

Site investigation of the proposed Ice Cream Parlour, Restaurant and Manager's Apartment – Swansea Foreshore.

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1. Introduction.

The City and County of Swansea and Marriott Hotels have proposed to create a new restaurant and ice-cream parlour, situated between County Hall and the Marriott Hotel (SA1 3SS), overlooking the beach. This new development would have a gross internal area of 300 square metres and include staff welfare facilities. A preliminary study of the proposal would be undertaken to establish and assess viability and feasibility. The study will focus on the industrial history and the mine workings, site accessibility, topography of the area including the soil, rock types (geology, borehole and ground water), contamination, vegetation and ecology, and underground services.

2. The Industrial History of Swansea

Waters (2005) explains how the Swansea conurbation was one of South Wales' main locations of industrial development. An area with an abundance of coal and water, industry arrived in Swansea in the 18th century and developed into the centre of the metallurgical industry, growing into the next century (BBC, 2013). Waters (2005) acknowledges that by the end of the 19th century, Swansea produced most of the world's zinc, 75% of its tinsplate and 90% of the copper. The initial growth of towns like Swansea in South Wales, was built on the extraction and processing of minerals (Waters, 2005).

One of the main locations for coal exporting and ore importing became Swansea Docks. The burgeoning smelting industry in the Neath and Lower Swansea valleys used coal as fuel. 22 plants were in the Lower Swansea Valley, where zinc, arsenic, lead and copper were smelted during the 18th and 19th centuries. The proposed development is sited near the Docks' previous location. Following the Second World War, the smelters were abandoned, became derelict, their legacy wastelands highly polluted (Waters, 2005).

The proposed development is built on land that was once a hub of coal mines and heavy industry. There is a possibility therefore that the site sits on previous mine workings, the top layers of soil consisting of made and anthropogenic ground. This poses the risk of the ground being unstable due to mine shafts and may be contaminated. Further investigation is required to confirm this and whether previous heavy industry has left a legacy that is still present today.

3. Site Location and Accessibility.

The chosen location affords excellent access, just off Oystermouth Road. One of the primary roads is a dual carriageway, used by many HGVs. Images 1 and 2 display the area of the proposed development. A limitation however is that the Marriott Hotel's parking area will be used to access the site, which could disrupt the hotel. According to (Gov.Wales, 2020) if there is a reduction in the spaces available planning permission will be required. Furthermore, disruption to The Marriot Hotel could be avoided by providing additional parking for guests at the adjacent car parks. Closing a section of the car park, using signs and barriers, would decrease the risk of any Health and Safety issues caused by HGVs entering the site carrying heavy material and machinery. In addition, residents use the footways along the front and next to the road which will be used to access the site. These footways will need to be closed to limit the risk of any potential harm to the public. Aerial images have also been taken to understand the surrounding area of the development (Figure 1). The site faces the Bristol Channel and there is a possibility that trees and shrubs may need to be removed. Vegetation will need to be checked and if it is on the list of protected species, Natural Resources Wales will need to be consulted, so permission can be granted for its removal.

Image 1: Image obtained from Google Earth illustrating the proposed site location and its accessibility. Site can be easily accessed from Oystermouth Road just north of the site and through the car park at the Marriott Hotel.



Image 2: Image obtained from Google Earth illustrating access to the site and the potential Health and Safety issues that will need to be addressed prior to the work commencing.



