access to the site is pedestrianised from any of the foot pathways and hard landscaping surrounding the adjacent buildings, which lead to the adjacent road network.

Soft landscaping comprised grass verges and mounded grass areas. Japanese knotweed or other invasive species were not observed to be present on site, however this does not exclude its absence or the absence of other invasive species.

The site was noted to be relatively flat with the exception of the mounded areas. The broader area slopes gently southward toward the Severn Estuary.

A number of manhole covers and live services have been identified throughout the site.

No visible sources of potential land contamination were observed during the site walkover on or near to the site.

2.3 History of site and surrounding area

The history of the land-use and development of the site and surrounding area is described within (RSK 314617 R01(00)) Geoenvironmental risk assessment and summarised in **Table 2**.

Table 2 Summary of historical development

Date	Land use/features on site	Land use/features in vicinity of site
1880's	The site is indicated below high water mark for ordinary tides.	Crymlyn Burrows is indicated in the surrounding area, north of the site The Great Western Railway is present approximately 600 m from the northern site boundary. Burrows chemical works is indicated some 700m northwest.
1897-1900	The site is indicated above high water mark for ordinary tides.	Some expansion of the railway has taken place with a carriage and wagon repair shop and associated sidings present some 720m north west. A sand pit is indicated near the chemical works some 720m north-northwest.
1914s	No significant changes	The railway has expanded further south with the development of the Kings Dock Tin Plate works some 250m north-northwest of the site, with associated roadways and tanks.

Date	Land use/features on site	Land use/features in vicinity of site
		Baldwin Crescent (presumed residential dwellings) have also been developed in the north west some 490m of the site.
1920's	No significant changes.	No significant changes.
1930's	No significant changes.	Development of Elba Crescent has taken place some 150m north the site. Elba Tin Plate works has been developed some 450m north.
1940's	No significant changes.	A rifle range is indicated some 250m north-northeast.
1960's	Trees are indicated across the site. By 1969 an oil storage depot is indicated on site. Large tanks are encroaching into southwest and northeast portions of the site. The trees are no longer indicated. A trackway associated with depot runs through the central portion of the site trending east west.	Development of the A483 roadway and associated drainage has occurred some 90m north of the site. A filling station is indicated some 139m northeast. A large circular object (1:1250, 1963-64 only) a presumed oil storage tank, is located some 170m west of the site. By 1969 a large oil storage depot is indicated. 12no storage tanks are located within 500m of the site boundary.
1980's	No significant changes.	The railway north of the site is now indicated as dismantled. No other significant changes.
1990's	No significant changes.	No significant changes.
2000's	Tanks are no longer indicated within the site boundary.	The tanks and storage depot are no longer indicated post 2003.
2010's	Construction of the Swansea University Bay Campus has occurred. The 2019 map indicates that the site layout is the same as present day.	Construction of the Swansea University Bay Campus has occurred around the site.

It is our understanding that the tanks were decommissioned and demolished by 2003.

Further to the above, it is our understanding that site levels have been raised post demolition of the storage depot.

2.4 Proposed development

It is understood that the site is proposed to be redeveloped for the 'Centre for Integrative Semiconductor Materials' (CISM), which will be a multiple storey building of traditional construction.

2.5 Ground conditions

2.5.1 Geology

Published records (British Geological Survey (BGS), 1:50,000 series, (Sheet No 247, 'Swansea 2011) and 1:10,000 for the area indicate the geology of the site to be characterised by the succession described in **Table 3**.

Table 3 Geology at the site

Geological unit	Description	Estimated thickness (m)
Made Ground	The supplied documents suggest that site wide levels have been previously raised during the enabling earthworks for the campus. Therefore, it is assumed that approximately 2.5m depth of made ground (albeit likely to be engineered fill) is located below the topsoil.	Up to depths >2.5m
Superficial Deposits Aeolian deposits (Blown Sands) and potentially fluvio-glacial till.	Sand and Diamicton.	Unknown.
Bedrock geology South Wales Middle Coal Measures Formation	Grey coal bearing mudstones/siltstones (BGS Lexicon).	Up to 240m in the Swansea area (BGS Lexicon).
Source: http://mapapps.bgs.ac.uk/geologyofbritain/home.html? http://www.bgs.ac.uk/lexicon/lexicon		

There are no BGS boreholes recorded on the site. The nearest recorded BGS borehole is located circa 500m north-west of site and is illegible. The other recorded BGS boreholes are considered to be located too far away to be a reliable indication of the underlying stratigraphical succession of the site.

2.5.2 Mining, quarrying and ground workings

Evidence has been sought to identify any ground workings, mining and quarrying operations, past and present, which have taken place within a radius of 1 km of the site. The sources of information referenced in this element of the desk study include:

- The environmental database report
- Historical Ordnance Survey maps and plans
- Geological mapping.

With reference to the above data, ground workings were undertaken between 1964 and 1979, with the construction of the former oil storage depot that occupied the site. Prior to this the site appeared to be sand (beach) with rough grass vegetation (as indicated in historical mapping) and on or close to the high-tide mark. The surrounding area has undergone considerable ground working with the construction of docks, railways, roads and residential, commercial and industrial buildings. Following demolition of the former oil depot, the new Swansea University Bay Campus has been constructed with associated ground level alterations.

There are no records of historical mining within 1000m of the site boundary.

The site lies in or in close proximity to a coal mining reporting area as defined by the Coal Authority. A report was obtained as part of the PRA (RSK 314617 R01(00) Geoenvironmental risk assessment.

There are two potential records of non-coal mining activity within 1km of the site boundary which include 'localised small-scale underground mining' for Iron Ore (Bedded) located 250m south and 340m south-west of the site. In addition, a record for a quarry exists for the 'Halfway House Sand Pit' located 800m north-west of the site (GroundSure Report). There are no other records of non-coal related mining and quarrying.

2.5.3 Landfilling and land reclamation

Evidence has been sought to identify any landfilling or land reclamation operations, past and present, which have taken place in the vicinity of the site. The sources of information referenced in this element of the desk study include:

- Environmental database report
- Historical Ordnance Survey maps and plans

There are no records of Environment Agency (EA) / Natural Resources Wales (NRW) landfill data, historical landfill sites or licenced waste sites within 250m of the site.

2.6 Hydrogeology

2.6.1 Aquifer characteristics

The hydrogeology of the site is likely to be characterised by the presence of an unconfined shallow aquifer within the superficial deposits (wind-blown sands) and bedrock (South Wales Middle Coal Measures Formation).

Given the site use, it is anticipated that considerable made ground is present beneath the site placed during construction of the previous oil terminal and existing Swansea University Bay Campus. Depending upon the composition of this made ground, localised areas of perched groundwater may be present beneath the site in the near-surface.

Given the anticipated low transmissivity of the South Wales Middle Coal Measures Formation, groundwater flow is likely to be slow to negligible. Any flow is anticipated to be in a general southerly direction, towards the River Severn Estuary.

