Technical Note 006



Project:	Centre for Integrated Semiconductor Materials (CISM), Swansea University	Job No:	60605215					
Subject:	Summary of Ground Conditions for Planning Pre-App							
Prepared by:	Richard Sambrook	Date:	03/12/2019					
Checked / Approved by:	Paul Wewer	Date:	03/12/2019					

The following technical note is required to summarise the ground condition information on the site, in support of the planning pre-application.

Previous Information

A site-specific ground investigation has not yet been completed for the CISM building. The site works for the ground investigation will commence in January 2020, with an interpretative report available in February 2020.

However, we have access to 3 previous ground investigation reports, completed for 3 adjacent buildings on the Bay campus (Computational Foundry, IMPACT and ESRI), which provide the basis for the following understanding of the possible ground conditions.

The following are the conclusions of the combined 3 ground investigation reports:

Ground Conditions

The anticipated ground conditions are as follows:

A 2-3m thick horizon of made ground (gravel, cobbles and sand) was observed across the site. Beneath the made ground was 8-13m deep layer of fine to medium grained sand, overlaying a 3-5m deep layer of stiff to very stiff gravelly clay. Bedrock was encountered at approximately 20.0m below ground level, comprising of extremely weak grey mudstone.

Summary of anticipated ground conditions

Strata	Depth range to top of stratum (m b.g.l)	Depth to base of stratum (m b.g.l)	Brief description
Made Ground	Ground Level	2.50-3.20	Gravelly fine to medium SAND with many cobbles and some boulders of Quartzitic Sandstone
Aeolian Sand	2.50-3.20	10.90-15.50	Medium dense to dense light brown and yellowish brown fine to medium SAND with calcareous shell fragments.
Fluvio-Glacial Till	10.90-15.50	20.30-23.00	Stiff in places very stiff dark brown and greyish brown slightly sandy gravelly CLAY with many subrounded cobbles.
Lower Coal Measures	20.30-23.00	Unknown	Extremely weak grey MUDSTONE received as clayey sub-angular fine to medium gravel sized fragments.

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Made ground:

The investigation revealed a variable thickness of Made Ground across the site, ranging from 1.5m to 6.2m. The Made Ground was found to comprise of sandy gravel/ gravelly sand in the upper horizons, this is most likely to be associated with the up-filling works undertaken across the wider Swansea Bay Campus site. Underlying this layer the Made Ground is found to comprise of coarse gravel of mixed lithology and slag. It is anticipated that a proportion of the Made Ground will be removed and replaced with selected granular fill and/or lightweight fill. Stiffness of the Made Ground has been derived using SPT correlation E'=N60 (MPa) after CIRIA 580 (2003).

There are significant sandstone cobbles and boulders within the Glacial Deposits underlying the site. These obstructions are likely to limit the piling solution to pre-cast driven piles as there is the flexibility to remove and reinstall piles in the event of an obstruction; this is less feasible with other piling methods.

Ground Water

Ground water was encountered at depths from 0.5m – 5.4m BGL. However, from knowledge of the site we would suggest that ground water level should be assumed to be approximately 1.0m below ground level. Therefore, due to the combination of shallow ground water table and sandy soil conditions, there is a risk of excavation instability and collapse.

Ground Gas

The results of a site-specific ground investigation for an adjacent plot (ESRI) (maximum gas concentration and maximum flow rate) have been reviewed and interpret that the adjacent site should be classified as Characteristic Situation 2 (CS2) (low risk). Therefore, it is assumed that results of the site-specific ground gas monitoring for CISM will also identify it to be a CS2 classification.

The ground gas monitoring results for the adjacent building are as follows:

- Atmospheric pressure ranged between 1008 and 1023 mB
- Methane GSV Max was 0.804 l/hour
- Carbon dioxide GSV Max was 0.124 l/hour
- Oxygen ranged between 0.00% and 79.8% v.v; and
- Ground gas flow was recorded between -8.1 l/hr and 4.0 l/hr.