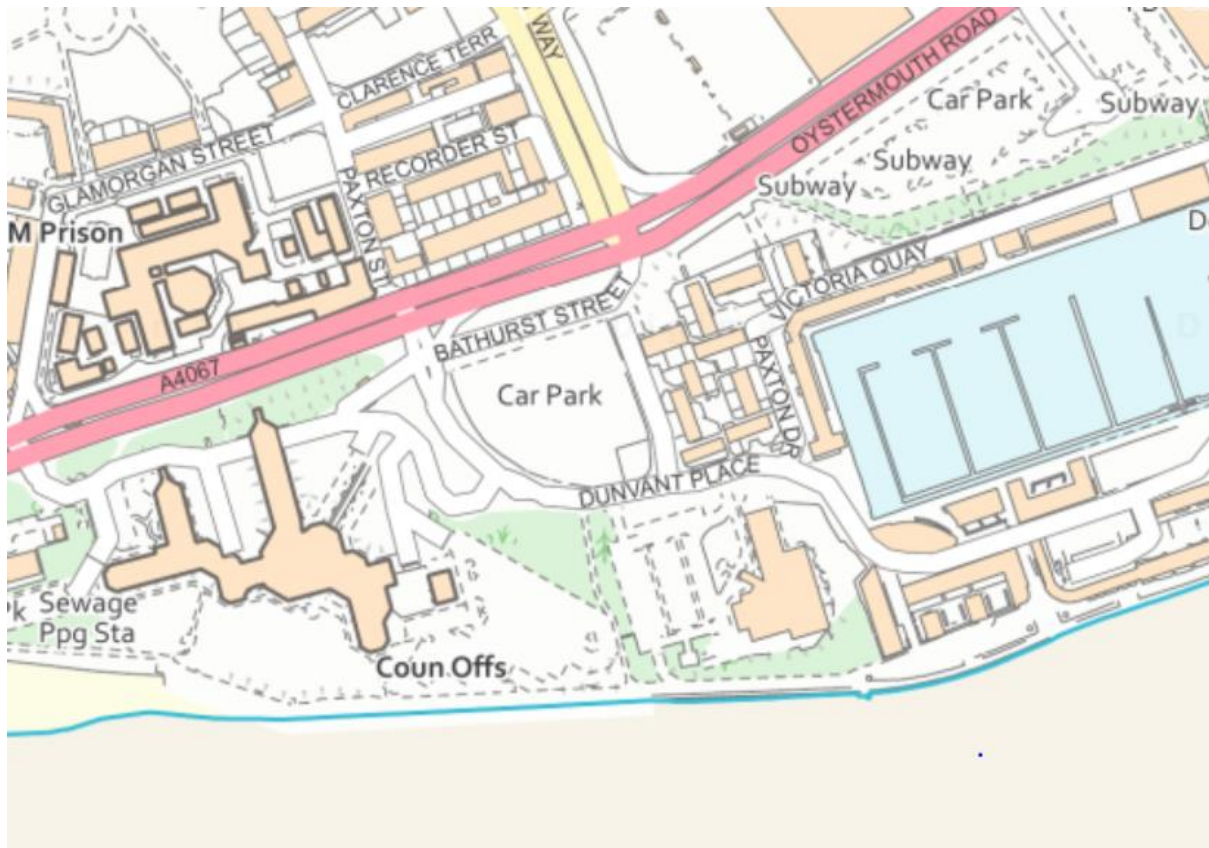


Figure 1: OS map of the area of the proposed development. Site can be easily accessed by Oystermouth Road via Dunvant Place. OS map acquired courtesy of Digimap, 2020.

4. Topography.

As part of the preliminary study, an investigation of the topography of the proposed site is required. This will provide an insight into the ground conditions and what type of land the development will be built upon. To aid the research of the topography, data from the British Geological Survey has been used.

4.1. Geology.

Bedrock geology and Superficial geology data has been used for the preliminary study.

The proposed development area is in the South Wales Coalfield, containing coal bearing siltstones, mudstones and minor sandstones from the Carboniferous Period. The British Geological Survey (2020) states the area consisted of mainly deltas, estuaries and swamps in the past, suggesting the bedrock geology of the development area is coal measures. (See figure 2).