3 PRELIMINARY GEOTECHNICAL HAZARDS

3.1 Preliminary geotechnical hazards assessment

A summary of commonly occurring geotechnical hazards associated with the anticipated geology outlined in **Section 2.5.1** is given in **Table 4**, together with an assessment of whether the site may be affected by each of the stated hazards.

Table 4 Summary of preliminary geotechnical risks that may affect site

Hazard category	Hazard status based on desk study findings and proposed development		Engineering considerations if hazard affects site
	Could be present and/or affect site	Unlikely to be present and/or affect site	
Sudden lateral changes in ground conditions	☐	☒	Likely to affect ground engineering and foundation design and construction
Shrinkable clay soils (Aeolian Sands) Cohesive Glacial Till and weathered Mudstone	☐	☒	Design to NHBC Standards Chapter 4 or similar
Highly compressible and low bearing capacity soils, (including peat and soft clay)	☒	☒	Made ground of variable composition is present onsite. Furthermore, land has historically been below high tide line indicating reclaimed land and potential tidal mudflat deposits.
Silt-rich soils susceptible to rapid loss of strength in wet conditions	☒	☐	Likely to affect ground engineering and foundation design and construction
Running sand at and below water table	☒	☐	Aeolian deposits of the Blown Sand formation may run within excavations due to high groundwater table
Karstic dissolution features (including 'swallow holes' in Chalk terrain)	☐	☒	May affect ground engineering and foundation design and construction – refer to Section 4.1.2
Evaporite dissolution features and/or subsidence	☐	☒	May affect ground engineering and foundation design and construction

Hazard category	Hazard status based on desk study findings and proposed development		Engineering considerations if hazard affects site
	Could be present and/or affect site	Unlikely to be present and/or affect site	
Ground subject to or at risk from landslides	☐	☒	Likely to require special stabilisation measures
Ground subject to peri-glacial valley cambering with gulls possibly present	☐	☒	Likely to affect ground engineering and foundation design and construction
Ground subject to or at risk from coastal or river erosion	☐	☒	Likely to require special protection/stabilisation measures
High groundwater table (including waterlogged ground) Groundwater likely to be influenced by tides	☒	☐	May affect temporary and permanent works
Rising groundwater table due to diminishing abstraction in urban area		☒	May affect deep foundations, basements and tunnels
Underground mining	☐	☒	Likely to require special stabilisation measures
Effects of extreme temperature (e.g. cold stores or brick kilns/furnaces)	☐	☒	Likely to affect ground engineering and foundation design and construction
Existing sub-structures (e.g. tunnels, foundations, basements, and adjacent sub-structures)	☒	☐	Buried concrete obstructions present. Likely to affect ground engineering and foundation design and construction
Filled and made ground (including embankments, infilled ponds and quarries)	☒	☐	Likely to affect ground engineering and foundation design and construction.
Adverse ground chemistry (including expansive slags and weathering of sulphides to sulphates)	☒	☐	May affect ground engineering and foundation design and construction. Mercia Mudstone is pyrite bearing.
Note: Seismicity is not included in the above table as this is not normally a design consideration in the UK.			

3.2 Design class

BS EN 1997-1 defines three different Geotechnical Categories that structures may fall into, which are summarised as follows:

- Category 1: Small and relatively simple structures for which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations; with negligible risk.
- Category 2: Conventional types of structure and foundation with no exceptional risk or difficult ground or loading conditions.
- Category 3: Structures or part of structures, which fall outside limits of Geotechnical Categories 1 and 2. Examples include very large or unusual structures; structures involving abnormal risks, or unusual or exceptionally difficult ground or loading conditions; structures in highly seismic areas; structures in areas of probable site instability or persistent ground movements that require separate investigation or special measures.

Based on the information provided above on the proposed development and in view of the anticipated ground conditions, a Geotechnical Category 2 has been assumed for the purposes of designing the geotechnical investigation. This should be reviewed at all stages of the investigation and revised where necessary.

4 SITE INVESTIGATION STRATEGY & METHODOLOGY

4.1 Introduction

RSK carried out intrusive investigation works and subsequent monitoring of boreholes between January and February 2020.

4.2 Objectives

The specific objectives of the investigation were as follows:

- to establish the underlying ground conditions including the extent and thickness of any made ground;
- to assess geotechnical properties of soils; and
- to determine groundwater depth.

4.3 Selection of investigation methods

The techniques adopted for the investigation were chosen with consideration of the objectives and site constraints, which are described below.

Cable percussion drilling and Dynamic sampling was chosen based on the targeted drill depth, requirement for in-situ geotechnical data, the opportunity to collect both disturbed and undisturbed samples and install monitoring wells. This was supplemented by mechanically excavated trial pitting to obtain a number of investigation locations and achieve greater visibility of the Made Ground.

Prior to conducting intrusive works, utility service plans were provided by the client, with further CAT scanning undertaken by RSK, in line with RSK's health and safety procedures.

4.4 Investigation strategy

The ground investigation was carried out using intrusive ground investigation techniques in general accordance with the recommendations of BS5930: 2015 Code of practice for ground investigations, which maintains compliance with BS EN 1997-1 and 1997-2 and their related standards. Whilst every attempt was made to record full details of the strata encountered in the boreholes, techniques of hole formation and sampling will inevitably lead to disturbance, mixing or loss of material in some soils and rocks.

The investigation strategy involved targeted boreholes and trial pits as outlined in the provided scope and where possible due to limitations imposed by buried services and areas of hard landscaping.

The constraints to the investigation were as follows:

- numerous live underground services throughout the site area;
- hard standing/paved walkways, under constant use;
- mounded soil areas within central portion, one with numerous pipes/pipework and potential ecological constraints;
- bike shed and maintenance shed; and
- planted areas with specialised plants and potential ecological constraints

Buried concrete was encountered at various depths across the site.

Details of the investigation locations, installations and rationale are presented in **Table 5** and are summarised below.

3no. machine excavated trial pits were dug to a maximum depth of 2.70 m bgl before being backfilled with arising.

2no. cable percussive boreholes were drilled to a maximum depth of 21.1m bgl, each was installed with a combined gas and groundwater monitoring well.

4no Dynamic sampling holes were drilled to a maximum depth of 4.2m bgl, two of which were installed with a combined gas and groundwater monitoring well.