Note: It is also important to consider that the site used to be a BP transit site, so there is a risk of petrochemical contamination, so hydrocarbon vapours could be a risk.

Contamination

CISM is located in the north-east corner of the former BP Transit Site, which was previously used for storage of petroleum hydrocarbons and chemical products. It is understood that the Fabian Way site has undergone decommissioning, environmental assessments and remedial works since 2002. However, the extent or depth of remediation below the proposed CISM building is not clear. A 2013 site investigation report suggested that no active remedial works has been completed for ground below ESRI and only earthworks to raise site levels.

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Note:

During a 2013 investigation, BH106 (shown on the attached borehole plan) encountered a reinforced concrete slab, below which hydrocarbon impacted sand deposits were observed from 3.2 to 4.0 below ground level. A strong hydrocarbon odour and sheens indicative of phase separated hydrocarbons were also noted in conjunction with the impact sand deposits. Globules of hydrocarbon product were also observed during the collection of ground water samples from BH106.

Soil contamination:

A review of the chemical analysis has highlighted elevated concentrations of lead and zinc in soil within TP3 located beneath the proposed ESRI building. Concentrations of Total Petroleum Hydrocarbons (TPH) were recorded within soil in BH106, albeit at lower concentrations than within groundwater and analysis.

Remediation Works (2009-2012)

The works were designed to focus on the treatment of residual sources of petroleum hydrocarbon contamination within the ground and groundwater, ensuring the site was suitable for its intended end-use. The sources of residual contamination were reduced to meet the agreed target levels for human health and groundwater. A groundwater monitoring programme was set in place in order to demonstrate natural attenuation on the site to the satisfaction of Natural Resources Wales. The remedial works were completed successfully in 2011, however groundwater monitoring is on-going and continues to show degrading conditions of residual contaminants.

Geotechnical Hazards

The following ground-related hazards have been identified during the investigation:

1. Engineered Fill and Made Ground

The ground investigation carried out has identified the presence of a significant thickness of Made Ground/Engineered Fill. The Made Ground stratum beneath the site is considered to be a low bearing capacity soils. Consequently, it is considered unsuitable for shallow foundations.

2. Shallow Groundwater

Groundwater had been identified at shallow depth in some of the exploratory holes. Shallow excavations are likely to encounter groundwater and appropriate groundwater control will be required. If control of groundwater at shallow depth is likely to be difficult to achieve it is recommended that shallow excavations are limited wherever possible.

3. Obstructions

Within the Glacial Deposits cobbles and boulders of sandstone were encountered at varying locations and depths throughout the site. During the site investigation many holes encountered hard drilling and chiselling was required to penetrate to the required depth. Any foundation solution should consider these obstructions.