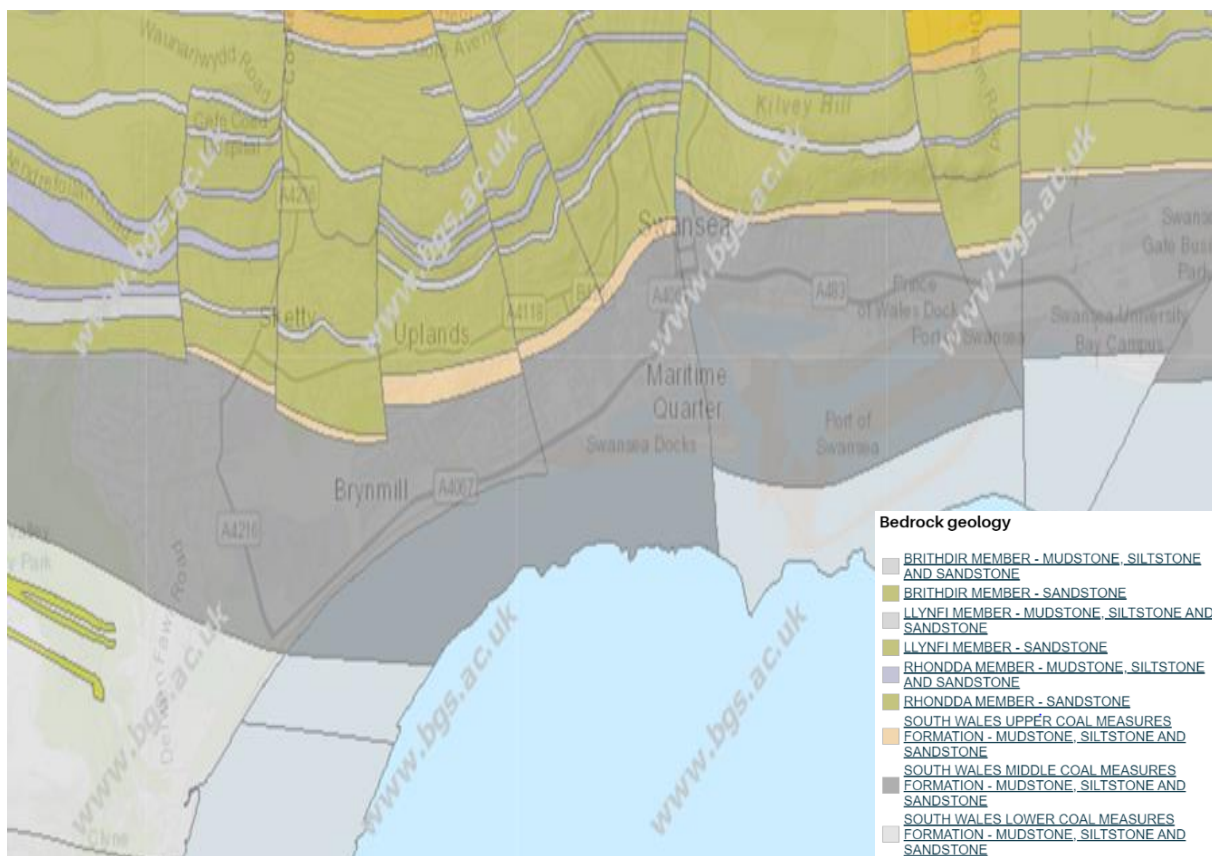


Figure 2: Geological map of the South Wales Coalfield, courtesy of the British Geological Survey (2020). Map proves that proposed development site has a bedrock geology consisting of coal measures.

Groundwater rates and flow paths are influenced by the bedrock's disposition and nature and this emphasises the importance of recognising the extensive presence of coal measures (Waters, 2005). Waters also states that Swansea's history of mineral extraction and processing left a legacy of contaminated land, water courses and groundwater. This site, therefore, could consist of made and worked ground and be highly unstable. The fact that the whole region was extensively mined for coal supports this. It should also be noted that the soil may contain toxic chemicals or gases and can be exposed upon excavation.

The superficial geology of the site would be mixed between sand (and blown sand,) silt and clay (figure 3). Where clay and silt deposits are dominated by shorelines, the alluvium deposits are fine-grained to medium, but are coarser grained than sand deposits (Anon., 2020). Due to the sandy, soft clays, the site may have poor bearing capacity, as suggested by the superficial geology of the area. The ground surrounding the site's foundations would be subject to expanding and contracting when there is an increase in rainfall and when the ground dries (Rock, 2020).