Table 5 Exploratory hole and monitoring well location rationale

Investigation type	Number	Designation	Monitoring well installation	Rationale
Boreholes by cable percussive methods	2	BH1 to BH2	Gas/ groundwater*	Located within areas of site accessible for the drilling rig and in areas that would have minimal impact on risks to current site users. To prove the geological succession beneath the site and obtain geotechnical data and to install combined gas and groundwater monitoring wells.
Boreholes by dynamic/ windowless sampling methods	4	WS1 to WS4c	Gas/ groundwater*	Located within areas of site accessible for the drilling rig and in areas that would have minimal impact on risks to current site users. To prove the shallow ground conditions and obtain

Investigation type	Number	Designation	Monitoring well installation	Rationale
				geotechnical data, along with determining the contamination status of the ground beneath the site and to install additional dual purpose groundwater and gas monitoring wells.
Trial-pits excavated by hand/mechanical excavator	3	TP1 to TP3.	n/a	To investigate the nature and variability of the made ground and near surface soils. To undertake infiltration testing.

4.4.1 Implementation of investigation works

The exploratory holes were logged by an engineer in general accordance with the recommendations of BS 5930:2015 (which incorporates the requirements of BS EN ISO 14688-1, 14688-2 and 14689-1).

The monitoring well construction and associated response zones are detailed on the exploratory hole records in **Appendix C**.

4.5 Monitoring programme

4.5.1 Groundwater monitoring and sampling

2no rounds of groundwater monitoring and 1No of sampling have been undertaken to date. As stated above 1No visit still outstanding at the time of writing. The monitoring records to date are shown in **Appendix D**.

4.6 Laboratory testing

Where appropriate, testing was undertaken in accordance with BS 1377:1990 Method of Tests for Soils for Civil Engineering Purposes or, where superseded, by the relevant part of BS EN ISO 17892:2014 Geotechnical investigation and testing - Laboratory Testing of Soil. Tests carried out in order to classify the concrete class required on-site have been undertaken following the procedures within BRE SD1:2005.

The programme of geotechnical tests undertaken on samples obtained from the intrusive investigation is presented in **Table 6**. The results and UKAS accreditation of tests methods are shown in **Appendix F**.

Table 6 Summary of geotechnical testing undertaken

Stratum	Tests undertaken	No. of tests
Blown Sands	Moisture content %	1
	Liquid/ plastic limits	1

Stratum	Tests undertaken	No. of tests
	Sieve analysis	2
	Soil chemical analysis (BRE SD1:2005)	3
Glacial Till	Moisture content %	3
	Liquid/ plastic limits	3
	Soil chemical analysis (BRE SD1:2005)	2

5 SITE INVESTIGATION FACTUAL FINDINGS

The results of the intrusive investigation and subsequent geotechnical laboratory analysis undertaken are detailed below.

5.1 Ground conditions encountered

The descriptions of the strata encountered, notes regarding visual or olfactory evidence of contamination, list of samples taken, field observations of soil and groundwater, in-situ testing and details of monitoring well installations are included on the exploratory hole records presented in **Appendix C**.

The exploratory holes revealed that the site is underlain by a variable thickness of made ground over superficial deposits associated with the Blown Sand deposits and Glacial Till underneath. The Coal Measures Bedrock was encountered at depth. This appears to confirm the stratigraphical succession described within the preliminary CSM.

For the purpose of discussion, the ground conditions encountered during the fieldworks are summarised in Table 7 with the strata discussed in subsequent subsections.

Table 7 General succession of strata encountered

Stratum	Exploratory holes encountered	Depth to top of stratum m bgl	Proven thickness (m)
Made ground	All	Ground level	1.2 - 3.2
Blown Sand	All except WS1 and WS4	1.2 – 2.1	10.5 - 11.1
Glacial Till	BH2 only	13.0 – 14.3	8.2
Middle Coal Measure bedrock	BH2 only	21.2	Not proven

5.1.1 Made ground

The made ground generally comprised a granular soil with a significant proportion of cohesive matrix and ranged in thickness from 1.9m to 3.2m. It is our understanding the made ground has been used as engineered fill to raise levels. Further to the granular fill encountered, in-situ concrete was identified at varying depths across the site. Anecdotal evidence suggests that in some areas a concrete slab is present at depths of up to 2m. This would correspond with some of the findings during the investigation, with dynamic sampling holes WS1 and WS4 terminating at similar depths.

A summary of the in-situ test results recorded in the stratum are presented in **Table 8**

Table 8 Summary of in-situ test results for made ground

Soil parameters	Min. Value	Max. Value	Reference
SPT 'N' values (uncorrected)	15	>50	Appendix C

5.1.2 Blown Sand

This stratum was encountered at a depth of between 1.9m and 3.2m below ground level and varies between 11.1m and 12.2m in thickness. Based on the site descriptions and laboratory and in-situ tests carried out this layer can be described as a medium dense to dense fine to coarse sand with occasional silt lenses.

A summary of the in-situ test results recorded in the stratum are presented in **Table 9**.

Table 9 Summary of in-situ test results for Blown Sand

Soil parameters	Min. Value	Max. Value	Reference
Sieve analysis	Fines-4 - 5%; Sand -88 – 95%; Gravel- 2 - 7%		Appendix F
SPT 'N' values (uncorrected)	12	>50	Appendix C
Density term	Medium dense	Very dense	

5.1.3 Glacial Till

This stratum was encountered beneath the Blown Sands and comprised a layer of stiff to very stiff gravelly clay and dense to very dense clayey gravels with low to medium cobble content, between 13.0m and 21.2m, approximately 8.2m in thickness.

A summary of the in-situ test results recorded in the stratum are presented in **Table 10**. SPT refusals within this stratum are likely as a result of sandstone/siltstone/mudstone cobbles.

Table 10 Summary of in-situ test results for Glacial Till

Soil parameters	Min. Value	Max. Value	Reference
Moisture content (%)	13.6	15.1	Appendix F
Modified moisture content (%)*	18.1	30.8	
Liquid limit (%)	21	28	
Plasticity limit (%)	13	15	
Plasticity index (%)	8	13	
Modified plasticity index (%)*	2.4	7.8	
Plasticity term	Low	-	
SPT 'N' values (uncorrected)	30	>50	Appendix C
Undrained strength from inferred from SPT N Values ($f_1=4.5$) (kN/m ²)	135	>225	

Soil parameters	Min. Value	Max. Value	Reference
Consistency term from field description	Stiff	Very stiff	
Strength Term	High	Very high	
Density Term	Dense	Dense	

5.1.4 Coal Measures Bedrock

This stratum is inferred at a depth of 21.1m below ground level in BH2 and proven to a depth of 21.6m where the borehole refused. Due to the limitations of cable percussive techniques with drilling in hard strata, it is not possible to categorically confirm if this is bedrock level or a possible boulder. BH1 also terminated on possible rockhead or cobbles/boulders in the Glacial Till at a depth of 15.45m bgl. Based on nearby borehole information, the Coal Measures bedrock can be described as interbedded mudstone, siltstone and sandstone.

5.1.5 Visual/olfactory evidence of soil contamination

Evidence of hydrocarbon contamination was noted within WS3 only, within the made ground at 2.0m bgl. Head space analysis of the sample, with the use of a PID, returned a result of 80ppm.

