



Tidal Lagoon (Swansea Bay) Plc

Tidal Lagoon Swansea – Onshore GI

**Ground Investigation Interpretive
Report (Phase 1)**

March 2017



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Figure 1 – Site Location Plan

Figure 2 (sheets 1-5) – Exploratory Hole Layout Plan

Figure 3a-j – Cross Sections

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Figure 5 – Site Layout Plan

Appendix A – Report Conditions

Appendix B – Exploratory Hole Logs and Photo Plates

Appendix C – CBR (by TRL Probe) Results

Appendix D – In-situ Permeability Testing

Appendix E – Geotechnical Laboratory Analysis Results

Appendix F – Chemical Laboratory Analysis Results

Appendix G – Landgas and groundwater monitoring results

Appendix H – Modelled Groundwater Levels

Appendix I – Level Logger Plots

Appendix J – Screened Chemical Analysis Results

Appendix K – CIRIA C552 Risk Assessment Methodology



Executive Summary

The Site	The site is located within the Associated British Ports Kings Dock area of Swansea Bay. The National Grid Reference for the entrance to the site is SS 69025, 92899.
Geology, Hydrogeology and Hydrology	The site is underlain by Made Ground deposits which are in turn underlain by Marine Beach Deposits and Glacial Till with Coal Measures present at depth. The Coal Measures and Marine Beach Deposits are classed as Secondary A aquifers. The nearest water features comprise Kings Dock and Swansea Bay immediately adjacent to the site.
Fieldwork	An intrusive Ground Investigation was undertaken on the site on 9th to 25th November 2016, which comprised the following scope of works; 45 No. Machine excavated trial pits, 34 No. Window Samples, 12 No. Cable percussive boreholes, 12 No. Hand-dug trial pits, 2 No. Surface water samples, topographical survey, deployment of continuous groundwater level-loggers and 6 No. ground gas and groundwater monitoring visits. A range of geotechnical, geo-environmental and ground gas samples were obtained for analysis. The field works are described in detail in a separate report.
Ground Conditions Encountered	Made Ground deposits have been encountered across all areas of the site and are typically extensive in thickness. The Made Ground soils are predominantly granular in nature and vary in composition with evidence of potential dredged material used within the construction of the outer sea wall and other mixed materials, likely to have been sourced from local industries, in many other areas of the site. A stockpile of soil arisings is present in the southwest of the site and this has been assessed as part of the investigation. The Made Ground deposits are typically underlain by Glacial Till soils comprising a mix of clay, sand and gravel; however Marine Beach Deposits of coarse sand were identified in the west of the investigation area. The underlying Coal Measures were not encountered. During the field works evidence of hydrocarbon contamination has been noted in the east of the site in the form of visual discolorations, oily soils and strong odours. These observations occurred in the vicinity of a former BP oil depot and correlate with odours and discolourations observed on the foreshore at low tide. Groundwater levels beneath the site range from approximately 7.5mAOD in the north to around 2-4mAOD in the south along the seawall. Landgas concentrations beneath the site typically indicate low flow rates and very low to low methane and carbon dioxide concentrations typical for Made Ground soils.
Ground contamination assessment	Contamination has been identified on the site comprising heavy metals (especially arsenic and lead), PAHs and trace levels of asbestos in the Made Ground soils. In addition there are significant levels of hydrocarbon contamination in parts of the site historically occupied by the tank farm and pipelines associated with a former BP oil depot. The hydrocarbon contamination present includes a range of TPH fractions, benzene and related benzene VOC compounds. The contamination present poses risks to a number of receptors. The most significant risk is considered to be to the surface water and groundwater environment arising from the source of hydrocarbon contamination within the former oil depot area. Other significant risks include risks to construction workers who may be exposed to contaminated soils during groundworks.
Conclusions and Recommendations	The principal risks to the water environment associated with hydrocarbon contamination, will require further risk assessment, monitoring and evaluation of remediation options in order to appropriately manage the risks. Risks during the construction works associated with made ground contamination will require mitigation in order to protect construction workers and other human health receptors. Soil arisings for reuse on site, or for disposal to off-site facilities, will need to consider the extent and nature of the contamination that is present. Re-use of soil arisings is likely to require a Materials Management Plan in order to comply with current guidance and waste regulations.



1 Introduction

1.1 Instruction

WYG Environment Planning Transport Ltd (WYG) was commissioned by Tidal Lagoon (Swansea Bay) Plc to undertake an intrusive ground investigation at the site of the proposed onshore works and to provide a Interpretative Report in support of the proposed construction of a Tidal Power Lagoon in Swansea Bay.

The onshore works for the Tidal Power Lagoon will comprise a series of temporary works (including site cabins / welfare, contractor compounds and laydown areas, transport / materials holding areas) and permanent works (namely; a western landfall building, access road, car parking and hardstanding public realm works). It is understood that the western landfall building will be built upon reclaimed materials.

There will also be a high voltage cable to connect the tidal turbines into the national grid at Baglan Bay. The cable route is currently excluded from the ground investigation works and will be assessed separately. A turbine manufacturing and assembly building is also proposed to be constructed on adjacent land within Swansea Docks and will also be subject to separate ground investigation.

1.2 Brief

The ground investigation was designed to provide information on the ground conditions, with a particular focus on the status of land contamination present on the site and geotechnical components in applicable areas of permanent development works. The proposed investigation included the following key elements:

- 12 No. Cable percussive boreholes to a maximum depth of 15.0m;
- 21 No. Windowless sample exploratory holes to a maximum depth of 5.0m;
- 42 No. Machine excavated trial pits;
- 14 No. in-situ TRL Probes tests (CBR) adjacent to trial pits;
- Collection of disturbed and undisturbed soil samples;
- Geotechnical and chemical laboratory testing of soil samples;
- Installation of groundwater monitoring standpipe piezometers in the boreholes to monitor groundwater levels and to sample groundwater;
- Installation of ground gas monitoring standpipes in the window sample exploratory holes to monitor for ground gases;
- 6 No. return visits to monitor and sample groundwater levels, surface waters and ground gases.



- Factual report containing records of the works carried out, exploratory hole logs, photographic log, in-situ test results, monitoring results and geotechnical and chemical laboratory analysis results.

Following the completion of the works, interpretative reporting was to be provided to include a Human Health Risk Assessment, Ground Gas Risk Assessment and Groundwater Risk Assessment.

1.3 Report Scope

This report summarises the work undertaken and includes the following key elements:

- A summary of the previous WYG Desk Top Study¹ including a summary of historical mapping, general expected ground and groundwater conditions and details of an Environmental database search of key relevant agencies (it should be noted that the DTS incorporated a larger area than that covered by this first phase of ground investigation. This phase of ground investigation covers the Swansea dock areas only and further phases of ground investigation are proposed for the cable route and turbine assembly building);
- Interpretation of all in-situ, geotechnical and chemical testing results as summarised in the WYG Factual Report.
- Refinement of the preliminary Conceptual Site Model and Risk Assessment initially developed within the WYG desk study report.
- Recommendations for further stages of works or risk mitigation requirements.

1.4 Limitations

This report has been prepared in accordance with the requirements of Tidal Lagoon (Swansea Bay) Plc. It is subject to the report conditions contained in Appendix A.

The information contained in this report is intended for the use of Tidal Lagoon (Swansea Bay) Plc. WYG can take no responsibility for the use of this information by any third party or for uses other than that described in this report.

¹ Tidal Lagoon Swansea Bay Onshore Works, Ground Conditions Desk Study Report, WYG, 19th April 2016.



2 Site Information

2.1 Location

The project site is located within the Associated British Ports Kings Dock area of Swansea Bay. The National Grid Reference for the entrance to the site is SS 69025, 92899, with the nearest postcode recorded as SA1 8QP.

A site location plan is provided in Figure 1 - Site Location Plan.

2.2 Site description

The site comprises five distinct areas as described below and as shown in Figure 5 – Site Layout Plan. Detailed descriptions and photographs can be found in the previous WYG Phase 1 Desk Top Study.

Western Landfall Area and Western Landfall Access Road

The area comprises a road extending from the Associated British Ports (ABP) security hut and limited areas of landscaping which extend out along the southern seawall towards the western most extremity of the site (the proposed location of the Western Landfall Building). A number of areas of stockpiled demolition crushings, soil arisings, general waste and scrap metal are present along the seawall road.

At the western terminus of the road the site is occupied by docks, hardstanding and a derelict building noted to include asbestos cement sheeting in a poor state of repair. There are areas of hardstanding and open ground present which were anecdotally reported by the Client to have been occupied by oil tanks. A recently constructed wind turbine is present.

The Western Landfall is intended to be developed to include a site operations and management building upon land to be reclaimed from the Lagoon / Swansea bay, car parking and hardstanding areas. Development of the Access Road will comprise further hardstanding and public realm works as well as installation of an underground 275kv high voltage cable to be placed at an approximate depth of 1.8mbgl.

Morrissey Land

This area is north of the central road that passes through the ABP site. To the north of the central ABP road and extending up to Fabian Way there is an area of soft and slightly boggy ground.

West of this area is an open area of former railway ballast which is intended to be used for site offices during the construction phase. A few items of scrap metal were noted across this area but there was no notable evidence of potential surface contamination. The area is raised approximately 2m higher than the adjacent dockside and shares a boundary, marked by a palisade fence, with the former Swansea Coach works to the immediate north.



The Morrissey Land area is intended to be used only on a temporary basis as the location of site cabins and welfare facilities during the development of the Tidal Lagoon. Permanent works are proposed in this area comprise the construction of part of the access road for future site visitors which will ultimately lead down to the Western Landfall area.

Contractor Laydown Area

The northern part of the proposed Contractor Laydown Area comprises a predominantly vacant hardstanding area surrounded by palisade fencing. The area is used for the temporary storage of windturbine parts on occasion.

Immediately south of the hardstanding area is an area predominantly covered in sand, with isolated areas of vegetation. The southern boundary of this area is defined by the Western Landfall Access Road. This area is also under the ownership of ABP and it is understood that some amount of voluntary remediation was undertaken in this area on behalf of ABP, albeit records could not be supplied to WYG for consultation at this time.

The Contractor Laydown area is intended to be used on a temporary basis for the storage of plant, equipment and materials, sub-assembly of materials and sub-contractor site accommodation. The permanent works proposed in this area comprise the installation of the high voltage (275kv) cable feed through to Fabian Way, the installation of a shallow 11kv cable to supply the construction phase works and the creation of part of the access road leading down to the Western Landfall.

Transport Hub

The Transport Hub area is located on a parcel of land broadly located south of the road between Baldwin's Crescent and the ABP security hut. The area largely comprises an area of sand although there is an area of stockpile material on the area surrounded by heras fencing (which is in poor condition). The area is understood to have been formerly occupied by a series of oil storage tanks operated by BP.

The Transport Hub is to be used during the construction phase as a temporary holding and receiving area for incoming and outgoing deliveries and plant movements. This is in order to avoid traffic congestion backing up at the ABP port entrance onto local site roads. There may be limited, temporary site accommodation in operation; however, there are no permanent works are proposed in this area.

2.3 Geology

The BGS Solid and Drift Map Number 247 for Swansea (1:50,000 scale) indicates that the area is underlain by superficial deposits comprising of Made Ground and Marine and Tidal Flat Deposits (undifferentiated), the latter of which is inferred to underlie the Made Ground. The BGS describe this as a composite of 'Beach deposits': Shingle, sand, silt and clay; may be bedded or chaotic; beach deposits may be in the form of



dunes, sheets or banks, and 'Tidal Flat Deposits': commonly silt and clay with sand and gravel layers; possible peat layers; from the tidal zone.

The underlying bedrock consists of the South Wales Middle Coal Measures Formation in the north and Lower Coal Measure Formation in the south. Both formations consist of mudstone, siltstone and sandstone.

2.4 Hydrogeology

The bedrock is classified as a Secondary A Aquifer by Natural Resource Wales (NRW). Secondary A Aquifers are defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

The Marine Beach Deposits are designated as Secondary Undifferentiated Aquifers. These comprise cases where it is not possible to attribute category A or B to a stratum. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the stratum type.

Secondary B Aquifers are defined as predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. This is generally assigned to the water-bearing parts of the former non-aquifers.

The site is not located within a Groundwater Source Protection Zone.

2.5 Hydrology

The River Tawe flows into the sea immediately west of the site. The western arm of the site is confined by the Queen's dock to the north and the sea to the south. The Queen's Dock is part of a wider dock system including the King's' Dock and Prince of Wales Dock which are located between the Queen's dock and the River Tawe to the north and west of the site. A pond is present within the Sewage works adjacent to the north of the site. Drainage ditches are marked along the A483 along the northern boundary of the site.

Coastal waters of Swansea Bay are located along the southern boundary of the site.

2.6 Radon

A site specific radon report indicated that the site is located in an area where radon protection measures are not required for the construction of new buildings on the site.

2.7 Site History

The site is located in an area with an extensive history of industrial development since the construction of the docks circa 1918. Land uses on the site have included:



- a timber yard, fish meal works, railway sidings, oil storage tanks and various other industrial processes at the Western Landfall area
- a BP oil depot with extensive oil storage tanks at the Contractor Laydown Area and Transport Hub
- Railway lines and oil pipelines connected to the former BP oil depot running along or adjacent to the Western Landfall Access Road.
- Various industrial works and railway sidings at the Morrisey Land area.



3 Preliminary Site Conceptual Model

The preliminary conceptual models for the site are presented below and are based on the information in the previous WYG Desk Top Study. Three conceptual models were presented within the previous desk study, the first two of which are applicable to this phase of the work whilst the third PCSM applies to an area of land not covered within this current phase of intrusive works. These PCSMs are summarised below, please refer to the DTS for more detail and drawings relating to these conceptual models.

3.1.1 Preliminary conceptual site model 1

PCSM1 covered the western area of the site along the Queen's Dock including the proposed Western Landfall Building, access road and part of the Contractor Laydown Area.

Sources

The sources of potential contamination stem from the historical industrial use of the site. The individual sources are outlined below:

- Potential contamination associated with storage tanks (leak or spillage of petroleum hydrocarbons);
- Potential contamination with asbestos at surface associated with derelict factory building (former fish meal factory);
- Potential contamination associated with Made Ground containing slag and clinker likely to be sourced from surrounding industrial processes (heavy metals, polyaromatic hydrocarbons (PAHs, sulphate and cyanide);
- Potential contamination associated with timber yard (metals and metalloids, inorganic compounds, acids/alkalis, organic solvents, preservatives);
- Evidence of hydrocarbon contamination identified in previous site investigations; and
- Ground gas from the Made Ground soils (methane, carbon dioxide and carbon monoxide).

Pathways

The primary pathways by which sensitive receptors may come into contact with ground contamination are considered to be the following:

- Direct contact of potentially contaminated soil with new built structures (chemical attack of potentially contaminated soil on new built structures);



- Direct dermal contact or ingestion of potentially contaminated soil or inhalation of dust originating from potentially contaminated soil;
- Migration and accumulation of gases or vapours through permeable sub-surface materials and/or preferential pathways;
- Leaching and horizontal or vertical migration through the unsaturated ground, either through permeable sub-surface materials and/or preferential pathways.

Receptors

The following are considered to be sensitive receptors:

- Current site users;
- Construction workers;
- Future site users;
- Proposed new structures (Western Landfall Building etc);
- Cable duct;
- Controlled waters (Tawe Estuary, Swansea Bay).

3.1.2 Preliminary conceptual site model 2

PCSM2 covers the Morrissey Land, northernmost area of the Contractor Laydown Area and the Transport Hub.

Sources

The potential sources of contamination considered in the risk assessment are listed below:

- Potential contamination associated with historical land use off and on site including smelter and paint works, aluminium and cable works, railway wagon repair works and gas works (metals, inorganic compounds, acids/alkalis, organic compounds e.g. aliphatic/aromatic hydrocarbons, halogenated solvents, asbestos, cyanide);
- Potential contamination associated with Made Ground containing slag and clinker from surrounding industrial processes (heavy metals, PAHs, sulphate and cyanide);
- Potential contamination associated with a former oil depot (leak or spillage of petroleum hydrocarbons, GRO/DRO and BTEX) which extends beyond the site boundary;



- Evidence of hydrocarbon contamination associated with fine sand lenses embedded in Marine Beach Deposits (petroleum hydrocarbons, GRO/DRO and BTEX);
- Potential contamination associated with redundant pipework in relation to the BP Transit site (leak of petroleum hydrocarbons, GRO/DRO and BTEX), and
- Ground gas from the Made Ground soils (methane, carbon dioxide and carbon monoxide).

Pathways

The primary pathways by which sensitive receptors may come into contact with ground contamination are considered to be the following:

- Direct contact of potentially contaminated soil with new built structures (chemical attack of potentially contaminated soil on new built structures);
- Direct dermal contact or ingestion of potentially contaminated soil or inhalation of dust originating from potentially contaminated soil;
- Migration and accumulation of gases or vapours through permeable sub-surface materials and/or preferential pathways;
- Leaching and horizontal or vertical migration through the unsaturated ground, either through permeable sub-surface materials and/or preferential pathways.

Receptors

The following are considered to be sensitive receptors:

- Current site users;
- Construction workers;
- Future site users;
- Proposed temporary structures of construction compound including offices and welfare units and haul road;
- Cable duct;
- Controlled waters (Swansea Bay).



4 Site Investigation

The site investigation was undertaken between the 9th November and 25th November 2016. Full details regarding the site investigation works and results obtained are provided in our separate Ground Investigation Factual Report², dated February 2017. **Error! Reference source not found.** sheets 1 - 5 show the layout of the exploratory holes advanced during the site investigation.

4.1 Scope

The scope of the site investigation included the following:

Western Landfall Area

- 2 No. cable percussive exploratory holes (BH1 and BH2) to a maximum depth of 10.20m and 12.40m. Standard Penetration Tests (SPTs) were conducted and undisturbed U70, bulk and environmental samples were collected. 50mm groundwater monitoring standpipes were installed in both holes upon completion.
- 28 No. machine excavated trial pits (TP01-TP08, TP27-TP31 and HP01-HP15) to depths ranging between 0.50m and 2.80m. Bulk disturbed and environmental samples were collected at various depths.
- 4 No. Windowless sample boreholes (WS01-WS04) to a depth of 5.0m. Bulk and environmental samples were collected. 50mm groundwater monitoring standpipes were installed in all holes upon completion.

Western Landfall Access Road

- 2 No. cable percussive exploratory holes (BH3 – BH4) to depths between 3.95m and 9.00m. Standard Penetration Tests (SPTs) were conducted and undisturbed U70, bulk and environmental samples were collected. 50mm groundwater monitoring standpipes were installed in both holes.
- 2 No. machine excavated trial pits (TP09-TP11) to depths ranging between 1.60m and 3.00m. Bulk disturbed and environmental samples were collected at various depths.
- 8 No. Windowless sample boreholes (WS05-WS07 and WS22-WS26) to a maximum depth of 5.0m. Bulk and environmental samples were collected. 50mm groundwater monitoring standpipes were installed in all holes upon completion.

² Tidal Lagoon Swansea Bay Onshore Ground Investigation Factual Report, WYG, February 2017.



Morrissey Land

- 1 No. cable percussive exploratory hole (BH5) to a depth of 12.40m. Standard Penetration Tests (SPTs) were conducted and undisturbed U70, bulk and environmental samples were collected. A 50mm groundwater monitoring standpipes was installed upon completion.
- 4 No. machine excavated trial pits (TP013-TP16) to depths ranging between 1.60m and 2.80m. Bulk disturbed and environmental samples were collected at various depths.
- 4 No. Windowless sample boreholes (WS08-WS11) to a maximum depth of 5.0m. Bulk and environmental samples were collected. 50mm groundwater monitoring standpipes were installed in all holes upon completion.

Contractor Laydown Area

- 6 No. cable percussive exploratory holes (BH6-BH11) to depths ranging between 9.50m and 15.00m. Standard Penetration Tests (SPTs) were conducted and undisturbed U70, bulk and environmental samples were collected. 50mm groundwater monitoring standpipes were installed in all holes upon completion.
- 5 No. machine excavated trial pits (TP12, TP17-TP20) to depths ranging between 2.10m and 2.20m. Bulk disturbed and environmental samples were collected at various depths.
- 6 No. Hand-dug pits on the foreshore (HP16-HP21).
- 14 No. Windowless sample boreholes (WS12-WS17 and WS27-WS34) to a maximum depth of 5.0m. Bulk and environmental samples were collected. 50mm groundwater monitoring standpipes were installed in all holes upon completion.

Transport Hub

- 1 No. cable percussive exploratory holes (BH12) to a depth of 9.00m. Standard Penetration Tests (SPTs) were conducted and undisturbed U70 (where possible) bulk and environmental samples were collected. 50mm groundwater monitoring standpipe installed.
- 6 No. machine excavated trial pits (TP21-TP26) to depths ranging between 0.50m and 3.40m. Bulk disturbed and environmental samples were collected at various depths.
- 4 No. Windowless sample boreholes (WS18-WS21) to a depth of 5.0m. Bulk and environmental samples were collected. 50mm groundwater monitoring standpipes were installed in all holes upon completion.
- 6 No. Hand-dug pits on the foreshore (HP22-HP27).



5 Ground Conditions Encountered

5.1 Strata encountered

The general sequence of strata encountered beneath the various parts of the site was as follows;

Western Landfall Area

- Made Ground
- Glacial Deposits.

Western Landfall Access Road

- Made Ground

Morrissey Land

- Made Ground
- Glacial Deposits.

Contractor Laydown Area

- Made Ground;
- Beach Deposits;
- Glacial Deposits.

Transport Hub

- Made Ground
- Glacial Deposits.

A more detailed description of the strata encountered is presented in the following sections by area.

5.2 Part A – Western Landfall Area

A summary of depth/thickness of each stratum is provided in Table 1 and descriptions of each stratum are detailed in the subsequent sections. Exploratory hole logs including photographic plates can also be seen in **Error! Reference source not found..**

Table 1 - Summary of strata depths (m bgl) for all exploratory holes

Exploratory Position	Made Ground (m)	Glacial Deposits (m)
BH1	GL - 10.20	ne ⁺
BH2	GL - 11.00	11.00 – 12.40
HP01	GL - 2.35	ne ⁺
HP02	GL - 2.40	ne ⁺
HP03	GL - 2.35	ne ⁺
HP04		ne ⁺
HP05	GL - 2.40	ne ⁺
HP06	GL - 2.20	ne ⁺
HP07	GL - 2.20	ne ⁺
HP08	GL - 2.40	ne ⁺
HP09	GL - 2.80	ne ⁺
TP01	GL - 2.80	ne ⁺
TP02	GL - 2.20	ne ⁺
TP03	GL - 2.20	ne ⁺
TP04	GL - 2.00	ne ⁺
TP05	GL - 2.00	ne ⁺
TP06	GL - 2.20	ne ⁺
TP07	GL - 1.20	ne ⁺
TP08	GL - 1.50	ne ⁺
TP27	GL - 1.00	ne ⁺
TP28	GL - 1.50	ne ⁺
TP29	GL - 2.60	ne ⁺
TP30		ne ⁺
TP31	GL - 1.60	ne ⁺
WS01	GL - 5.00	ne ⁺
WS02	GL - 5.00	ne ⁺
WS03	GL - 5.00	ne ⁺
WS04	GL - 1.46	ne ⁺

ne⁺ - Not Encountered

5.2.1 Made Ground

Made Ground was encountered within all the exploratory holes across the Western Landfall Area. It was generally found to comprise black becoming brown (with depth) sand with varying amounts of gravel that decreased in content with depth.

It is worth noting that HP01 to HP10 were excavated within a material stockpile within the Western Landfall Area. This material was generally described as 'black slightly silty very gravelly fine to coarse SAND with

frequent sandstone and iron slag cobbles'. The gravel was sub-angular to sub-rounded fine to coarse and composed of sandstone, brick, iron slag with variable amounts of wood, coal, metal and glass.

5.2.2 Glacial Deposits

Glacial deposits were only encountered in BH2 - the base of which was not proven by the investigation. It was described as a 'dense brown clayey GRAVEL with cobbles'. The gravel was medium to coarse sub-rounded to rounded sandstone.

Depths and thicknesses for the principal soil types are given in Table 1 with exploratory hole logs presented in Appendix B. Figure 3a provides a cross section of the ground conditions encountered across the Western Landfall Area.

5.3 Western Landfall Access Road

A summary of depth/thickness of each stratum is provided in Table 2 and descriptions of each stratum are detailed in the subsequent sections. Exploratory hole logs including photographic plates can also be seen in **Error! Reference source not found..**

Table 2 - Summary of strata depths (m bgl) for all exploratory holes

Exploratory Position	Made Ground (m)
BH3	GL - 9.00
BH4	GL - 3.95
HP10	GL - 2.80
HP11	GL - 2.10
HP12	GL - 2.10
HP13	GL - 2.10
HP14	GL - 2.10
HP15	GL - 2.10
TP09	GL - 2.00
TP10	GL - 1.80
TP11	GL - 2.00
TP12	GL - 1.80
WS05	GL - 5.00
WS06	GL - 5.00
WS07	GL - 5.00
WS22	GL - 4.00
WS23	GL - 0.40
WS24	GL - 4.00
WS25	GL - 3.90
WS26	GL - 4.00

5.3.1 Made Ground

Made Ground was encountered within all the exploratory holes across the Western Landfall Access Road. It was generally found to comprise black becoming brown (with depth) sand with varying amounts of gravel

that decreased in content with depth. Visual and olfactory evidence of hydrocarbon contamination was noted from BH3 northwards along the Western Landfall Access Road. Hydrocarbon impacted Made Ground was encountered in BH3 (3.40-3.95m), WS05 (3.60-5.00m), WS06 (3.25-5.00m), WS07 (1.20-5.00m), WS22 (3.00-4.00m), WS24 (3.00-4.00m) and WS25 (0.10-3.90m).

It should be noted that HP10 to HP15 were excavated within a material stockpile along the Western Landfall Access Road. This material was generally described as 'black silty or clayey very gravelly fine to coarse SAND with frequent sandstone and iron slag cobbles'. The gravel was sub-angular to sub-rounded fine to coarse and composed of sandstone, brick, iron slag with variable amounts of wood, coal, metal, plastic, tiles and glass.

Figures 3b-3e provides a cross section of the ground conditions encountered across the Western Landfall Area.

5.4 Morrissey Land

A summary of depth/thickness of each stratum is provided in Table 3 and descriptions of each stratum are detailed in the subsequent sections. Exploratory hole logs including photographic plates can also be seen in **Error! Reference source not found..**

Table 3 - Summary of strata depths (m bgl) for all exploratory holes

Exploratory Position	Made Ground (m)	Glacial Deposits (m)
BH5	GL – 8.10	8.10 – 12.40
TP13	GL – 2.40	ne ⁺
TP14	GL – 3.00	ne ⁺
TP15	GL – 1.60	ne ⁺
TP16	GL – 2.80	ne ⁺
WS08	GL - 5.00	ne ⁺
WS09	GL - 4.00	ne ⁺
WS10	GL - 3.00	ne ⁺
WS11	GL – 0.40	ne ⁺

ne⁺ - Not Encountered

5.4.1 Made Ground

Made Ground was encountered within all the exploratory holes across the Morrissey Land area of the site. It was generally found to comprise coarse grained sand and gravel deposits ranging from brown sandy cobbly Gravels of sandstone, brick and iron slag and grey to black gravelly coarse SAND. Significant visual or olfactory evidence of hydrocarbon contamination was not noted within this area of the site.

5.4.2 Glacial Deposits

Glacial Deposits were only encountered in BH5 - the base of which was not proven by the investigation. It was described as a 'soft grey silty slightly cobbly CLAY'.

Figure 3i provides a cross section of the ground conditions encountered across the Morrissey Land.

5.5 Contractor Laydown Area

A summary of each stratum is provided in Table 4 and descriptions of each stratum are detailed in the subsequent sections. Exploratory hole logs and photographic plates are provided in **Error! Reference source not found..**

Table 4 - Summary of strata depths (m bgl) for all exploratory holes

Exploratory Position	Made Ground (m)	Beach Deposits (m)	Glacial Deposits (m)
BH6	GL – 6.50	6.50 – 9.00	9.00 – 10.00
BH7	GL – 8.80	-	8.80 – 15.45
BH8	GL – 5.30	5.30 – 9.00	9.00 – 10.10
BH9	GL – 9.70	-	9.70 – 15.00
BH10	GL – 7.50	7.50 – 9.00	9.00 – 9.50
BH11	GL – 9.00	-	9.00 – 15.00
TP17	GL – 2.50	ne+	ne
TP18	GL – 2.10	ne+	ne
TP19	GL – 2.30	ne+	ne
TP20	GL – 3.20	ne+	ne
WS12	GL – 4.00	ne+	ne
WS13	GL – 4.00	ne+	ne
WS14	GL – 4.00	ne+	ne
WS15	GL – 3.00	ne+	ne
WS16	GL – 4.00	ne+	ne
WS17	GL – 4.00	ne+	ne
WS27	GL – 5.00	ne+	ne
WS28	GL – 5.00	ne+	ne
WS29	GL – 4.00	ne+	ne
WS30	GL – 5.00	ne+	ne
WS31	GL – 5.00	ne+	ne
WS32	GL – 5.00	ne+	ne
WS33	GL – 5.00	ne+	ne
WS34	GL – 5.00	ne+	ne



ne⁺ - Not Encountered

5.5.1 Made Ground

Made Ground was encountered within all the exploratory holes across the Contractor Laydown Area. It was generally found to be coarse grained in nature comprising black to brown sand or gravel with variable cobble contents. Variable amounts of metal waste, iron slag, concrete, brick and wood were encountered within the Made Ground. Visual and olfactory evidence of hydrocarbon contamination was noted in the Contractor Laydown Area – most prominently in BH9 – BH11. Hydrocarbon impacted Made Ground was encountered in BH7 (4.00-5.00m), BH9 (1.00-9.70m), BH10 (0.50-6.00m), BH11 (0.50-9.00m), TP18 (2.10m), TP20 (0.20 – 3.20m), WS13 (2.60 – 3.40m), WS14 (1.30-3.00m), WS16 (2.00-3.30m), and WS17 (1.90-4.00m).

5.5.2 Marine Beach Deposits

Marine Beach deposits were encountered at depths of around 6.5 to 9mbgl in BH6, BH8 and BH10 near the approximate centre of the Contractor Laydown area. The deposits are described as a grey or brown coarse sand.

5.5.3 Glacial Deposits

Glacial Deposits were only encountered in BH6 - BH11 - the base of which was not proven by the investigation. It was generally described as a soft grey silty or sandy (sometimes slightly cobbly or gravelly) CLAY.

Visual or olfactory evidence of the hydrocarbon contamination noted in shallower strata was not identified within the Glacial Deposits in this area.

Figure 3f-h provides cross sections of the ground conditions and petroleum hydrocarbon contamination encountered across the Contractor Laydown Area.

5.6 Transport Hub

A summary of depth/thickness of each stratum is provided in Table 5 and descriptions of each stratum are detailed in the subsequent sections. Exploratory hole logs including photographic plates can also be seen in **Error! Reference source not found..**

Table 5 - Summary of strata depths (m bgl) for all exploratory holes

Exploratory Position	Made Ground (m)	Glacial Deposits (m)
BH12	GL – 7.00	7.00 – 9.00
TP21	GL – 2.00	-
TP22	GL – 2.30	-
TP23	GL – 3.30	-
TP24	GL – 3.40	-
TP25	GL – 0.50	-
TP26	GL – 0.50	-
WS18	GL – 4.00	-
WS19	GL – 4.00	-
WS20	GL – 4.00	-

5.6.1 Made Ground

Made Ground was encountered within all the exploratory holes across the Transport Hub area. It was generally found to be coarse grained in nature comprising black to brown sand with variable silt, gravel and cobble contents. Variable amounts of iron slag, brick and glass were encountered within the Made Ground. Visual and olfactory evidence of hydrocarbon contamination was noted in the Transport Hub area. Hydrocarbon impacted Made Ground was encountered in BH12 (0.20-4.50m), TP21 (0.30-2.0), TP22 (2.00-2.30m), TP23 (GL- 3.30m), TP24 (GL – 23.40m), WS18 (1.85 – 4.00m), WS19 (1.95 – 4.00m) and WS20 (3.00-4.00m).

5.6.2 Glacial Deposits

Glacial Deposits were only encountered in BH12 - the base of which was not proven by the investigation. It was described as grey clayey SAND.

Significant visual or olfactory evidence of the hydrocarbon contamination noted in shallower strata was not identified within the Glacial Deposits in this area – although a low PID reading of 3.20ppm was recorded at 9.00m bgl. Figure 3j provides a cross section of the ground conditions encountered across the Transport Hub.

5.7 Groundwater

Groundwater strikes and observations are summarised in Table 6 below. The majority of groundwater strikes occurred at depths ranging between 2 to 4 mbgl. Variation in groundwater levels on the site may be due to potential tidal influences on the groundwater regime.

Evidence of potential hydrocarbon contamination was noted on the groundwater encountered in trial pits in portions of the Contractors Laydown area, Transport hub and the Western Landfall.

Table 6 - Summary of groundwater strike

Exploratory Position	Strike (m)	Water Level after 20 mins	Observations
BH1	10.00	8.00	-
BH2	8.00	6.90	-
BH5	1.20	0.60	-
BH6	3.00	2.10	-
BH7	3.00	1.90	-
BH8	3.00	2.00	-
BH9	3.10	2.00	-
BH10	3.00	2.40	-
BH12	3.10	1.80	-
WS02	3.00	2.40	-
WS06	3.00	2.90	-
WS07	3.00	2.90	-
WS09	4.00	3.80	-
WS10	3.00	2.70	-
WS12	1.95	1.75	-
WS13	2.00	1.80	-
WS14	2.00	2.00	-
WS15	3.00	2.70	-
WS16	3.00	2.80	-
WS17	3.00	2.90	-
WS19	2.00	1.70	-
WS20	3.00	2.90	-
WS21	2.00	1.70	-
WS22	4.00	3.60	-
WS24	3.00	2.70	-
WS25	3.00	2.90	-
WS26	3.00	2.80	-
WS27	4.00	3.80	-
WS28	4.00	3.90	-
WS29	4.00	3.80	-
WS30	4.00	3.90	-
WS31	4.00	3.90	-
WS32	4.00	3.90	-
WS33	4.00	3.80	-
WS34	3.00	2.90	-
TP13	0.20	-	Seepage
TP14	0.20	-	Seepage
TP15	1.50	-	Seepage
TP16	2.50	-	Seepage – oily sheen on water's surface
TP17	2.10	-	Seepage
TP18	1.90	-	Seepage
TP20	3.00	-	Water/hydrocarbon "oozing" from pit sidewalls
TP21	2.00	-	Seepage
TP22	2.30	-	Seepage
TP23	3.10	-	Seepage – oily sheen on water's surface



TP24	3.20	-	Seepage – oily sheen on water's surface
TP29	0.50	-	Seepage – oily sheen on water's surface
TP31	0.20	-	Seepage – oily sheen on water's surface

5.8 PID Testing

A Photo-ionisation Detector (PID) was used to screen a number of samples, particularly when olfactory and visual contamination was noted as the site works progressed. The results are presented below, with respect to the specific areas of the ground investigation.