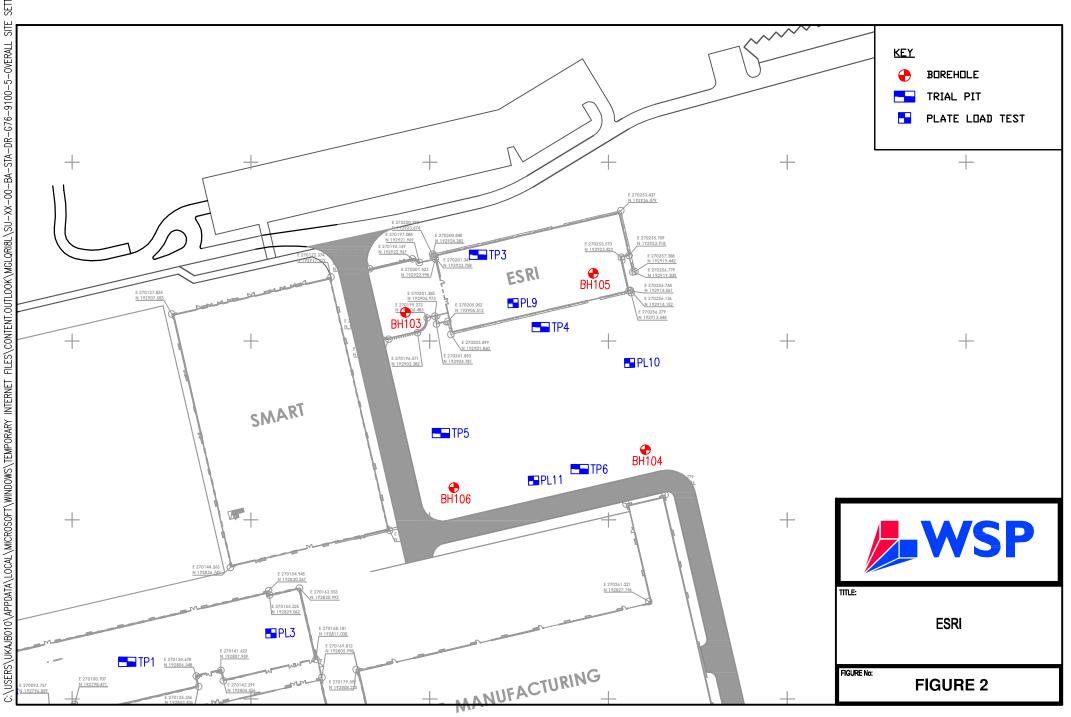
4. Contamination at Depth

The site has been remediated to a specific depth, therefore, there is a risk that ground may be contaminated at a much greater depth. Therefore, any intrusive investigations or any bored piles need to be aware of the risks associated and ensure mitigating measures.

Appendix A

2013 Ground Investigation (ESRI)

Borehole Logs



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13.50 13.50-14.00	SPT B	2,3,5 5,7,8 N=25(C)																
15.00 15.00-15.50	SPT B	3,5,5 8,8,10 N=31(C)					<	15.50	subro	ounded fine to	ightly sandy g o medium of y stone (Glacial	ravelly CLAY. ellowish brow Till).	Gravel is sub n sandstone,	angula dark g	ar to rey			
16.50 16.50-17.00	SPT B	9,7,9 12,15,15 N=51(S)																
- 18.00 18.00-18.50	SPT B	7,9,15 20,20,10 N=65(S)						- (4.80) 									GT	
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Job No	377	721			Clie	nt				Lead	bitter			D	ate	10-07- 12-07-	-13 -13	
Contracto	or / Dril Apex			Met	hod/		Used do CP		L	ogged By MC	CL	E	ates (NGR) 5 70205.000 N 92862.000		Grour	ıd Level	l (m AC	D)
SA	MPLE	S & TE	STS									STRAT	A					Install / Backfill
Depth	Туре	Test Result	DID (Vmqq)	HSV (kN/m2)	P.Pen (kN/m2)	Water	Elev. (mAOD	Depth (Thick -ness)			De	escription				Legend	Geology	Dia.
						1 <u>−</u>		(0.80) 0.80	SAN dian Cob	ND with many neter). Gravel bles and bould	comprising yel cobbles and o is subangular ders are subar ncrete (Piling I	ccassional bo fine to coarse Igular and tab	ulders (up to 3 of sandstone	300mm and cor	ncrete.		MG	
- - 1.00 - - 1.00-1.50	SPT	3,2,4 4,4,4 N=16(S)						-(1.20)	MAI GR/ of re	DE GROUND AVEL with son	comprising da ne cobbles. Gr re slag concret	rk brown and avel is angula	ar to subangula	ar fine to			MG	
-								2.00					$\langle \rangle$			\bigotimes	>	
-2.00	SPT B	2,6,12 25,25,0 N=62/ 0.225(S)						- (0.60) - 2.60	suba red	angular to sub	comprising bro rounded mediu ubangular fine out horizon,	im to coarse	of quartzitic sa	andstone	e and		MG	
-3.00	SPT	25,25,0						- (0.60) - 3.20		DE GROUND	comprising rei	nforced concr	rete (buried co	ncrete			MG	
-3.20-3.50	ES	0,0,0 N=0/ 0(C)						(0.80)	MAI impa	DE GROUND acted with hyd	comprising da rocarbon. Stro	rk grey and bl ng HC odour	ack fine to me noted.	dium S <i>I</i>	AND		MG	
						2		- - - - (0.50) - 4.50	is sı	ubangular to s	dense light brounded fine eolian Sand).	to medium c					AEOLD	
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		Time			-	rogres		Dia /-)	Meter Det	Data	Timer	Water		itee	Stordi		aoine
210-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-	-	Time 16.30 16.30		Depth 2.00 4.50		2.	ng Dpt 00 50	Dia. (m 200	111)	Water Dpt 1.00 1.5	Date 10-07-13 11-07-13	Time	Strike 0.50 4.50	Minu		Standing	1	asing 1.00 1.50
		Chis	elling					W	/ater	Added								
		To 3 3.2	-	<u>Hours</u> 1 0.45		Han	ool nmer nmer	From 0		<u>To</u> 0.5		tion obtained us	sing hand-held G bject to review fo				ely 5m.	
											-		otential hydroca	-		-		
Sca	ale 1:62.	.5	Notes: All dimensions in metres. Logs should be read in accordance with the provided Key. Descriptions are based on visual and manual identification.															