Within the same borehole, olfactory evidence of hydrocarbon contamination was also suspected at 3.25m, head space analysis of the sample returned a result of 10ppm. Head space analysis of the strata between the layers returned similar diminishing results with a sample tested at 2.6m returning a result of 11ppm.

No visual evidence of asbestos containing material (ACM) was noted.

5.2 Groundwater and surface water

5.2.1 Groundwater encountered during intrusive works

Groundwater was encountered during the intrusive investigation works as detailed on the logs in **Appendix C**.

5.2.2 Groundwater encountered during monitoring

Rest groundwater levels recorded during the monitoring programme are summarised in **Table 11** based on the data provided in **Appendix D**. Field data measurements are also included in **Appendix D**.

Table 11 Summary of groundwater monitoring results

Monitoring well	Response zone stratum	Depth to water (mb TOC)
BH1	Blown Sand	2.76
BH2	Blown Sand	1.78
WS1	Made Ground	N/A (dry)
WS3	Made Ground	1.68

The findings reflect the groundwater table in the Blown Sand deposits, with a potential perched groundwater body within the made ground.

It should be noted that groundwater levels may fluctuate for a number of reasons including seasonal and tidal variations. On-going monitoring would be required to establish both the full range of conditions and any trends in groundwater levels.

Two monitoring visits are outstanding at the time of reporting.

5.2.3 Visual/olfactory evidence of groundwater contamination

No evidence of contamination was noted within the groundwater samples.

5.3 Constraints and Limitations

Due to the site still being in use, with numerous underground services, paved walkways, pathways under constant use by staff/students/groundworkers, all exploratory holes were placed in areas without services in the near vicinity and that was accessible for plant and to avoid unnecessary risk to current site users.

The area of soft landscaping in the central southern/southeast portion of the site was mounded. It is RSK's understanding that a nature reserve is present. Further to this, specialised plants and trees have been planted within the south western area. It is RSK's understanding that an ecological survey is due for both areas in the near future.

The presence of concrete and gravel/cobbles with the fill material restricted locations of the borehole and also the depth and number that could be achieved.

The cable percussive deep boreholes terminated on cobbles/boulders in the Glacial Till or bedrock, but rotary drilling techniques would be required to confirm bedrock levels by coring at least 3m to 5m into rock.

6 GEOTECHNICAL ASSESSMENT

6.1 Proposed development

It is understood the proposed CISM will be a 3 storey research facility, approximately 35.0m x 40.0m in plan, located to the north east of the Swansea University Bay Campus. The occupancy of the new build will consist of laboratory space, testing facilities, large plant rooms to service separate clean room classifications and commercial office space.

From review of the supplied documents, the vibration performance is a critical consideration for the structural design of the CISM. CISM will house vibration sensitive equipment, such as the E-Beam, Nanoprobes, Mask aligners and others. All vibration sensitive equipment will be located on separated structures isolated from the main building and designed to specific design vibration criteria.

It is our understanding that a piled foundation solution is being considered and the preferred method of piling is precast driven piles.

6.2 Key geotechnical hazards / development constraints

The key risks identified from the available ground investigation data are discussed below:

- Deep and variable Made Ground;
- existing underground infrastructure/sub-structures (services, foundations associated with sites historical use etc);
- a significant thickness of Blown Sand Deposits are present across the site that could potentially cause problems with flighting for CFA piles or result in premature of driven piles within locally 'dense' layers encountered; and
- a relatively high groundwater table has been identified that needs careful consideration for any deeper excavations.

6.3 Foundations

6.3.1 Foundation options

Based upon the ground conditions revealed by the investigation and the anticipated relatively high loads and sensitive equipment proposed within the new development, it is considered that spread foundations will not be appropriate. It is therefore recommended that piled foundations are adopted for the proposed development.

6.3.2 Piled foundations

Preliminary recommendations for the design and construction of pile foundations in relation to the ground conditions identified beneath the site are set out in Table 12. The preliminary recommendations given below are based on the ground conditions revealed by boreholes BH1 to BH2 (**Appendix C**).

Table 12 Design and construction of piled foundations

Design and construction considerations	Design/construction recommendations		
Pile type	The construction CFA and driven piles (pre-cast concrete and driven cast in-situ) is considered technically feasible at this site.		
Possible constraints on choice of pile type	Given the close proximity of the commercial areas, the possible vibrations / noise associated with pile driving will require consideration, however, it is understood that this is the preferred method of construction. Driven piles may require pre-drilling through the made ground and could potentially reach premature set in 'dense' layers encountered in the Blown Sand. deposits CFA piles may encounter problems with 'flighting' within the poorly graded medium sands of the Blown Sand deposits. These constraints should be discussed with a piling specialist at an early stage to determine the most suitable pile type for the site and ground conditions.		
Temporary casing	Groundwater was encountered at shallow depths, however, the use of continuous-flight-auger (CFA) injected bored piles or driven piles usually overcomes this issue.		
Limitations afforded by ground	For the purpose of assessing pile capacities, the made ground has been presumed not to contribute to the load-carrying capacity for the piles for the first 3.5m bgl. At this time, no negative skin friction has been considered.		
Man-made obstructions	The presence of buried sub-structures or other obstructions within made ground were present on site and may lead to some difficulty during piling. Where buried obstructions are encountered, it will be necessary to either relocate the pile(s) or make allowance for removing the obstruction. Additionally, the made ground comprised very dense soils and therefore it will be necessary to pre bore locations if driven piles are installed. A minimum of 4.0m depth should accommodate this.		
Hard strata	An allowance should be made for the presence of cobbles / boulders within Glacial Till and an appropriate technique selected to socket into weak rock within the Middle Coal Measures (if required).		
	Pile design parameters	Bored	Driven
Blown Sands	Shaft friction factor ($k_s \times \tan \delta$)	0.45	0.65
	End bearing factor (N_q)	15-17	
Glacial Till	Undrained shear strength c_u (kN/m ²)	140 (250 for lower till)	
	Adhesion factor α	0.50	0.65
	End bearing factor (N_c)	9	

Design and construction considerations	Design/construction recommendations		
General parameters	Model factor (γ_{Rd})	1.4	
	SLS factor on ultimate shaft friction	1.2	N/A
	Limiting end bearing pressure (kN/m ²)	11000	
	Limiting shaft friction (kN/m ²)	110	

The design procedure for piles varies considerably, depending on the proposed type of pile. However, for illustrative purposes **Tables 14** and **15** give likely working pile loads for traditional CFA piles and driven, precast concrete piles of various diameters and lengths, based on the design parameters given in **Table 11**.

The soil profile was derived based on information indicated in boreholes BH1 and BH2; the deepest of which was terminated at 21.60m bgl within siltstone/sandstone bedrock of the Middle Coal Measures. An SPT 'N' value /depth profiles is presented in **Figure 3**. It has been assumed that no positive skin friction will be obtained from ground level to about 3.50m depth due to the inherently variable Made Ground and disturbance during the piling operations.