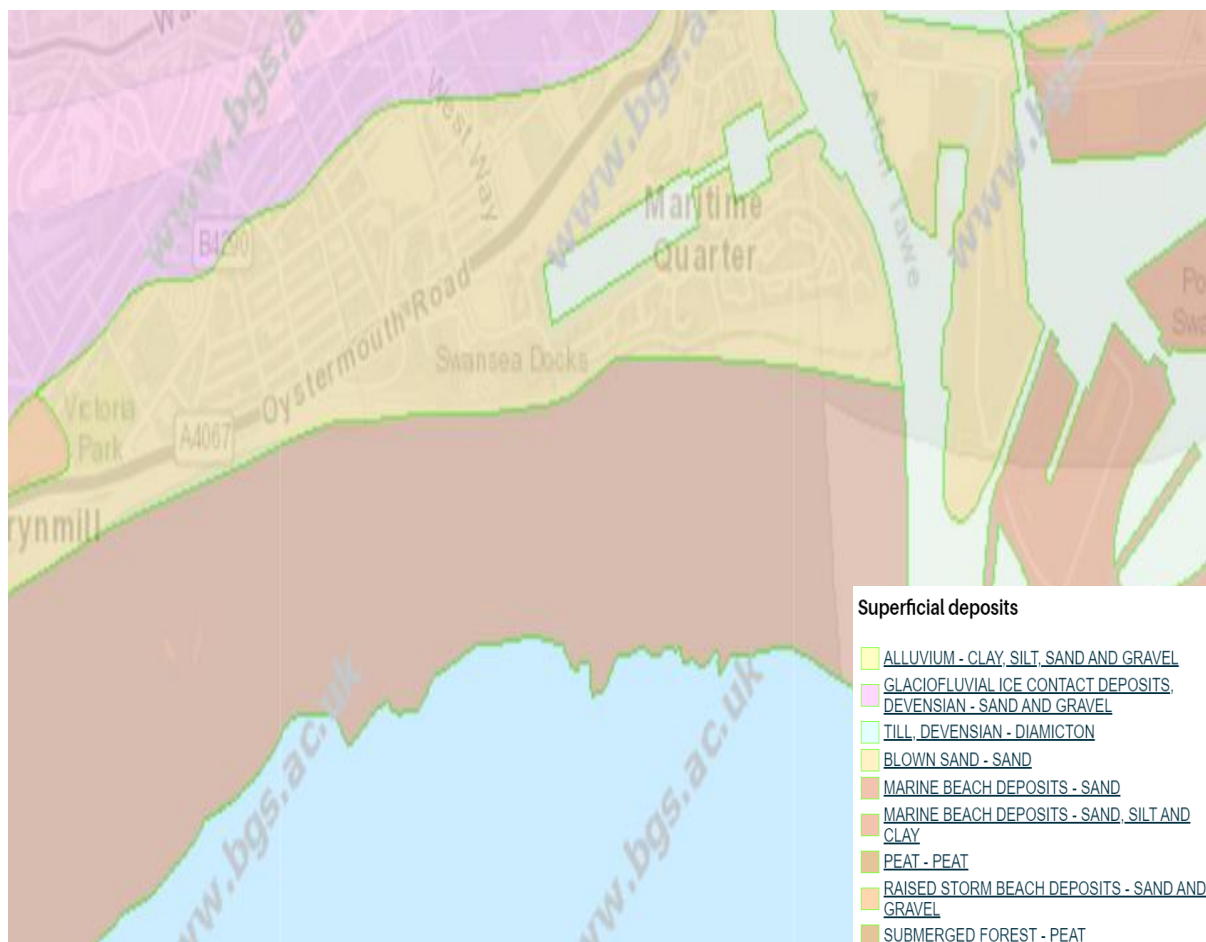


Figure 3: Superficial Geological map of the area of the proposed development site. The development site sitting between Marine Beach Deposits of Sand Silt and Clay and Blown Sand deposits.

4.2. Boreholes and Ground Water.

Further topographical analysis was undertaken by investigating Boreholes of the region through the Single Onshore Borehole Index (SOBI) via the BGS website. The investigation has established that there is a borehole adjacent to the proposed site with a depth of 22 metres (figure 4). To gather more information about the borehole and the surrounding geology, drilling was also undertaken, and a borehole log has been created, describing the strata discovered (figure 5). The results of the drilling were taken from the BGS, 2020.



Figure 4: Borehole index of the proposed site obtained by the BGS, 2020. Boreholes characterised by depth. Ranging from 0-10 metres, 10-30 metres, 30+ metres, Unknown and Confidential or Restricted. A borehole is present at the proposed development site with a depth of 22 metres.