Appendix B

2013 Ground Investigation (ESRI)

Ground Gas Monitoring

Groundwater and Ground Gas Monitoring Form

VISIT 1



Site Name	Fabian Way, Swansea
Client	Leadbetter
Job No.	00037221
Date	05/08/2013
Start Time	09:30:00
End Time	16:30:00

		Equipment
Operator	Kirsty Meyer	Gas Analy
Pressure at Start mB	1008	Dipmeter
Pressure at End mB	1008	Interface F
Weather Conditions	Heavey rain	PID
Temperature oC	15 degress Celcius	

Equipment	Serial No.	Calibrated			
Gas Analyser	GA2000	Yes			
Dipmeter					
Interface Probe					
PID					

	Borehole			Response Zone (m)		. (as Flow (l/nr)		Borehole Pressure	Methan	e (% v/v)	Carbon D v/	lioxide (% v)	Oxygen	(% v/v)	Other	Gasses ((ppmV)	Depth to Water	Depth to Base	Thickness of product	
		Тор	Bottom	Initial	Steady	(mB)	Initial	Steady	Initial	Steady	Initial	Steady	PID	H2S	CO	(m)	(m)	(mm)	(Y/N)		
1	BH100(s)	0.50	3.00	-0.3	-0.3		0	0	2.6	2.6	4.5	0.8	1	0	0		3.01	0	No		
2	BH100(d)	3.50	11.20	0	0		0	0	20.1	20.1	79.2	79.8	1	0	0	2.97	8.89	0	Yes		
3	BH101(s)	0.50	3.00	2.5	2.5		1.7	1.7	3.5	3.5	1.6	0.0	2	0	0		3.04	0	No		
4	BH101(d)	3.50	10.00	-0.3	-0.3		0	0	0.1	0	20.1	20.5	2	0	0	3.11	9.78	0	Yes		
5	BH102(s)	0.50	3.00	2.2	2.2		3.1	3	2.6	2.5	0.2	0.1	0	0	0		3.06	0	No		
6	BH102(d)	3.50	10.00	1.8	1.8		0.5	1.2	0.7	1.4	8.2	1.1	0	0	0	3.13	9.01	0	Yes		
7	BH103(s)	0.50	3.00	3.0	3.1		0.1	0.1	1.5	1.5	0.5	0.0	0	0	0	2.51	3.10	0	No		
8	BH103(d)	3.50	10.00	0.1	-0.1		0	0.1	0.9	0.9	12.6	11.0	0	0	0	2.49	9.77	0	Yes		
9	BH104(s)	0.50	3.00	3.2	3.1		0	0	4.4	4.4	2.7	2.6	0	0	0	2.62	2.98	0	No		
10	BH104(d)	3.50	10.10	2.9	2.5		0	0	3.2	4	5.2	3.2	0	0	0	2.57	9.78	0	Yes		
11	BH105(s)	0.50	3.00	2.2	2.2		0	0	0	0	2.7	2.7	0	0	0	2.5	3.52	0	No		
12	BH105(d)	3.50	15.50	2.2	1.8		0.1	0.1	0.5	0.1	12.8	3.5	0	0	0	2.5	14.09	0	Yes		
13	BH106(s)	1.00	4.00	4.0	4.0		0	0	4	4.7	1.9	1.8	0	0	0	2.53	4.01	0	Yes		
14																					
15																					
16																					
	COMMENT	S & GRC	DUND CC	NDITIO	NS: BH1	01 (S) LEL = 3	3% BH10	2(S) LEL =	60% BH10)2(d) LEL =	24% BH10	03(s) LEL=2	8 BH10	4(S) and	I BH105	(s) vent air	noticeabl	у.			