Table 7a – PID readings Western Landfall and Access Road

Exploratory Hole	Depth (m)	PID reading (ppm)
BH4	1.5	1.4
BH4	2.5	130
BH4	3	140
WS07	0.3	0
WS07	0.6	0.3
WS07	1.2	0.3
WS07	2	3
WS07	3	27
WS07	5	141
WS25	2	1.1
WS25	3	5.6
WS25	3.9	240
WS26	0.5	1.3
WS26	3	14.1
WS26	4	264

PID readings in the Western Landfall area are typically low; however along the access road several locations (BH4, WS7, WS25 and WS26) have elevated PID readings occurring from depths of around 2.5m or more and these are generally consistent with site observations of potential hydrocarbon impacts in these areas.

**Table 7b – PID readings Morrisey Land**

Exploratory Hole	Depth (m)	PID reading (ppm)	Exploratory Hole	Depth (m)	PID reading (ppm)
BH5	0.5	0.1	TP13	1.6	0
BH5	1.5	1.1	TP13	2.4	0
BH5	2.5	1	TP13	3	0
BH5	3.5	1.5	WS08	0.15	0
BH5	4.5	1.4	WS08	1	0.1
BH5	6.5	1.4	WS08	2	0.4
BH5	8.5	0.3	WS08	3	2.3
BH5	10.5	0.1	WS08	4	4.9
TP16	1	0	WS09	1.2	0
TP16	1.5	0	WS09	2	0
TP15	1	0	WS09	3	0
TP15	1.5	0	WS09	3.8	0
TP14	0.3	0	WS10	1.2	0
TP14	1.3	0	WS10	2	0
TP14	3	1.2	WS10	3	0
TP13	0.25	0	WS10	3.8	0
TP13	0.6	0	WS11	0.4	0

PID readings in the Morrisey Land area are consistently low and are not considered to be indicative of any significant hydrocarbon impacts.

**Table 7c – PID readings Contractor Laydown Area**

Exploratory Hole	Depth (m)	PID reading (ppm)	Exploratory Hole	Depth (m)	PID reading (ppm)
BH6	0.5	5.2	WS12	0.3	0
BH6	1.5	18.8	WS12	1.2	0
BH6	2.5	28.2	WS12	2	19.1
BH6	3.5	60.3	WS12	3	4.3
BH6	4.5	26.3	WS12	4	8.4
BH6	5.5	6.6	WS13	0.3	1.6
BH6	7.5	3.8	WS13	1.2	0.9
BH6	9.5	3.1	WS13	2.8	32.6
BH7	0.5	9.5	WS13	3.4	1.9
BH7	1.5	175	WS14	0.3	0.1
BH7	3.5	48.4	WS14	2	783
BH7	5.5	19.5	WS14	3	385
BH7	7.5	3.4	WS14	4	61.5
BH7	10.5	2.2	WS15	0.3	1
BH7	13.5	1.1	WS15	1	0.1
BH7	15	0.8	WS15	2	1.4
BH9	0.2	0	WS15	3	1.9
BH9	0.9	3.8	WS16	0.7	0
BH9	1.1	3.7	WS16	1.8	0
BH9	1.7	14.5	WS16	3	23.9
BH9	2.5	12.1	WS16	4	2.9
BH9	3.5	11	WS17	0.8	0.2
BH10	0.5	140	WS17	3	17.1
BH10	1	258	WS17	4	18.9
BH10	2	552	WS27	0.5	0.1
BH10	4.5	68	WS27	0.8	0.1
BH10	7.5	12	WS27	1.2	6.3
BH11	0.3	4.2	WS27	2	5.8
BH11	1	147	WS27	2	6.3
BH11	2	212	WS27	3	7.1
BH11	3	278	WS27	3	5.8
BH11	4	145	WS27	4	10.1
BH11	5	40	WS27	5	458
BH11	6	12	WS31	0.7	0.3
BH11	7	3.7	WS31	1.2	1.5
BH11	8	6.7	WS31	2	7.9
BH11	9	8	WS31	3	751
TP18	0.8	1.7	WS31	4	401
TP18	1.8	14.9	WS31	5	882
TP18	2.1	158	WS33	0.8	0.9
TP20	0.3	54.5	WS33	2	1.9
TP20	0.8	469	WS33	3	536
TP20	1.4	214	WS34	0.7	0
TP20	2.4	213	WS34	1.95	0.9
TP20	3.2	55	WS34	3	2.3

PID readings in the Contractor Laydown Area are variable with a significant number of elevated results obtained predominantly from the southern half of the area. The higher PID readings typically occur at depths of 2m or more but this is not always the case and in several instances relatively shallow samples



contain elevated PID readings. These results are generally consistent with site observations of potential hydrocarbon impacts and indicate the presence of potentially volatile hydrocarbon contamination.

Table 7d - PID readings Transport Hub

Exploratory Hole	Depth (m)	PID reading (ppm)	Exploratory Hole	Depth (m)	PID reading (ppm)
BH12	0.1	2	TP24	1.2	32.1
BH12	0.3	1.7	TP24	3	16.2
BH12	0.5	1.6	TP24	3.4	464
BH12	1.7	225	WS18	1.2	0
BH12	2.6	220	WS18	1.85	58
BH12	4.6	7.6	WS18	4	835
BH12	6.6	3.4	WS19	1	0.4
BH12	9.6	3.2	WS19	2	30.1
TP21	0.3	0.3	WS19	3	213
TP21	0.8	332	WS19	4	142
TP21	2	281	WS20	1.2	0
TP21	2	281	WS20	2	3.8
TP22	0.2	1.2	WS20	3	24.2
TP22	1	1.6	WS20	4	130
TP22	2	8.7	WS21	0.4	0.6
TP23	0.8	36.2	WS21	0.4	0.6
TP23	1	522	WS21	1.2	0.8
TP23	2.5	1246	WS21	1.2	0.8
TP23	3.3	1480	WS21	2	2.7
TP24	0.1	0.2	WS21	2	2.7

PID readings in the Transport Hub are variable with a significant number of elevated results present across the area. The higher PID readings typically occur at depths of 1m or more. These results are generally consistent with site observations of potential hydrocarbon impacts and indicate the presence of potentially volatile hydrocarbon contamination.

5.9 In Situ Testing

5.9.1 Standard Penetration Testing

Standard Penetration Tests (SPTs) were undertaken in all cable percussive boreholes. The results are presented on the exploratory hole logs included in **Error! Reference source not found..**

5.9.2 CBR (by TRL) Testing

CBR values have been determined in-situ by TRL Probe at 14 locations. The results are presented in Appendix F and summarised in **Error! Not a valid bookmark self-reference..**

Table 8 – TRL Probe Results

Location	Depth range (m bgl)	Stratum	CBR (%)	CBR over entire test section (%)
TP1	GL – 0.195	Made Ground	11.70	28.38
	0.195 – 0.274		70.70	
TP4	0.3 – 0.389	Made Ground	11.37	27.35
	0.389 – 0.397		222.81	
TP5	0.300 – 0.475	Made Ground	14.66	27.89
	0.475 – 0.519		76.48	
TP9	0.300 – 0.375	Made Ground	20.92	25.98
	0.375 – 0.403		52.33	
	0.403 – 0.478		31.45	
	0.478 – 0.575		18.79	
TP11	0.200 – 0.448	Made Ground	18.88	24.04
	0.448 – 0.474		80.34	
TP13	GL – 0.116	Made Ground	6.34	34.65
	0.116 – 0.130		114.65	
	0.130 – 0.250		65.43	
	0.250 – 0.349		40.81	
TP14	GL – 0.140	Made Ground	32.52	32.39
	0.140 – 0.192-		14.81	
	0.192 – 0.248		47.30	
TP16	GL – 0.290	Made Ground	8.59	12.91
	0.290 – 0.296		302	
TP18	GL – 0.097	Made Ground	33.16	47.68
	0.097 – 0.172		65.67	
TP19	GL – 0.068	Made Ground	19.14	52.58
	0.068 – 0.115		90.31	
TP22	GL – 0.106	Made Ground	6.98	19.75
	0.106 – 0.660		22.26	
TP31	GL – 0.048	Made Ground	16.12	50.36
	0.048 – 0.098		82.11	
WS07	GL – 0.124	Made Ground	69.76	19.07
	0.124 – 0.887		11.27	
WS32	GL – 0.626	Made Ground	21.33	20.41
	0.626 – 0.817		10.56	
	0.817 – 0.870		52.33	

5.9.3 In-Situ Permeability Testing

Falling head permeability tests were undertaken in fifteen of the standpipes installed within the boreholes and window sample holes. The testing was undertaken in accordance with BS EN ISO 22282-2 Geotechnical investigation and testing – Geohydraulic testing Part 2: Water permeability tests in a borehole using open systems. Given the likely high permeability of the soils, falling head tests were performed. Water was added to the selected installation and a water level data logger installed to monitor the changes in groundwater levels in real time.



A summary of the permeability tests and results are presented in Table 9 below and detailed calculation sheets are presented in Appendix D.

Table 9 – Summary of In-situ Permeability Test Results

Location	Standpipe Response Zone (mbgl)	Coefficient of Permeability (m/s)
BH1	9.00 to 6.00	2.798×10^{-5}
BH2	11.00 to 8.00	8.937×10^{-5}
BH3	8.50 to 7.00	1.242×10^{-4}
BH5	9.00 to 6.00	7.149×10^{-6}
BH6	7.00 to 9.00	1.337×10^{-6}
BH7	8.00 to 5.00	3.979×10^{-5}
BH8	6.00 to 2.00	2.558×10^{-5}
BH9	6.50 to 4.50	FAILED TEST
BH10	9.00 to 6.00	1.533×10^{-5}
BH11	9.00 to 6.00	6.551×10^{-6}
BH12	9.00 to 6.00	2.064×10^{-4}
WS4	4.00 to 1.00	3.609×10^{-5}
WS6	3.25 to 4.00	1.114×10^{-4}
WS8	3.80 to 1.00	8.270×10^{-5}
WS17	3.80 to 1.00	3.957×10^{-6}

The resultant rates of permeability that have been calculated for a range of depths across all the areas of the site are concurrent with the ground conditions recorded. While these tests are not appropriate for soakaway design, they give a good indication that soakaway drainage would be viable at the site on the basis of permeability.

However, as presented above, significant visual and olfactory evidence of hydrocarbon contamination has been noted. This is in addition to results that show other contaminants, such as heavy metals, in the Made Ground across the site. Due to the nature of the site, it is considered that soakaway drainage would not be an appropriate option for the site, as it could result in increased mobilisation of contaminants from within the site soils.

6 Laboratory Testing

6.1 Geotechnical Testing

Geotechnical testing was scheduled by WYG and undertaken by GSTL Ltd, an approved supplier in accordance with the requirements of WYG's quality system and are UKAS accredited for a range of geotechnical tests. The test procedures used in each case are given in **Error! Reference source not found.10**, with the results presented in Appendix E.

Table 10 - Summary of Geotechnical Tests

Test	Standard (BS1377:1990) and Accreditation	No.
Moisture content	Part 2, Clause 3.2. UKAS	12
4 Point Liquid and Plastic Limits	Part 2, Clause 4.3 and 5.3. UKAS	12
Particle size distribution by wet sieving	Part 2, Clause 9.2. UKAS	35
Particle size distribution by wet sieve and pipette analysis	Part 2, Clause 9.4. UKAS	10
Organic Matter Content – dichromate method	Part 3, Clause 3. NA	20
Dry density/moisture content relationship (4.5kg Rammer method 1 Litre Mould)	Part 4, Clause 3.3. UKAS	13
CBR at each compaction point		9
California Bearing Ratio on recompacted disturbed sample		9
Undrained shear strength of a single 100mm diameter specimen in triaxial compression without the measurement of pore pressure	Part 7, Clause 8.2	2
BRE SD1 Suite D pH, Total Sulphate, Aqueous Soluble Sulphate, Total Sulphur, Aqueous Nitrate, Aqueous Magnesium, Chloride	NA	20

6.2 Environmental Testing

The environmental chemistry of the ground was investigated by specialist chemical analysis of selected soil, surface water, groundwater and landgas samples carried out by Jones Environmental Forensics Ltd, which is an approved supplier in accordance with the requirements of WYG's quality system and is UKAS accredited for a range of chemical analyses. The test result certificates are included in Appendix .



7 Groundwater and Ground Gas Monitoring

Six return monitoring visits have been made to site, the scope of each is summarised below:

- Visit 1 and 2 - groundwater levels, ground gas concentrations (window samples only) and to obtain groundwater samples (boreholes only);
- Visit 3 – install level-loggers to determine tidal influences (boreholes only), groundwater levels and ground gas concentrations (window samples only);
- Visit 4, 5 and 6 - groundwater levels and ground gas concentrations (window samples only) with ground gas samples obtained during visit 5.

The groundwater levels were monitored during six return monitoring visits between the 1st December 2016 and 19th January 2017. A dual phase dipmeter was used to identify if any free phase LNAPL or DNAPL was present.

Groundwater samples were obtained during the first two monitoring visits using a low flow pump and in-line monitoring of water quality parameters (pH value, dissolved oxygen, temperature, specific conductivity and ORP). Water quality parameters were continually monitored until steady results were recorded which is considered to indicate that sufficient water has been purged and that groundwater being abstracted is therefore representative of the local groundwater regime. All purged groundwater was temporarily stored on site in a bulk container and removed as waste (to an appropriate facility) once laboratory analysis results were available. The monitoring data is presented in **Error! Reference source not found.** and summarised in

Groundwater levels for the site have been modelled using Surfer contouring software in order to illustrate the groundwater flow direction. The modelling process has utilised the average groundwater levels recorded for each borehole over the full monitoring period. The contoured groundwater levels, relative to ordnance datum, are presented in Appendix H and are considered to indicate a flow direction directly towards the sea as would be expected for the site.



Table overleaf.

Groundwater levels for the site have been modelled using Surfer contouring software in order to illustrate the groundwater flow direction. The modelling process has utilised the average groundwater levels recorded for each borehole over the full monitoring period. The contoured groundwater levels, relative to ordnance datum, are presented in Appendix H and are considered to indicate a flow direction directly towards the sea as would be expected for the site.

Table 11 - Summary of groundwater levels over the monitoring period

Location	Visit 1 01/12/16 Water level (m bgl)	Visit 2 12/12/16 Water level (m bgl)	Visit 3 15/12/16 Water level (m bgl)	Visit 4 20/12/16 Water level (m bgl)	Visit 5 11/01/17 Water level (m bgl)	Visit 6 19/01/17 Water level (m bgl)
WS01	3.54	3.60	3.56	3.55	3.65	3.59
WS02	Dry	Dry	Dry	Dry	Dry	Dry
WS03	Dry	Dry	Dry	Dry	Dry	Dry
WS04	3.37	3.40	3.10	3.16	3.48	3.11
WS05	3.16	3.13	3.01	3.10	3.22	3.09
WS06	2.77	2.76	2.70	nt	2.91	2.84
WS07	2.97	2.92	2.88	nt	3.01	2.95
WS08				3.40	3.57	3.33
WS09	Dry	Dry	3.35	3.37	Dry	3.31
WS10	Dry	Dry	Dry	2.60	Dry	2.54
WS12	1.40	1.51	1.38	1.41	1.45	1.39
WS14	1.88	1.90	1.88	1.88	2.02	1.79
WS15	2.07	2.15	2.09	2.10	2.14	2.04
WS16	2.18	2.17	2.17	2.16	2.20	2.09
WS17	nt	2.16	2.94	3.10	3.24	3.02
WS19	1.87	1.91	1.89	1.95	2.08	1.82
WS20	2.81	2.76	2.65	2.87	3.01	2.80
WS25		2.70	2.88	2.60	2.89	2.53
WS28	3.40	3.45	3.14	3.29	3.58	3.21
WS29	3.37	3.41	3.38	3.20	3.44	3.08
WS31	3.60	3.70	3.60	3.60	3.68	3.55
WS34	3.54	3.61	3.17	3.30	3.61	3.22
BH1	4.46	4.50	Levelloggers installed to determine tidal influence.			
BH2	4.89	4.91				
BH3	3.37	3.41				
BH4	2.67	2.68				
BH5	2.09	2.18				
BH6	1.87	1.80				
BH7	1.97	2.02				
BH8	2.57	2.62				
BH9	2.07	2.11				
BH10	1.96	2.04				
BH11	2.69	2.71				
BH12	1.40	1.4				

Note - LNAPL (denoting light non-aqueous phase liquid) was detected in WS25 only during the monitoring period. It was recorded to be between 0.11 – 0.22m thickness above the surface of the water.

7.1 Tidal Influence

Continuous level-loggers were installed for a period of time to determine if there was a tidal effect on the groundwater in the area.

The results recorded by the level-loggers are provided in Appendix I. As expected, the results show that there is a tidal influence on the local groundwater regime. Boreholes adjacent or close to the dock walls (BH1, BH3, BH10, BH11 and BH12) exhibited a fluctuation range typically in the order of around 0.1 to



0.25m in groundwater levels approximately twice per day. BH2 at the Western Landfall exhibited a twice daily fluctuation of approximately 0.6m in groundwater levels. Boreholes sited further away from the sea wall (BH5, BH7, BH8 and BH9) exhibited minimal fluctuations, generally 0.02m or less, each day.

This is considered to indicate that there is a degree of tidal influence upon the groundwater levels, particularly close to the sea wall. Therefore, it is reasonable to conclude that there is some degree of hydraulic connectivity between the shallow groundwater and the sea. The typically low fluctuations in groundwater levels suggest that the rate of flow from the groundwater into the sea may be lower than would be expected for the predominantly granular soils that have been encountered on site.

7.2 Landgas Monitoring

Landgas monitoring visits were undertaken during six return visits to site between the 1st December 2016 and 19th January 2017.

The monitoring data is presented in **Error! Reference source not found.** and the peak values, as a conservative worst case scenario, obtained during the visits are presented below in Table . Concentrations of methane exceeding 1% or carbon dioxide exceeding 5% are highlighted in bold.

Generally the most significantly elevated land gas concentrations occur within the Contractor Laydown Area (WS14, WS16 and WS31) proximal to areas noted during the fieldworks to demonstrate visual and/or olfactory evidence of hydrocarbon contamination. Similarly WS25 on the Western Access Road has elevated methane and carbon dioxide and visual evidence of hydrocarbons was noted in this area.

There is a slightly elevated (5.1%) carbon dioxide concentration in WS08 located within the Morrisey Land area. This monitoring well is installed into granular Made Ground deposits noted to contain iron slag, coal and wood fragments.

Landgas flows rates are consistently low in all locations suggesting that there is little potential for significant landgas ingress into buildings or confined spaces.

Table 12 - Summary of peak landgas concentrations over monitoring period

Location	Methane (% vol)	Carbon Dioxide (% vol)	Oxygen (minimum) (% vol)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	Borehole flow (l/h)
WS01	0.1	1.6	17.5	0	0	0.3
WS02	0.2	1.6	18.3	0	0	0.1
WS03	0.2	1.8	19.3	0	0	0.1
WS04	0.3	2.4	16.0	0	0	0.1
WS05	0.3	4.6	14.7	0	0	0.2
WS06	0.3	1.0	20.3	0	0	0.0
WS07	0.3	0.4	21.1	0	0	0.1
WS08	0.2	5.1	12.6	0	0	0.1
WS09	0.2	1.4	19.8	0	0	0.1
WS10	0.2	4.3	14.0	0	0	0.1
WS12	0.4	1.6	21.0	0	0	0.0
WS14	6.4	12.4	0.3	0	0	0.0
WS15	0.6	2.5	15.9	0	0	0.1
WS16	0.4	6.9	10.3	0	0	0.1
WS17	0.1	2.7	18.8	0	0	0.0
WS19	0.3	0.8	20.9	0	0	0.2
WS20	0.3	2.8	18.8	0	0	0.2
WS25	3.4	5.5	12.9	0	0	0.2
WS28	0.1	1.4	20.2	0	0	0.2
WS29	0.1	2.0	19.4	0	0	0.2
WS31	0.5	15.9	1.9	0	0	0.1
WS34	0.2	4.5	12.6	0	0	0.1

A total of nine landgas samples (from WS01, WS05, WS10, WS12, WS14, WS16, WS25, WS31 and WS34) were taken on the fifth monitoring visit and were analysed for bulk landgases (methane, carbon dioxide, nitrogen, oxygen and carbon monoxide) and VOCs. Results for the gas analysis are enclosed in Appendix F.

The results for the bulk gases correlate well with the data obtained from the field monitoring works with broadly similar concentrations of methane, carbon dioxide and oxygen being identified. None of the concentrations exceed the peak values identified from the field monitoring works as summarised in table 12 above.

7.3 Volatile Gas Samples

The VOC results for the gas samples record the presence of some volatiles above the limit of detection as summarised in Table 13 below.

**Table 13 - Summary of VOCs Above Limit of Detection in Landgas samples**

Determinand	Units	WS01	WS05	WS10	WS12	WS14	WS16	WS25	WS31	WS34
Benzene	ppbv	1.7		10.1		890.7	18.7	9.2		18
Toluene	ppbv	6.5	7.9	10.2	4.2	11.6	3.2	3.1	13.8	7.2
Ethylbenzene	ppbv	3	3	17.8	2.1		2.1	3.2	11.4	1.8
m&p Xylene	ppbv	8.9	5.5	12.8	5.1		3	6.7	8.9	6.7
o-Xylene	ppbv	3.6	3.1	6.1	2.2	2.3	2.4	3.5	3.1	2.7
Styrene	ppbv	3.3	3.3	3.4	2.2	2.1		1.9	2.1	1.7
Tetrachloroethene (PCE)	ppbv	1.9	13.2		1.9					
1,2-Dichloropropane	ppbv			4.5	9.4					
1,1,1-Trichloroethane	ppbv	2.6								
TPH aliphatic C4-C6	ppbv		18			1401		692	2071	14
TPH aliphatic C6-C8	ppbv	24	402	528	61	13347	798	1954	12742	740
TPH aliphatic C8-C10	ppbv	161	835	2257	280	7280	1882	4671	6518	2162
TPH aliphatic C10-C12	ppbv	70	122	503	34	73	228	331	609	193
TPH aromatic C5-C7	ppbv	13.7		10.1		890.7	18.7	9.2		18
TPH aromatic C7-C8	ppbv	6.5	7.9	10.2	4.2	11.6	3.2	3.1	13.8	7.2
TPH aromatic C8-C10	ppbv	19	15	40	11	48	10	28	38	31
TPH aromatic C10-C12	ppbv			21					53	



The volatile gas samples generally demonstrate low concentrations of BTEX compounds fractions across the site, typically at around 2 to 19 parts per billion by volume (ppbv) or less. The exception to this is WS14 where vapour phase benzene is notably higher at 890.7 ppbv. This is located within the portion of the Contractor Laydown area previously occupied by bulk storage tanks associated with the BP fuel depot.

Concentrations of vapour phase TPH fractions are present, albeit at very low levels (less than 1 part per million) in WS01 and WS05 (Western Landfall and Access Road) and WS12 in the northern part of Contractor Laydown area not previously occupied by storage tanks. TPH fractions in other areas are higher and are most notable in WS14 and WS31 located within the former tank farm on the Contractor Laydown area and in WS25 located adjacent to one of the oil depot jetties.

There are very low concentrations of chlorinated VOCs present including Tetrachloroethene (PCE), 1,2-Dichloropropane and 1,1,1-Trichloroethane. These are located as sporadic occurrences across the site and are only marginally above the limit of detection.

It is considered that the sample results indicate vapour phase BTEX and TPH fractions to be present within the footprint of the former tank farm in the Contractor Laydown area. These concentrations are not likely to be a significant risk to an open space end use but they may pose a risk to future buildings (including temporary cabins) and confined spaces such as excavations. Low concentrations of vapour phase VOCs are shown to be present across the remaining site areas at levels that are not likely to pose a significant risk to human health for the proposed end use of the site.



8 Ground Contamination Assessment

8.1 Introduction

The UK Contaminated Land Regime allows for a tiered approach to the assessment of ground contamination which is designed to allow increasingly site specific assessment, with each tier providing decreasing levels of conservatism if required. The first tier of assessment has been undertaken and is presented in this section; it comprises a comparison of site chemical data with accepted generic assessment criteria/ screening values in order to identify potential constituents of concern (CoCs) that may require further consideration by means of subsequent, more site specific tiers of assessment.

The Tier 1 screening process is intended to indicate to an assessor that any elevated concentrations of chemical compounds identified might present an unacceptable risk and that further assessment/ risk management may be required.

It should be noted that the assessment criteria for human health and controlled waters are intended to indicate to an assessor that concentrations above this level might present an unacceptable risk to the receptor and that further assessment, site investigation or remediation/risk management may be required. They are not intended to be used as categoric indicators of significant contamination.

Screened chemical data is presented in Appendix J. Figures 4a-e show the extent of contamination exceeding the applicable screening criteria.

8.2 Ground contamination assessment – Human Health

8.2.1 Tier 1 reference criteria

Generic assessment criteria/screening values are derived by means of computer modelling using input parameters reflective of typical ground conditions, chemical fate and transport properties and typical receptors and exposure scenarios. In March 2014, the Department of Environment, Food and Rural Affairs (DEFRA) with Contaminated Land: In Real Environments (CL:AIRE) published Category 4 Screening Levels (C4SLs) for a limited number of contaminants for soil with 6% Soil Organic Matter (SOM) using the Contaminated Land Exposure Assessment (CLEA) Model. Contaminant concentrations below C4SLs are considered to pose an acceptably low risk. Where C4SLs have been published, these values have been used as Generic Assessment Criteria (GAC) and where not available values produced by CIEH/LQM have been used – termed Suitable for Use Levels (S4ULs). The following screening values for soils have been used which are the most up to date at the time of reporting:

- CL:AIRE published C4SLs;



- CIEH/LQM published S4ULs.
- EA Science Report SC050021 for the sum of Poly Chlorinated Dibenzodioxins (PCDDs), Poly Chlorinated Dibenzofurans (PCDFs) and dioxin like Poly Chlorinated Biphenyls (PCBs).
- WYG internal Tier 1 Screening Criteria (issue 11) derived using the derivation tool CLEA version 1.06, in line with the current UK Contaminated Land Regime.
- Limit of Detection (LOD) for VOCs and SVOCs that do not have current applicable screening criteria.

The Soil Screening Values used in the assessment of risks to human health from soil are based on generic land-use scenarios modelled over the operational life of the site. Consequently short term (acute) exposure risks arising from activities which deviate from the assumed land-use scenario (i.e. risk to construction workers) are not considered by this assessment process. Similarly, issues of waste classification and management are not addressed by the UK CLR Framework.

The Soil Screening Values (SSVs) used as part of this assessment process (gQRA) have been developed specifically for a commercial/industrial land use scenario. This is considered to be the most appropriate end use scenario given the nature of the proposed development. The screening values adopted initially assume 1% Soil Organic Matter (SOM) for conservatism.

Due to the significant visual and olfactory evidence of hydrocarbon contamination noted during the ground investigation, a screening value of 2000mg/kg has also been used for total petroleum hydrocarbons. This is used in addition to the commercial screening criteria, to indicate where further consideration is required in relation to the petroleum hydrocarbon contamination on the site relating not only to human health but also of the wider environment and potential amenity or visual impacts. The TPH value of 2,000mg/kg has been derived based on a review of analysed samples visually identified to contain free product (i.e. described as oily soils or similar) which indicates a good correlation.

8.2.2 Tier 1 – Soil Screening

The following section identifies potential contaminants of concern (CoC) exceeding the SSV in soil samples taken during the site investigation, presenting them within the respective areas of the ground investigation. The results have been screened against the relevant (commercial land use) Tier 1 screening criteria and the potential constituents of concern are presented in Table 14(a-e) below.

Table 14a - Summary of Constituents of Concern in Soil Samples - Western Landfall Stockpile (units are mg/kg unless noted)

Constituent of Concern	No. of Samples	Min	Max	SSV	Exceedances	
					No. of exceedances	Location
Asbestos Screen	28	Absence	Presence	-	12	HP1 @ 0.30m; HP1 @ 2.0m; HP2 @ 1.0m; HP4 @ 0.50m; HP4 @ 2.0m; HP6 @ 0.50m; HP06 @ 1.00m; HP09 @ 2.00m; HP11 @ 1.00-1.50m; HP12 @ 0.50m; HP12 @ 1.00m; HP13 @ 0.50m;
Lead	28	<5	6875	2,300	1	HP04 @ 2.00m (6,875mg/kg).
Nickel	28	5.4	1860.2	980	1	HP04 @ 0.50m (1,860.2mg/kg).
Benzo(b)fluoranthene	28	<0.05	47.3	44	1	HP14 @ 0.50m (47.3mg/kg).
Dibenzo(ah)anthracene	28	<0.04	5.94	3.5	4	HP14 @ 0.50m (5.94mg/kg); HP11 @ 1.00-1.50m (3.70mg/kg); HP10 @ 1.0m (3.65mg/kg); HP08 @ 0.5m (4.20mg/kg).
Benzo(bk)fluoranthene	28	<0.07	65.47	44	3	HP14 @ 0.50m (65.47mg/kg); HP08 @ 0.5m (51.3mg/kg); HP06 @ 1.0m (44.77mg/kg).
Total aliphatics and aromatics (C5-C35) or EPH (C8-C4)	28	<30 or <38	6253	2000*	3	HP1 @ 2.00m (6019mg/kg); HP5 @ 0.50m (6253mg/kg); HP11 @ 1.00-1.50m (2068mg/kg);
Dichloromethane (DCM)	2	<0.03	0.245	0.03#	2	HP8 @ 2.00m (0.242mg/kg); HP11 @ 0.50m (0.245mg/kg);
2-methylnphthalene	2	<0.01	2.144	<0.01#	2	HP7 @ 0.30m (0.153mg/kg); HP8 @ 2.00m (2.144mg/kg);
Carbazole	3	<0.01	1.294	<0.01#	3	HP3 @ 1.00m (0.404mg/kg); HP7 @ 0.30m (0.187mg/kg); HP8 @ 2.00m (1.294mg/kg);
Dibenzofuran	4	<0.01	4.119	0.24	3	HP3 @ 1.00m (0.558mg/kg); HP7 @ 0.30m (0.244mg/kg); HP8 @ 2.00m (4.119mg/kg)

Limit of Detection (LOD) adopted for purposes of screening in absence of generic assessment criteria

* A screening value of 2,000mg/kg has been adopted to indicate potential soil sources of gross hydrocarbon that may impact upon the wider environment and controlled waters



Asbestos fibres, albeit traces of, are distributed throughout the stockpile materials. This is broadly the same with petroleum hydrocarbons. One “hotspot” of significantly elevated concentrations of lead and nickel is located in HP04.

There are low levels of a few VOCs and SVOCs present (namely dichloromethane, 2-methylnaphthalene and carbazole) in the stockpile soils above the LOD. HP3, HP7 and HP8 have elevated concentrations of dibenzofuran present exceeding the screening criteria, these are consistent with the presence and levels of carbazole present in the same samples and are likely to be due to the presence of iron slag materials in the Made Ground.

**Table 14b - Summary of Constituents of Concern in Soil Samples - Western Landfall Area (units are mg/kg unless noted)**

Constituent of Concern	No. of Samples	Min	Max	SSV	Exceedances	
					No. of exceedances	Location
Asbestos Screen	29	Absence	Presence	-	4	TP07 @ 0.30m; TP07 @ 0.50m; TP27 @ 1.0m; TP29 @ 0.60m;
Arsenic	29	5.9	1,417	640	1	TP04 @ 0 – 0.30m (1,417mg/kg)
Lead	29	<5	22,580	2,300	2	TP04 @ 0 – 0.30m (22,580mg/kg); TP06 @ 2.00m (4,901mg/kg).
Benzo(b)fluoranthene	29	<0.05	72.87	44	1	TP07 @ 0.30m (72.87mg/kg).
Dibenzo(ah)anthracene	29	<0.04	7.53	3.5	1	TP07 @ 0.30m (7.53mg/kg).
Benzo(bk)fluoranthene	29	<0.07	101.21	44	1	TP07 @ 0.30m (101.21mg/kg).
Total aliphatics and aromatics (C5-C35) or EPH (C8-C4)	29	<30 or <38	3925	2000*	1	TP01 @ 0.50m (3925mg/kg)
Dichloromethane (DCM)	1	<0.03	0.12	0.03#	1	TP05 @ 0.30m (0.123mg/kg);
2-Methylnaphthalene	2	<0.01	19.2	<0.01 [#]	2	TP01 @ 2.00m (0.072mg/kg); TP05 @ 2.00m (19.2mg/kg);
Carbazole	2	<0.01	16.5	<0.01 [#]	3	TP02 @ 1.00-1.50m (0.023mg/kg); TP01 @ 2.00m (0.03mg/kg); TP05 @ 0.30m (16.5mg/kg);
Dibenzofuran	2	<0.01	20.6	0.24	1	TP05 @ 0.30m (20.6mg/kg);

Limit of Detection (LOD) adopted for purposes of screening in absence of generic assessment criteria

* A screening value of 2,000mg/kg has been adopted to indicate potential soil sources of gross hydrocarbon that may impact upon the wider environment and controlled waters



Traces of asbestos fibres were recorded in the northern most part of the Western landfall Area (immediately north of the stockpile area). Elevated concentrations of PAH's were identified at one location only (TP07) with elevated TPH also being identified in one location (TP01). Significantly elevated concentrations of metals (arsenic and lead) are recorded in the northern (TP06) and southern (TP04) parts of the area. All of the significant CoCs identified above are found within the Made Ground soils.

There are low levels of a number of VOCs and SVOCs present (namely dichloromethane, 2-methylnaphthalene and carbazole) in the Made Ground soils in TP01, TP02 and TP05. TP05 also has an elevated concentration of dibenzofuran present at 0.3mbgl which is likely to be due to iron slag deposits in the Made Ground at this location.