The design resistance has been calculated in accordance with BS EN 1997-1 and the UK National Annex, using partial resistance factors for CFA piles, given in **Table 12**, and driven piles given in **Table 13**.

Table 13 Partial resistance factors - CFA (γ_R)

Resistance	Set	
	DA1 C1	DA1 C2
Base - γ_b	1.0	2.0
Shaft (compression) - γ_s	1.0	1.6 Compression
Total (compression) - γ_t	1.0	2.0

Table 14 Partial resistance factors – Driven piles (γ_R)

Resistance	Set	
	DA1 C1	DA1 C2 ¹⁾
Base - γ_b	1.0	1.7
Shaft (compression) - γ_s	1.0	1.5 Compression
Total (compression) - γ_t	1.0	2.0

¹⁾ no serviceability verification

Table 15 Illustration of typical design resistances for CFA piles

Typical Design resistance for DA1 – Combinations C1 & C2 (kN)									
Depth of toe below ground (mbgl)	Pile diameter								
	450 mm			600 mm			750 mm		
	C1	C2	SLS	C1	C2	SLS	C1	C2	SLS
10	469	264	198	764	421	264	1138	618	330
11	535	303	241	860	478	322	1257	689	402
12	604	345	288	952	533	384	1378	761	480
13	671	386	338	1056	595	451	1533	851	564
14	752	435	392	1175	666	523	1679	889	654
15	684	410	451	976	578	602	1300	763	752
16	755	454	510	1271	637	680	1418	993	850
17	979	580	603	1419	830	804	1916	1108	1005
18	1090	649	695	1567	922	927	2101	1224	1159
19	1201	718	788	1715	1015	1050	2286	1340	1313
20	1312	788	880	1863	1107	1174	2471	1455	1467

Table 16 Illustration of typical design resistances for Driven piles

Typical Design resistance for DA1 – Combinations C1 & C2 (kN)						
Depth of toe below ground (mbgl)	Pile diameter					
	250 mm		300 mm		400 mm	
	C1	C2	C1	C2	C1	C2
10	317	205	406	261	607	387
11	375	243	474	306	705	451
12	436	284	550	356	810	520
13	502	328	630	409	917	597
14	532	350	652	428	905	592
15	597	393	730	480	1009	661
16	706	463	871	569	1226	797
17	785	515	966	632	1352	881
18	863	567	1060	695	1478	965
19	942	620	1154	758	1604	1049
20	1020	672	1249	821	1729	1133

From **Table 16**, it can be seen that most of the pile loads are limited by Design Approach 1 - Combination 2 or Serviceability Limit State (SLS) in some instances for CFA piles.

It should be stressed that the above capacities do not take into consideration limiting concrete stress (to be verified by a separate load case as defined in EC2) nor pile group effects, the latter of which is more pronounced for a large number of closely spaced piles.

Notwithstanding the above, it is recommended that the detailed advice of a specialist-piling contractor be sought as to the most suitable type of pile for the prevailing ground conditions and as to their lengths and diameters to support the required design loads.

6.3.3 Foundation works risk assessment

It is anticipated that a foundation works risk assessment report will not be required for the development because:

- no free-phase product was identified at the site; and
- shallow groundwater quality has been shown not to be impacted above GACs

6.4 Floor slabs

Due to the presence of relatively thick and variable made ground deposits at the site (>3.0m in some areas), RSK considers that ground bearing floor slabs would not be suitable for the development unless some form of ground improvement or excavation and replacement were undertaken.

Therefore, suspended floor slabs are recommended for the proposed development.

All formation levels should be proof-rolled, and all topsoil and any other loose, soft, organic or otherwise unsuitable materials should be removed and replaced with well-compacted, suitable granular fill.

6.5 Roads and hardstanding

The anticipated subgrade soils are likely to comprise predominantly granular made ground soils. The potentially poorest subgrade soil is considered to be the made ground. 7No DCP test were attempted at the site, however, none progressed further than the upper portions (eg topsoil etc). The probable cause of all DCP refusals was shallow concrete/cobble obstructions.

For preliminary design purposes a CBR value of just above 2.0% is recommended. This value assumes that during construction the formation level will be carefully compacted, and any soft spots removed and replaced with well-compacted granular fill, to ensure design values are achieved. Once the proposed pavement layout has been established, it is recommended that in-situ CBR or plate bearing tests be undertaken on the proposed sub-grade to confirm pavement design thickness.

With respect to the made ground encountered at site being predominantly granular in composition, the sub-grade soils can be regarded as not being frost-susceptible, based upon the criteria given in Appendix 1 of TRRL (1970) Report Road Note 29.

6.6 Excavations for foundations and services

Excavation throughout the site will be within the capabilities of conventional mechanical excavators although an allowance should be made for possible concrete obstructions.

All of the trial pits became unstable during excavation. It is therefore recommended that excavation support systems are made available during the groundwork stage of the development, should deep excavations be required. Drainage design will also need to take account of the poor ground conditions and potential risk of differential settlement if constructed within the made ground horizon or across variable strata.

Manned entry into any excavations must not be undertaken without provision of suitable shoring and support and dewatering or suitable regrading and battering of side slopes to safe angles. Confined spaces protocols for the Health and Safety of personnel must always be used where manned entry into excavations is to be undertaken as low oxygen conditions may be present.

The presence of a relatively high groundwater table has been recorded during the investigation. Excavations taken close to or below the groundwater table are therefore likely to require continuous support and dewatering. Pumping from open sumps in non-cohesive soils (sands) should be avoided as this can result in instability and general loosening of the soils at the base of the excavation. It is likely that dewatering in non-cohesive soils will require the use of well-pointing systems.

The ground gas and ground water monitoring are still ongoing. An update to this report will be issued upon completion of the monitoring programme.

6.7 Chemical attack on buried concrete

This assessment of the potential for chemical attack on buried concrete at the site is based on BRE Special Digest 1: Concrete in aggressive ground, which represents the most up-to-date guidance on this topic currently available in the UK.

The desk study and site reconnaissance indicate that, for the purposes of assessing the aggressive chemical environment of the site, the site should be considered as comprising natural ground likely to contain pyrite.

Based on testing results, Table 17 gives the characteristic pH and water-soluble content values for soils from each of the geological units and groundwater encountered on-site.

Table 17 Characteristic pH, water soluble sulphate and total sulphate values

Stratum	pH Range	Water Soluble Sulphate (mg/l)
Blown Sands	8.44 -9.03	55-272
Glacial Till	8.57 – 8.86	32 - 47

The recommended ACEC Classification is therefore AC-1 with a Design Sulphate Class of DS-1.

6.8 Infiltration drainage

One infiltration test has been undertaken at the site. The results of soakaway testing are summarised in Table 18.