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Groundwater and Ground Gas Monitoring Form

VISIT 2



Calibrated

Yes

N/A No

Site Name	Fabian Way, Swansea
Client	Leadbetter
Job No.	00037221
Date	16/08/2013
Start Time	10:00:00
End Time	14:00:00

Operator K Meyer Gas Analyser	GA5000
Pressure at Start mB 1014 Dipmeter	
Pressure at End mB 1016 Interface Probe	Bristol
Weather Conditions Sunny PID	Rem
Temperature oC 18	

	Borehole	Response Zone (m)				(as Flow (l/nr)		Borehole Pressure	Methan	ie (% v/v)	Carbon Dioxide (% v/v)		Oxygen (% v/v)		Other Gasses (ppmV)			Depth to Water	Depth to Base	Thickness of product	Sampled?
		Тор	Bottom	Initial	Steady	(mB)	Initial	Steady	Initial	Steady	Initial	Steady	PID	H2S	CO	(m)	(m)	(mm)	(Y/N)		
1	BH100(s)	0.50	3.00	0.0	0.0	-0.14	0	0	1	2.1	14.7	8.4	0	1	1	2.4185	3.04		No		
2	BH100(d)	3.50	11.20	0.0	0.0	-0.55	0	0	0.3	0.4	13.2	13.2	0	1	2	2.82	8.82		No		
3	BH101(s)	0.50	3.00	-0.7	-0.7	0.20	0.4	0.3	1.2	1.6	8.1	1.6	0	0	0	2.98	3.04		No		
4	BH101(d)	3.50	10.00	-0.1	-0.1	0.30	0	0	0.1	0.1	18.8	19.9	0	0	1	2.98	9.73		No		
5	BH102(s)	0.50	3.00	-0.9	-0.9	0.34	0.1	0	0.7	0.8	11.4	8.5	0	0	1	2.96	3.03		No		
6	BH102(d)	3.50	10.00	-5.0	-5.0	-0.20	0	0	0.3	0.3	19.1	15.0	0	0	1	2.96	8.92		No		
7	BH103(s)	0.50	3.00	-1.3	-1.3	-0.03	0.3	0.3	1.4	1.4	0.2	0.2	1	0	1	2.33	3.10		No		
8	BH103(d)	3.50	10.00	-1.3	-1.3	-0.05	0	0	0.1	0	20.6	21.0	3	0	1	2.325	9.69		No		
9	BH104(s)	0.50	3.00	-1.1	-1.1	0.10	0	0	2.5	4.3	9.8	2.3	0	0	1	2.52	2.97		No		
10	BH104(d)	3.50	10.10	-7.0	-7.0	0.27	0	0	0.6	0.6	18.0	18.0	0	0	2	2.515	9.73		No		
11	BH105(s)	0.50	3.00	-1.1	-1.1	0.00	0.21	0.1	0	0	2.2	2.1	0	0	2	2.32	3.20		No		
12	BH105(d)	3.50	15.50	-1.2	-1.2	0.00	0.3	0.5	0.3	0.5	7.6	4.7	0	0	1	2.325	13.91		No		
13	BH106(s)	1.00	4.00	-1.3	-1.3	0.17	0	0	5	5.3	1.6	1.4	1	0	1	2.55	4.02		No		
14																					
15																					
16																					
	COMMENT	S & GRC	DUND CC	NDITIO	NS:																