Table 14c - Summary of Constituents of Concern in Soil Samples - Western Landfall Access Road (units are in mg/kg unless noted)

Constituent of Concern	No. of Samples	Min	Max	SSV	Exceedances	
					No. of exceedances	Location
Asbestos Screen	31	Absence	Presence	-	3	WS06 @ 0.30m;
Arsenic	31	5.9	668.3	640	1	TP09 @ 0.50m (668.3mg/kg).
Lead	31	<5	42,740	2,300	9	TP09 @ 0.20m (11,720mg/kg); TP09 @ 0.50m (13,650mg/kg); TP11 @ 0.30m (14,720mg/kg); WS06 @ 0.30m (11,157mg/kg); WS06 @ 1.00m (10,700mg/kg); WS07 @ 0.30m (2,943mg/kg); WS25 @ 1.00m (16,980mg/kg); WS25 @ 3.00m (42,740mg/kg); BH03 @ 1.00m (3,479mg/kg).
TPH CWG Aliphatic >C8-C10	31	<0.1	6341.8	2000	1	WS05 @ 4.0m (6341.8mg/kg).
Total aliphatics and aromatics (C5-C35) or EPH (C8-C4)	31	<30 or <38	36751	2000*	6	WS05 @ 4.00m (11,103mg/kg); WS05 @ 5.00m (1,925mg/kg); WS07 @ 4.50m (11,558mg/kg); WS06 @ 4.50m (2197mg/kg); WS24 @ 3.50m (2785mg/kg); WS25 @ 3.00m (36,751mg/kg);
Dichloromethane (DCM)	2	<0.03	0.339	0.003#	2	BH04 @ 3.00m (0.056mg/kg); WS26 @ 0.50m (0.339mg/kg)
Isopropylbenzene	6	<0.003	11.519	0.003#	6	WS05 @ 4.00m (9.340mg/kg); WS05 @ 5.00m (11.519mg/kg); WS07 @ 4.50m (1.286mg/kg); WS06 @ 4.50m (0.096mg/kg); WS24 @ 3.50m (0.126mg/kg); WS25 @ 3.00m (4.138mg/kg);
Propylbenzene	6	<0.004	33.148	0.004#	6	WS05 @ 4.00m (33.148mg/kg); WS05 @ 5.00m (25.660mg/kg); WS07 @ 4.50m (2.798mg/kg); WS06 @ 4.50m (0.224mg/kg); WS24 @ 3.50m (0.038mg/kg); WS25 @ 3.00m (6.982mg/kg);
1,2,4-Trimethylbenzene	4	<0.006	201.803	0.006#	4	WS05 @ 4.00m (24.260mg/kg); WS05 @ 5.00m (201.803mg/kg); WS07 @ 4.50m (0.070mg/kg); WS25 @ 3.00m (0.216mg/kg);
sec-Butylbenzene	5	<0.004	25.660	0.004#	5	WS05 @ 5.00m (25.660mg/kg); WS07 @ 4.50m (3.153mg/kg); WS06 @ 4.50m (0.290mg/kg); WS24 @ 3.50m (0.502mg/kg); WS25 @ 3.00m (19.348mg/kg);



Constituent of Concern	No. of Samples	Min	Max	SSV	Exceedances	
					No. of exceedances	Location
4-Isopropyltoluene	3	<0.006	4.932	0.006#	3	WS05 @ 4.00m (4.932mg/kg); WS05 @ 5.00m (0.651mg/kg); WS07 @ 4.50m (0.038mg/kg);
n-Butylbenzene	5	<0.004	30.713	0.004#	5	WS05 @ 4.00m (30.713mg/kg); WS05 @ 5.00m (27.499mg/kg); WS07 @ 4.50m (2.386mg/kg); WS06 @ 4.50m (0.174mg/kg); WS25 @ 3.00m (5.983mg/kg);
2-Methylnaphthalene	2	<0.001	0.072	0.01#	2	WS26 @ 0.50m (0.072mg/kg); WS26 @ 4.00m (0.014mg/kg);
Carbazole	1	<0.01	0.104	0.01#	1	WS26 @ 0.50m (0.104mg/kg);

Limit of Detection (LOD) adopted for purposes of screening in absence of generic assessment criteria

* A screening value of 2,000mg/kg has been adopted to indicate potential soil sources of gross hydrocarbon that may impact upon the wider environment and controlled waters

Traces of asbestos fibres were recorded in one sample from the Western Landfall Access Road only (WS06). As in other areas of the site, significantly elevated concentrations of lead (also one elevated concentration of arsenic) were encountered in the shallow Made Ground.

The petroleum hydrocarbon contamination that is evident across the wider area, is first noted in WS05 and then eastwards across the access road towards the contractor laydown area. A range of benzene and toluene compounds are present above the limit of detection in the soils. These are most significant in WS05, WS07, WS25 where concentrations of propylbenzenes, butylbenzenes, 1,2,4-trimethylbenzene and 4-isopropyltoluene are notably high. The elevated concentrations of the various hydrocarbon compounds are generally recorded between 3.50-5.00m bgl, and this correlates well with the visual, olfactory observations and PID readings made in these areas.

Table 14d - Summary of Constituents of Concern in Soil Samples - Morrissey Land (units in mg/kg unless noted)

Constituent of Concern	No. of Samples	Min	Max	SSV	Exceedances	
					No. of exceedances	Location
Asbestos Screen	13	Absence	Presence	-	1	WS10 @ 2.0m;
Lead	13	<5	45,220	2,300	8	TP14 @ 0.50m (38,190mg/kg); TP14 @ 2.00m (43,240mg/kg); TP15 @ 1.50m (3,290mg/kg); WS08 @ 1.00m (5,711mg/kg); WS09 @ 0.50m (29,730mg/kg); WS09 @ 2.00m (8,750mg/kg); WS10 @ 2.00m (4,136mg/kg); BH05 @ 2.50m (45,220mg/kg).
Dichloromethane (DCM)	2	<0.03	0.095	0.03#	2	WS09 @ 0.50m (0.068mg/kg); WS10 @ 2.00m (0.095mg/kg);
1,3,5-Trimethylbenzene	1	<0.003	0.011	0.003#	1	WS10 @ 2.00m (0.011mg/kg);
2-Methylnaphthalene	2	<0.01	0.89	0.01#	2	WS09 @ 0.50m (0.136mg/kg); WS10 @ 2.00m (0.89mg/kg);
Carbazole	2	<0.01	1.745	0.01#	2	WS09 @ 0.50m (0.573mg/kg); WS10 @ 2.00m (1.745mg/kg);
Dibenzofuran	2	<0.01	1.230	0.24	1	WS10 @ 2.00m (1.230mg/kg);

Limit of Detection (LOD) adopted for purposes of screening in absence of generic assessment criteria

* A screening value of 2,000mg/kg has been adopted to indicate potential soil sources of gross hydrocarbon that may impact upon the wider environment and controlled waters

Traces of asbestos fibres were recorded in one sample from the Morrissey Land only (WS10). As in other areas of the site, significantly elevated concentrations of lead were encountered in the Made Ground across the area.

The petroleum hydrocarbon contamination noted in other area of the site is less evident in the Morrissey Land area, which is concurrent with the field observations. There are low levels of a number of VOCs and SVOCs present (namely dichloromethane, 1,3,5-trimethylbenzene, 2-methylnaphthalene and carbazole) in the Made Ground soils in WS09 and WS10. WS10 also has an elevated concentration of dibenzofuran present at 2.0mbgl and this is likely to be due to iron slag deposits in the Made Ground at this location.

Table 14e - Summary of Constituents of Concern in Soil Samples (Contractor Laydown Area)

Constituent of Concern	No. of Samples	Min	Max	SSV	Exceedances	
					No. of exceedances	Location
Asbestos Screen	58	Absence	Presence	-	13	TP17 @ 0.30; TP18 @ 1.0m; TP18 @ 1.90m; TP20 @ 1.0m; TP20 @ 3.0m; TP22 @ 0.10m; BH06 @ 1.50m; BH07 @ 5.50m; BH08 @ 7.50m; BH10 @ 0.50m; BH10 @ 2.0m, WS13 @ 0.30m; WS14 @ 0.50m; WS34 @ 0.40m;
Lead	58	<5	61,746	2,300	8	TP17 @ 0.30m (61,746mg/kg); TP20 @ 3.00m (2,947mg/kg); WS13 @ 0.30m (5,715mg/kg); WS13 @ 2.00m (15,870mg/kg); WS27 @ 0.30m (17,700mg/kg); WS31 @ 0.50m (12,180mg/kg); WS33 @ 4.50m (2,668mg/kg); BH10 @ 2.00m (6,537mg/kg).
Total aliphatics and aromatics (C5-C35) or EPH (C8-C4)	58	<30 or <38	12,888	2000*	13	WS16@ 1.50m (2509/kg); WS14 @ 0.50m (2862mg/kg); TP19 @ 0.30m (3064mg/kg); BH10 @ 0.50m (2161mg/kg); BH10@ 1.00m (2209mg/kg); BH10@ 2.00m (3280mg/kg); TP20@ 3.00m (8915mg/kg); BH11 @ 2.00m (3093mg/kg); BH09 @ 0.50m (12,888mg/kg); TP18 @ 1.90m (4550mg/kg); WS33@ 3.50m (2520mg/kg); WS33 @ 4.50m (5719mg/kg); WS30 @ 4.00m (4513mg/kg);
Chloroethane	1	<0.006	0.012	0.006#	1	WS33@ 3.50m (0.012mg/kg);
Dichloromethane (DCM)	8	<0.03	0.404	0.03#	8	WS16 @ 3.50m (0.169mg/kg); BH10 @ 1.00m (0.058mg/kg); TP20 @ 0.20m (0.404mg/kg); TP20 @ 1.00m (0.181mg/kg); WS13 @ 4.00mg/kg (0.262mg/kg); BH9 @ 3.50m (0.035mg/kg); WS27 @ 0.30m (0.247mg/kg); WS17 @ 1.50m (0.076mg/kg);
Isopropylbenzene	16	<0.003	10.471	0.003#	15	WS16 @ 3.50m (0.006mg/kg); WS14 @ 4.00m (0.059mg/kg); BH10 @ 1.00m (0.005mg/kg); BH10 @ 2.00m (0.652mg/kg); TP20 @ 0.20m (0.004mg/kg); TP20 @ 3.00m (1.606mg/kg); BH11 @ 2.00m (0.048mg/kg); BH9 @ 3.50m (0.066mg/kg); TP18 @ 1.90m (0.011mg/kg); WS33 @ 3.50m (0.055mg/kg); WS33 @ 4.50m (10.471mg/kg); WS17 @ 1.50m (0.050mg/kg); WS17 @ 4.00m (0.006mg/kg); WS30 @ 4.00m (1.423mg/kg); WS31 @ 2.60m (0.012mg/kg);
Propylbenzene	16	<0.004	7.093	0.004#	16	WS14 @ 4.00m (0.230mg/kg); BH10 @ 1.00m (0.018mg/kg); BH10 @ 2.00m (1.805mg/kg); TP20 @ 0.20 (0.006mg/kg); TP20 @ 1.00 (0.0012mg/kg); TP20 @ 3.00 (3.245mg/kg); BH11 @ 2.00

Constituent of Concern	No. of Samples	Min	Max	SSV	Exceedances	
					No. of exceedances	Location
						(0.160mg/kg); BH9 @ 3.50 (0.01mg/kg); TP18 @ 1.90 (0.034mg/kg); WS33 @ 3.50 (0.06mg/kg); WS33 @ 4.50 (7.093mg/kg); WS17 @ 1.50 (0.031mg/kg); WS17 @ 4.00 (0.006mg/kg); WS30 @ 4.00 (3.478mg/kg); WS31 @ 2.60 (0.086mg/kg); WS32 @ 2.50 (0.005mg/kg);
1,3,5-Trimethylbenzene	11	<0.003	0.410	0.003#	11	WS14 @ 4.00 (0.007mg/kg); BH10 @ 1.00 (0.03mg/kg); BH10 @ 2.00 (0.149mg/kg); TP20 @ 0.20 (0.015mg/kg); TP20 @ 1.00 (0.215mg/kg); TP20 @ 3.00 (0.031mg/kg); BH11 @ 2.00 (0.204mg/kg); TP18 @ 1.90 (0.012mg/kg); WS33 @ 4.50 (0.083mg/kg); WS17 @ 1.50 (0.007mg/kg); WS31 @ 2.60 (0.004mg/kg).
tert-Butylbenzene	2	<0.005	0.410	0.005#	2	TP20 @ 3.00 (0.178mg/kg); WS33 @ 4.5 (0.410mg/kg);
1,2,4-Trimethylbenzene	14	<0.006	5.048	0.006#	14	WS14 @ 4.00 (0.046mg/kg); BH10 @ 1.00 (0.077mg/kg); BH10 @ 2.00 (5.048mg/kg); TP20 @ 0.20 (0.368mg/kg); TP20 @ 1.00 (0.097mg/kg); TP20 @ 3.00 (0.091mg/kg); BH11 @ 2.00 (0.415mg/kg); TP18 @ 1.90 (0.114mg/kg); WS14 @ 4.00 (0.046mg/kg); WS27 @ 0.30 (0.037mg/kg); WS33 @ 3.5 (0.056mg/kg); WS33 @ 4.5 (2.197mg/kg); WS17 @ 1.50 (0.038mg/kg); WS31 @ 2.60 (1.027mg/kg);
sec-Butylbenzene	10	<0.004	13.347	0.004#	10	WS14 @ 4.00 (0.029mg/kg); BH10 @ 2.00 (0.759mg/kg); TP20 @ 3.00 (3.555mg/kg); BH11 @ 2.00 (0.082mg/kg); BH9 @ 3.50 (0.058mg/kg); WS33 @ 3.5 (0.358mg/kg); WS33 @ 4.5 (13.347mg/kg); WS17 @ 1.50 (0.033mg/kg); WS30 @ 4.00 (4.999mg/kg); WS31 @ 2.60 (0.095mg/kg);
4-Isopropyltoluene	6	<0.006	16.431	0.006#	6	BH10 @ 2.00 (0.231mg/kg); BH11 @ 2.00 (0.019mg/kg); WS33 @ 3.5 (0.057mg/kg); WS33 @ 4.5 (1.6431mg/kg); WS17 @ 1.50 (0.029mg/kg); WS31 @ 2.60 (0.015mg/kg);
n-Butylbenzene	9	<0.004	8.330	0.004#	9	WS14 @ 4.00 (0.038mg/kg); BH10 @ 2.00 (0.985mg/kg); TP20 @ 3.00 (4.378mg/kg); BH11 @ 2.00 (0.062mg/kg); BH9 @ 3.50 (0.069mg/kg); WS33 @ 4.5 (8.330mg/kg); WS17 @ 1.50 (0.011mg/kg); WS30 @ 4.00 (3.881mg/kg); WS31 @ 2.60 (0.203mg/kg);
2-Methylnaphthalene	9	<0.01	7.673	0.01#	9	WS14 @ 4.00 (0.257mg/kg); BH10 @ 2.00 (0.573mg/kg); BH11 @ 2.00 (0.528mg/kg); BH9 @



Constituent of Concern	No. of Samples	Min	Max	SSV	Exceedances	
					No. of exceedances	Location
						6.50 (0.029mg/kg); WS27 @ 0.30 (0.274mg/kg); WS33 @ 3.5 (0.096mg/kg); WS17 @ 1.50 (0.074mg/kg); WS17 @ 4.00 (0.019mg/kg); WS30 @ 4.00 (7.673mg/kg);
Carbazole	4	<0.01	0.449	0.01#	4	BH9 @ 6.50 (0.025mg/kg); WS27 @ 0.30 (0.449mg/kg); WS17 @ 1.50 (0.069mg/kg); WS30 @ 1.00 (0.015mg/kg);
Dibenzofuran	7	<0.01	0.266	0.01	1	WS27 @ 0.30 (0.266mg/kg);

Limit of Detection (LOD) adopted for purposes of screening in absence of generic assessment criteria

* A screening value of 2,000mg/kg has been adopted to indicate potential soil sources of gross hydrocarbon that may impact upon the wider environment and controlled waters

Traces of asbestos fibres were recorded widely within the shallow Made Ground of the contractor Laydown area. It was also noted in deeper samples of Made Ground (BH07 at 5.50m and BH08 at 7.50m). As in other areas of the site, elevated concentrations of lead were encountered in the Made Ground.

In line with the visual and olfactory evidence of petroleum hydrocarbon contamination that was noted during the works, the results show elevated concentrations of petroleum hydrocarbons in the Contractor Laydown area. A range of predominantly benzene and toluene VOC compounds, as well as dichloromethane, are widely present above the limit of detection in the soils in the contractor laydown area. These are most significant in TP20, BH10, WS30, WS31 and WS33 where concentrations of propylbenzenes, butylbenzenes, and trimethylbenzenes are notably high. These locations are all sited in the southern and eastern parts of the area beneath the former storage tank farm location. In the other samples the VOCs and SVOCs are generally low, typically less than 1mg/kg. There is an isolated and marginal exceedance for dibenzofuran in WS27 and an isolated result for chloroethane in WS33.

Table 14d - Summary of Constituents of Concern in Soil Samples – Transport Hub Area (unites mg/kg unless noted)

Constituent of Concern	No. of Samples	Min	Max	SSV	Exceedances	
					No. of exceedances	Location
Asbestos Screen	58	Absence	Presence	-	1	WS21 @ 0.30m
Total TPH (C5-C35) and EPH (C8-C4)	58	<30 or <38	6744	2000*	6	WS20 @ 4.00m (6744mg/kg); WS18 @ 4.00m (4469mg/kg); TP24 @ 2.50m (3558mg/kg); TP24 @ 3.20m (5403mg/kg); TP23 @ 3.10m (4040mg/kg); BH12 @ 0.30m (3535mg/kg).
Dichloromethane (DCM)	4	<0.03	0.591	0.03	4	TP22 @ 0.50m (0.051mg/kg); TP22 @ 2.10m (0.084mg/kg); WS19 @ 3.00m (0.591mg/kg); WS21 @ 2.00m (0.086mg/kg);
1,2-Dibromoethane	1	<0.003	0.036	0.003#	1	TP24 @ 3.20m (0.036mg/kg);
Isopropylbenzene	5	<0.003	1.357	0.003#	5	TP22 @ 2.10m (0.01mg/kg); WS19 @ 3.00m (0.057mg/kg); WS18 @ 4.00m (0.086mg/kg); TP24 @ 3.20m (1.357mg/kg); TP23 @ 3.10m (0.055mg/kg);
Propylbenzene	4	<0.004	2.033	0.004#	4	WS19 @ 3.00m (0.057mg/kg); WS18 @ 4.00m (0.086mg/kg); TP24 @ 3.20m (2.033mg/kg); TP23 @ 3.10m (0.057mg/kg);
1,2,4-Trimethylbenzene	5	<0.006	1.357	0.006#	5	WS18 @ 4.00m (0.086mg/kg); TP24 @ 3.20m (1.357mg/kg); TP23 @ 3.10m (0.055mg/kg); WS18 @ 4.00m (0.012mg/kg); TP24 @ 3.20m (0.022mg/kg);
sec-Butylbenzene	5	<0.004	1.864	0.004#	5	TP22 @ 0.50m (0.015mg/kg); WS18 @ 4.00m (0.178mg/kg); TP24 @ 3.20m (1.864mg/kg); TP23 @ 3.10m (0.0299mg/kg); BH12 @ 2.60 (0.007mg/kg);
4-Isopropyltoluene	1	<0.006	0.009	0.006#	1	BH12 @ 2.60 (0.009mg/kg);
n-Butylbenzene	3	<0.004	2.110	0.004#	3	WS18 @ 4.00m (0.085mg/kg); TP24 @ 3.20m (2.110mg/kg); TP23 @ 3.10m (0.161mg/kg);
Carbazole	1	<0.01	0.153	0.01#	1	WS19 @ 3.00m (0.153mg/kg);

Limit of Detection (LOD) adopted for purposes of screening in absence of generic assessment criteria

* A screening value of 2,000mg/kg has been adopted to indicate potential soil sources of gross hydrocarbon that may impact upon the wider environment and controlled waters



Trace levels of asbestos fibres were recorded within one sample of Made Ground (WS21 at 0.30m).

In line with the visual and olfactory evidence of petroleum hydrocarbon contamination that was noted during the works, the results show elevated concentrations of petroleum hydrocarbons in the area. This was generally in the southern extent of the transport hub area between the depths of 2.50 – 4.00m, with the exception of a result from BH12, where an elevated concentration was recorded near the surface at 0.30m.

A range of benzene and toluene VOC and SVOC compounds are present above the limit of detection in the soils. These are most significant in TP24 where concentrations of propylbenzenes, butylbenzenes, and 1,2,4-trimethylbenzene are notably high. In the other samples the VOCs and SVOCs are generally low, typically less than 0.1mg/kg.

As can be seen from Table a-d, a number of potential CoCs have been identified during the screening exercise in the respective areas. Consideration of these is given in the conceptual models presented later in this report.

The distribution of contaminants exceeding applicable generic screening criteria is illustrated on Figures 4a-e (this excludes contaminants exceeding LODs for purposes of clarity).



8.3 Ground Contamination Assessment – Wider Environment

The following sections consider the risk to the wider environment from soil contaminants and from local groundwater beneath the site. Assessment of potential risk to the wider environment is important to evaluate whether ground conditions, or indeed current or historic activities/facilities associated with the site, are impacting significantly on sensitive nearby habitats and/or water resources.

8.3.1 Controlled Waters Reference Criteria

Given the immediate proximity of the coastal waters of the Bristol Channel, it is considered to be the most significant receptor of contaminants in the groundwater below the site. As such the following environmental quality screening criteria, listed in order of preference, are used in the assessment process:

- Environmental Quality Standards (EQS) – Coastal and transitional waters; and
- UK Drinking Water Standards (DWS) (where EQS values are not available).
- World Health Organisation (WHO) guide values for TPH-CWG fractions in drinking water (quoted in the new CL:AIRE Petroleum Hydrocarbons in Groundwater guidance March 2017).

With regard to the controlled waters assessment, some generic assessment criteria are below the laboratory method detection limit for particular constituents. In these instances the limit of detection is considered sufficient in highlighting potentially significant contamination and so has been defaulted to as the screening tool where necessary.

8.3.2 Tier 1 – Groundwater Screening

Twenty-two groundwater samples were taken during two return monitoring visits obtained between one to two weeks after the intrusive site investigation works were completed. These were submitted for chemical testing and the results screened against the EQS (coastal and transitional waters) or UK DWS where necessary.

A number of exceedances of the relevant screening values were identified and are summarised in Table (a-e) below.

Table 15a - Summary of Constituents of Concern in Groundwater Samples (Western Landfall Access Road)

Determinant	No. of exceedances	Min (ug/L)	Max (ug/L)	Screening Value (ug/L)	Sample exceedances
Arsenic	1	<0.9	42.2	25 [#]	BH03 (42.2ug/l)
Fluoranthene	2	<0.01	0.02	0.01 ^{LOD}	BH03 (0.01ug/l); BH03 (0.02ug/l);
Boron	2	56	3285	1000 ⁺	BH03 (3249ug/l); BH03 (3285ug/l).

EQS (Transitional and Coastal Waters)

+ UK Drinking Water Standard

- EQS (Transitional and Coastal Waters) plus regional freshwater EQS

Two samples of groundwater were taken from BH03 along the Western Landfall Access Road. Results from one of the samples indicate an exceedance of the arsenic screening values which is an EQS for transitional and coastal waters. Results from the Made Ground in the area also show elevated concentrations when compared with natural background levels as described in the WYG Desk Study report (not the human health criteria discussed above). The BGS Urban Soil Chemistry (measured concentration map) for Arsenic also indicates that arsenic concentrations are elevated in the area. Therefore, while it is likely that the Made Ground is impacting upon local groundwater, this is likely to be a local trend.

Exceedances of Fluoranthene were also identified, both of which is considered to be marginal in nature. With respect to boron the screening criteria used is the UK DWS and therefore is inherently conservative.

Table 15b - Summary of Constituents of Concern in Groundwater Samples (Western Landfall Area)

Determinant	No. of exceedances	Min (ug/L)	Max (ug/L)	Screening Value (ug/L)	Sample exceedances
Cadmium	1	<0.5	1.6	0.2 [#]	BH01 (1.6ug/l).
Copper	2	<3	19	3.76 [#]	BH02 (12ug/l); BH02 (19ug/l);
Zinc	4	<3	273	9.6 ⁻	BH01 (273ug/l); BH01 (23ug/l); BH02 (25ug/l); BH02 (25ug/l)
Cyanide	1	<1	2	1 [#]	BH03 (2ug/l);



Determinant	No. of exceedances	Min (ug/L)	Max (ug/L)	Screening Value (ug/L)	Sample exceedances
Fluoranthene	1	<0.01	0.01	0.01 ^{LOD}	BH01 (0.01ug/l).
Boron	4	56	1573	1000 ⁺	BH01 (1520ug/l); BH01 (1467ug/l); BH02 (1566ug/l); BH02 (1573ug/l);

EQS (Transitional and Coastal Waters)

+ UK Drinking Water Standard

- EQS (Transitional and Coastal Waters) plus regional freshwater EQS

Four samples of groundwater were taken from BH01 and BH02 (two from each) within the Western Landfall Area. Chemical analysis of the samples indicates exceedances of cadmium, copper and zinc when compared to the screening values (EQS for transitional and coastal waters). Results from the Made Ground in the area also show elevated concentrations of zinc and when compared with natural background levels (not the human health criteria discussed above) and therefore it is likely that the Made Ground is impacting upon local groundwater to some extent. Additionally, the BGS Urban Soil Chemistry (measured concentration map) for cadmium also indicates that cadmium concentrations are elevated in the area. It should be noted that the geochemistry of zinc and cadmium are associated. It is therefore likely that the exceedance of cadmium is a local trend.

It is noted that the high concentrations of arsenic and lead identified in the soil samples in parts of this area (TP04 and TP06) do not appear to have had a corresponding impact to groundwater quality.

Exceedances of cyanide and Fluoranthene were also identified, both of which are considered to be marginal in nature. With respect to boron the screening criteria used is the UK DWS and therefore is inherently conservative.

Table 15c - Summary of Constituents of Concern in Groundwater Samples (Morrissey Land)

Determinant	No. of exceedances	Min (ug/L)	Max (ug/L)	Screening Value (ug/L)	Sample exceedances
Arsenic	2	<0.9	486.2	25 [#]	BH05 (39.7ug/l); BH05 (486.2ug/l)
Zinc	2	<3	121	9.6 ⁻	BH05 (105ug/l); BH05 (121ug/l);

EQS (Transitional and Coastal Waters)

+ UK Drinking Water Standard

- EQS (Transitional and Coastal Waters) plus regional freshwater EQS

Two samples of groundwater were taken from BH05 within the Morrissey Land. Results from both samples indicate exceedances of the arsenic and zinc screening values which are both the EQS for transitional and coastal waters. Results from the Made Ground in the area also show elevated concentrations when compared with natural background levels (not the human health criteria discussed above). The BGS Urban Soil Chemistry (measured concentration map) for Arsenic also indicates that arsenic concentrations are elevated in the area. Therefore, while it is likely that the Made Ground is impacting upon local groundwater, this is likely to be a local trend.

Table 15d - Summary of Constituents of Concern in Groundwater Samples (Contractor Laydown Area)

Determinant	No. of exceedances	Min (ug/L)	Max (ug/L)	Screening Value (ug/L)	Sample exceedances
Arsenic	6	<0.9	29.6	25 [#]	BH07 (29.6ug/l); BH08 (27.0ug/l)
Mercury	1	<0.01	0.09	0.07	BH06 (0.09ug/l)
Zinc	17	<3	548	9.6 ⁻	BH06 (35ug/l); BH06 (58ug/l); BH07 (76ug/l); BH07 (83ug/l); BH08 (10ug/l); BH10 (46ug/l); BH10 (27ug/l); BH11 (44ug/l); BH11 (548ug/l).
Cyanide	3	<1	5	1 [#]	BH11 (2ug/l); BH11 (5ug/l).
Fluoranthene	9	<0.01	0.36	0.01 ^{LOD}	BH06 (0.10ug/l); BH08 (0.01ug/l); BH09 (0.36ug/l); BH09 (0.35ug/l); BH11 (0.04ug/l); BH12 (0.01ug/l).
Benzene	2	<0.5	42.2	8 [#]	BH11 (36.3ug/l); BH11 (42.2ug/l).
TPH CWH Aliphatic >C5-C6	4	<10	83	10 ⁺	BH11 (50ug/l); BH11 (83ug/l)
				15,000 [*]	No exceedances
TPH CWH	3	<10	427	10 ⁺	BH11 (293ug/l); BH11 (427ug/l);

Determinant	No. of exceedances	Min (ug/L)	Max (ug/L)	Screening Value (ug/L)	Sample exceedances
Aliphatic >C6-C8				15,000*	No exceedances
TPH CWH Aliphatic >C8-C10	2	<10	115	10 ⁺	BH11 (90ug/l); BH11 (115ug/l).
				150	No exceedances
TPH CWH Aromatic >EC5-EC7	2	<10	50	8 [#]	BH11 (27ug/l); BH11 (50ug/l).
				10 [*]	BH11 (27ug/l); BH11 (50ug/l).
TPH CWH Aromatic >EC10-EC12	1	<5	116	2 [#]	BH11 (116ug/l).
				90 [*]	BH11 (116ug/l).

EQS (Transitional and Coastal Waters)

+ UK Drinking Water Standard

* WHO (2008) Drinking Water Standards

- EQS (Transitional and Coastal Waters) plus regional freshwater EQS

Concentrations of arsenic, mercury, zinc and cyanide have been recorded to exceed their respective screening values, as in the other areas of the site described above. The arsenic, mercury and cyanide exceedances are considered to be marginal in comparison to the screening criteria, whilst the zinc exceedances are more significant.

There are exceedances of groundwater screening values related to petroleum hydrocarbon fractions, benzene and fluoranthene, most notably in BH11 located in the south of the site towards the sea wall. The screening criteria used for the TPH aliphatic fractions are related to drinking water standards (due to the absence of applicable EQS criteria) and hence are inherently conservative.

Alternative guidance in relation to the assessment of petroleum hydrocarbons in water have been published by the World Health Organisation (WHO). The TPH aliphatic fractions do not exceed the WHO drinking water standards. There are several potentially significant exceedances of EQS values by benzene and TPH aromatic fractions which may pose a risk to the coastal waters.

Guidance also suggests that consideration should be given to the overall relative mobility of specific hydrocarbon fractions in groundwater. All of the hydrocarbon fractions highlighted as potential CoC are considered to have either moderate or high mobility in groundwater, with the exception of the aliphatic C8-C10 band which is considered to have low mobility.

Table 15e - Summary of Constituents of Concern in Groundwater Samples (Transport Hub)

Determinant	No. of exceedances	Min (ug/L)	Max (ug/L)	Screening Value (ug/L)	Sample exceedances
TPH CWH	4	<10	48	10 ⁺	BH12 (44ug/l). BH12 (48ug/l);

Determinant	No. of exceedances	Min (ug/L)	Max (ug/L)	Screening Value (ug/L)	Sample exceedances
Aliphatic >C5-C6				15,000*	<u>No exceedances</u>
TPH CWH Aliphatic >C6-C8	3	<10	34	10 ⁺	BH12 (34ug/l).
				700*	<u>No exceedances</u>
Selenium	1	<1.2	30.9	10 ⁺	BH12 (30.9ug/l).

EQS (Transitional and Coastal Waters)

+ UK Drinking Water Standard

- EQS (Transitional and Coastal Waters) plus regional freshwater EQS

* WHO (2008) Drinking Water Standards

Selenium is indicated to be a potential CoC in groundwater at the transport hub area. However, the screening value is a UK drinking water standard (in the absence of other appropriate screening values) and is therefore likely to be conservative. In light of this, the concentrations of selenium recorded in the area are not likely to be a significant risk to Controlled Waters.

Aliphatic petroleum hydrocarbons have been identified as a potential CoC in the groundwaters of the transport hub area based upon comparison with UK DWS values. These occur in locations that generally correlate with the presence of hydrocarbon contamination identified within the soils. The TPH fractions do not exceed the WHO drinking water standards. Both of the petroleum hydrocarbon fractions highlighted in the table above are considered to have moderate to high mobility in groundwater.

8.3.3 Tier 1 – Surface water screening (foreshore)

Two surface water samples were taken from the foreshore during the site investigation works. These were from locations at the base of the sea defence wall, where visibly hydrocarbon impacted water was seeping out onto the foreshore area. The seepages were adjacent to the contractor laydown area (sample SW1) and transport hub area (SW2) where significant visual and olfactory evidence of hydrocarbon contamination has been identified in both the Made Ground and the groundwater.

These were submitted for chemical testing and the results screened against the EQS (coastal and transitional waters) or UK DWS where necessary.

A number of exceedances of the relevant screening values were identified and are summarised in Table below.

Table 16 - Summary of Constituents of Concern in Groundwater Samples (from foreshore)

Determinant	No. of exceedances	Min (ug/L)	Max (ug/L)	Screening Value (ug/L)	Sample exceedances
Cyanide	2	4	5	1	SW1 (5ug/l); SW2 (4ug/l).
Fluoranthene	1	0.07	0.07	0.01 ^{LOD}	SW2 (0.07ug/l).
Benzo(b)-fluoranthene	1	0.03	0.03	0.017 [#]	SW2 (0.03ug/l).
Benzo(a)pyrene	1	0.02	0.02	0.01 ^{LOD}	SW2 (0.02ug/l).
EPH >C10-C12	2	<10	280	10 ⁺	SW2 (280ug/l).
				90 [*]	SW2 (280ug/l).
EPH >C12-C16	2	330	420	10 ⁺	SW1 (420ug/l); SW2 (330ug/l).
				90 [*]	SW1 (420ug/l); SW2 (330ug/l).
EPH >C16-C21	2	60	790	10 ⁺	SW1 (790ug/l); SW2 (60ug/l).
				90 [*]	SW1 (790ug/l); SW2 (60ug/l).
Boron	2	1100	2,005	1000 ⁺	SW1 (2005ug/l); SW2 (1100ug/l).

EQS (Transitional and Coastal Waters)

+ Drinking Water Standard

- EQS (Transitional and Coastal Waters) plus regional freshwater EQS

* WHO (2008) Drinking Water Standards

The exceedances of boron and cyanide in both samples are relatively low (especially for boron which is assessed using a drinking water standard) and these are not likely to represent a significant risk to the coastal waters.