Table 18 Infiltration test results

Trial pit	Geological unit	Test result (m/s)
TP2 (SA1)	Blown Sands	2.09×10^{-7}
Notes: Tests carried out in accordance with BRE Digest 365 (2016)		

With regards to the above, the ground conditions do not appear suitable for the use of conventional pit soakaways due to a poor infiltration rate within the trial pit, not successfully emptying below 75% of the effective depth.

Furthermore, the groundwater encountered during the site works and recent monitoring visits would suggest a relatively shallow groundwater body exists, further limiting the soils transmissivity and storage potential.

6.9 Temporary working platform

No plate load testing has been undertaken at the site to date and it is recommended that testing is completed to confirm parameters to aid the design of working platforms.

The relatively shallow standing groundwater levels recorded will need to be considered within the design.

All remnant substructures will need to be removed and replaced with well compacted granular fill to prevent the significant risk of the piling rig toppling.

The proposed formation must be visually inspected and if any pockets of soft or loose material or any excavated/filled area (poorly compacted area) including organic rich material be encountered, then these should be removed and the working platform locally thickened.

The installation should be adequately supervised, with inspection and proof rolling used as necessary to ensure that the sub-grade is of uniform and suitable quality, and that the granular platform is constructed and compacted adequately. Adequate inspection, control and maintenance arrangements should be in place to ensure the design assumptions are reasonable and valid for the intended life of the platform.

7 CONCLUSIONS AND RECOMMENDATIONS

Based upon the ground conditions revealed by the investigation and anticipated relatively high loads and sensitive equipment proposed within the new development, it is considered that spread foundations will not be appropriate. It is therefore recommended that piled foundations are adopted for the proposed development.

Suspended floor slabs are recommended for the development due to deep and variable made ground encountered.

A CBR value of just above 2.0% is recommended for preliminary design purposes. The sub-grade condition at the time of construction should be confirmed by plate testing at the proposed formation level.

A Design Sulphate Class for the site of DS-1 and Aggressive Chemical Environment for Concrete classification of AC-1 may be assumed for design purposes.

The ground conditions do not appear suitable for the use of pit soakaways to discharge surface run-off water to ground due to the poor infiltration characteristics of the near surface soils, relatively high groundwater table recorded and the risk of facilitating contaminant migration.

The relatively shallow standing groundwater levels recorded will need to be considered during design of both the temporary and permanent works.

The ground gas and ground water monitoring are still ongoing. An update to this report will be issued upon completion of the monitoring programme.

BIBLIOGRAPHY

Previous SI reports and other site related information

BGS Website (accessed February 2019): www.BGS.co.uk

Magic Map website, DEFRA (accessed February 2019): www.magicmaps.co.uk

Standards and guidance

AGS Interim Guidance (2013), 'Site investigation and asbestos risk assessment for the protection of site investigation and geotechnical laboratory personnel', February.

Baker, K., Hayward, H., Potter, L., Bradley, D. and McLeod, C. (2009), CIRIA Report C682. The VOCs Handbook. Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination (London: CIRIA).

British Standards Institution (BSI) (1990), 'BS 1377:1990. Methods of test for soils for civil engineering purposes'.

British Standards Institution (2015), 'BS 5930:2015. Code of practice for ground investigations'.

British Standard Institution (BSI) (2015), 'BS 8485:2015. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'.

British Standards Institution (2011), 'BS 10175:2011 + A2:2017. Investigation of potentially contaminated sites: Code of practice'.

British Standards Institution (2013), BS8576:2013. Guidance on investigations for ground gas – permanent gases and volatile organic compounds (VOCs).

Building Research Establishment (2005), BRE Special Digest 1: Concrete in aggressive ground.

Card G, Wilson S, Mortimer S. 2012. A Pragmatic Approach to Ground Gas Risk Assessment. CL:AIRE Research Bulletin RB17. CL:AIRE, London, UK. ISSN 2047- 6450 (Online).

Chartered Institute of Environmental Health (CIEH) and CL:AIRE (2008), Guidance on Comparing Soil Contamination Data with a Critical Concentration (London: CIEH).

CIRIA (2014). Good practice on the testing and verification of protection systems for buildings against hazardous ground gases.

Environment Agency (2015), 'Technical Guidance WM3. Guidance on the classification of and assessment of waste. 1st Edition.

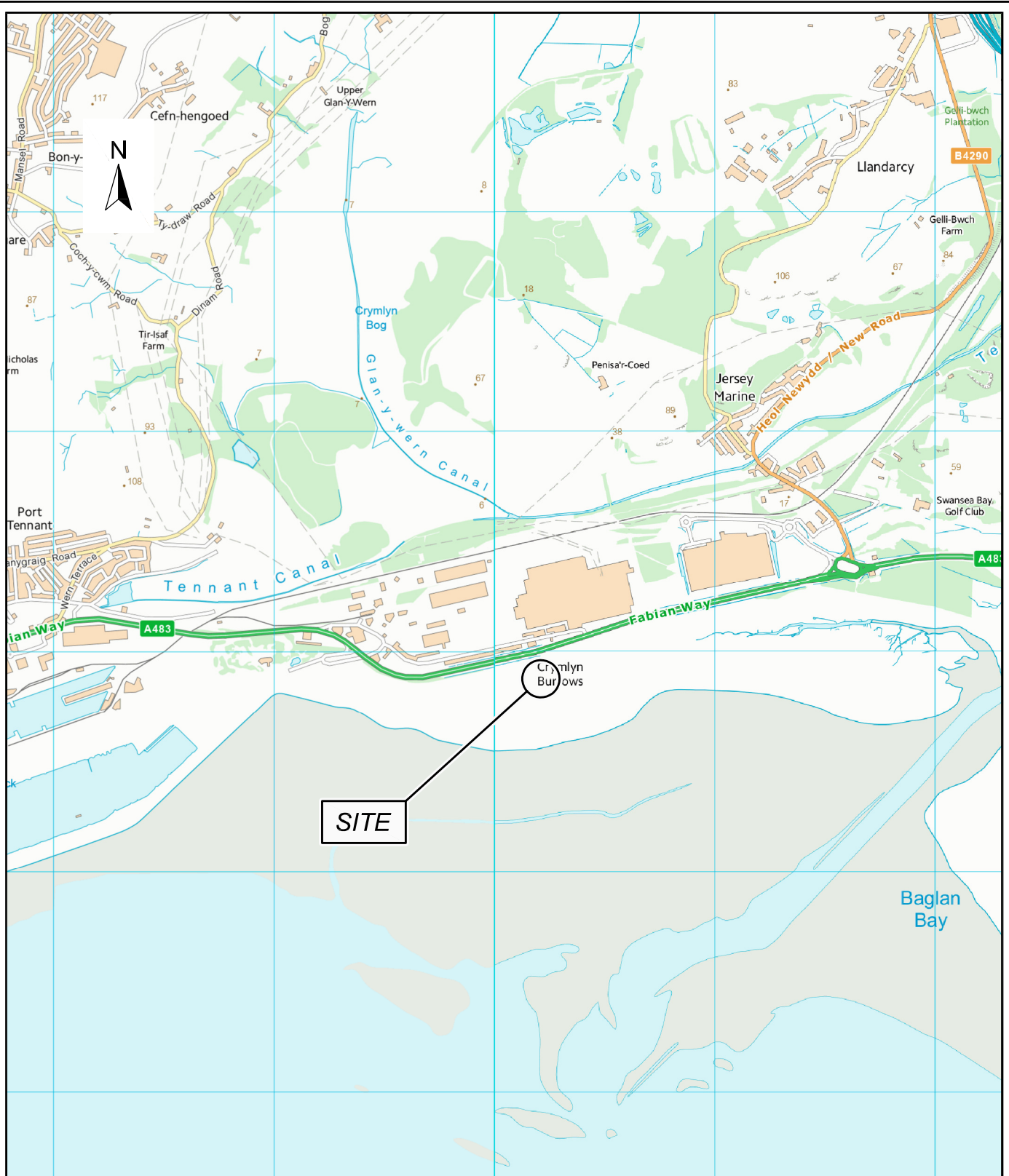
Environment Agency (2004), Model Procedures for the Management of Contaminated Land. Contaminated Land Report Number 11 (CLR11), September (Bristol: Environment Agency).