DRILLING METHOD		GROUND LEVEL		SITE REFERENCE		BOREHOLE NUMBER		
Percussion 200 mm dia. to 15.0m "Open hole" rotary drilling From 15.0m to 22.0m		+ 9.18 m O.D		SS 65399228 ~~SS6956~~ 315		2		
MACHINE Dando "Investigator"	CORE BARREL AND BIT DESIGN	ORIENTATION Vertical		SITE PROPOSED NEW COUNTY HALL PAXTON STREET SWANSEA				
SOIL SAMPLES DEPTH AND TYPES	DRILLING AND CASING PROGRESS	WATER RECOVERY % AND a.m. LEVEL	R. Q. D.	CORE RECOVERY % AND SIZE	DESCRIPTION OF STRATA	THICKNESS	O.D. LEVEL	SYMBOL LOG
	5-2-75				MADE GROUND consisting of ashes.	0.50	5.18	
1.00 P N= 8					MADE GROUND consisting of loose, Light grey fine-medium sand.	1.00	5.68	
1.50 P N= 6					MADE GROUND consisting of grey sand with layers of soft sandy clay	1.05	7.68	
3.00 P N= 9					MADE GROUND consisting of soft red-brown sand clay with brick shale.	0.95	6.63	
4.00 P N= 75 for 150 mm					MADE GROUND consisting of dense bricks, ashes, sand and clay.	1.45	5.68	
5.00 P N= 105 for 225 mm							4.23	
6.00 P N= 75 for 150 mm	5-2-75 6-2-75	6-2-75 7-2-75 10-2-75 11-2-75 ▼ 5.7			Very dense brown sandy GRAVEL with traces of sandy clay	2.05		
7.00 P N= 77							2.18	
8.00 P N= 34					Very dense brown SAND with same gravel.	0.95		
9.00 P N= 67					Stiff grey-brown gravelly BOULDER CLAY	3.05	1.23	
10.00 P N= 63					Borehole continued to 22.0m.			
REMARKS Borehole drilled by STRATA SURVEYS Ltd Cheshire. Scale 1:50 Sheet 1 of 3 P = Standard Penetration Test N = Number of blows for 300 mm (unless otherwise stated) ▼ = Water a.m. level Borehole chiselled from 4.0m to 15.0m								
WEST GLAMORGAN COUNTY COUNCIL				COUNTY ENGINEER AND SURVEYOR'S DEPT.				

Figure 5: Borehole log created from the results of the drilling on the proposed development site. Drilling results demonstrate that the borehole goes to a depth of 22 metres. In addition, the results of the drilling also confirm what rock types are present at the different depths.

The results of the drilling demonstrate a vertical cross-section of the strata present at the site. Figure 5 proves that much of the soil of the area is made ground with some layers containing ash, meaning that there are remains from the previous mines. It also confirms that the ground type is anthropogenic. Additionally, the strata description contains brick from the depth of 2.55 metres to 4.95 metres. This points to the possible presence of retaining walls of mine shafts. On the other hand, the evidence of brick in the strata description could be evidence of a basement that spreads past the planned footprint of existing buildings or could be evidence of shallow tunnels in the proposed site. The strata description also gives an insight into how deep the foundations of the development will need to be so that it can be stable and to ensure that any other structures are also stable. Because of the strata observed, the bearings will need to be at around 7 metres or more deep. This is because the ground is less disturbed and denser, containing more favourable geology for the bearings. This would allow the building to be more secure, limiting risks of future problems. Despite this, before building the footings of the development, a trial excavation would be required to understand where the brick material has come from, which will aid understanding of any risks present. Further information on this can be observed in section 8. Moreover, as the development will be built on the seafront, the surrounding ground will be on a low contour (5 metres Above Ordnance Datum -AOD). Waters (2005) suggests that in the main valleys where tidal shift affects groundwaters in the made ground and alluvium deposits, the lower reaches and estuaries 5m in height can flood during high tides in the spring and autumn. There could be therefore, a higher risk of flooding during extreme weather due to higher ground water levels. The borehole log has demonstrated that there is 5 metres of made and anthropogenic ground, implying that the permeability rate of the ground is slow, giving an increased risk of flooding.

Boreholes have often been used as a method of supplying water, but because of previous land use, the water in the borehole could be contaminated. Further discussion on the contamination can be observed below.