The SW1 sample appeared to be visually contaminated to an extent such that the analytical laboratory deemed it necessary to perform a 100x dilution on the sample. This dilution results in a significant increase in the reporting LOD for PAH's for this sample which are 100 times higher than usual. All of the PAH's in SW1 were recorded to be below the LOD; however, it should be noted that the LOD is higher than the screening criteria as a result of the dilution. In this case, it is therefore assumed that PAH's in the surface waters of SW1 are a potential CoC, especially in view of the elevated PAHs recorded in SW2 which may suggest similar PAH exceedances are present in SW1.

There are potentially significant exceedances of EPH fractions in both SW1 and SW2. This correlates with the presence of hydrocarbon impacts on the soils in the adjacent parts of the site and TPH impacts in the groundwater in BH11 and BH12.

8.3.4 Discussion and Summary

The WYG Tier 1 groundwater and surface water screening exercise has indicated a number of CoCs that require further consideration. Specifically the risk to Controlled Waters appears to be from petroleum

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hydrocarbon products and benzene. As indicated above, the assessment with respect to specific petroleum hydrocarbon fractions are based on drinking water standards which may be inherently conservative given the nature of the site and respective receptor (i.e. coastal waters of Swansea Bay). Nevertheless there are exceedances of EQS values by benzene and other TPH fractions. In light of this there is a plausible risk to Controlled Waters of Swansea Bay from the benzene and petroleum hydrocarbon contamination noted in the groundwaters (and soils) of the Contractor Laydown area and Transport Hub.

Consideration should also be given to the receptor itself, while this has been considered to be the coastal waters of Swansea Bay in isolation, it is however part of a much larger receptive water body (i.e. the sea / future tidal lagoon). It is noted that the wide range of VOCs and SVOCs, predominantly comprising benzene compounds, that have been identified in the soil samples in the access road, contractor laydown area and the transport hub, have not been identified within the surface water or groundwater samples. This is considered to indicate that any impact occurring to these receptors is likely to be minimal in scale.

Consideration should also be given to the source of the hydrocarbons in the water. This is most likely to be related to the oil storage facility formerly present within the Contractor Laydown area. Spills and leaks from tanks or pipelines in this area is likely to have led to the petroleum hydrocarbon contamination noted during the site works and noted later from the chemical results. Since the closure of the storage facility (Circa 1990's), the contamination is likely to have been the subject of natural degradation, likely aided by the continual movement of tidally influenced groundwater. With the input of the original contaminant source (i.e. the storage facility) removed, the contamination is not going to get worse and is likely to attenuate further through natural processes over the life time of the proposed construction of the lagoon and more so over the lifetime of the lagoon itself (c.120 years).

Further consideration of these potential CoCs is presented in Section **Error! Reference source not found.**



9 Landgas Assessment

9.1 Introduction

Six return visits were made to site to undertake landgas monitoring between the 1st December 2016 and 19th January 2017.

A full factual record is presented in Appendix G.

9.2 Potential Sources

Based on the information obtained as part of the desk top study and the findings of the site investigation, areas of Made Ground and hydrocarbon impacted soils are considered to be potentially significant sources of Landgas.

Given the proximity of the site to the coast there is the potential for the landgas regime to be influenced by the action of the tides as well as changes in atmospheric pressure.

9.3 Data Summary

Table below summarises the maximum land gas concentration and flow results obtained from the monitoring visits in each subject area of the ground investigation.

Table 17 - Maximum Landgas concentrations

Western Landfall area						
Location	Methane (% vol)	Carbon Dioxide (% vol)	Oxygen (minimum) (% vol)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	Borehole flow (l/h)
WS01	0.1	1.6	17.5	0	0	0.3
WS02	0.2	1.6	18.3	0	0	0.1
WS03	0.2	1.8	19.3	0	0	0.1
WS04	0.3	2.4	16.0	0	0	0.1
Western Landfall Access Road						
Location	Methane (% vol)	Carbon Dioxide (% vol)	Oxygen (minimum) (% vol)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	Borehole flow (l/h)
WS05	0.3	4.6	14.7	0	0	0.2
WS06	0.3	1.0	20.3	0	0	0.0
WS07	0.3	0.4	21.1	0	0	0.1
WS25	3.4	5.5	12.9	0	0	0.2
Morrissey Land						
Location	Methane (% vol)	Carbon Dioxide (% vol)	Oxygen (minimum) (% vol)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	Borehole flow (l/h)
WS08	0.2	5.1	12.6	0	0	0.1
WS09	0.2	1.4	19.8	0	0	0.1
WS10	0.2	4.3	14.0	0	0	0.1
Contractor Laydown Area						
Location	Methane (% vol)	Carbon Dioxide (% vol)	Oxygen (minimum) (% vol)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	Borehole flow (l/h)
WS12	0.4	1.6	21.0	0	0	0.0
WS14	6.4	12.4	0.3	0	0	0.0
WS15	0.6	2.5	15.9	0	0	0.1
WS16	0.4	6.9	10.3	0	0	0.1
WS17	0.1	2.7	18.8	0	0	0.0
WS28	0.1	1.4	20.2	0	0	0.2
WS29	0.1	2.0	19.4	0	0	0.2
WS31	0.5	15.9	1.9	0	0	0.1
WS34	0.2	4.5	12.6	0	0	0.1
Transport Hub						
Location	Methane (% vol)	Carbon Dioxide (% vol)	Oxygen (minimum) (% vol)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	Borehole flow (l/h)
WS19	0.3	0.8	20.9	0	0	0.2
WS20	0.3	2.8	18.8	0	0	0.2



9.4 Landgas risk assessment methodology

The key reference documents which have been used to undertake the semi-quantitative land gas assessment presented in this report are as follows:

- BS 8485 (2015) Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings
- CIRIA C665 (2007) Assessing risks posed by hazardous ground gases to buildings.

These documents provide a framework for assessment of land gas risk to buildings/structures with a range of foundation designs. The collected data has been used for the purposes of undertaking a semi-quantitative assessment in accordance with BS8485 methodology, a worst case assessment has been undertaken with the peak landgas concentrations recorded during all the monitoring visits used in conjunction with the maximum flow rate. The calculation used to assess the borehole hazardous gas flow rate for the site, together with the relevant definition of units, is as follows:

$$\begin{array}{ccccc} \text{GSV} & = & \text{borehole flow rate} & \times & \text{gas concentration} \\ \text{(litres of gas/hr)} & & \text{(litres per hour)} & & \text{(volume/100)} \end{array}$$

9.5 Land gas risk assessment

The following preliminary land gas risk assessment is based on the results from the segments of land that the ground investigation was split into.

9.5.1 Part A – Western Landfall Area

Based on the maximum flow recorded of 0.3 l/h and the maximum concentrations of methane and carbon dioxide recorded during the landgas monitoring the following GSV have been calculated (Table 18).

Table 18– Initial GSV Calculations

	Maximum Concentration (%)	Maximum Flow Rate (l/hr)	GSV (l/hr)	Characteristic Situation
Methane	0.3	0.3	0.0009	1 (Very Low Risk)
Carbon Dioxide	2.4		0.0072	1 (Very Low Risk)

Based on this initial risk assessment the Western Landfall Area is considered to be representative of Characteristic Situation 1 (Very Low Risk). Based on recommendations made in BS8485 (2015) and CIRIA C665 92007) landgas protection measures would not need to be incorporated into new development in this area of the site.

9.5.2 Part A – Western Landfall Access Road

Based on the maximum flow recorded of 0.2 l/h and the maximum concentrations of methane and carbon dioxide recorded during the landgas monitoring the following GSV have been calculated (Table 19).

Table 19 – Initial GSV Calculations

	Maximum Concentration (%)	Maximum Flow Rate (l/hr)	GSV (l/hr)	Characteristic Situation
Methane	3.4	0.2	0.0068	1 (Very Low Risk)
Carbon Dioxide	5.5		0.011	1 (Very Low Risk)

Based on this initial risk assessment the Western Landfall Access Road is considered to be representative of Characteristic Situation 1 (Very Low Risk). Based on recommendations made in BS8485 (2015) and CIRIA C665 92007) consideration should be given to elevating the risk level to Characteristic Situation 2 where methane and carbon dioxide concentrations are recorded above 1% and 5% respectively. The maximum methane and carbon dioxide concentrations in these areas exceed this threshold. However, at this stage the area is proposed for use as an access road only. If development plans in this area change, then consideration would need to be given to elevating the area to Characteristic Situation 2.

9.5.3 Part A – Morrisey Land

Based on the maximum flow recorded of 0.1 l/h and the maximum concentrations of methane and carbon dioxide recorded during the landgas monitoring the following GSV have been calculated (Table 20).

Table 20 – Initial GSV Calculations

	Maximum Concentration (%)	Maximum Flow Rate (l/hr)	GSV (l/hr)	Characteristic Situation
Methane	0.2	0.1	0.0002	1 (Very Low Risk)
Carbon Dioxide	5.1		0.0051	1 (Very Low Risk)

Based on this initial risk assessment the Morrisey Land area is considered to be representative of Characteristic Situation 1 (Very Low Risk). Based on recommendations made in BS8485 (2015) and CIRIA C665 92007) consideration should be given to elevating the risk level to Characteristic Situation 2 where methane and carbon dioxide concentrations are recorded above 1% and 5% respectively. The maximum carbon dioxide concentration in this area marginally exceeds this threshold. At this stage, this area is proposed to be used for temporary office and welfare facilities (site compound) during the construction

phase. Guidance on land gas protection measures for such a temporary facility is not available, albeit given the length of the construction programme they could be considered semi-permanent. However, cabins that are used to house such facilities are usually raised off the floor with blocks which would therefore create a well vented void space beneath the cabins. In such a scenario, risks to humans inside those cabins would be considered to be low.

If development plans in this area change and permanent buildings are to be constructed, then consideration would need to be given to elevating the area to Characteristic Situation 2, with appropriate mitigation measures incorporated into the design.

9.5.4 Part B – Contractor Laydown Area

Based on the maximum flow recorded of 0.2 l/h and the maximum concentrations of methane and carbon dioxide recorded during the landgas monitoring the following GSV have been calculated (Table 21).

Table 1 – Initial GSV Calculations

	Maximum Concentration (%)	Maximum Flow Rate (l/hr)	GSV (l/hr)	Characteristic Situation
Methane	6.4	0.2	0.0128	1 (Very Low Risk)
Carbon Dioxide	15.9		0.0318	1 (Very Low Risk)

Based on this initial risk assessment the Contractor Laydown Area is considered to be representative of Characteristic Situation 1 (Very Low Risk). However, the high maximum concentrations of both methane and carbon dioxide are noteworthy and based on guidance in BS8485 (2015) and CIRIA C665 92007) consideration should be given to raising the risk level to Characteristic Situation 2 (Low Risk) with appropriate mitigation measures incorporated into the design of new buildings.

9.5.5 Part C – Transport Hub

Based on the maximum flow recorded of 0.2 l/h and the maximum concentrations of methane and carbon dioxide recorded during the land gas monitoring the following GSV have been calculated (Table 22).

Table 22 – Initial GSV Calculations

	Maximum Concentration (%)	Maximum Flow Rate (l/hr)	GSV (l/hr)	Characteristic Situation
Methane	0.3	0.2	0.0006	1 (Very Low Risk)
Carbon Dioxide	2.8		0.0056	1 (Very Low Risk)

The Transport Hub area is considered to be representative of Characteristic Situation 1 (Very Low Risk) based on this initial risk assessment. Based on recommendations made in BS8485 (2015) and CIRIA C665



92007) land gas protection measures would not need to be incorporated into the design of new development in this area of the site. At this stage, it is understood that there are no plans for buildings in this area.

9.6 Discussion

Six monitoring visits have been carried out on the site to date, within the shallow window samples which target the underlying Made Ground (encompassing the areas where visual and olfactory evidence of hydrocarbon contamination was observed during the ground investigation). The monitoring visits covered periods of both falling and rising atmospheric pressure conditions. Additionally they also covered periods of time when the tide was low, high, rising and falling. Based on this, it is considered that the monitoring periods have covered the range of scenarios that may have affected the ground gas regime (particular changes in flow) and would provide a worst case scenario for the site.

Based on the assessment presented above, all areas of the site can be considered to be represented by Characteristic Situation 1 (Very Low Risk). However, results from the Western landfall Access Road, Morrissey Land and Contractor Laydown Area indicate that consideration should be given to elevating the risk level to Characteristic Situation 2 (Low Risk). This was based on some higher methane and carbon dioxide concentrations. At this stage, it is understood that there are no plans for permanent buildings in these areas and as such, it is not considered necessary to increase the risk rating.



10 Site Conceptual Model and Ground Contamination Risk Assessment

10.1 Introduction

In general, ground contamination can occur through several causes, particularly from historical operations and activities. The contamination can result from either on site sources or from on-site migration from off-site sources, leading to long term liabilities under recent legislation for any site owner.

The Environment Act 1995 (Section 57) makes provisions for a risk based framework for the identification, assessment, management and redevelopment of contaminated land within the UK. The provisions of the Act came into effect in England and Wales in July 2001 and are aimed at ensuring that actions taken with respect to contaminated land are directed by a technically well founded assessment of risk.

The process of risk assessment is an evaluation of the probability of harm, and comprises the identification of sources of contamination, receptors that may be affected by the contamination and pathways by which the receptors may be harmed forming a pollution linkage. The site conceptual model (presented below) forms the basis for the qualitative assessment of ground contamination risks associated with the site.

10.2 Site conceptual model

The site conceptual model for the site has been updated from Section 3 and reflects the most significant findings and observations made during the site investigation and subsequent laboratory testing of samples obtained from the site.

The key source, pathway, receptor model is outlined below within the context of the proposed commercial/industrial type development.

10.2.1 Western landfall Area

10.2.1.1 Sources

The following sources of contamination have been identified on site,

- Significant thicknesses of Made Ground that has been identified to contain elevated concentrations of arsenic, lead, nickel, TPH, SVOCs and PAH's.
- Asbestos fibres have been identified within the Made Ground.
- Landgas potential associated with significant Made Ground deposits.



- The stockpile within the area has also been shown to contain elevated concentrations of lead, nickel and PAH's and also contains traces of asbestos fibres.

10.2.1.2 Pathways

The primary pathways by which sensitive receptors may come into contact with ground contamination are considered to be the following:

- Direct dermal contact or ingestion of soils, or inhalation of dust (i.e. human interaction with surface and sub-surface materials).
- Leaching and horizontal or vertical migration through the unsaturated ground, either through permeable sub-surface materials and/or preferential pathways.
- Lateral and vertical migration of groundwater through permeable sub-surface materials and/ or preferential pathways.
- The migration and accumulation of gases or vapours through permeable sub-surface materials and/ or preferential pathways.
- Lateral and vertical migration through surface water flow, drainage streams and surface runoff.

10.2.1.3 Potential receptors

The following are considered to be sensitive receptors:

- Current site users
- Site construction workers
- Future site users (future site workers/operatives and visitors to the site).
- Controlled surface water bodies (Principally coastal waters of Swansea Bay, groundwater
- Building Infrastructure (including buried pipework).

10.2.2 Western landfall Access Road

10.2.2.1 Sources

The following sources of contamination have been identified on site,

- Significant thickness of Made Ground that has been identified to contain elevated concentrations of lead, arsenic, VOCs, SVOCs and petroleum hydrocarbons.
- Free phase (LNAPL) product in WS25 noted during monitoring works as being 0.11 to 0.22m in thickness.



- Asbestos fibres have been identified within the Made Ground.
- Landgas potential associated with significant Made Ground deposits.

10.2.2.2 Pathways

The primary pathways by which sensitive receptors may come into contact with ground contamination are considered to be the following:

- Direct dermal contact or ingestion of soils, or inhalation of dust (i.e. human interaction with surface and sub-surface materials).
- Leaching and horizontal or vertical migration through the unsaturated ground, either through permeable sub-surface materials and/or preferential pathways.
- Lateral and vertical migration of groundwater through permeable sub-surface materials and/ or preferential pathways.
- The migration and accumulation of gases or vapours through permeable sub-surface materials and/ or preferential pathways.
- Lateral and vertical migration through surface water flow, drainage streams and surface runoff.

10.2.2.3 Potential receptors

The following are considered to be sensitive receptors:

- Current site users
- Site construction workers
- Future site users (future site workers/operatives and visitors to the site).
- Controlled surface water bodies (Principally coastal waters of Swansea Bay, groundwater
- Building Infrastructure (including buried pipework).

10.2.3 Morrissey Land

10.2.3.1 Sources

The following sources of contamination have been identified on site,

- Significant thicknesses of Made Ground across the site that has been shown to contain elevated concentrations of lead and SVOCs.
- Asbestos fibres have been identified within the Made Ground.
- Landgas potential associated with significant Made Ground deposits.



10.2.3.2 Pathways

The primary pathways by which sensitive receptors may come into contact with ground contamination are considered to be the following:

- Direct dermal contact or ingestion of soils, or inhalation of dust (i.e. human interaction with surface and sub-surface materials).
- Leaching and horizontal or vertical migration through the unsaturated ground, either through permeable sub-surface materials and/or preferential pathways.
- Lateral and vertical migration of groundwater through permeable sub-surface materials and/ or preferential pathways.
- The migration and accumulation of gases or vapours through permeable sub-surface materials and/ or preferential pathways.
- Lateral and vertical migration through surface water flow, drainage streams and surface runoff.

10.2.3.3 Potential receptors

The following are considered to be sensitive receptors:

- Current site users
- Site construction workers
- Future site users (future site workers/operatives and visitors to the site).
- Controlled surface water bodies (Principally coastal waters of Swansea Bay, groundwater)
- Building Infrastructure (including buried pipework).

10.2.4 Contractor Laydown Area

10.2.4.1 Sources

The following sources of contamination have been identified on site,

- Significant thicknesses of Made Ground that has been identified to contain elevated concentrations of lead, SVOCs, VOCs and petroleum hydrocarbons.
- Asbestos fibres have been identified within the Made Ground.
- Landgas potential associated with significant Made Ground deposits.

10.2.4.2 Pathways

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The primary pathways by which sensitive receptors may come into contact with ground contamination are considered to be the following:

- Direct dermal contact or ingestion of soils, or inhalation of dust (i.e. human interaction with surface and sub-surface materials).
- Leaching and horizontal or vertical migration through the unsaturated ground, either through permeable sub-surface materials and/or preferential pathways.
- Lateral and vertical migration of groundwater through permeable sub-surface materials and/ or preferential pathways.
- The migration and accumulation of gases or vapours through permeable sub-surface materials and/ or preferential pathways.
- Lateral and vertical migration through surface water flow, drainage streams and surface runoff.

10.2.4.3 Potential receptors

The following are considered to be sensitive receptors:

- Current site users
- Site construction workers
- Future site users (future site workers/operatives and visitors to the site).
- Controlled surface water bodies (Principally coastal waters of Swansea Bay, groundwater)
- Building Infrastructure (including buried pipework).

10.2.5 Transport Hub

10.2.5.1 Sources

The following sources of contamination have been identified on site,

- Significant thicknesses of Made Ground that has been identified to contain elevated concentrations of petroleum hydrocarbons and VOCs.
- Asbestos fibres have been identified within the Made Ground.

10.2.5.2 Pathways

The primary pathways by which sensitive receptors may come into contact with ground contamination are considered to be the following:



- Direct dermal contact or ingestion of soils, or inhalation of dust (i.e. human interaction with surface and sub-surface materials).
- Leaching and horizontal or vertical migration through the unsaturated ground, either through permeable sub-surface materials and/or preferential pathways.
- Lateral and vertical migration of groundwater through permeable sub-surface materials and/ or preferential pathways.
- The migration and accumulation of gases or vapours through permeable sub-surface materials and/ or preferential pathways.
- Lateral and vertical migration through surface water flow, drainage streams and surface runoff.

10.2.5.3 Potential receptors

The following are considered to be sensitive receptors:

- Current site users
- Site construction workers
- Future site users (future site workers/operatives and visitors to the site).
- Controlled surface water bodies (Principally coastal waters of Swansea Bay, groundwater)
- Building Infrastructure (including buried pipework).

10.3 Ground contamination risk assessment table

The pollution linkages and a qualitative risk assessment are presented in Table 2 below. The risk assessment considers the site within an area context and assesses potential risks to identified receptors in relation to the existing site setting and the proposed development. CIRIA C552 has been used to define the risk rating presented in the Qualitative Risk Assessment matrix, methodology for which is presented in Appendix K.

Table 2 - CIRIA C552 Qualitative Risk Assessment

Source	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk Classification	Potential risk management requirements
<u>Western Landfall Area</u>						
Made Ground recorded to contain elevated lead, nickel and PAH's (including stockpile)	Direct dermal contact or ingestion of soils, or inhalation of dust	Current site users	Medium	Low Likelihood (Current use of site is limited to hard-landscaped areas)	Low Risk	Construction workers are more likely to interact with the near surface soils. Whilst this interaction is likely only to be short term in nature the risks should be adequately mitigated. This is likely to be achieved by standard good working practices and will likely include the use of appropriate PPE. The exact details of the mitigation measures required to deal with risks to construction workers should be detailed in a Construction Method Statement. Future site users will be protected by the extensive hardstanding cover of the permanent site development works.
		Site construction workers		Likely	Moderate Risk	
		Future site users		Unlikely (New development includes for minimal soft-landscaped areas)	Low Risk	
	Leaching and lateral migration	Groundwater	Medium	Low Likelihood (limited impacts to groundwater identified)	Moderate/Low Risk	Risks to the water environment may require some targeted remediation or source removal. The removal of the stockpiles during redevelopment of the western landfall area will result in the removal of the majority of soil samples containing exceedances in this area.
		Surface water (Swansea Bay)				
		Building Infrastructure (inc. water supply pipes)		Likely	Moderate Risk	Liaison with Welsh Water should be undertaken to assess the requirements for the use of barrier pipe at the site. However, given the nature of the site, barrier pipe or clean backfilled trenches and other protective measures are likely to be required to protect water supply pipes.

Source	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk Classification	Potential risk management requirements
Asbestos within Made Ground and stockpile	Inhalation	Current site users	Severe	Low likelihood (Asbestos fibres identified – however found to be less than 0.001% by weight)	Moderate Risk	The proposed development does not include significant areas of soft landscaping and as such the risk to future site users is considered to be suitably mitigated. In the event that areas of soft landscaping are incorporated into the design, it is recommended that these areas of the site should be capped with a suitable cover layer which will break this pollution linkage or to remove the source material. With respect to the risk to site construction workers, it is recommended that any excavation or re-working of soils is only undertaken under an asbestos management plan, with appropriate health and safety measures in place. Any screening, crushing or other processing of soils should only be undertaken following removal of asbestos containing materials from the soils. All site operatives should be made aware of the presence of asbestos within the Made Ground.
		Site construction workers	Severe	Low likelihood (Asbestos fibres identified – however found to be less than 0.001% by weight)	Moderate Risk	
		Future site users	Severe	Unlikely (New development includes extensive hardstanding)	Moderate/ Low Risk	

Source	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk Classification	Potential risk management requirements
Land gas generated from Made Ground	Migration and accumulation of gases or vapours though permeable sub-surface materials and/or preferential pathways into new buildings on the site	Current site users	Medium	Unlikely	Low risk	Based on the landgas monitoring undertaken to date, it is considered that the site is representative of Characteristic Situation 1 (very low Risk). No risk management measures are necessary.
		Future site users				
		Site construction workers				
		Site construction workers				
<u>Western Landfall Access Road</u>						
Made Ground recorded to contain elevated lead, arsenic, VOCs and petroleum hydrocarbons and LNAPL product in WS25	Direct dermal contact or ingestion of soils, or inhalation of dust	Current site users	Medium	Low Likelihood <i>(Current use of site is limited to hard-landscaped areas)</i>	Low Risk	Construction workers are more likely to interact with the near surface soils. Whilst this interaction is likely only to be short term in nature the risks should be adequately mitigated. This is likely to be achieved by standard good working practices and will likely include the use of appropriate PPE. The exact details of the mitigation measures required to deal with risks to construction workers should be detailed in a Construction Method Statement.
		Site construction workers		Likely	Moderate Risk	

Source	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk Classification	Potential risk management requirements
	Leaching and lateral migration	Future site users		Unlikely <i>(New development includes for minimal soft-landscaped areas)</i>	Low Risk	
		Groundwater	Medium	Likely	High Risk	Elevated concentrations of lead, arsenic and petroleum hydrocarbons have been identified in this area of the site. Potential risk management requirements and remediation works are likely to be required to address the high levels of hydrocarbon contamination that is likely to be impacting upon the water environment. Liaison with Welsh Water is recommended regarding the potential requirements for the use of barrier pipe or other mitigation measures for potable water supplies.
		Surface water (Swansea Bay)				
		Building Infrastructure (inc. water supply pipes)		Likely	Moderate Risk	
Asbestos within Made Ground	Inhalation	Current site users	Severe	Low likelihood <i>(Asbestos fibres identified – however found to be less than 0.001% by weight)</i>	Moderate Risk	The proposed development does not include significant areas of soft landscaping and as such the risk to future site users is considered to be suitably mitigated. In the event that areas of soft landscaping are incorporated into the design, it is recommended that these areas of the site should be capped with a suitable cover layer which will break this pollution linkage. With respect to the risk to site construction workers, it

Source	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk Classification	Potential risk management requirements
		Site construction workers	Severe	Low likelihood <i>(Asbestos fibres identified – however found to be less than 0.001% by weight)</i>	Moderate Risk	is recommended that any excavation or re-working of soils is only undertaken under an asbestos management plan, with appropriate health and safety measures in place. Any screening, crushing or other processing of soils should only be undertaken following removal of asbestos containing materials from the soils. All site operatives should be made aware of the presence of asbestos within the Made Ground.
		Future site users	Severe	Unlikely <i>(New development includes for minimal soft-landscaped areas)</i>	Moderate/ Low Risk	
Land gas generated from Made Ground	Migration and accumulation of gases or vapours through permeable sub-surface materials and/or preferential pathways into new buildings on the site	Current site users	Medium	Unlikely	Low risk	Based on the landgas monitoring undertaken to date, it is considered that the site is representative of Characteristic Situation 1 (very low Risk). No risk management measures are necessary at this stage. This is based on the assumption that no buildings will be constructed in this area of the site. If buildings are proposed at a later date, then consideration will need to be given to raising the risk rating to Characteristic Situation 2 (Low Risk).
		Future site users				
		Site construction workers				

Source	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk Classification	Potential risk management requirements
		Site construction workers				
<u>Morrissey Land</u>						
Made Ground recorded to contain elevated lead and low concentrations of VOCs and SVOCs.	Direct dermal contact or ingestion of soils, or inhalation of dust	Current site users	Medium	Low Likelihood <i>(Current use of site is limited to hard-landscaped areas)</i>	Low Risk	Construction workers are more likely to interact with the near surface soils. Whilst this interaction is likely only to be short term in nature the risks should be adequately mitigated. This is likely to be achieved by standard good working practices and will likely include the use of appropriate PPE. The exact details of the mitigation measures required to deal with risks to construction workers should be detailed in a Construction Method Statement.
		Site construction workers		Likely	Moderate Risk	
		Future site users		Unlikely <i>(New development includes for minimal soft-landscaped areas)</i>	Low Risk	
	Leaching and lateral migration	Groundwater	Medium	Likely	Moderate Risk	Elevated concentrations of arsenic and zinc have been recorded in the groundwater in this area of the site. These are thought to more reflective of the region and not specifically related to the Morrissey Land in isolation. Specific risk management requirements are not thought likely to be required.
		Surface water (Swansea Bay)		Low Likelihood	Moderate/ Low Risk	

Source	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk Classification	Potential risk management requirements
		Building Infrastructure (inc. water supply pipes)		Low	Low Risk	Liaison with Welsh Water is recommended regarding the potential requirements for the use of barrier pipe or other mitigation measures for potable water supplies..
Asbestos within deeper Made Ground soils (WS10 at 2.0mbgl)	Inhalation	Current site users	Severe	Unlikely (<i>Asbestos fibres identified – however found to be less than 0.001%by weight</i>)	Moderate/Low Risk	The proposed development does not include significant areas of soft landscaping. In addition low levels of asbestos have been encountered at a depth of 2m (which is not likely to be readily accessible to human receptors) in only a single location (WS10). As such it is considered unlikely that significant exposure will occur. With respect to the risk to site construction workers, it is recommended that any excavation or re-working of soils is only undertaken under an asbestos management plan, with appropriate health and safety measures in place. Any screening, crushing or other processing of soils should only be undertaken following removal of asbestos containing materials from the soils. All site operatives should be made aware of the presence of asbestos within the Made Ground.
		Site construction workers	Severe	Low likelihood (<i>Asbestos fibres identified – however found to be less than 0.001%by weight</i>)	Moderate Risk	
		Future site users	Severe	Unlikely (<i>New development includes for minimal soft-landscaped areas</i>)	Moderate/Low Risk	

Source	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk Classification	Potential risk management requirements
Land gas generated from Made Ground	Migration and accumulation of gases or vapours through permeable sub-surface materials and/or preferential pathways into new buildings on the site	Current site users	Medium	Unlikely	Low risk	Based on the landgas monitoring undertaken to date, it is considered that the site is representative of Characteristic Situation 1 (very low Risk). No risk management measures are necessary.
		Future site users				
		Site construction workers				
Contractor Laydown Area						
Made Ground containing elevated lead and significant concentrations of hydrocarbon contamination. Elevated concentrations of PAH's and petroleum hydrocarbons have been recorded in the groundwater.	Direct dermal contact or ingestion of soils, or inhalation of dust	Current site users	Medium	Low Likelihood <i>(Soft-landscaped area currently unused)</i>	Low Risk	Construction workers are more likely to interact with the near surface soils. Whilst this interaction is likely only to be short term in nature the risks should be adequately mitigated. This is likely to be achieved by standard good working practices and will likely include the use of appropriate PPE. The exact details of the mitigation measures required to deal with risks to construction workers should be detailed in a Construction Method Statement.
		Site construction workers		Likely	Moderate Risk	
		Future site users		Unlikely <i>(New development includes for minimal soft-landscaped areas)</i>	Low Risk	

Source	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk Classification	Potential risk management requirements
	Leaching and lateral migration	Groundwater	Medium	High Likelihood (<i>due to significant hydrocarbon type contaminants identified on site to date</i>)	High Risk	Elevated concentrations of metals, PAH's and petroleum hydrocarbons have been identified in this area. Significant visual and olfactory evidence of hydrocarbon contamination was also noted. Visual and olfactory evidence of hydrocarbon contamination was also noted on the foreshore adjacent to this area. Chemical results from this area also suggest that water on the foreshore is impacted by hydrocarbon contamination.. Further risk assessment is required with regard to the risk to controlled waters. Liaison with Welsh Water is recommended regarding the potential requirements for the use of barrier pipe or other mitigation measures for potable water supplies..
		Surface water (Swansea Bay)				
		Building Infrastructure (inc. water supply pipes)		Likely	Moderate Risk	
Asbestos within Made Ground	Inhalation	Current site users	Severe	Unlikely (<i>Asbestos fibres identified – however found to be less than 0.001%by weight</i>)	Moderate/Low Risk	The proposed development does not include significant areas of soft landscaping and as such the risk to future site users is considered to be suitably mitigated. In the event that areas of soft landscaping are incorporated into the design, it is recommended to cap these areas of the site with a suitable cover layer in order to break the pathway for exposure. With respect to the risk to site construction workers, it is recommended that any excavation or re-working of soils is only undertaken under an asbestos management plan, with appropriate health and safety measures in place. Any screening, crushing or other processing of soils should only be undertaken following removal of asbestos containing materials from the soils. All site operatives should be made aware of the
		Site construction workers	Severe	Low likelihood (<i>Asbestos fibres identified – however found to be less than 0.001%by weight</i>)	Moderate Risk	

Source	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk Classification	Potential risk management requirements
		Future site users	Severe	Unlikely <i>(New development includes for minimal soft-landscaped areas)</i>	Moderate/Low Risk	presence of asbestos within the Made Ground. It is likely that the temporary use of the area during the construction works will incorporate a temporary layer of imported crush material which will act so as to reduce the likelihood of exposure to asbestos fibres.
Land gas generated from Made Ground	Migration and accumulation of gases or vapours though permeable sub-surface materials and/or preferential pathways into new buildings on the site	Current site users	Medium	Unlikely	Low risk	The Contractor Laydown Area is considered to be representative of Characteristic Situation 1 (Very Low Risk). However, the high maximum concentrations of both methane and carbon dioxide are noteworthy and based on guidance in BS8485 (2015) and CIRIA C665 92007) consideration should be given to raising the risk level to Characteristic Situation 2 (Low Risk) if new buildings are proposed in the area. Temporary accommodation such as site cabins should have a well ventilated underfloor void to prevent the ingress of landgas.
		Future site users				
		Site construction workers				
		Site construction workers				
Transport Hub						
Asbestos within Made Ground	Inhalation	Current site users	Severe	Unlikely <i>(Asbestos fibres identified in only one location at less than 0.001%by weight)</i>	Moderate/Low Risk	The proposed development does not include significant areas of soft landscaping and as such the risk to future site users is considered to be suitably mitigated. In the event that areas of soft landscaping are incorporated into the design, it is recommended that these areas of

Source	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk Classification	Potential risk management requirements
		Site construction workers	Severe	Low likelihood (<i>Asbestos fibres identified in only one location at less than 0.001% by weight</i>)	Moderate Risk	the site should be capped with a suitable cover layer which will break this pollution linkage. With respect to the risk to site construction workers, it is recommended that any excavation or re-working of soils is only undertaken under an asbestos management plan, with appropriate health and safety measures in place. Any screening, crushing or other processing of soils should only be undertaken following removal of asbestos containing materials from the soils. All site operatives should be made aware of the presence of asbestos within the Made Ground.
		Future site users	Severe	Unlikely (<i>New development includes for minimal soft-landscaped areas</i>)	Moderate/Low Risk	
Made Ground containing significant concentrations of petroleum hydrocarbon contamination and elevated VOC/SVOCs. Elevated concentrations of petroleum hydrocarbons have been recorded in the groundwater.	Direct dermal contact or ingestion of soils, or inhalation of dust	Current site users	Medium	Low Likelihood (<i>Site is currently unused</i>)	Low Risk	Construction workers are more likely to interact with the near surface soils. Whilst this interaction is likely only to be short term in nature the risks should be adequately mitigated. This is likely to be achieved by standard good working practices and will likely include the use of appropriate PPE. The exact details of the mitigation measures required to deal with risks to construction workers should be detailed in a Construction method Statement.
		Site construction workers		Likely	Moderate Risk	
		Future site users		Unlikely (<i>New development includes for minimal soft-landscaped areas</i>)	Low Risk	
	Leaching and lateral migration	Groundwater	Medium	High Likelihood (<i>due to significant hydrocarbon type</i>)	High Risk	Elevated concentrations of petroleum hydrocarbons and VOCs/SVOCs. Significant visual and olfactory evidence of hydrocarbon contamination was also noted.