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Groundwater and Ground Gas Monitoring Form

VISIT 3



Calibrated Yes

No

Site Name	Fabian Way, Swansea
Client	Leadbetter
Job No.	00037221
Date	21/08/2013
Start Time	08:00:00
End Time	11:15:00

	Equipment	Serial No.
Kirsty Meyer	Gas Analyser	GA5000
1023	Dipmeter	
1023	Interface Probe	
o/cast	PID	WSP REM
19		
	1023 1023 o/cast	Kirsty Meyer Gas Analyser 1023 Dipmeter 1023 Interface Probe o/cast PID

I

	Borehole	Response Zone (m)		Gas Flow (l/hr)		Borehole Pressure	Methane (% v/v)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Other Gasses (ppmV)			Depth to Water	•	Thickness of product	Sampled?
		Тор	Bottom	Initial	Steady	(mB)	Initial	Steady	Initial	Steady	Initial	Steady	PID	H2S	CO	(m)	(m)	(mm)	(Y/N)
1	BH100(s)	0.50	3.00	1.4	1.4	-0.09	0	0	2.3	2.6	7.9	5.9	0	0	1	2.8	3.03		No
2	BH100(d)	3.50	11.20	-8.1	-7.0	0.14	0.1	0	0.2	1.1	18.3	11.3	0	1	1	2.8	8.83		
3	BH101(s)	0.50	3.00	0.8	1.0	0.12	0.7	0.7	2.2	2.3	1.4	0.3	0	0	0	2.97	3.04		
4	BH101(d)	3.50	10.00	1.2	1.2	0.03	0.3	0.2	0.8	0.6	11.9	13.9	0	0	0	2.97	9.73		
5	BH102(s)	0.50	3.00	1.0	1.0	0.22	0	0.2	0.2	1.4	19.2	10.1	0	0	0	2.96	3.05		
6	BH102(d)	3.50	10.00	-7.0	-7.0	0.40	0.1	0.1	0.3	0.3	18.8	19.0	0	0	2	2.96	8.92		
7	BH103(s)	0.50	3.00	0.8	0.8	0.70	0.4	0.4	1.4	1.4	1.3	0.5	1	0	1	2.35	3.09		
8	BH103(d)	3.50	10.00	0.6	0.6	0.00	0	0	0.1	0.1	20.0	21.0	0	0	1	2.35	9.69		
9	BH104(s)	0.50	3.00	0.1	0.1	-0.10	0	0	4.8	4.9	3.5	3.0	0	0	1	2.55	2.97		
10	BH104(d)	3.50	10.10	-0.2	-0.2	-0.20	0	0	1.3	0.5	14.8	18.9	0	0	2	2.55	9.73		
11	BH105(s)	0.50	3.00	0.4	0.4	-0.60	0	0	0.2	0.1	16.0	8.6	0	0	1	2.35	3.21		
12	BH105(d)	3.50	15.50	0.2	0.2	-0.03	0	0	0.2	0.2	17.8	18.2	0	0	1	2.35	13.86		
13	BH106(s)	1.00	4.00	-0.1	-0.1	0.15	0	0	4.8	5.4	2.9	1.5	1	0	1	2.56	3.99		
14																			
15																			
16																			
						01 &BH402-Va 11 continual ris							remove	bung as	water b	eing pulled	l and was	blocked, no	steady

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