5. Contamination.

The history and the ground conditions of the local area confirm that heavy industry has had a strong impact on the area. Many boreholes have been used for water abstraction to feed areas. A study undertaken by the Environment Agency (1996) in relation to Groundwater Vulnerability in Coal Measures and Alluvium deposits, discovered that it is classified in its entirety as a Minor Aquifer and comprises fractured or potentially fractured rocks which do not have a high primary permeability. These will not produce large quantities of water for abstraction, suggesting that even if the water quality was suitable for consumption, there would not be enough for the demand of the proposed development. On the other hand, Jones et al (2000) comment that for bedrock within the Coalfield, there are a few aquifer property data available, meaning that our understanding of the topic is limited. There is lack of strong evidence to prove that despite being contaminated previously, the current groundwater and borehole conditions are still unsuitable for use. Further investigation is required on the contamination of the proposed site before drawing to a firm conclusion on how feasible supplying the proposed development with borehole water will be.

6. Vegetation and Ecology.

Much of the area surrounding the site is urban (figure 6) and so there is not much vegetation present. The development though will be located on the Welsh Coastal Path and could well extend onto Swansea Bay with Littoral Rock and Littoral Sediment land cover.

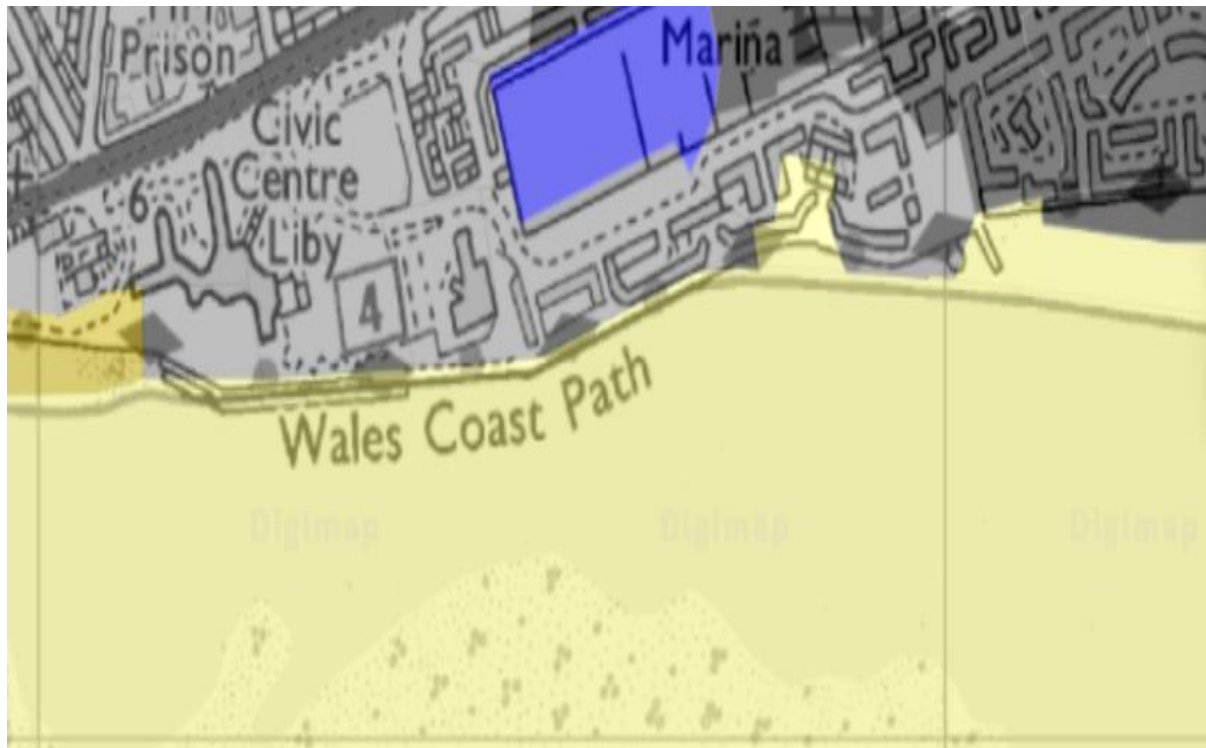


Figure 6: Land cover map obtained by Digimap, 2020. Map distinguishing the land covers in the area. With the yellow being Littoral Rock and Littoral Sand and the Grey showing an Urban Land Cover. The blue in the image is Fresh Water.