Source	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk Classification	Potential risk management requirements
		Surface water (Swansea Bay)		<i>contaminants identified on site to date)</i>		Visual and olfactory evidence of hydrocarbon contamination was also noted on the foreshore adjacent to this area. Chemical results from this area also suggest that water on the foreshore is impacted by hydrocarbon type contamination. Further risk assessment is required with regard to the risk to controlled waters. Liaison with Welsh Water is recommended regarding the potential requirements for the use of barrier pipe or other mitigation measures for potable water supplies..
		Building Infrastructure (inc. water supply pipes)		Likely	Moderate Risk	
Land gas generated from Made Ground	Migration and accumulation of gases or vapours through permeable sub-surface materials and/or preferential pathways into new buildings on the site	Current site users	Medium	Unlikely	Low risk	No permanent buildings are proposed for this area at this stage. Based on the landgas monitoring undertaken to date, it is considered that the site is representative of Characteristic Situation 1 (very low Risk). No risk management measures are necessary.
		Future site users				
		Site construction workers				
		Site construction workers				



11 Ground Contamination Conclusions

11.1 Conclusions

The investigation works have identified extensive, predominantly granular Made Ground soils across the site. These soils include a range of man-made inclusions, including brick, wood, iron slag and coal, indicating that the Made Ground soils are likely to have been sourced from a wide range of local industries at the time the docks were constructed. Made Ground soils along the sea wall / western access road include a high proportion of sand which may have been sourced from dredging activities.

A series of risks have been identified due to the presence of soil and groundwater contamination. The Made Ground across all areas of the site is shown to contain asbestos, albeit in low concentrations (<0.001% by weight), and various heavy metals including high concentrations of lead. The soil stockpile in the Western Landfall area of the site is shown to contain frequent occurrences of asbestos, metals and PAHs.

The most notable contamination risks are associated with the petroleum hydrocarbons and VOCs (predominantly benzene and toluene compounds) within the Made Ground soils in the eastern portion of Western Landfall Access Road (roughly correlating with the locations of the former BP oil depot jetties in Queen's Dock), Contractor Laydown Area and the Transport Hub. This includes LNAPL product (between 0.11 to 0.22m in thickness) detected in WS25 during the monitoring works. There are also isolated occurrences of elevated hydrocarbons in the Western Landfall Area.

The current development proposals do not incorporate permanent buildings except for the Western landfall building which is to be built upon reclaimed land, as a result the risks to future site users from volatile vapours are considered to be low.

With respect to the risks to Human Health from the site, the most significant risk is towards construction workers due to the increased likelihood of contact or exposure to contaminated soils. During construction works any excavation operations within the Made Ground will need to be undertaken in a manner cognisant of the presence of asbestos and other contaminants. Suitable mitigation measures, such as adequate training or appropriate PPE/RPE, should be provided to construction workers.

Risks to future site users have generally been considered to be low, however this is based on the assumption that the future development will predominantly comprise of hardstanding and an open space land use (car parking and public realm areas). If this assumption materially changes, then this rating may need to be revisited.



Risks to the wider environment, specifically Controlled Waters (groundwater and coastal waters of Swansea Bay) are considered to be high, especially in view of the elevated TPH fractions identified in the surface water samples taken from the foreshore adjacent to the Contractor Laydown Area and Transport Hub. These risks are principally considered to arise from the presence of significant petroleum hydrocarbon contamination in the soils associated with the former BP oil pipelines along the eastern edge of the western landfall access road to the oil jetties, and the former BP tank farm locations in the southern portion of the contractor laydown area and the transport hub. However, the original sources of the petroleum hydrocarbons (i.e. the storage tanks) are no longer present, as a result of which ground conditions could be expected to improve over time as the contaminants naturally degrade and disperse. There is relatively little evidence of significant impact on controlled waters from the elevated metals and PAHS identified within the site soils.

Monitoring of the groundwater levels indicates flow direction towards the sea as would be expected. Continual monitoring of water levels suggests that there is a degree of tidal influence upon the groundwater regime and hence a degree of connectivity between the water bodies. However, the relatively small variations in groundwater levels in response to the tidal levels are considered to indicate that there is not a free and rapid connection between groundwater and sea waters.

Given the nature of the underlying Made Ground, which is likely to have been sourced from a wide range of historic local industrial sites during the construction of the docks, there is the potential for unidentified contamination to be present on site. A reactive approach will therefore need to be adopted on site during the development works to manage any contaminated material identified during the works and to ensure that adequate risk management procedures are implemented to ensure the protection of the highlighted receptors at risk.

Based on the landgas monitoring undertaken to date, the site areas are considered to be representative of Characteristic Situation 1 (very low risk). However, should design changes result in buildings being proposed along the Western landfall Access Road, Morrissey Land or the Contractor Laydown Area, then consideration should be given to raising the risk rating to Characteristic Situation 2 Low Risk). In this scenario, advice should be sought from a Landgas Protection Specialist who can advise on the requirements for landgas protection appropriate to the proposed development in line with BS8485:2015 based on the size of the proposed building and the intended end use.



12 Recommendations

Based on the current level of information, the following recommendations are made in the context of the proposed development on the site.

Remediation Options Appraisal

A Remediation Options Appraisal will need to be developed primarily focussing on the significant hydrocarbon type contamination identified in the Made Ground of the Contractor Laydown Area, Transport Hub and Western landfall Access Road. The risks to the wider environment (specifically Controlled Waters – groundwater and coastal waters of Swansea Bay, including the foreshore area where hydrocarbon contamination has been noted) from this contamination was considered to be High.

This should include further risk assessment (including a Detailed Quantitative Risk Assessment) and evaluation of the natural attenuation of the hydrocarbon contamination in combination with an on-going monitoring programme. This could be aided by focussed in-situ remediation (e.g. chemical oxidation, pump and treat methods) or ex-situ remediation (e.g. biopiles) to speed up the process and the removal of free product. Other options for remediation should also be discussed along with an appraisal of the various pros and cons of each remedial option and the likely outcomes of each.

The Remediation Options Appraisal should include consideration of the proposed high voltage cable route, part of which is likely to pass through the dock area covered within this report, and the logistics of the construction and installation of the cable.

The options appraisal process would feed into the development of a Remediation Strategy. The Remediation Strategy should include consideration of options to treat contaminant sources (such as free phase product) and assessment or treatment of residual, orphan contamination plumes.

Asbestos

During the construction phase all works within the Made Ground should be undertaken in line with the requirements of an Asbestos Management Plan which should document the presence of asbestos within the Made Ground on the site, the potential for previously unidentified asbestos to be present across the site and the methodology by which the risks to site users and adjacent site users should be mitigated. All operatives should be made aware of the presence of asbestos within the Made Ground and the requirements outlined in the Asbestos Management Plan.



Waste

Remediation and construction work on site is likely to result in the generation of waste arisings. Based on the results of the contamination testing (including metals and PAHs across the wider site) and the visual and olfactory evidence of petroleum contamination it is likely that a significant portion of this would be classified as hazardous waste. It will be the responsibility of the Principal Contractor to classify any waste arisings prior to disposal off-site.

If soil arisings are to be re-used on the site, possibly including materials within the existing stockpiles in the Western Landfall area, then a Materials Management Plan (MMP) and subsequent Qualified Person review will be required in order to demonstrate how the use of these arisings will be appropriately controlled in accordance with applicable waste regulations.

Unidentified Contamination

A Discovery Strategy/Reactive Strategy should be developed for the site and incorporated into an overall Remediation Strategy to highlight the potential for previously unidentified contamination to be encountered during the development phase. This document should highlight the method for identification, delineation and treatment of contaminated materials on the site if they are encountered during the construction of the proposed development.

Risk Assessment

The risk assessment is based upon our current understanding of the site development proposals which include extensive hardstanding coverage and minimal buildings (namely the Western Landfall Building) to be located upon reclaimed land. If there are changes to the development proposals then it may be necessary to revise the risk assessment accordingly.

Soakaways

Whilst the site soils are likely to be sufficiently permeable to facilitate soakaways it is considered that the presence and nature of contamination within the site soils should preclude the use of soakaways as these could increase the mobilisation and migration of the contaminants.

Water Supply Pipes

Base on the contamination recorded at the site, it is likely that barrier pipe, clean backfilled trenches or other similar methods will be required to provide potable water supply at the site. Liaison should be undertaken with Welsh Water to confirm their requirements.



Third Party Liaison

An initial meeting was held on 28th March 2017 between NRW, Tidal Lagoon Power (TLP) and WYG in order to verbally present a summary of the key findings from the site investigation works and initial considerations of the contamination risks identified. Due to the timescales and complexities for the construction work a potential option for zoning of the site, based upon contamination risk was discussed. This could in turn lead to a potential phased remediation approach, depending upon the selected remedial methodology, for the various areas of the site. Broad agreement to this approach was reached between NRW, TLP and WYG; however, this would require planning conditions (particularly pre-commencement conditions) to reflect the potential phased remediation works and this should be discussed with the Local Planning Authorities.

On-going liaison with third parties, such as Associated British Ports, the Local Planning Authorities and Natural Resources Wales (NRW) should be undertaken to discuss the findings of this report and subsequent further studies or remediation strategies.

Construction Phase Issues

The presence of contamination across the site will require appropriate working procedures (e.g. hygiene controls, PPE) and worker briefings to be adopted in order to protect the health of construction workers. In addition the potential for off-site contamination impacts to arise due to the generation of soil dusts, fibres or vapours should be addressed and managed in a suitable manner. It would be prudent to incorporate monitoring for dusts, vapours and potential fibres within the construction works.



13 References

- 1) BS5930:2015, British Standard Code of Practice for Site Investigations, BSI.
- 2) BS 10175: 2001, British Standard Code of Practice for Investigation of Potentially Contaminated Sites.
- 3) Chartered Institute of Environmental Health (CIEH) and CL:AIRE. May 2008.
- 4) CLEA Software (Version 1.05) Handbook. Environment Agency. September 2009.
- 5) CIRIA C552 - Construction Industry Research and Information Association (CIRIA) Publication C552. Contaminated Land Risk Assessment: A guide to good practice. D J Rudland, R M Lancefield and P N Mayell, January 2001.
- 6) CIRIA C665 - Construction Industry Research and Information Association (CIRIA) Publication C665 Assessing risks posed by hazardous ground gases to buildings. S Wilson, S Oliver, H Mallett, H Hutchings, G Card. December 2007.
- 7) BS8485:2015 – Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. February 2016.
- 8) BRE 211 (2015) - Radon: Guidance on protective measures for new buildings. 2015.

Notes

1. Standards

All boring operations, sampling of soils, *in situ* testing and geotechnical laboratory testing have been carried out in accordance with the recommendations of the British Standards BS 5930+A2 (2010)⁽¹⁾, BS 1377 (1990)⁽²⁾ and BS10175 (2001)⁽³⁾.

Soil and rock descriptions follow the recommendations of BS 5930+A2. Where descriptions or classifications are based on other documents (e.g. BS 8004 (1986) or CIRIA Project Report 11 (1993)), this is stated in the report text.

2. Site methods

Unless specifically stated otherwise, the following methods are used for exploratory holes.

- Holes described as cable percussive are bored using a light cable percussive rig. Standard penetration tests are carried out where appropriate, as shown in the logs. Disturbed and undisturbed samples are taken from the exploratory holes at the depths on the records.
- Window sampling generally uses the windowless sampling method, using a tracked Geotool.
- Dynamic probes are usually heavy dynamic probes, using the same tracked Geotool used for window sampling.

3. Definitions and abbreviations

The following terms are used in the exploratory hole logs

Samples

U	Undisturbed 102mm dia. sample
TW	Thin Walled undisturbed 102mm dia. sample
B	Bulk sample
D	Small disturbed sample
W	Water sample
CBR	California Bearing Ratio test or CBR value obtained from Mexiprobe test

In situ tests

S	Standard penetration test (SPT)
N	SPT N value (blows/300mm)
HP	Hand penetrometer – shear strength
SV	Hand shear vane – shear strength
VOC	Volatile organic compounds (ppm)
PID	Photo-ionisation detector – used to detect the presence of VOCs.

Core recovery and rock quality

TCR	Total core recovery (%)
SCR	Solid core recovery (%)
RQD	Rock quality designation (%)
FI	Fracture index
NR	No recovery
NI	Not intact

Rotary drilling sizes

Index letter	Nominal diameter (mm)	
	Borehole	Core
N	75	54
H	99	76
P	120	92
S	146	113

Water strikes

▽	Level of water strike
▼	Water level rose to this level (see Remarks at foot of log for details)

Depth means depth below existing ground level unless otherwise specified. Values specified in soil descriptions given in the exploratory hole logs are depths unless otherwise specified.



Figures



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(SWANSEA BAY) PLC**

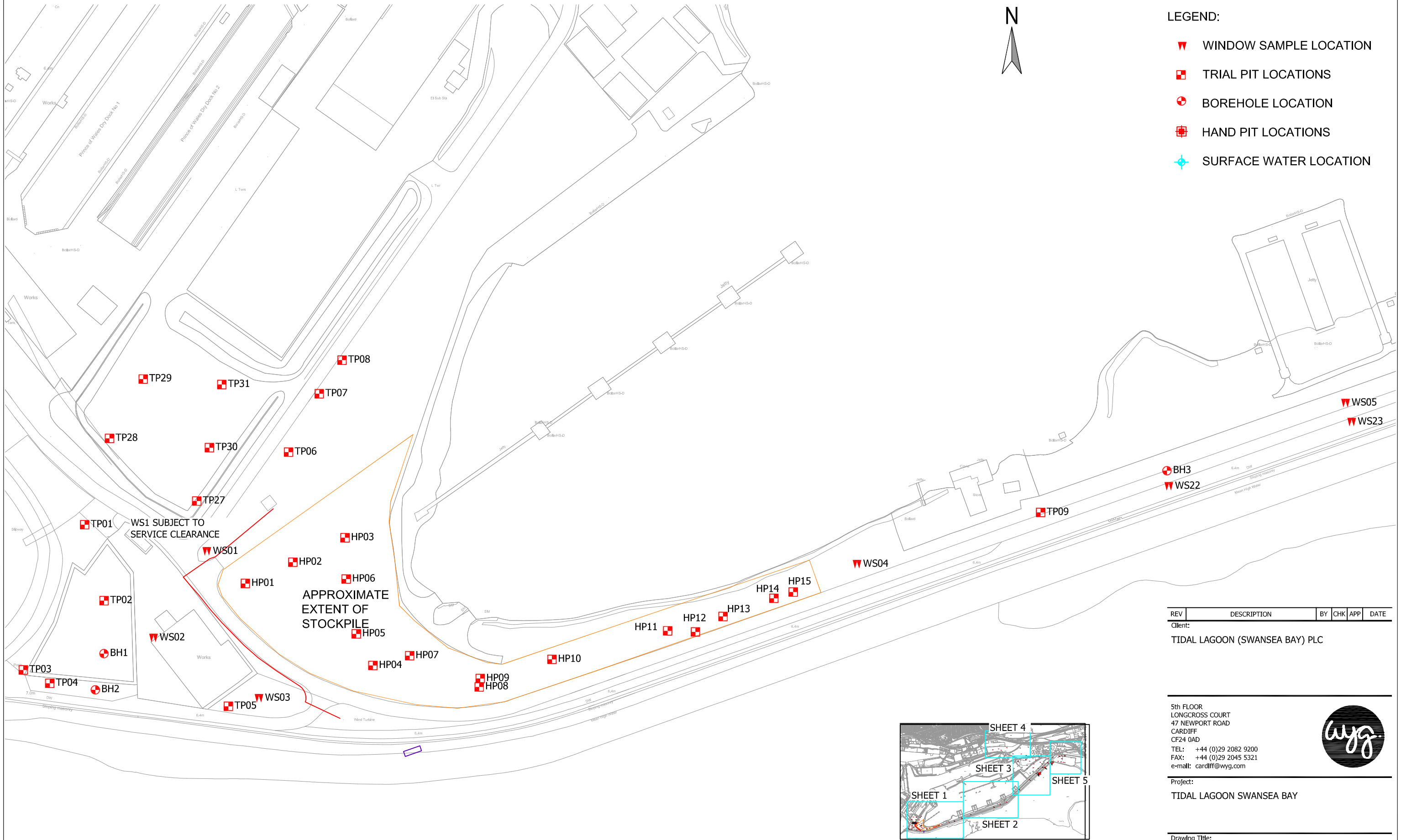
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**TIDAL LAGOON
SWANSEA**

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LEGEND:

- WINDOW SAMPLE LOCATION
- TRIAL PIT LOCATIONS
- BOREHOLE LOCATION
- HAND PIT LOCATIONS
- SURFACE WATER LOCATION



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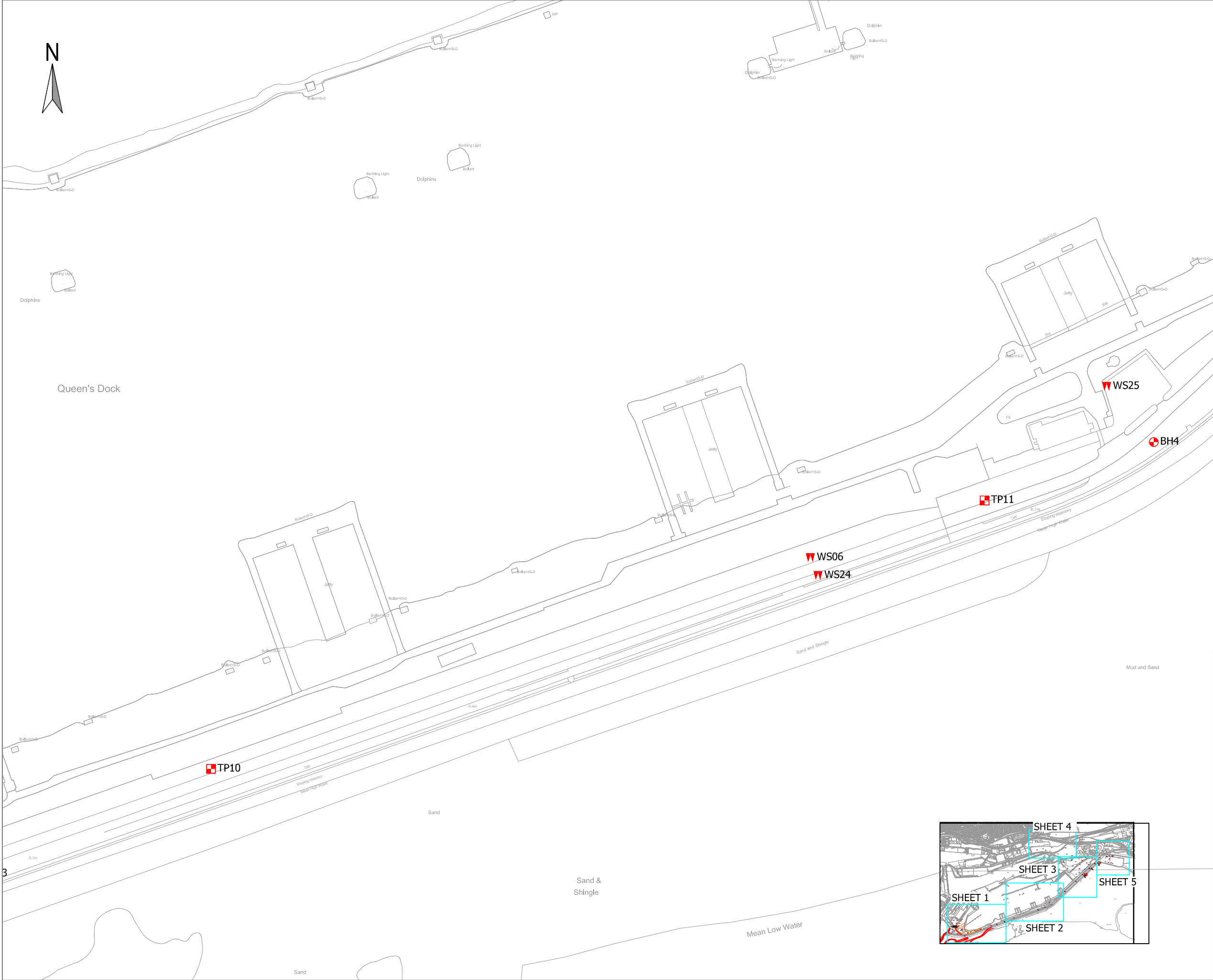
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Project:
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Drawing Title:
EXPLORATORY HOLE LOCATION PLAN
(SHEET 1 OF 5)

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Project No. A095973-2	Office CDF	Type N	Drawing No. 2	Revision 00		



DO NOT SCALE. CONTRACTOR TO CHECK ALL DIMENSIONS AND REPORT ANY OMISSIONS OR ERRORS



- LEGEND:
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 - ⊕ BOREHOLE LOCATION
 - ⊞ HAND PIT LOCATIONS
 - ⊕ SURFACE WATER LOCATION

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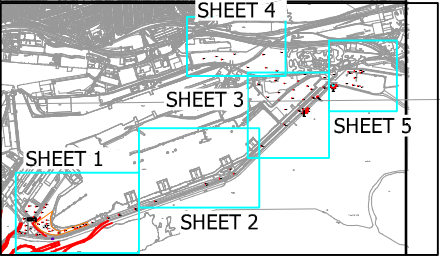
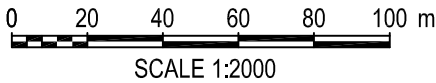
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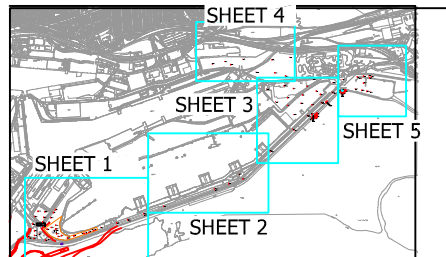
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LEGEND:

- WINDOW SAMPLE LOCATION
- TRIAL PIT LOCATIONS
- BOREHOLE LOCATION
- HAND PIT LOCATIONS
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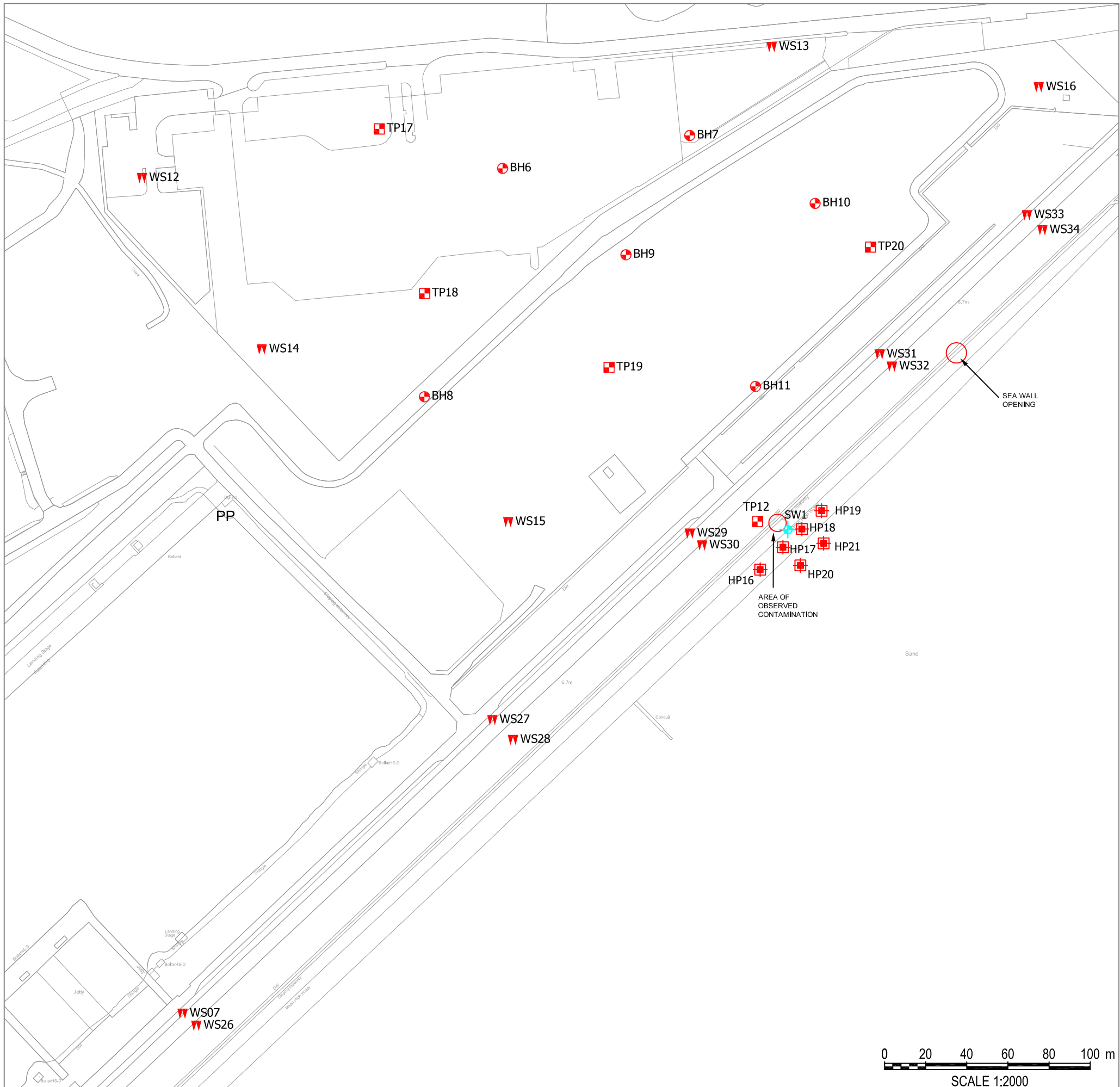
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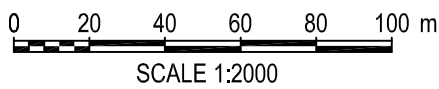
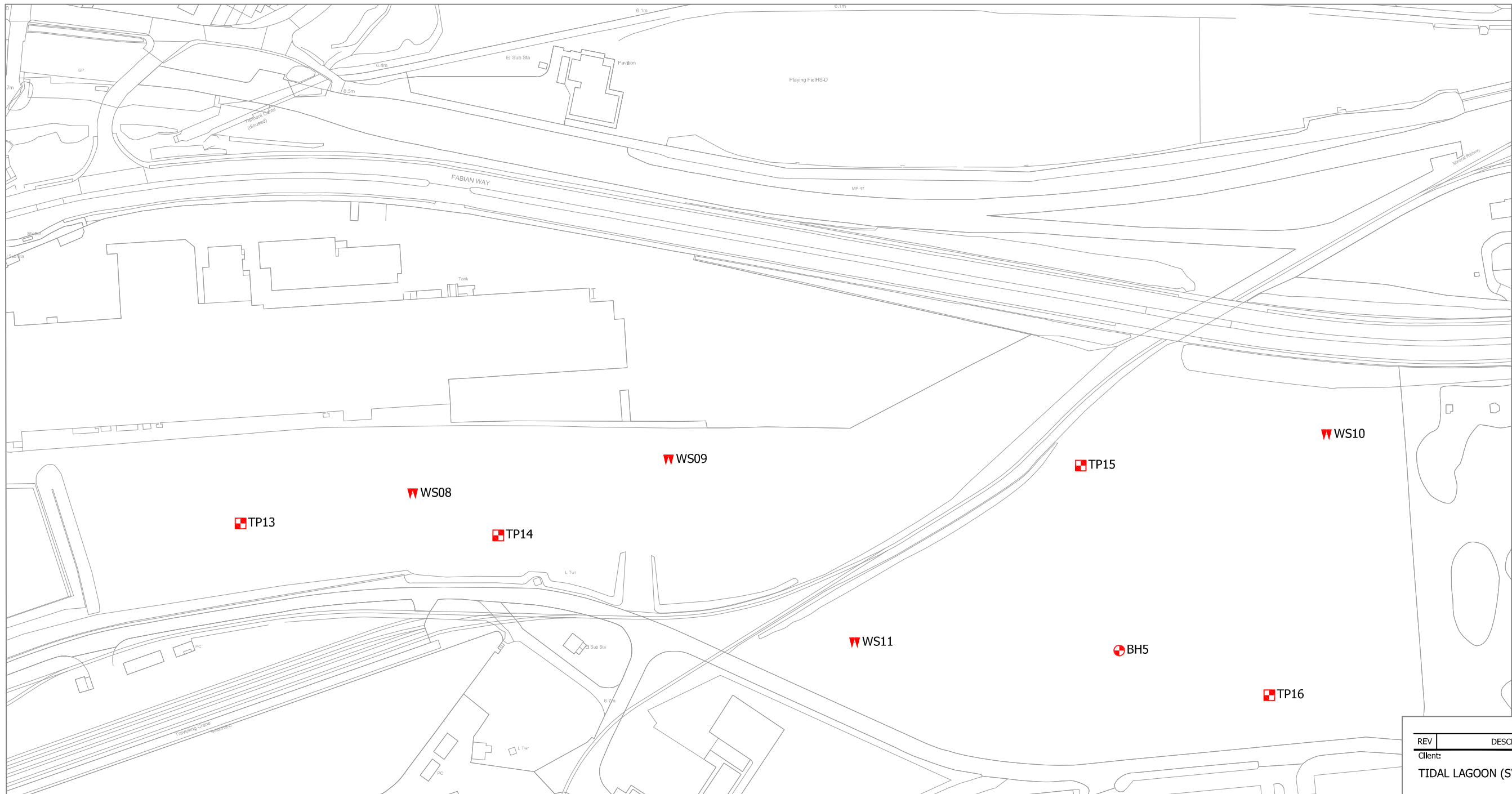
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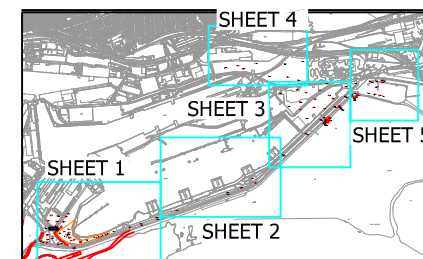
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LEGEND:

-  WINDOW SAMPLE LOCATION
-  TRIAL PIT LOCATIONS
-  BOREHOLE LOCATION
-  HAND PIT LOCATIONS
-  SURFACE WATER LOCATION



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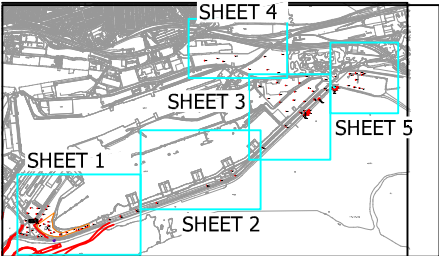
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(SHEET 4 OF 5)

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LEGEND:

- WINDOW SAMPLE LOCATION
- TRIAL PIT LOCATIONS
- BOREHOLE LOCATION
- HAND PIT LOCATIONS
- SURFACE WATER LOCATION



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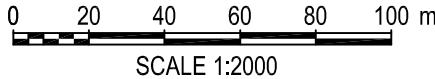
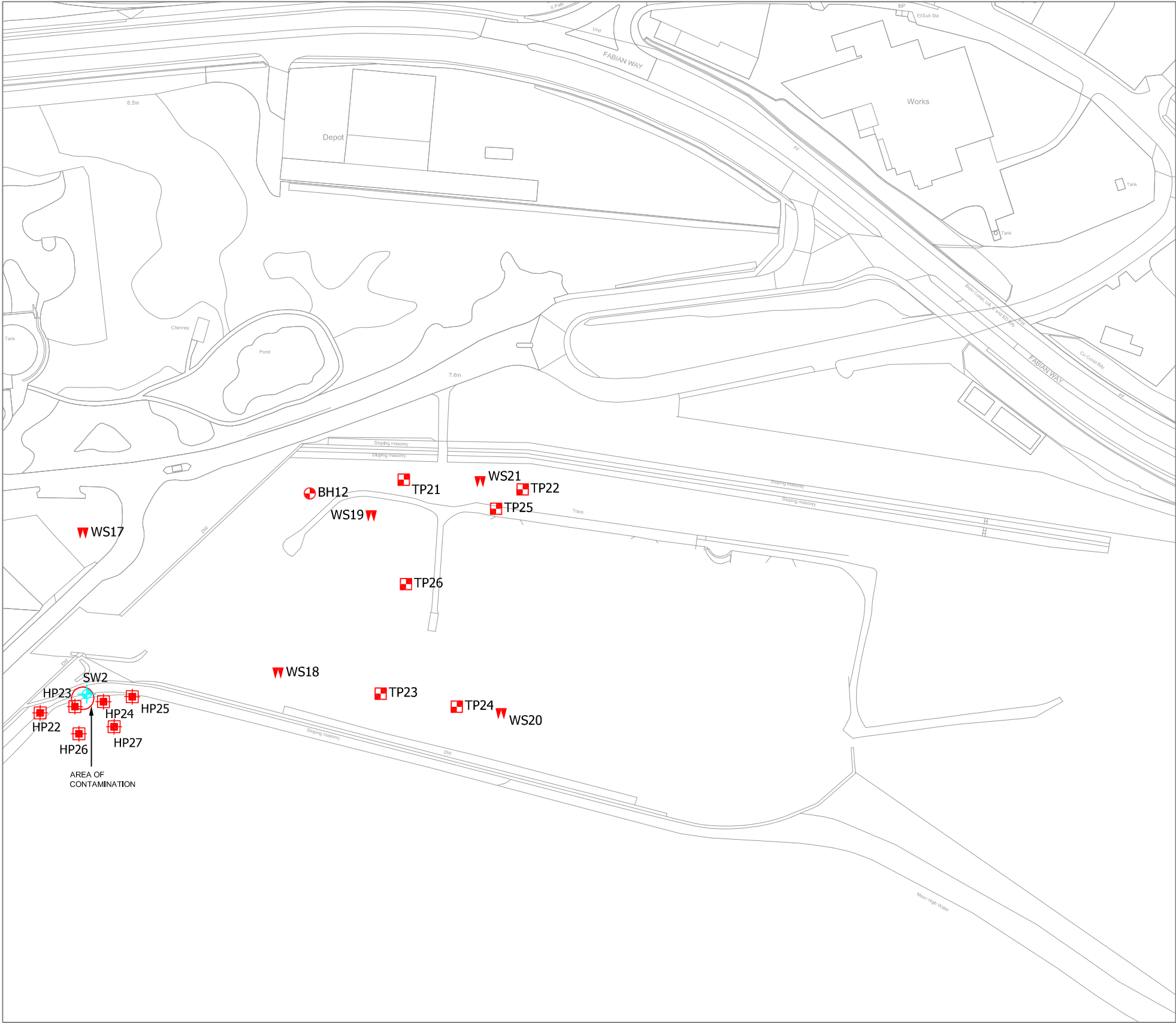
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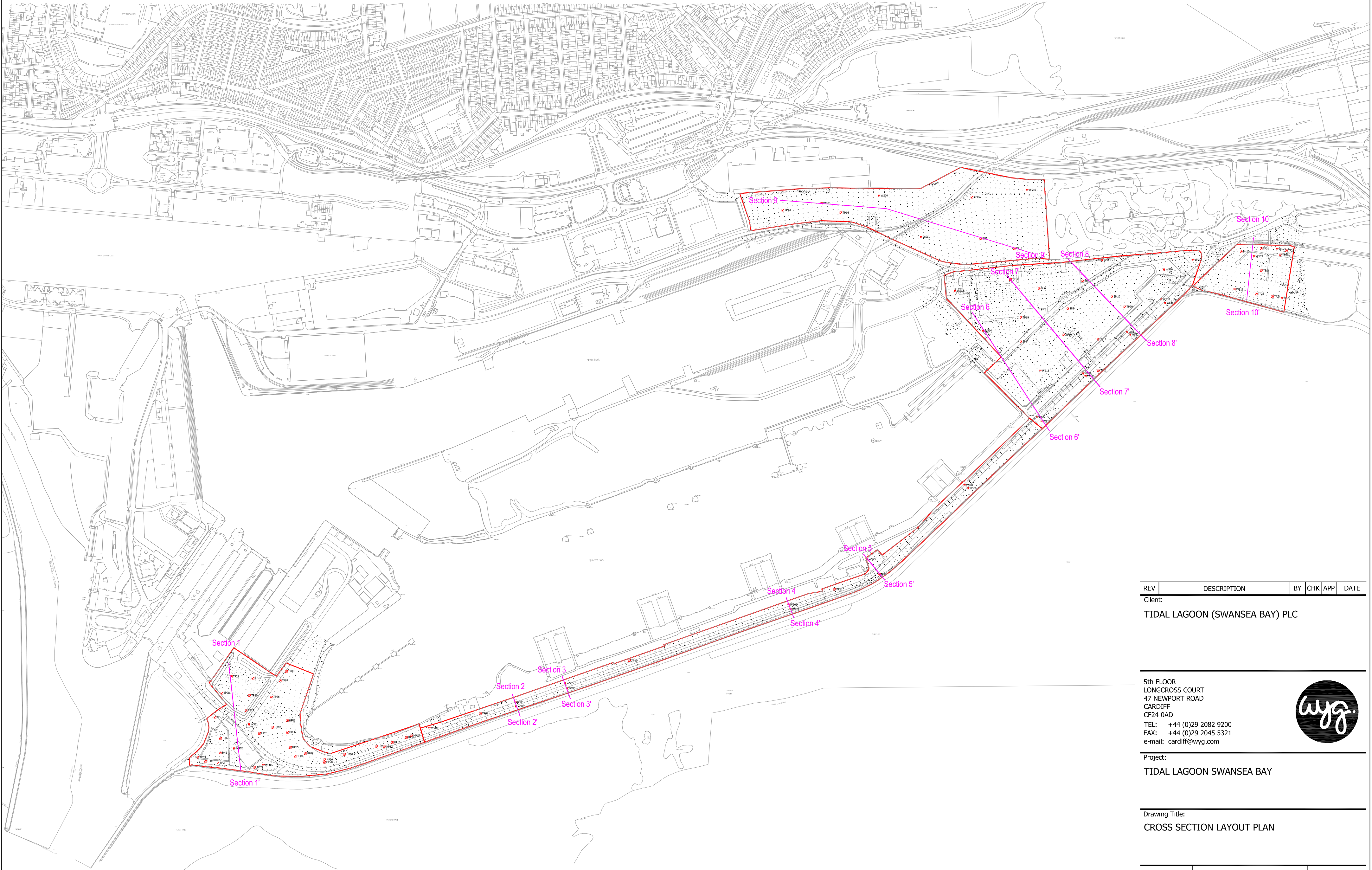
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Drawing Title:

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(SHEET 5 OF 5)

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Project No. A095973-2	Office CDF	Type N	Drawing No. 2	Revision 00		





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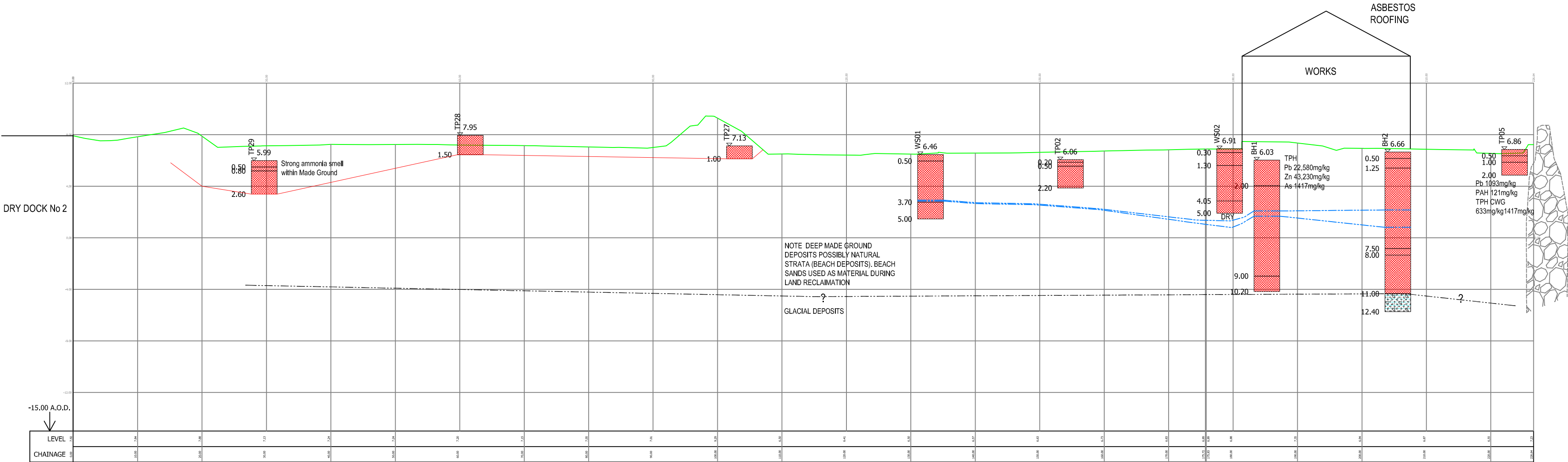
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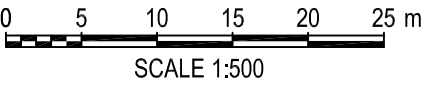
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SECTION 1
WESTERN LANDFALL AREA
Horiz. 1:200
Vert. 1:100

LEGEND:
MADE GROUND
INFERRED HYDROCARBON



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TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com



Client:
TIDAL LAGOON (SWANSEA BAY) PLC

Project:
TIDAL LAGOON SWANSEA BAY

Drawing Title:
CROSS SECTION 1
WESTERN LANDFALL AREA

REV	DESCRIPTION				BY	CHK	APP	DATE
	Scale @	A2	Drawn	Date	Checked	Date	Approved	Date
	PP		13.03.17		CW	13.03.17	CBP	13.03.17
Project No.		Office	Type	Drawing No.		Revision		
A095973-2		CD	N	3(a)		00		

LEGEND:



MADE GROUND

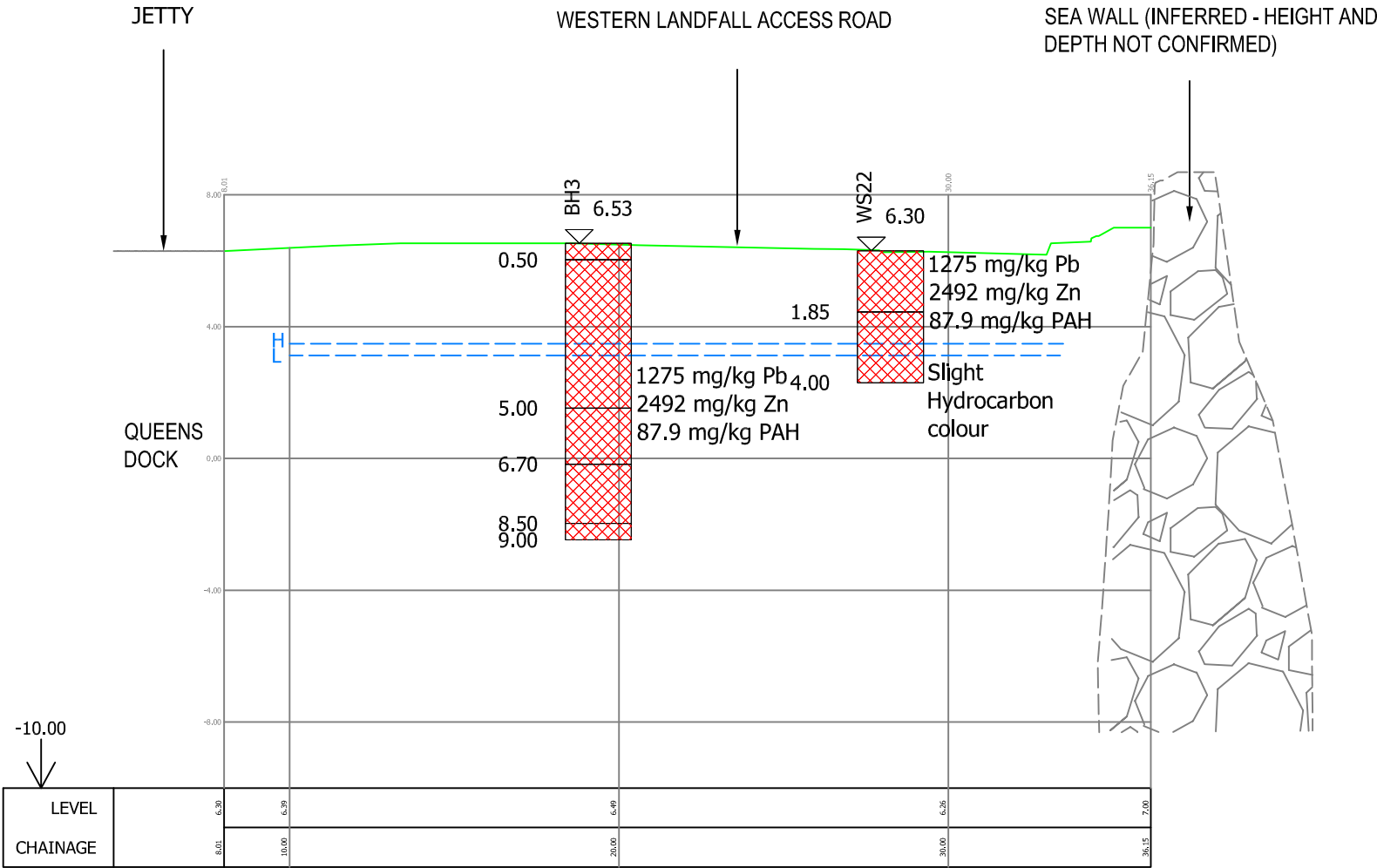


INFERRED HYDROCARBON

TIDES

H HIGHEST POINT RECORDED

L LOWEST POINT RECORDED



SECTION 2
WESTERN LANDFALL ACCESS ROAD

REV	DESCRIPTION	BY	CHK	APP	DATE
Client:					
TIDAL LAGOON (SWANSEA BAY) PLC					

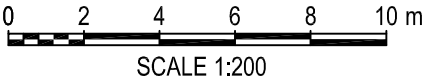
5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com



Project:
TIDAL LAGOON SWANSEA BAY

Drawing Title:
CROSS SECTION 2
WESTERN LANDFALL ACCESS ROAD

Scale @	A3	Drawn	Date	Checked	Date	Approved	Date
		PP	13.03.17	CW	13.03.17	SJ	13.03.17
Project No.	Office	Type	Drawing No.	Revision			
A095973-2	CDF	N	3(b)	00			



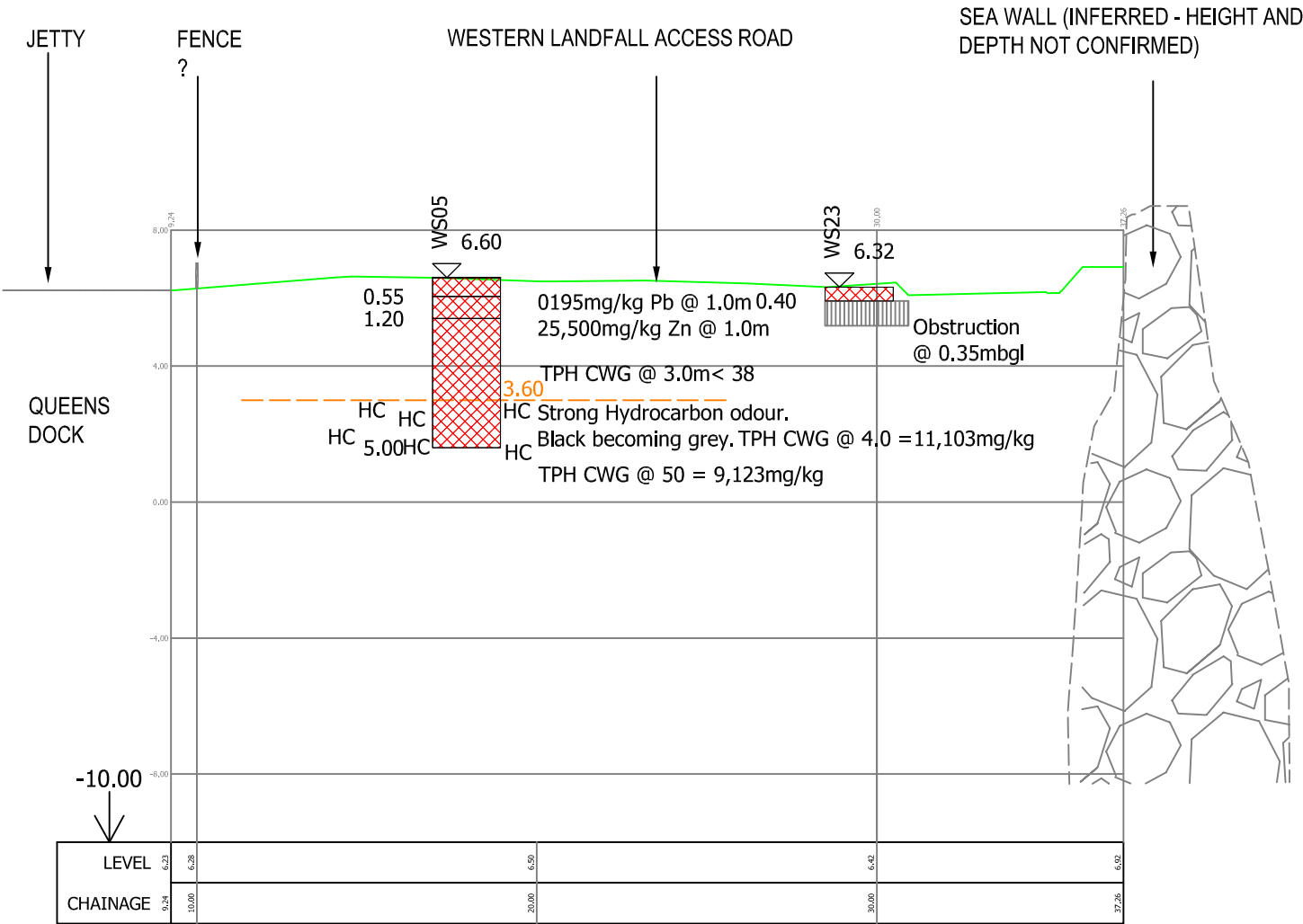
LEGEND:



MADE GROUND



INFERRED HYDROCARBON



SECTION 3
WESTERN LANDFALL ACCESS ROAD

REV	DESCRIPTION	BY	CHK	APP	DATE
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Client:

TIDAL LAGOON (SWANSEA BAY) PLC

5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardlff@wyg.com



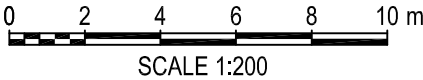
Project:

TIDAL LAGOON SWANSEA BAY

Drawing Title:

CROSS SECTION 3
WESTERN LANDFALL ACCESS ROAD

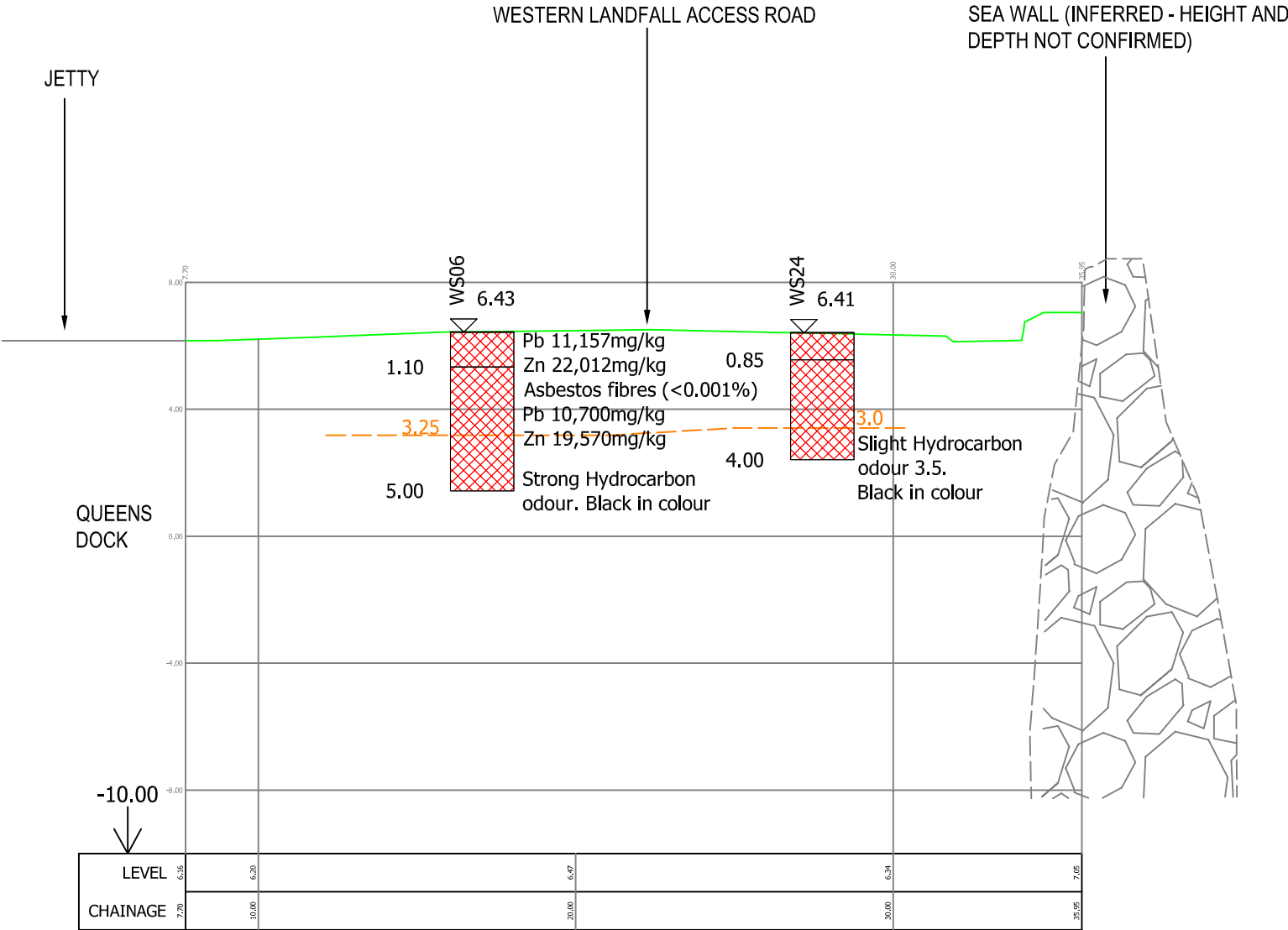
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Project No.	Office	Type	Drawing No.	Revision			
A095973-2	CDF	N	3(c)	00			



LEGEND:

 MADE GROUND

 INFERRED HYDROCARBON



SECTION 4
WESTERN LANDFALL ACCESS ROAD

REV	DESCRIPTION	BY	CHK	APP	DATE
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Client:
TIDAL LAGOON (SWANSEA BAY) PLC

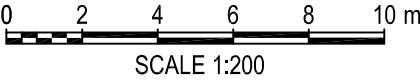
5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com



Project:
TIDAL LAGOON SWANSEA BAY

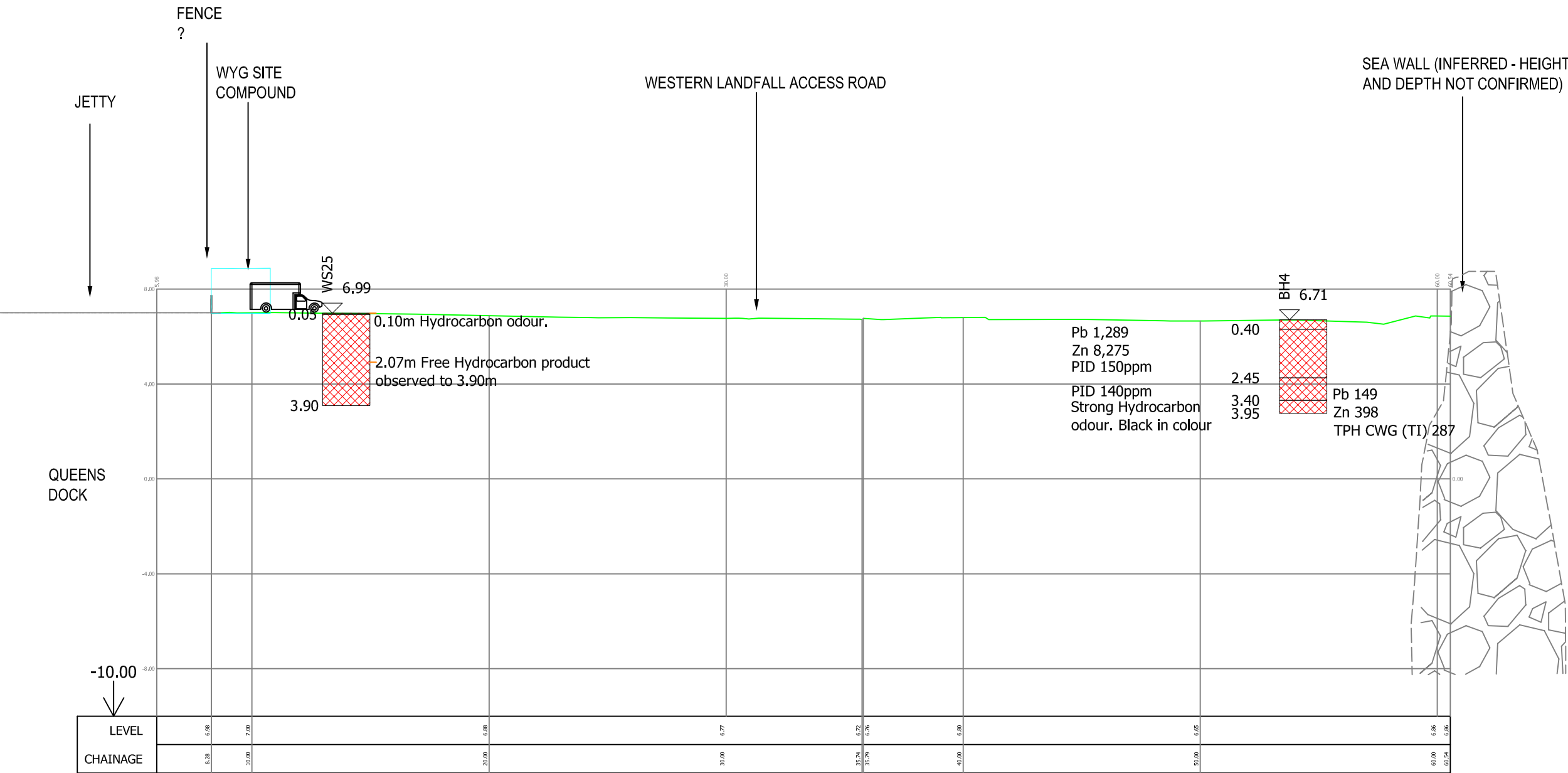
Drawing Title:
CROSS SECTION 4
WESTERN LANDFALL ACCESS ROAD

Scale @	A3	Drawn	Date	Checked	Date	Approved	Date
Project No.	Office	Type	Drawing No.	Revision			
A095973-2	CDF	N	3(d)	00			

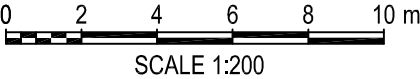


LEGEND:

-  MADE GROUND
-  INFERRED HYDROCARBON



SECTION 5
WESTERN LANDFALL ACCESS ROAD



REV	DESCRIPTION	BY	CHK	APP	DATE
Client:					
TIDAL LAGOON (SWANSEA BAY) PLC					

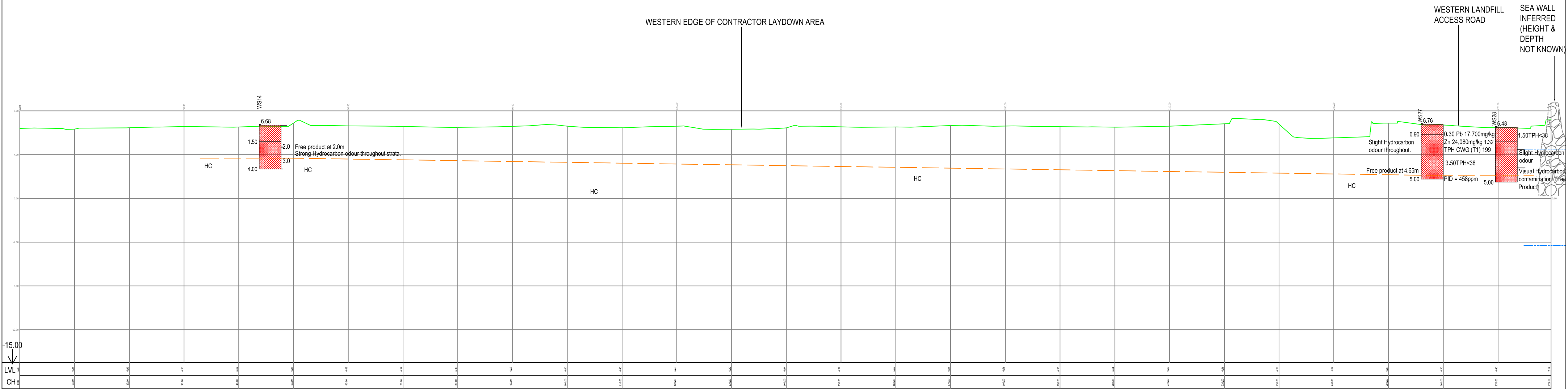
5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardlff@wyg.com



Project:
TIDAL LAGOON SWANSEA BAY

Drawing Title:
CROSS SECTION 5
WESTERN LANDFALL ACCESS ROAD

Scale @	A3	Drawn	Date	Checked	Date	Approved	Date
Project No.	Office	Type	Drawing No.	Revision			
A095973-2	CDF	N	3(e)	00			



SECTION 6
CONTRACTOR LAYDOWN AREA
Horiz. 1:200
Vert. 1:100

LEGEND:

- MADE GROUND
- INFERRED HYDROCARBON

REV	DESCRIPTION	BY	CHK	APP	DATE
-----	-------------	----	-----	-----	------

Client:

TIDAL LAGOON (SWANSEA BAY) PLC

5th FLOOR
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CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com



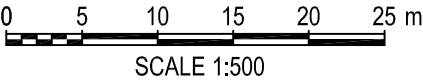
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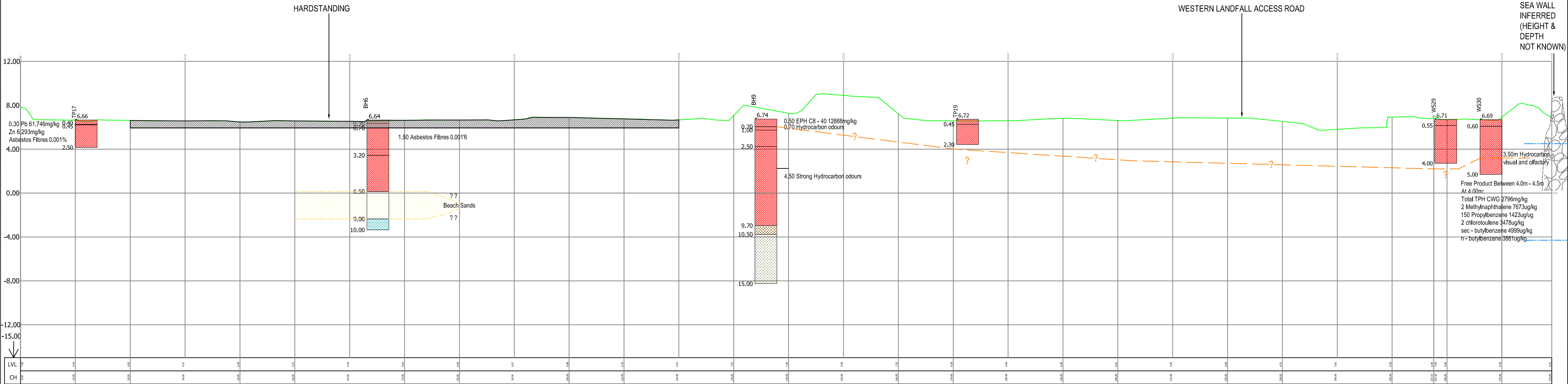
TIDAL LAGOON SWANSEA BAY

Drawing Title:

CROSS SECTION 6
CONTRACTOR LAYDOWN AREA

Scale @	A2	Drawn	Date	Checked	Date	Approved	Date
		PP	13.03.17	CW	13.03.17	SJ	13.03.17
Project No.	Office	Type	Drawing No.	Revision			
A095973-2	CDF	N	3(f)	00			





SECTION 7
CONTRACTOR LAYDOWN AREA
Horiz. 1:200
Vert. 1:100

LEGEND:

- MADE GROUND
- INFERRED HYDROCARBON

REV	DESCRIPTION	BY	CHK	APP	DATE
-----	-------------	----	-----	-----	------

Client:

TIDAL LAGOON (SWANSEA BAY) PLC

5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com



Project:

TIDAL LAGOON SWANSEA BAY

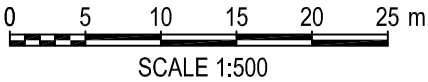
Drawing Title:

CROSS SECTION 7
CONTRACTOR LAYDOWN AREA

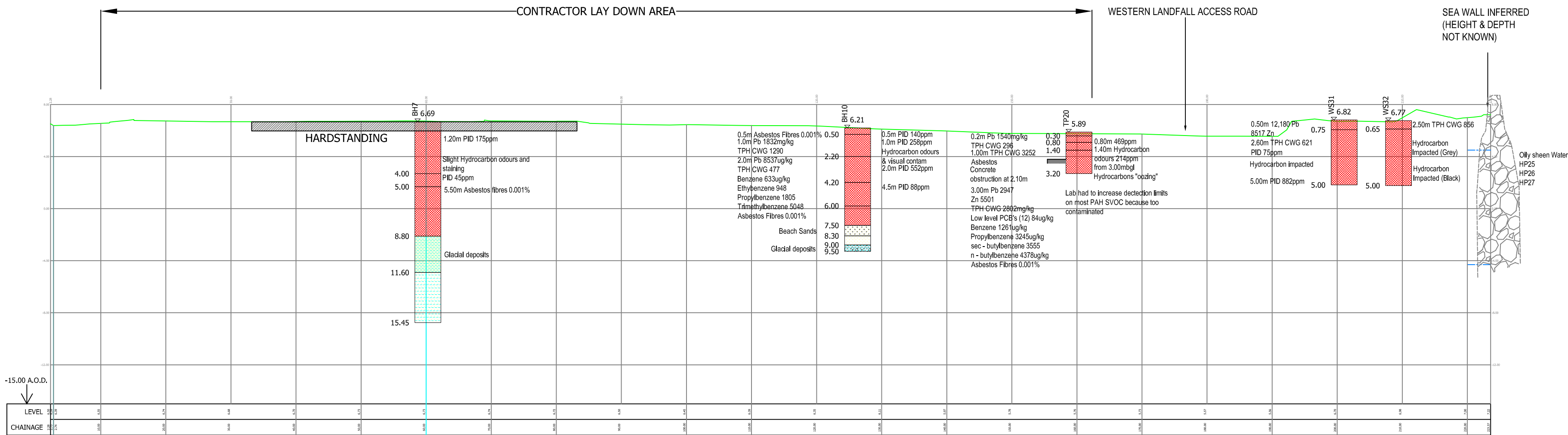
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PP	13.03.17	CW	13.03.17	SJ	13.03.17		
Project No.	Office	Type	Drawing No.	Revision			
A095973-2	CDF	N	3(g)	00			



Photo shows discharge of visually contaminated water from the base of the sea wall (SW1)



SCALE 1:500



SECTION 8
CONTRACTOR LAYDOWN AREA

Horiz. 1:200
Vert. 1:100

LEGEND:

- MADE GROUND
- INFERRED HYDROCARBON

REV	DESCRIPTION	BY	CHK	APP	DATE
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Client:
TIDAL LAGOON (SWANSEA BAY) PLC

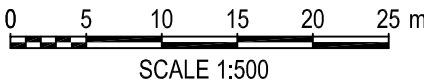
5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com