Norbury, D. (2010), Soil and Rock Description in Engineering Practice (Caithness: Whittles).

Part IIA of the Environmental Protection Act (Contaminated Land Regulations (England) 2002 (London: HMSO).

Rudland, D. J., Lancefield, R. M. and Mayell, P. N. (2001), CIRIA C552. Contaminated Land Risk Assessment: A Guide to Good Practice (London: CIRIA).

FIGURES



Contains Ordnance Survey data © Crown copyright and database right 2013



The Old School,
Stillhouse Lane,
Bedminster,
Bristol,
BS3 4EB

Tel: +44 (0)117 947 1006
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client

AECOM Ltd

Project Title

Swansea University Bay Campus

Drawing Title

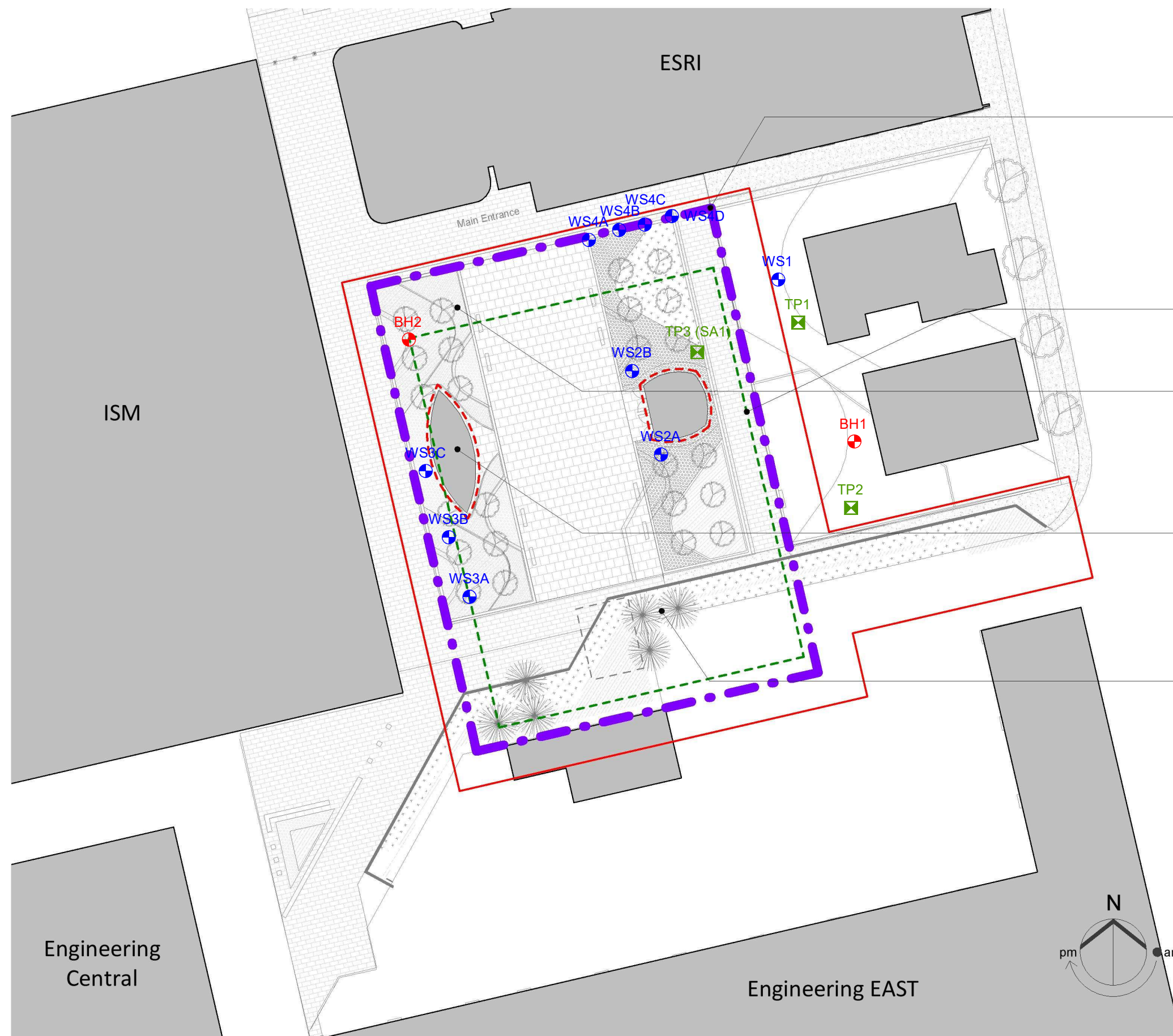
SITE LOCATION MAP

Rev	Drawn	Date	Checked	Date	Approved	Date
00	NP	03.02.20	AH	03.02.20	-	-
Dimensions		Scale		Original Size		
m		1:25,000		A4		

Project Number	Grid Ref
314617	SS 702 928



Drawing Number
FIGURE 1



TP1		Machine Excavated Trial Pit
WS1		Dynamic (Window) Sampler Borehole
BH1		Cable Percussion Borehole

Drawing edited from 'Existing Site Plan and Demolition Plan - CISM SU Bay Campus' (DWG No. 152296-STL-2222-XX-PR -A-XX-19000 Rev P1) drawn by Stride Treglown dated 09.08.19.

- **Cycle sh**
relocate
drawing
Building

— Soft land
fence to
line bou

00	14.02.2020	-	AH	CL	CL
Rev.	Date	Amendment	Drawn	Chkd.	Appd.