On the other hand, with the development impacting the site and part of Swansea Bay (sandy area), it should be recognised that the work can disturb the Flora and Fauna of the whole area. This could mean disturbing the breeding season of animals that migrate to the Bay. Hankantra (1981) studied the Sublittoral Microbenthic Fauna of the Inner Swansea Bay and describes the Ecology as showing a considerable variation in biological life. The fauna of the Bay consists mainly of filter feeding polychaetes and bivalves, together with hydroids, sponges and compound ascidians. Despite the area not being a Site of Special Scientific Interest (SSSI), the results demonstrated by Hankantra suggest that the area has a diverse ecology. The development may impact the flora and fauna that is present in the region. To understand if the proposed development will have an impact on the ecology - and if so, how much - an Environmental Impact Assessment will need to be undertaken prior to any work starting.

7. Underground Utilities.

With the development being in an urban area, it is probable that there are many underground utilities around the site, as well as overhead utilities. Underground cables locations are often not well documented (Metje N, 2019) and the detection of these utilities should be undertaken in accordance with PAS28. This can be accomplished by using the Cable Avoidance Tool (CAT) for scanning or by digging inspection pits to locate the services. Overhead cables will also need to be considered prior to starting any work. A site visit will be required to identify any manhole covers that are in line with the site and this could provide an insight into the location of the utilities.

8. Building Capacity

Section 4 has provided an insight into what will need to be accomplished so that the development can be secure on the site. Specific foundations have been chosen which will ensure that the weight of the building is carried, transferring the load safely to the ground. Factors such as the underlying geology, soil type and conditions and presence of water has demonstrated what foundations will be needed. Section 4 has demonstrated that the development site consists of alluvium deposits which would make the area more prone to stress or subsidence. Additionally, section 4 has highlighted that the soil conditions consist of anthropogenic ground suggesting that shallow foundations would be unsuitable for the development. Figure 5 illustrates that a reasonable bearing layer for the foundations should be at 8 metres deep because of the man-made ground not being compacted shallower than this level. This suggests that deep foundations will be required to support the proposed building. The soil type, condition and geology at 8 metres and deeper is much more feasible to support the loads of the structure and therefore a deep bearing layer will be needed making the stress bulb larger. In order to allow spread foundations to be constructed economically and where there is no satisfactory bearing stratum, consideration should be given to using deep foundations, such as piles. (GeotechnicalDesign.Info, 2018) . As advised above pile foundations will be used to support the weight of the development. Pile foundations will be used because it can transfer the load efficiently through compressible and weaker strata onto stronger and more stiff soil types and strata. Due to the urban area and the need to limit vibration, bored piles will be used and will be of concrete material. The excavations made for the bored pile foundations will be supported meaning that the excavation is provided with casing, thus avoiding collapsing. Continuous flight auger (CFA) or rotary drilling is used to create prefabricated concrete piles in supported borings (GeotechnicalDesign.Info, 2018), in accordance with BS EN 12794 (GeotechnicalDesign.Info, 2018). A sketch of a bored pile foundation and its designations can be observed in figure 7.