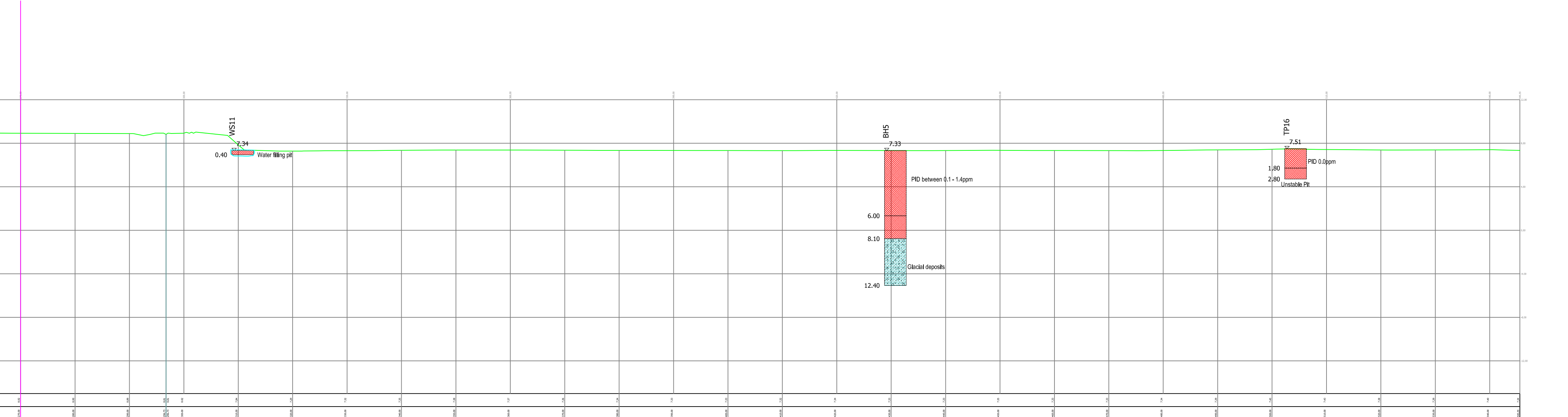
Project:
TIDAL LAGOON SWANSEA BAY

Drawing Title:
CROSS SECTION 8
CONTRACTOR LAYDOWN AREA

Scale @	A2	Drawn	Date	Checked	Date	Approved	Date
		PP	13.03.17	CW	13.03.17	SJ	13.03.17
Project No.	Office	Type	Drawing No.	Revision			
A095973-2	CDF	N	3(h)	00			



LEVEL	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	800	810	820	830	840	850	860	870	880	890	900	910	920	930	940	950	960	970	980	990	1000	1010	1020	1030	1040	1050	1060	1070	1080	1090	1100	1110	1120	1130	1140	1150	1160	1170	1180	1190	1200	1210	1220	1230	1240	1250	1260	1270	1280	1290	1300	1310	1320	1330	1340	1350	1360	1370	1380	1390	1400	1410	1420	1430	1440	1450	1460	1470	1480	1490	1500	1510	1520	1530	1540	1550	1560	1570	1580	1590	1600	1610	1620	1630	1640	1650	1660	1670	1680	1690	1700	1710	1720	1730	1740	1750	1760	1770	1780	1790	1800	1810	1820	1830	1840	1850	1860	1870	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2110	2120	2130	2140	2150	2160	2170	2180	2190	2200	2210	2220	2230	2240	2250	2260	2270	2280	2290	2300	2310	2320	2330	2340	2350	2360	2370	2380	2390	2400	2410	2420	2430	2440	2450	2460	2470	2480	2490	2500	2510	2520	2530	2540	2550	2560	2570	2580	2590	2600	2610	2620	2630	2640	2650	2660	2670	2680	2690	2700	2710	2720	2730	2740	2750	2760	2770	2780	2790	2800	2810	2820	2830	2840	2850	2860	2870	2880	2890	2900	2910	2920	2930	2940	2950	2960	2970	2980	2990	3000	3010	3020	3030	3040	3050	3060	3070	3080	3090	3100	3110	3120	3130	3140	3150	3160	3170	3180	3190	3200	3210	3220	3230	3240	3250	3260	3270	3280	3290	3300	3310	3320	3330	3340	3350	3360	3370	3380	3390	3400	3410	3420	3430	3440	3450	3460	3470	3480	3490	3500	3510	3520	3530	3540	3550	3560	3570	3580	3590	3600	3610	3620	3630	3640	3650	3660	3670	3680	3690	3700	3710	3720	3730	3740	3750	3760	3770	3780	3790	3800	3810	3820	3830	3840	3850	3860	3870	3880	3890	3900	3910	3920	3930	3940	3950	3960	3970	3980	3990	4000	4010	4020	4030	4040	4050	4060	4070	4080	4090	4100	4110	4120	4130	4140	4150	4160	4170	4180	4190	4200	4210	4220	4230	4240	4250	4260	4270	4280	4290	4300	4310	4320	4330	4340	4350	4360	4370	4380	4390	4400	4410	4420	4430	4440	4450	4460	4470	4480	4490	4500	4510	4520	4530	4540	4550	4560	4570	4580	4590	4600	4610	4620	4630	4640	4650	46
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SECTION 9
MORRISSEY LAND
Horiz. 1:200
Vert. 1:100



Client: TIDAL LAGOON (SWANSEA BAY) PLC

Project: TIDAL LAGOON SWANSEA BAY

Drawing Title:

CROSS SECTION 9
MORRISSEY LAND

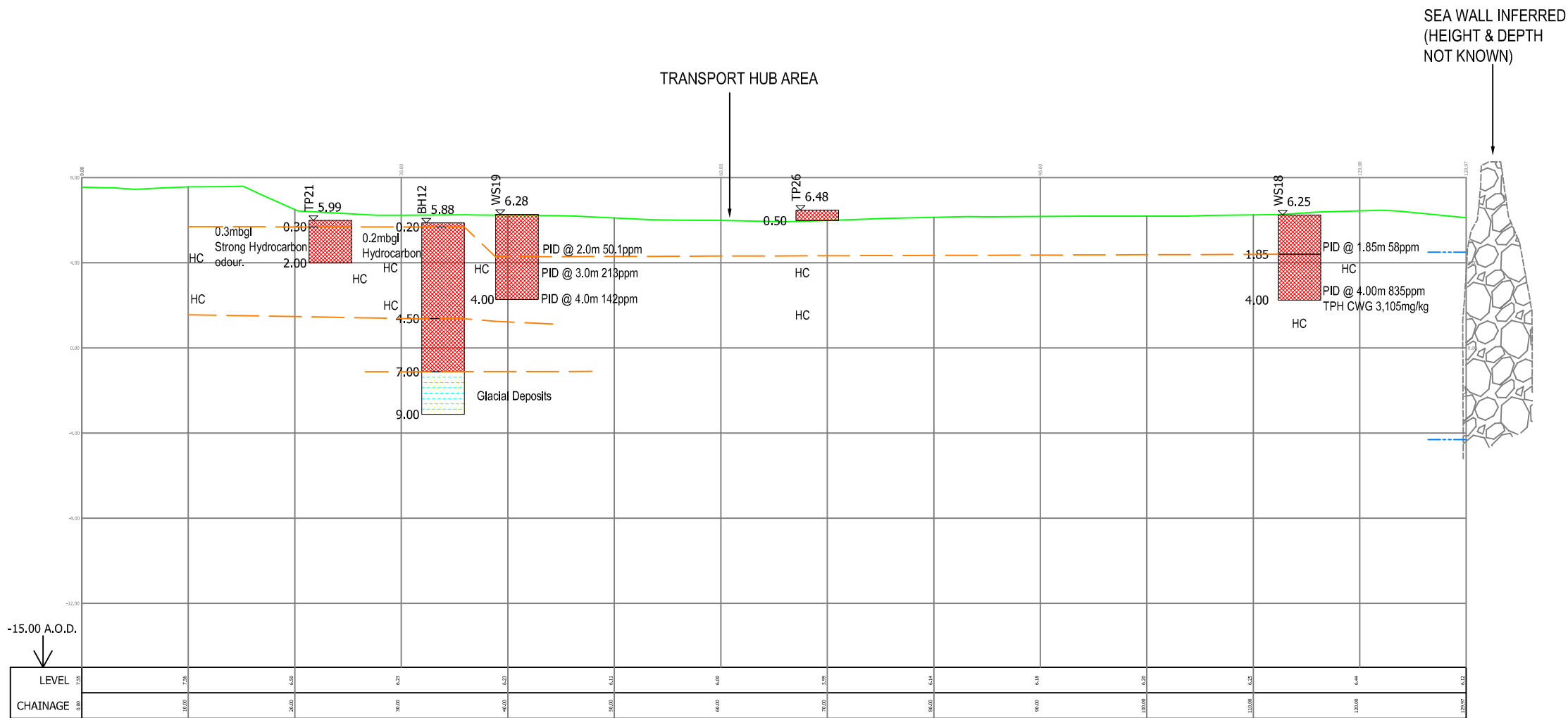
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	Project No. A095973-2	Office CDF	Type N	Drawing No. 3(i)			Revision 00	

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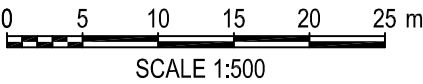
LEGEND:

MADE GROUND

INFERRED HYDROCARBON



SECTION 10
TRANSPORT HUB AREA
Horiz. 1:200
Vert. 1:100



REV	DESCRIPTION	BY	CHK	APP	DATE
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Client:
TIDAL LAGOON (SWANSEA BAY) PLC

5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com



Project:
TIDAL LAGOON SWANSEA BAY

Drawing Title:
CROSS SECTION 10
TRANSPORT HUB AREA

Scale @	A2	Drawn	Date	Checked	Date	Approved	Date
Project No.	A095973-2	Office	13.03.17	CW	13.03.17	SJ	13.03.17
Type	CDF	N	Drawing No.	3(j)	Revision	00	



Key:

 Asbestos (traces)

 Metals

 Hydrocarbons in Ground water
Risk to (elevated) controlled waters

 TPH or EPH above 2000mg/kg

WESTERN LANDFALL AREA

WS1 SUBJECT TO SERVICE CLEARANCE

APPROXIMATE
EXTENT OF
STOCKPILE

PAH

Pb 11,197 @ 0.30m
C8 - C10
6341.8mg/kg @ 0.40m
TPH (11,103mg/kg)
(1,925mg/kg)

Pb 3,479 @ 1.00m

As 668mg/kg @ 0.50m
Pb 13,650 @ 0.50m
Pb 11,720 @ 0.20m

3,925mg/kg @ 0.50m

8019mg/kg @ 2.0m

6253mg/kg @ 0.5m

2068mg/kg @ 1 - 1.5m

Pb 6,875
Ni 1860.2

As 1,417 @ 0.9mg/kg
Pb 22,580 @ 0.3

0 10 20 30 40 50 m

SCALE 1:1000

REV	DESCRIPTION	BY	CHK	APP	DATE
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Client:

TIDAL LAGOON (SWANSEA BAY) PLC

5th FLOOR
LONGCROSS COURT
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CARDIFF
CF24 0AD
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FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com



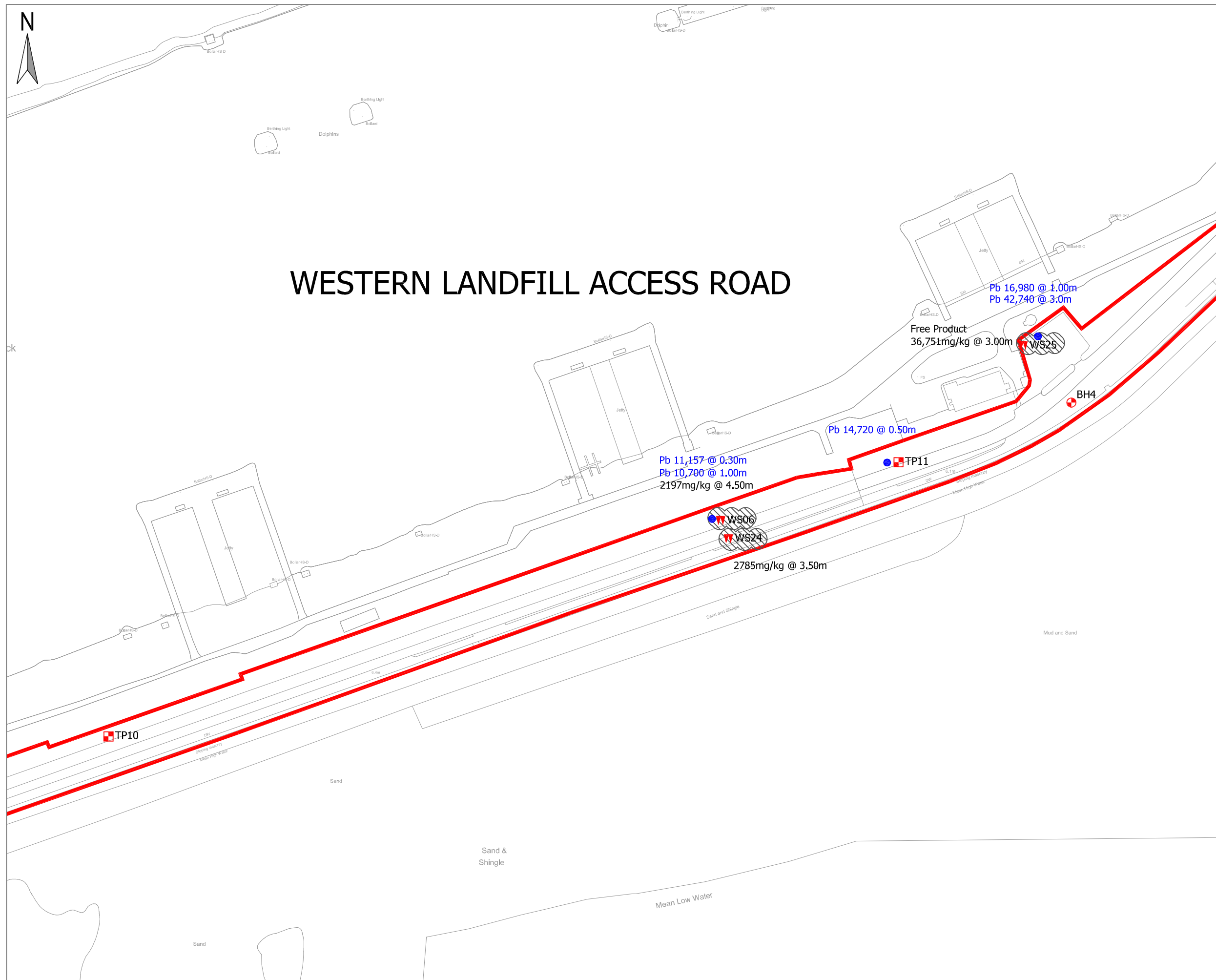
Project:

TIDAL LAGOON SWANSEA BAY

Drawing Title:

GROUND CONTAMINATION SUMMARY PLAN
WESTERN LANDFALL AREA

Scale @ A3	Drawn PP	Date 13.03.17	Checked CW	Date 13.03.17	Approved SJ	Date 13.03.17
Project No. A095973-2	Office CDF	Type N	Drawing No. 4(a)	Revision 00		



- Key:
-  Asbestos (traces)
 -  Metals
 -  Hydrocarbons in Ground water
Risk to (elevated) controlled waters
 -  TPH or EPH above 2000mg/kg

REV	DESCRIPTION	BY	CHK	APP	DATE
Client:					
TIDAL LAGOON (SWANSEA BAY) PLC					

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FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com



Project:
TIDAL LAGOON SWANSEA BAY

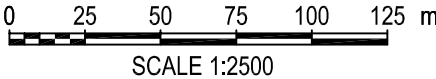
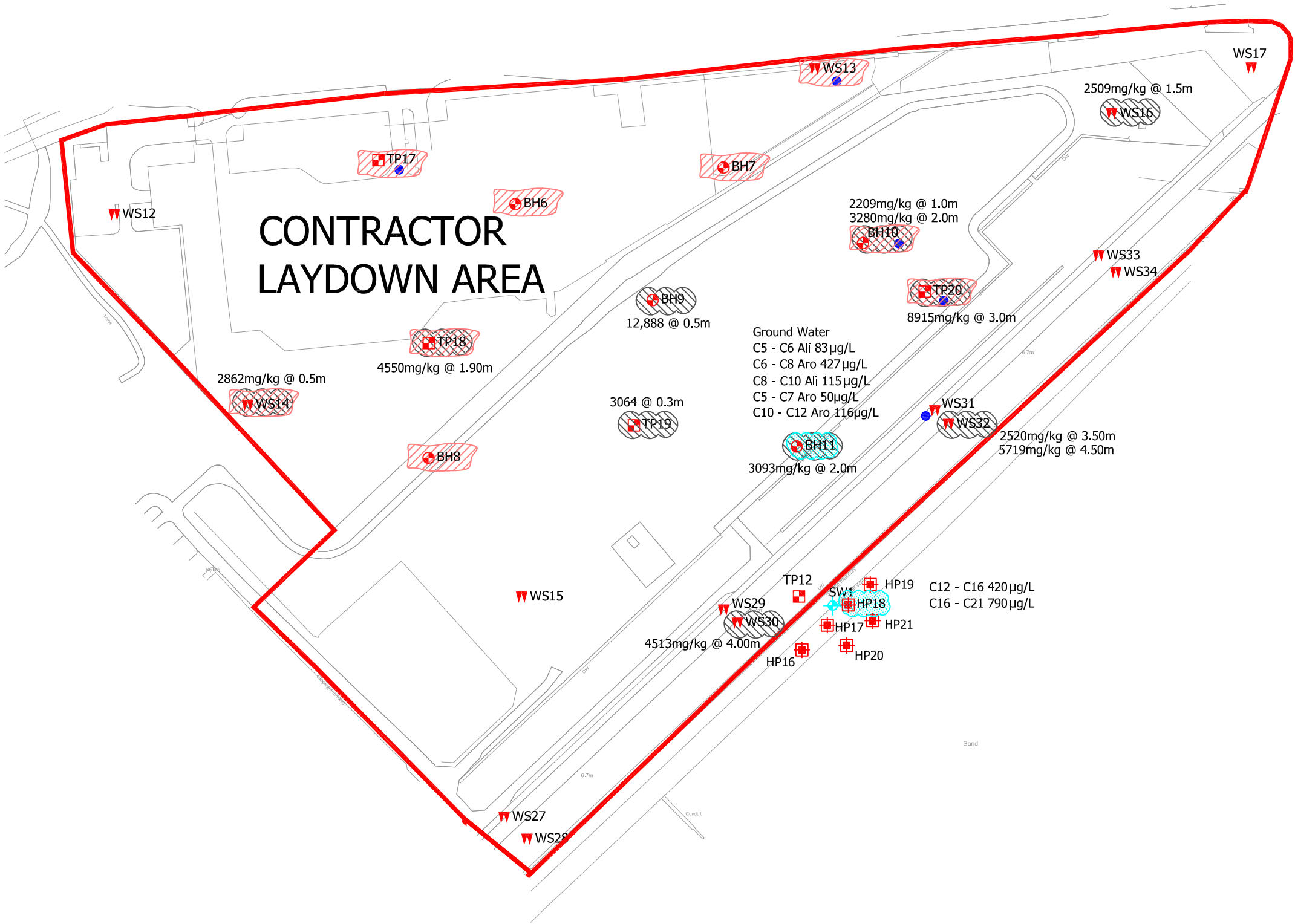
Drawing Title:
GROUND CONTAMINATION SUMMARY PLAN
WESTERN LANDFALL ACCESS ROAD

Scale @	A3	Drawn	Date	Checked	Date	Approved	Date
Project No.	Office	Type	Drawing No.	Revision			
A095973-2	CDF	N	4(b)	00			



Key:

- Asbestos (traces)
- Metals
- Hydrocarbons in Ground water
Risk to (elevated) controlled waters
- TPH or EPH above 2000mg/kg



REV	DESCRIPTION	BY	CHK	APP	DATE
Client:					
TIDAL LAGOON (SWANSEA BAY) PLC					

5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com



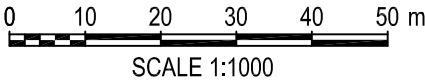
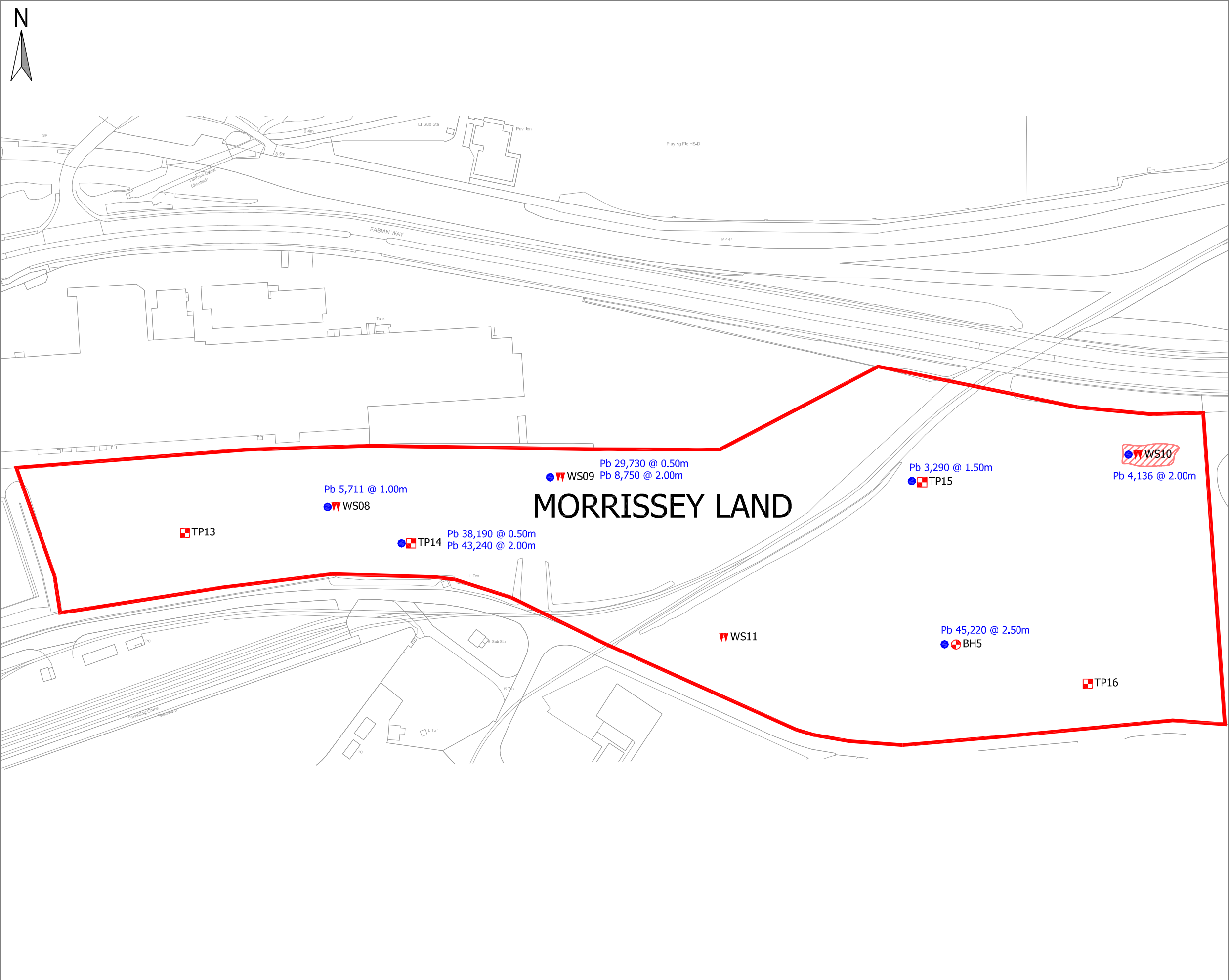
Project:
TIDAL LAGOON SWANSEA BAY

Drawing Title:
GROUND CONTAMINATION SUMMARY PLAN
CONTRACTOR LAYDOWN AREA

Scale @	A3	Drawn	Date	Checked	Date	Approved	Date
Project No.	Office	Type	Drawing No.	Revision			
A095973-2	CDF	N	4(c)	00			



- Key:
-  Asbestos (traces)
 -  Metals



REV	DESCRIPTION	BY	CHK	APP	DATE
-----	-------------	----	-----	-----	------

Client:
TIDAL LAGOON (SWANSEA BAY) PLC

5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
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CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardlff@wyg.com



Project:
TIDAL LAGOON SWANSEA BAY

Drawing Title:
GROUND CONTAMINATION SUMMARY PLAN
MORRISSEY LAND

Scale @	A3	Drawn	Date	Checked	Date	Approved	Date
Project No.	Office	Type	Drawing No.	Revision			
A095973-2	CDF	N	4(d)	00			

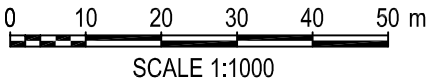
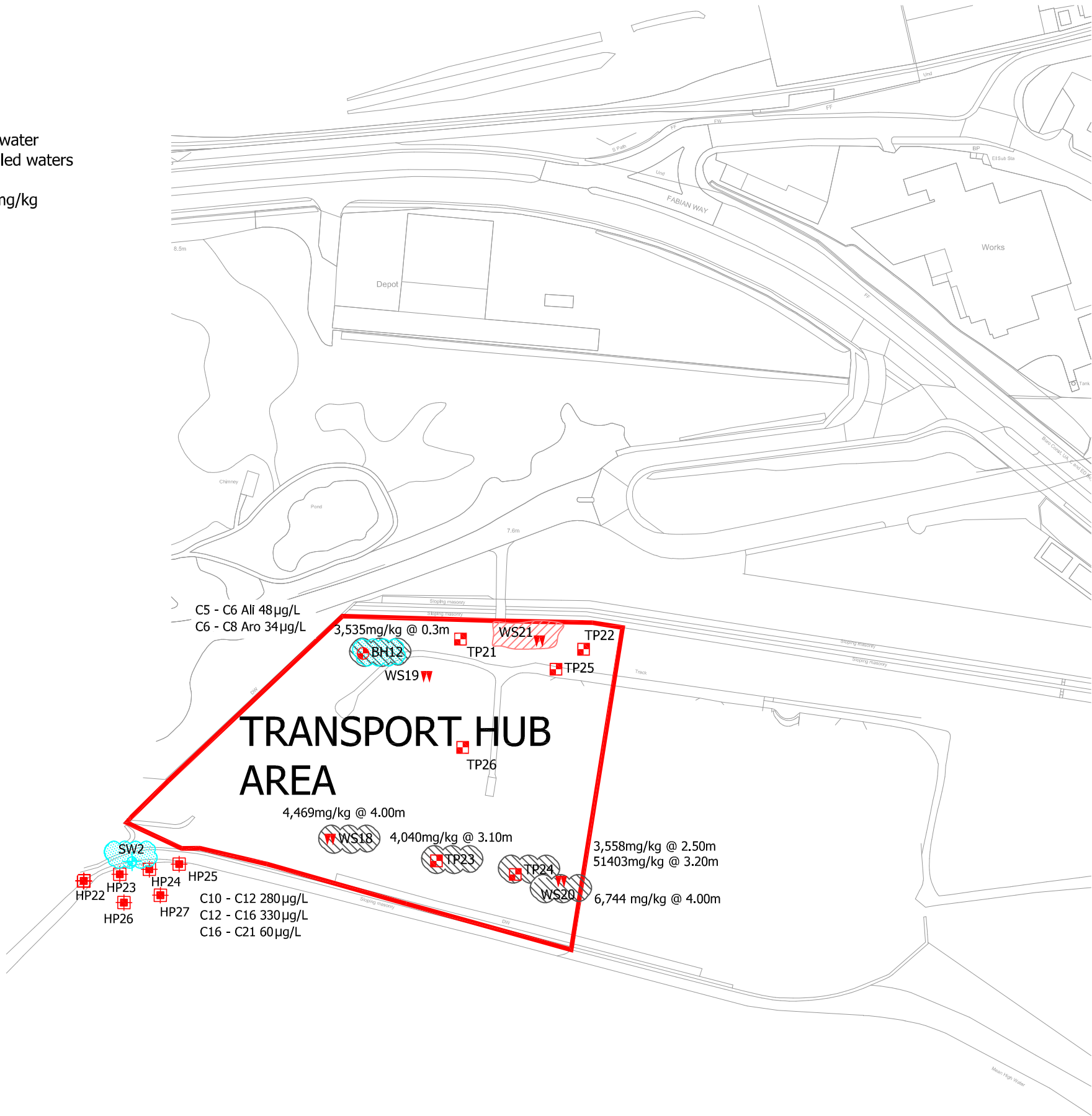
Key:

 Asbestos (traces)

 Metals

 Hydrocarbons in Ground water
Risk to (elevated) controlled waters

 TPH or EPH above 2000mg/kg



REV	DESCRIPTION	BY	CHK	APP	DATE
Client:					
TIDAL LAGOON (SWANSEA BAY) PLC					

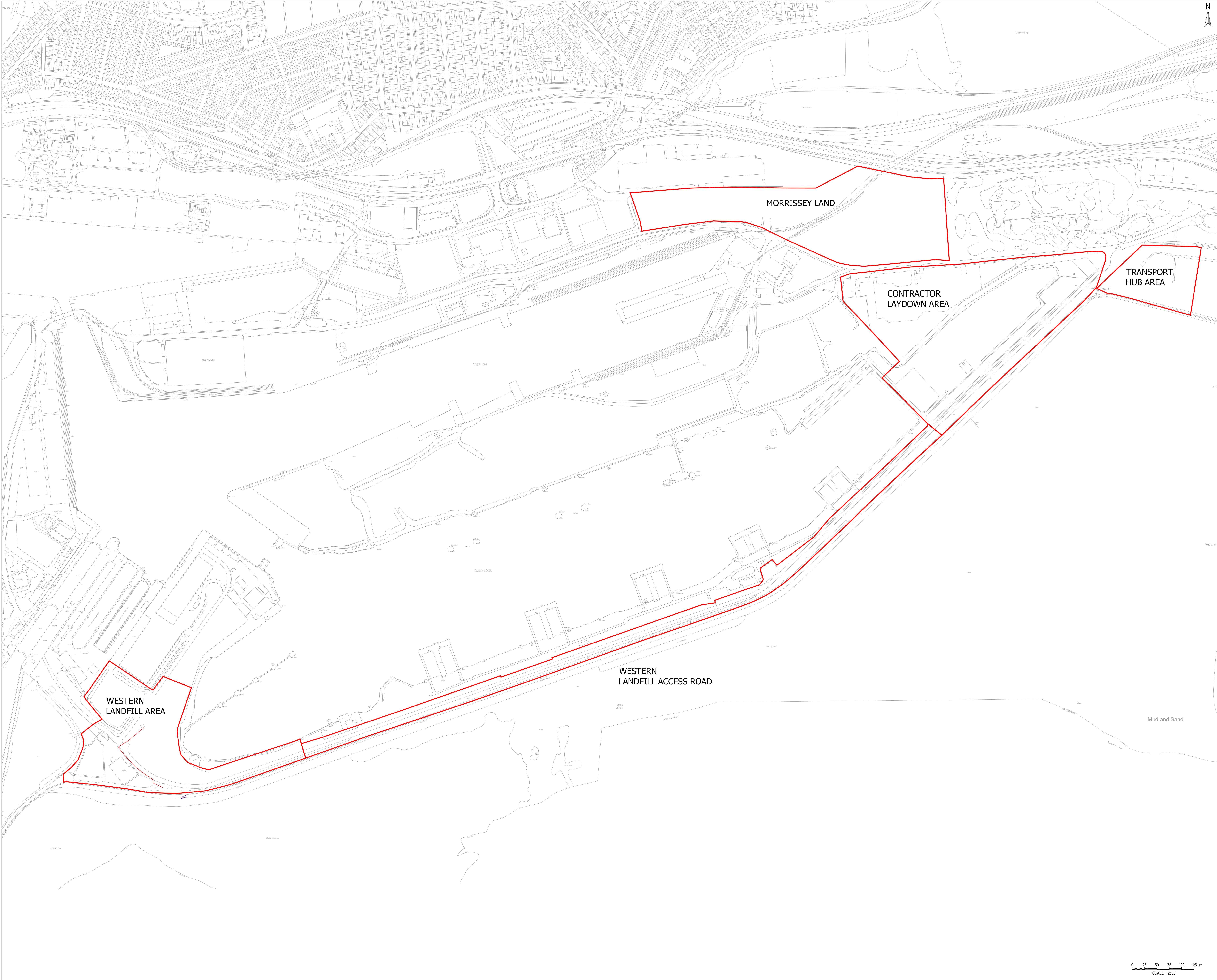
5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardlff@wyg.com



Project:
TIDAL LAGOON SWANSEA BAY

Drawing Title:
GROUND CONTAMINATION SUMMARY PLAN
TRANSPORT HUB AREA

Scale @	A3	Drawn	Date	Checked	Date	Approved	Date
Project No.	Office	Type	Drawing No.	Revision			
A095973-2	CDF	N	4(e)	00			



DO NOT SCALE: CONTRACTOR TO CHECK ALL DIMENSIONS AND REPORT ANY OMISSIONS OR ERRORS

KEY:
SITE LAYOUT BOUNDARIES

REV	DESCRIPTION	BY	CHK	APP	DATE
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Client:
TIDAL LAGOON (SWANSEA BAY) PLC

5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
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CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com



Project:
TIDAL LAGOON SWANSEA BAY

Drawing Title:
SITE LAYOUT PLAN

Scale @	A0	Drawn	Date	Checked	Date	Approved	Date
Project No.		Office	Type	Drawing No.	?	Revision	
A095973-2	CDF	N				00	



Appendices



Appendix A – Report Conditions



APPENDIX A - REPORT CONDITIONS GROUND INVESTIGATION

This report is produced solely for the benefit of Tidal Lagoon (Swansea Bay) Plc and no liability is accepted for any reliance placed on it by any other party unless specifically agreed in writing otherwise.

This report refers, within the limitations stated, to the condition of the site at the time of the inspections. No warranty is given as to the possibility of future changes in the condition of the site.

This report is based on a visual site inspection, reference to accessible referenced historical records, information supplied by those parties referenced in the text and preliminary discussions with local and Statutory Authorities. Some of the opinions are based on unconfirmed data and information and are presented as the best that can be obtained without further extensive research. Where ground contamination is suspected but no physical site test results are available to confirm this, the report must be regarded as initial advice only, and further assessment should be undertaken prior to activities related to the site. Where test results undertaken by others have been made available these can only be regarded as a limited sample. The possibility of the presence of contaminants, perhaps in higher concentrations, elsewhere on the site cannot be discounted.