The Old School,
Stillhouse Lane,
Bedminster,
Bristol,
BS3 4EB

Tel: +44 (0)117 947 1006
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client

AECOM

Project Title

Project Title
Swansea University Bay Campus

Drawing Title

Exploratory Hole Location Plan

Drawn	Date	Checked	Date	Approved	Date
AH	14.02.20	CL	14.02.20	CL	14.02.20

Dimensions	Scale	Original Size
m	NTS	A3

Project Number	314617	Drawing Number	-
----------------	--------	----------------	---

Drawing File	314617 - EHLP	Rev	00
--------------	---------------	-----	----

[illegible]

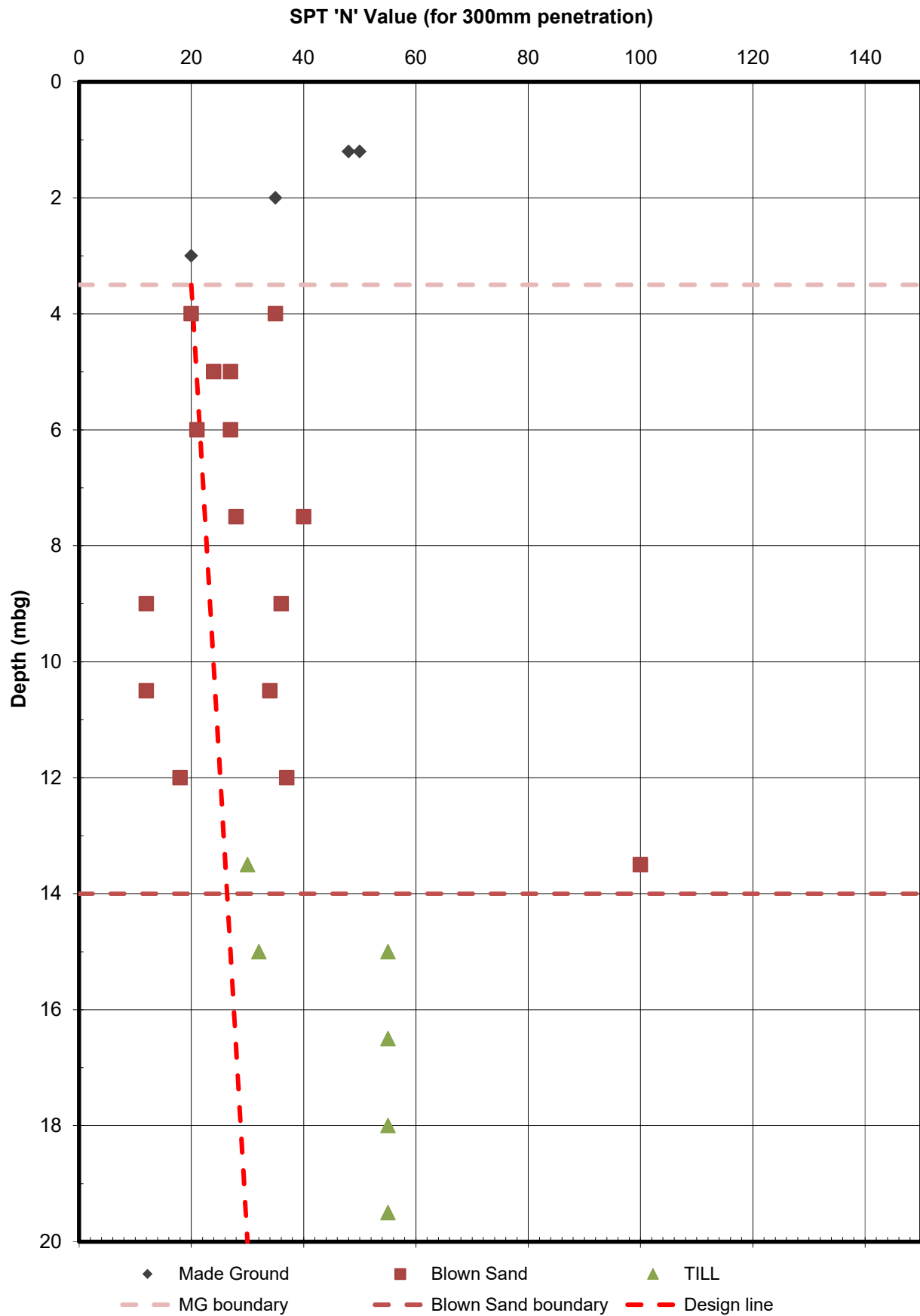


SPT 'N' VALUE vs DEPTH

Site:
Swansea University Bay Campus

Client:
AECOM

Job Number: 314617
Figure: 3



APPENDIX A

SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for AECOM Ltd (the "Client") in accordance with RSK Environment Standard Terms and Conditions between RSK and the Client, dated 11th December 2019. The Services were performed by RSK with the reasonable skill and care ordinarily exercised by an environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the Client.
2. Other than that, expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the Client. RSK is not aware of any interest of or reliance by any party other than the Client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the Client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the Client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, invasive plants, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials, unless specifically identified in the Services.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a visual inspection of the site together with RSK's interpretation of information, including documentation, obtained from third parties and from the Client on the history and usage of the site, unless specifically identified in the Services or accreditation system (such as UKAS ISO 17020:2012 clause 7.1.6):
 - a. The Services were based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely.

- b. The Services were limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the visual inspection.
- c. The Services did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services.

RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the Client and RSK.

- 8. The intrusive environmental site investigation aspects of the Services are a limited sampling of the site at pre-determined locations based on the known historic / operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the properties of the materials adjacent and local conditions, together with the position of any current structures and underground utilities and facilities, and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters (as stipulated in the scope between the client and RSK, based on an understanding of the available operational and historical information) and it should not be inferred that other chemical species are not present.
- 9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (intrusive and sample locations etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.
- 10. The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels and ground gas concentrations and flows, may vary from those reported due to seasonal, or other, effects and the limitations stated in the data should be recognised.
- 11. Asbestos is often observed to be present in soils in discrete areas. Whilst asbestos-containing materials may have been locally encountered during the fieldworks or supporting laboratory analysis, the history of brownfield and demolition sites indicates that asbestos fibres may be present more widely in soils and aggregates, which could be encountered during more extensive ground works.
- 12. Unless stated otherwise, only preliminary geotechnical recommendations are presented in this report and these should be verified in a Geotechnical Design Report, once proposed construction and structural design proposals are confirmed.

APPENDIX B

PHOTOGRAPHIC LOG

PHOTOGRAPHIC LOG

Site Location: Swansea University Bay Campus, Swansea

Photo No.
1

Date:
21/01/2020

General view
of site facing
north



Photo No.
2

Date:
21/01/2020

General view
of site facing
southwest
from
northeast
portion