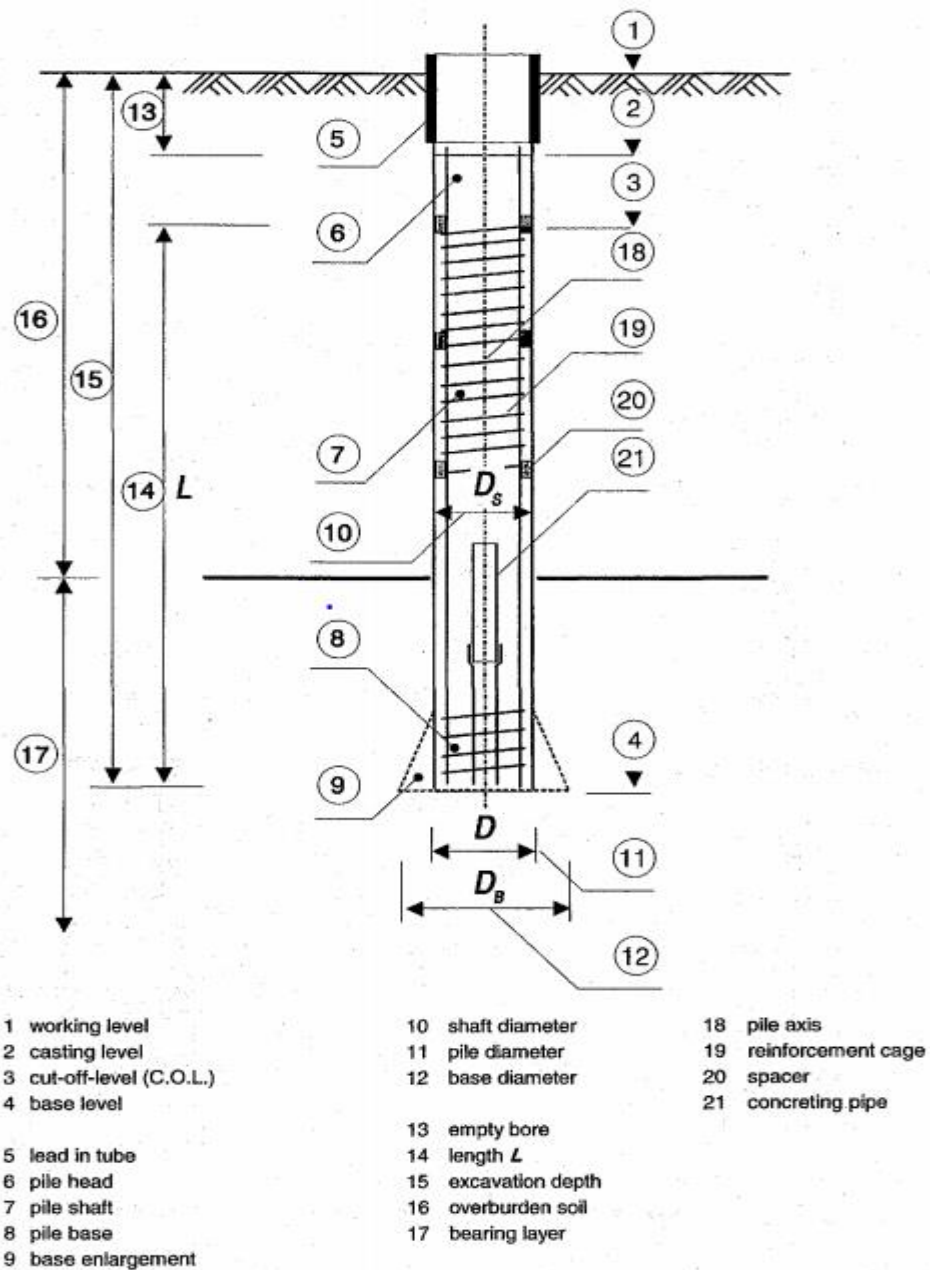


Figure 7: Bored Pile foundation example and the designations obtained by (CEN, 1999). The bored pile will be used as the foundation for the proposed development.

Additionally, due to the site being adjacent to a borehole, the foundations will need to be protected from water damage. The BSI British Standards (2009) state that in order to ensure foundations are protected from damage, a combination or one type of waterproofing protection should be selected viz;

- Type A (barrier) protection
- Type B (structurally integral) protection
- Type C (drained) protection.

Because of this the foundations will need to be protected at depth from water any other elements that the foundations can be exposed too.

9. Conclusion

The preliminary study has demonstrated that building the proposed development on this site poses many risks and challenges. Extra consideration is required for the building methods when planning the new build, with much of the attention focused on the soil and ground conditions, contamination (including mine workings) and the environment. On the other hand, the site itself provides a great opportunity for a development, with the location looking onto the Bristol Channel and is accessible from Oystermouth Road and sitting next to the Marriott Hotel. It provides an economic opportunity which would attract tourism. For the site to be feasible, bored pile foundations will be required with the bearing layer needing to be 8 metres deep. This is because of the loose soil and anthropogenic ground closer to the surface. It should be anticipated for utilities to be found on the site and the suspected utilities should be traced before any excavation begins. With the main risks identified in this report and to develop a greater understanding of the risks, a full site investigation is required. This will enable the developer to see the full perspective, so that a strategic plan can be completed to limit any of the underlying risks. With the correct methods used to control these risks and following the advice given above, the project is feasible.

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