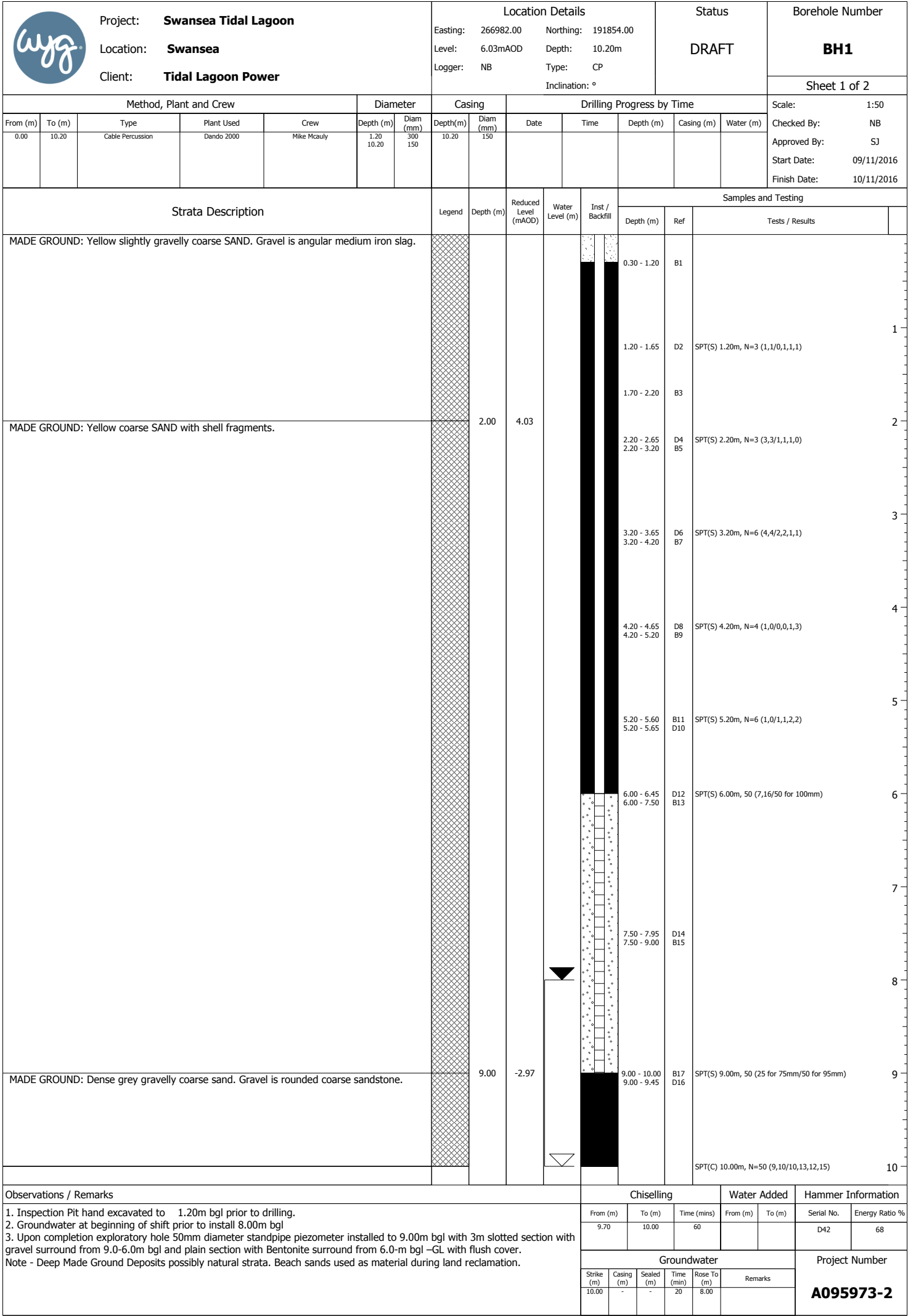
Whilst confident in the findings detailed within this report because there are no exact UK definitions of these matters, being subject to risk analysis, we are unable to give categorical assurances that they will be accepted by Authorities or Funds etc. without question as such bodies often have unpublished, more stringent objectives. This report is prepared for the proposed uses stated in the report and should not be used in a different context without reference to WYGE. In time improved practices or amended legislation may necessitate a re-assessment.

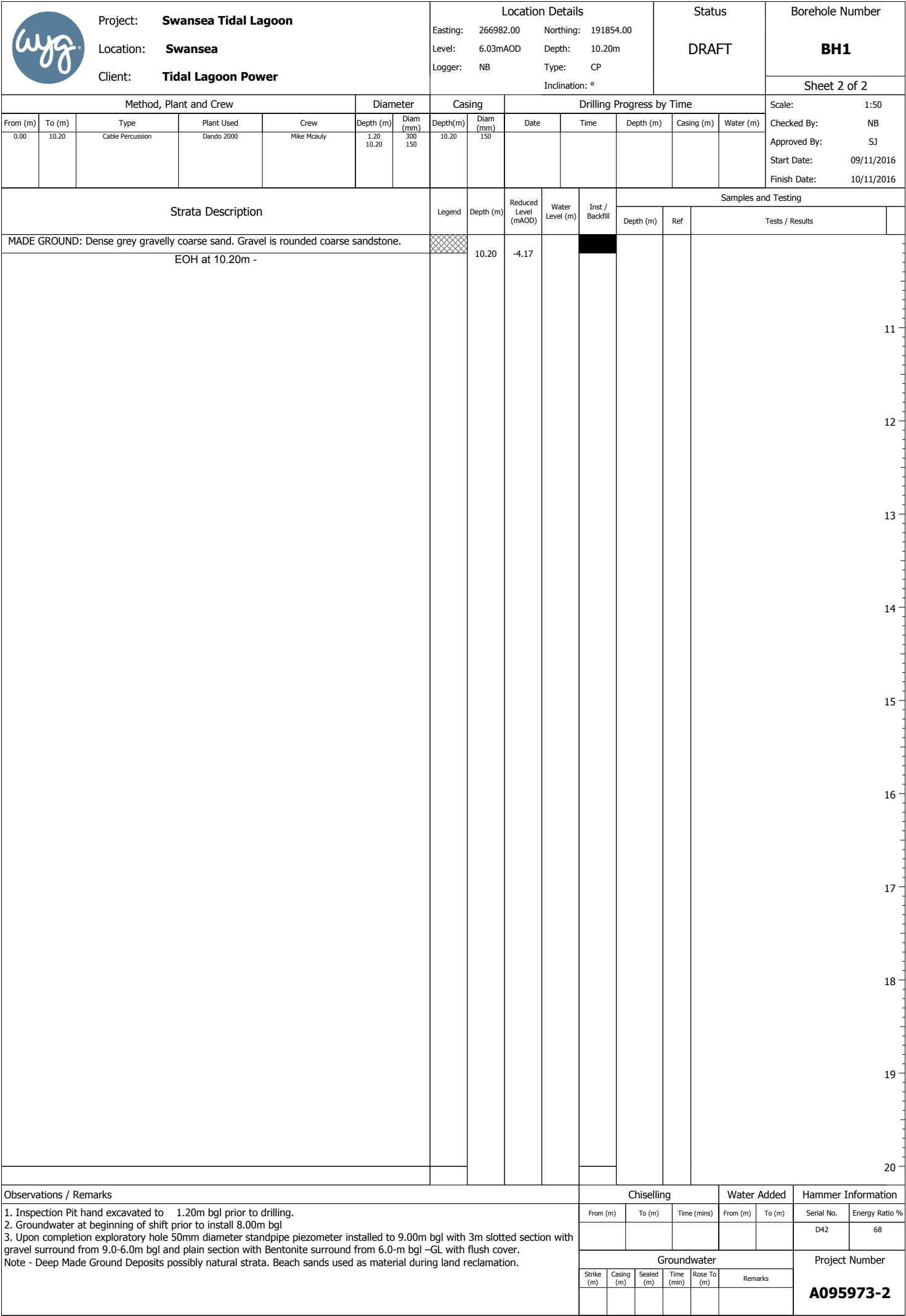
The assessment of ground conditions within this report is based upon the findings of the study undertaken. We have interpreted the ground conditions in between locations on the assumption that conditions do not vary significantly. However, no investigation can inspect each and every part of the site and therefore changes or variances in the physical and chemical site conditions as described in this report cannot be discounted.

The report is limited to those aspects of land contamination specifically reported on and is necessarily restricted and no liability is accepted for any other aspect especially concerning gradual or sudden pollution incidents. The opinions expressed cannot be absolute due to the limitations of time and resources imposed by the agreed brief and the possibility of unrecorded previous use and abuse of the site and adjacent sites. The report concentrates on the site as defined in the report and provides an opinion on surrounding sites. If migrating pollution or contamination (past or present) exists further extensive research will be required before the effects can be better determined.

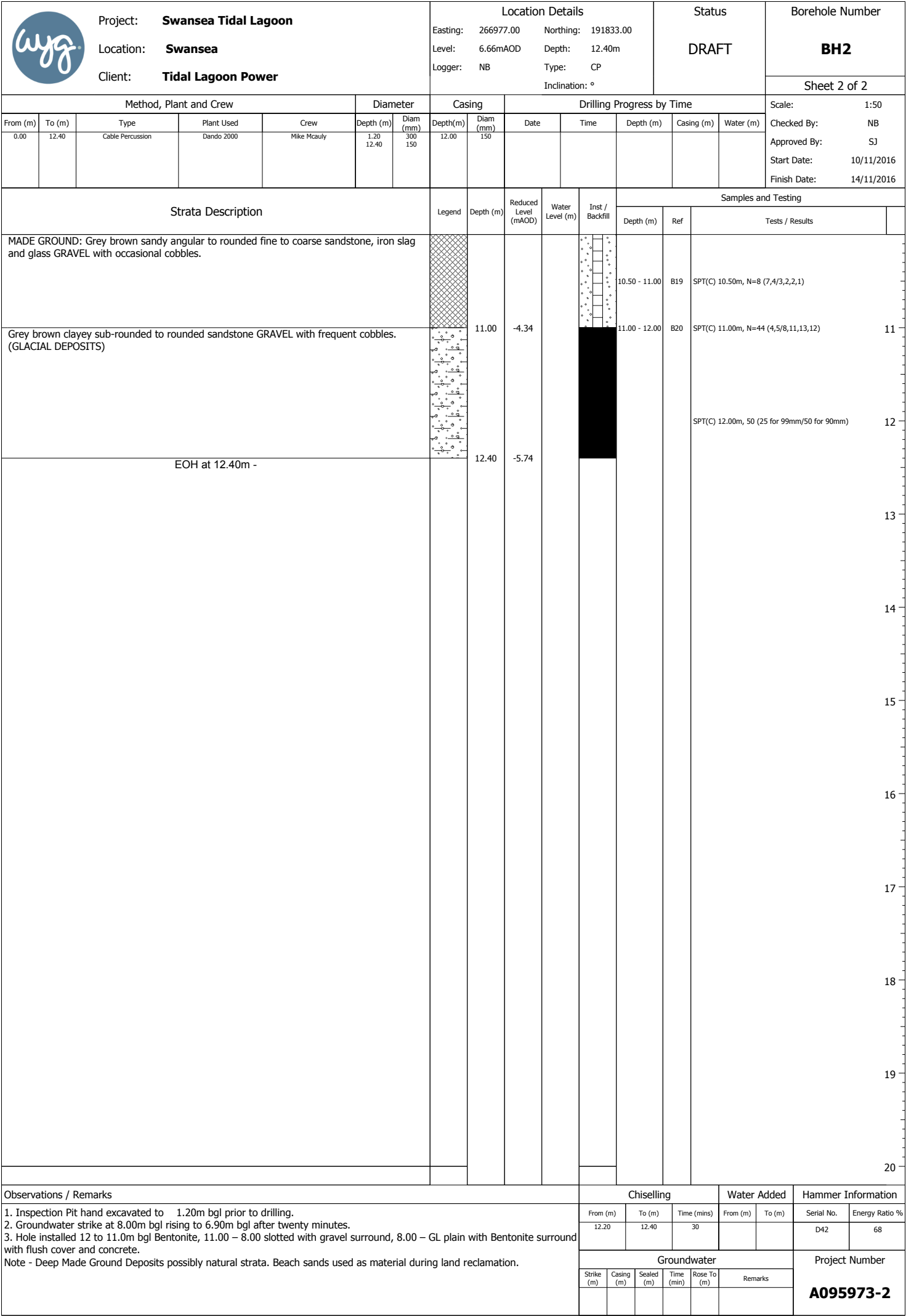


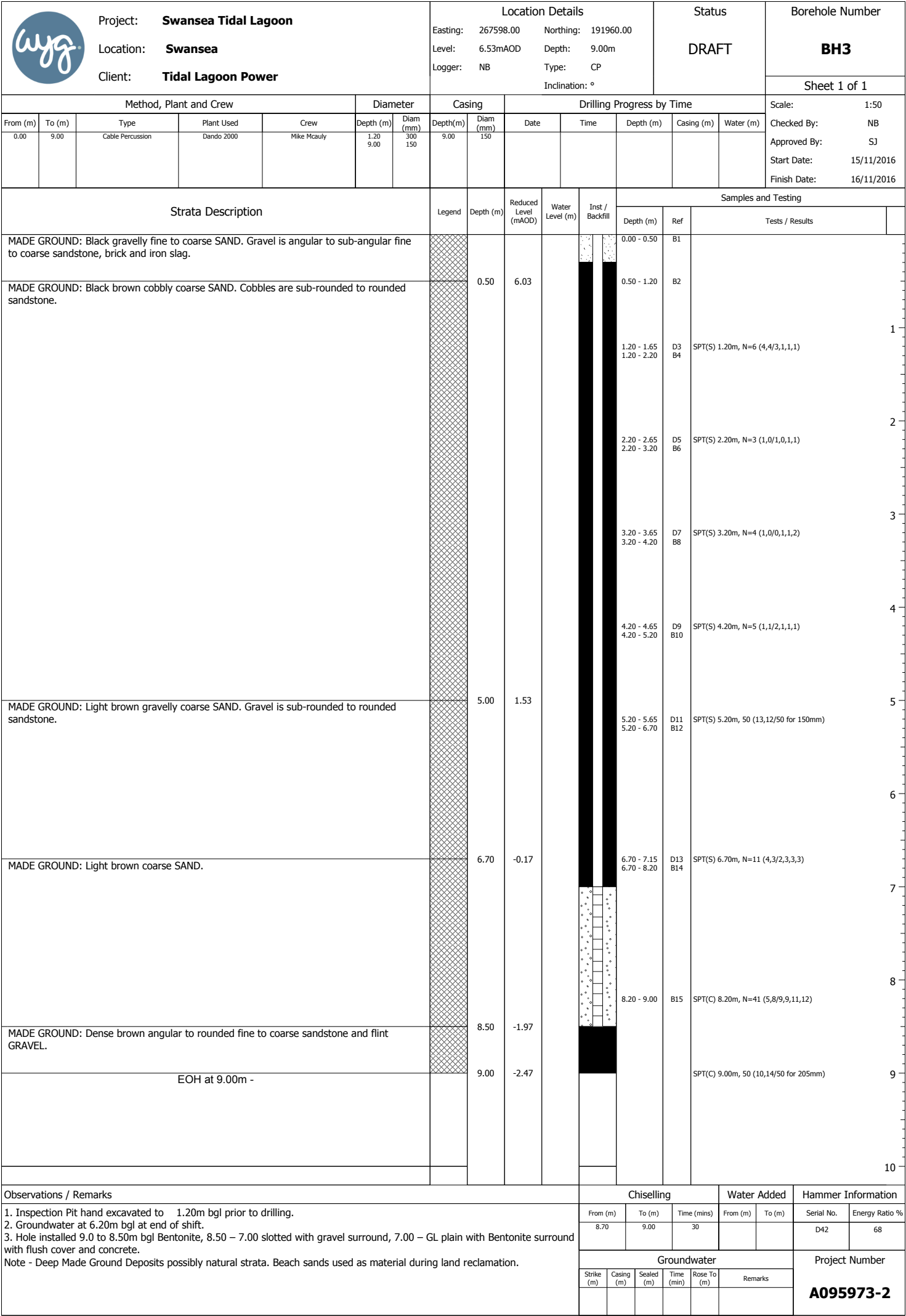
Appendix B – Exploratory Hole Logs and Photo Plates





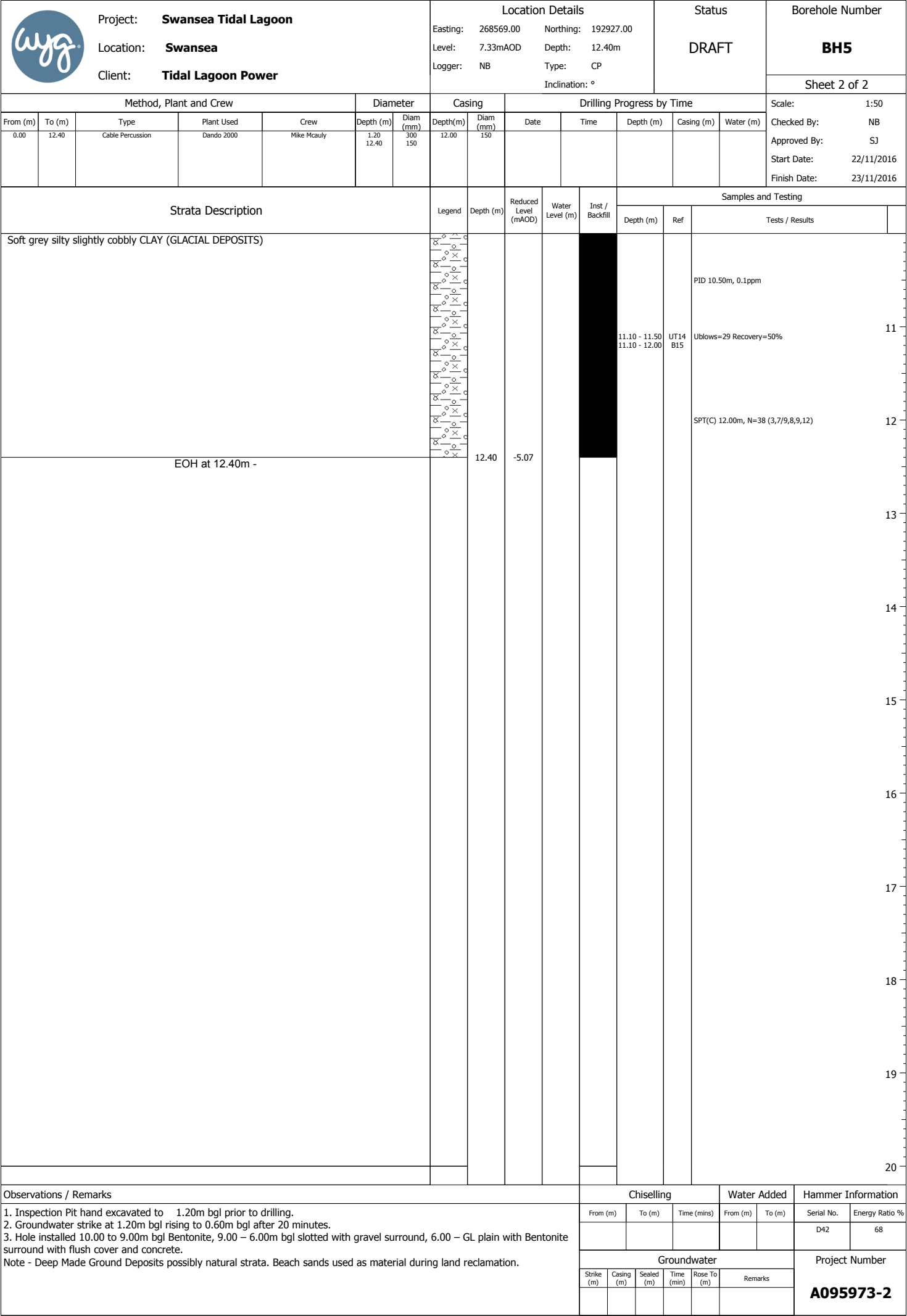
 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details						Status DRAFT		Borehole Number BH2	
						Easting: 266977.00 Northing: 191833.00 Level: 6.66mAOD Depth: 12.40m Logger: NB Type: CP Inclination: °								Sheet 1 of 2	
						Method, Plant and Crew					Diameter		Casing		Drilling Progress by Time
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Date	Time	Depth (m)	Casing (m)	Water (m)	Checked By: NB	
0.00	12.40	Cable Percussion	Dando 2000	Mike McAuly	1.20 12.40	300 150	12.00	150						Approved By: SJ	
														Start Date: 10/11/2016	
														Finish Date: 14/11/2016	
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing			
												Depth (m)	Ref	Tests / Results	
MADE GROUND: Black gravelly fine to coarse SAND. Gravel is angular to sub-angular fine to coarse sandstone, brick and iron slag.								0.50	6.16			0.00 - 0.50	B1	SPT(S) 1.20m, N=2 (1,1/0,1,0,1)	
MADE GROUND: Grey brown coarse SAND.												0.50 - 1.20	B2		
MADE GROUND: Light brown coarse SAND.												1.20 - 1.65 1.20 - 2.20	D3 B4		
												2.20 - 2.65 2.20 - 3.20	D5 B6		
												3.20 - 3.65 3.20 - 4.20	D7 B8		
												4.20 - 4.65 4.20 - 5.20	D9 B10		
												5.20 - 5.65 5.20 - 6.50	D11 B12		
												6.50 - 6.95 6.50 - 7.50	D13 B14		
MADE GROUND: Brown gravelly coarse SAND. Gravel is sub-rounded to rounded sandstone.												7.50 - 7.95 7.50 - 8.00	D15 B16		
MADE GROUND: Grey brown sandy angular to rounded fine to coarse sandstone, iron slag and glass GRAVEL with occasional cobbles.												8.10 - 9.00	B17		
												9.00 - 10.50	B18		





 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details					Status		Borehole Number			
						Easting: 268358.00 Northing: 192227.00 Level: 6.71mAOD Depth: 3.95m Logger: NB Type: CP Inclination: °					DRAFT		BH4			
													Sheet 1 of 1			
Method, Plant and Crew					Diameter		Casing		Drilling Progress by Time							
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Date	Time	Depth (m)	Casing (m)	Water (m)			
0.00	3.95	Cable Percussion	Dando 2000	Matthew Paine	1.20 4.50	300 200	4.50	200								
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing				
												Depth (m)	Ref	Tests / Results		
MADE GROUND: Black gravelly fine to coarse SAND. Gravel is angular to sub-angular fine to coarse sandstone, brick and iron slag.								0.40	6.31			0.00 - 0.40	B1	SPT(S) 1.20m, N=3 (1,1/0,1,1,1) PID 1.50m, 1.4ppm SPT(S) 2.00m, N=6 (3,5/2,2,1,1) PID 2.50m, 130.0ppm SPT(S) 3.00m, N=16 (2,3/5,5,3,3) PID 3.00m, 140.0ppm SPT(C) 3.50m, N=47 (5,9/9,8,13,17)		
MADE GROUND: Black brown gravelly cobbly coarse SAND. Cobbles are sub-rounded to rounded sandstone, iron slag, brick and tile.												0.40 - 0.70	B2			
MADE GROUND: Light brown slightly gravelly coarse SAND. Gravel is sub-rounded to rounded fine sandstone.												1.00 - 1.20	B3			
												1.20 - 1.65	D4			
MADE GROUND: Black grey coarse SAND.strong hydrocarbon odour								2.45	4.26			2.00 - 2.45	D5			
EOH at 3.95m - Hole terminated - Casing kicking off to the north at 3.95m bgl SPT went full depth but also kicked to the North. Suspect casing on top of angled sea defence construction.												2.50 - 2.80	B6			
														3.00 - 3.45	D7	
														3.40 - 3.50	B8	
								3.95	2.76							
Observations / Remarks																
1. Inspection Pit hand excavated to 1.20m bgl prior to drilling. 2. Groundwater not encountered. 3. Hole installed 3.95 to 3.45m bgl Bentonite, 3.40 – 2.40m bgl slotted with gravel surround, 2.40 – GL plain with Bentonite surround with flush cover and concrete. Note - Deep Made Ground Deposits possibly natural strata. Beach sands used as material during land reclamation.										Chiselling			Water Added		Hammer Information	
										From (m)	To (m)	Time (mins)	From (m)	To (m)	Serial No.	Energy Ratio %
													1.20	3.95	D45	69
										Groundwater						
Strike (m)	Casing (m)	Sealed (m)	Time (min)	Rose To (m)	Remarks	A095973-2										

 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details Easting: 268569.00 Level: 7.33mAOD Logger: NB Northing: 192927.00 Depth: 12.40m Type: CP Inclination: °						Status DRAFT		Borehole Number BH5	
												Sheet 1 of 2			
Method, Plant and Crew					Diameter		Casing		Drilling Progress by Time					Scale: 1:50	
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Date	Time	Depth (m)	Casing (m)	Water (m)	Checked By:	NB
0.00	12.40	Cable Percussion	Dando 2000	Mike McAuly	1.20 12.40	300 150	12.00	150						Approved By:	SJ
														Start Date:	22/11/2016
														Finish Date:	23/11/2016
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing			
												Depth (m)	Ref	Tests / Results	
MADE GROUND: Brown sandy cobbly angular to sub-rounded fine to coarse sandstone, brick and iron slag GRAVEL.												0.00 - 1.20	B1	PID 0.50m, 0.1ppm	
												1.20 - 2.20	B2	SPT(S) 1.20m, 50 (25 for 75mm/50 for 85mm) PID 1.50m, 1.1ppm	
												2.00 - 3.00	B3	SPT(C) 2.20m, N=26 (3,5/5,7,8,6) PID 2.50m, 1.0ppm	
												3.00 - 4.00	B4	SPT(C) 3.00m, N=10 (1,1/2,2,2,4) PID 3.50m, 1.5ppm	
												4.00 - 5.00	B5	SPT(C) 4.00m, N=4 (1,0/1,1,1,1) PID 4.50m, 1.4ppm	
												5.00 - 6.00	B6	SPT(C) 5.00m, N=9 (1,1/1,2,3,3)	
MADE GROUND: Dark grey gravelly coarse SAND. Gravels are rounded to sub-rounded fine to medium sandstone and rare iron slag.								6.00	1.33			6.00 - 7.50 6.00 - 7.50	B7 B8	SPT(S) 6.00m, N=25 (3,3/4,5,9,7) PID 6.50m, 1.4ppm	
												7.50 - 8.10	B9	SPT(C) 7.50m, 50 (11,10/50 for 265mm)	
Soft grey silty slightly cobbly CLAY (GLACIAL DEPOSITS)								8.10	-0.77			8.10 - 8.55 8.10 - 9.60	D10 B11	SPT(S) 8.10m, N=4 (1,0/1,1,1,1) PID 8.50m, 0.3ppm	
												9.60 - 10.00 9.60 - 11.10	UT12 B13	Ublows=21 Recovery=50%	

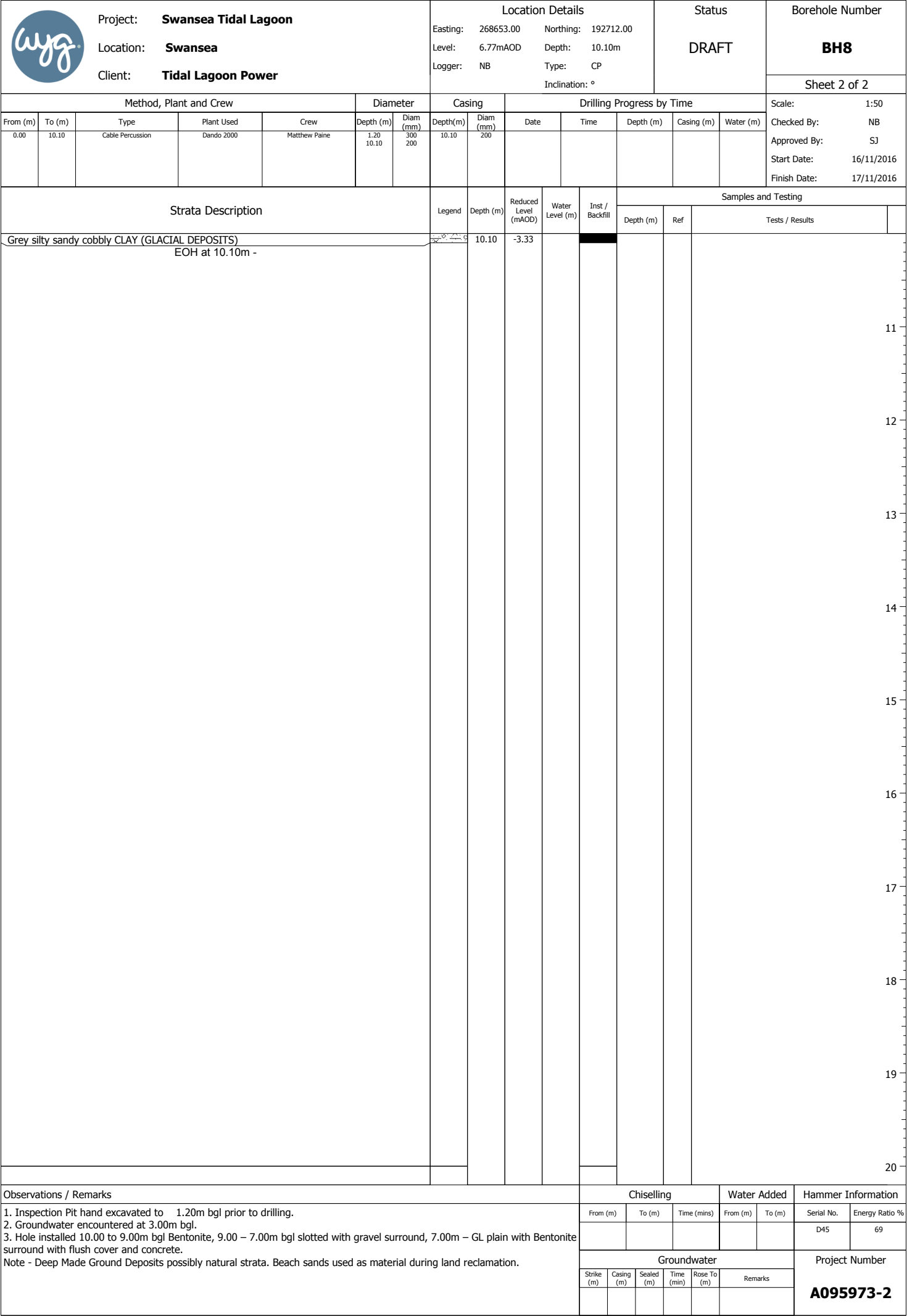


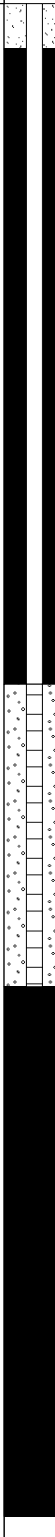
		Project: Swansea Tidal Lagoon		Location Details				Status		Borehole Number						
		Location: Swansea		Easting: 268691.00 Northing: 192823.00 Level: 6.64mAOD Depth: 10.00m Logger: NB Type: CP Inclination: °				DRAFT		BH6						
		Client: Tidal Lagoon Power								Sheet 1 of 1						
Method, Plant and Crew					Diameter		Casing		Drilling Progress by Time					Scale: 1:50		
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Date	Time	Depth (m)	Casing (m)	Water (m)	Checked By:	NB	
0.00	10.00	Cable Percussion	Dando 2000	Mike McAuly	1.20 10.00	300 150	10.00	150						Approved By:	SJ	
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing			Start Date:	21/11/2016
												Depth (m)	Ref	Tests / Results		
MADE GROUND: Reinforced Concrete								0.30	6.34				0.30 - 0.70	B1	PID 0.50m, 5.2ppm	
MADE GROUND: Black sandy angular to sub-angular iron slag and sandstone COBBLES. Sand is fine to coarse.								0.70	5.94				0.70 - 1.20	B2		
MADE GROUND: Black silty sandy angular fine to coarse iron slag, sandstone and brick GRAVEL with moderate cobble content.													1.20 - 1.65	D3	SPT(S) 1.20m, N=21 (1,2/5,4,7,5)	
													1.20 - 2.20	B4	PID 1.50m, 18.8ppm	
													2.20 - 2.65	D5	SPT(S) 2.20m, N=18 (1,1/2,4,6,6)	
													2.20 - 3.20	B6	PID 2.50m, 28.2ppm	
MADE GROUND: Black silty sandy angular to sub-rounded brick, concrete and sandstone GRAVEL with moderate cobble content and metal waste including metal bars and nails.								3.20	3.44				3.20 - 3.65	D7	SPT(S) 3.20m, N=8 (2,3/2,2,2,2)	
													3.20 - 4.20	B8	PID 3.50m, 60.3ppm	
													4.20 - 5.20	B9	SPT(S) 4.20m, N=20 (6,8/7,5,5,3)	
															PID 4.50m, 26.3ppm	
													5.20 - 6.50	B10	SPT(S) 5.20m, N=17 (3,6/5,3,3,6)	
Brown coarse SAND. (BEACH DEPOSITS)																
													6.50 - 6.95	D11	SPT(S) 6.50m, N=9 (1,1/2,2,2,3)	
													6.50 - 8.00	B12	PID 7.50m, 3.8ppm	
Grey very silty CLAY. (GLACIAL DEPOSITS)																
													8.00 - 8.45	D13	SPT(S) 8.00m, N=13 (1,2/3,3,4)	
													8.00 - 9.00	B14	PID 9.50m, 3.1ppm	
EOH at 10.00m -								10.00	-3.36				9.00 - 10.00	B16	SPT(S) 9.00m, N=18 (3,2/3,5,5,5)	
													9.00 - 9.45	D15	PID 9.50m, 3.1ppm	
Observations / Remarks										Chiselling			Water Added		Hammer Information	
1. Inspection Pit hand excavated to 1.20m bgl prior to drilling. 2. Groundwater encountered at 3.00m bgl. 3. Hole installed 10.00 to 9.00m bgl Bentonite, 9.00 – 7.00m bgl slotted with gravel surround, 7.00m – GL plain with Bentonite surround with flush cover and concrete. Note - Deep Made Ground Deposits possibly natural strata. Beach sands used as material during land reclamation.										From (m)	To (m)	Time (mins)	From (m)	To (m)	Serial No.	Energy Ratio %
															D42	68
										Groundwater						Project Number
Strike (m)	Casing (m)	Sealed (m)	Time (min)	Rose To (m)	Remarks	A095973-2										
3.00	-	-	20	2.10												

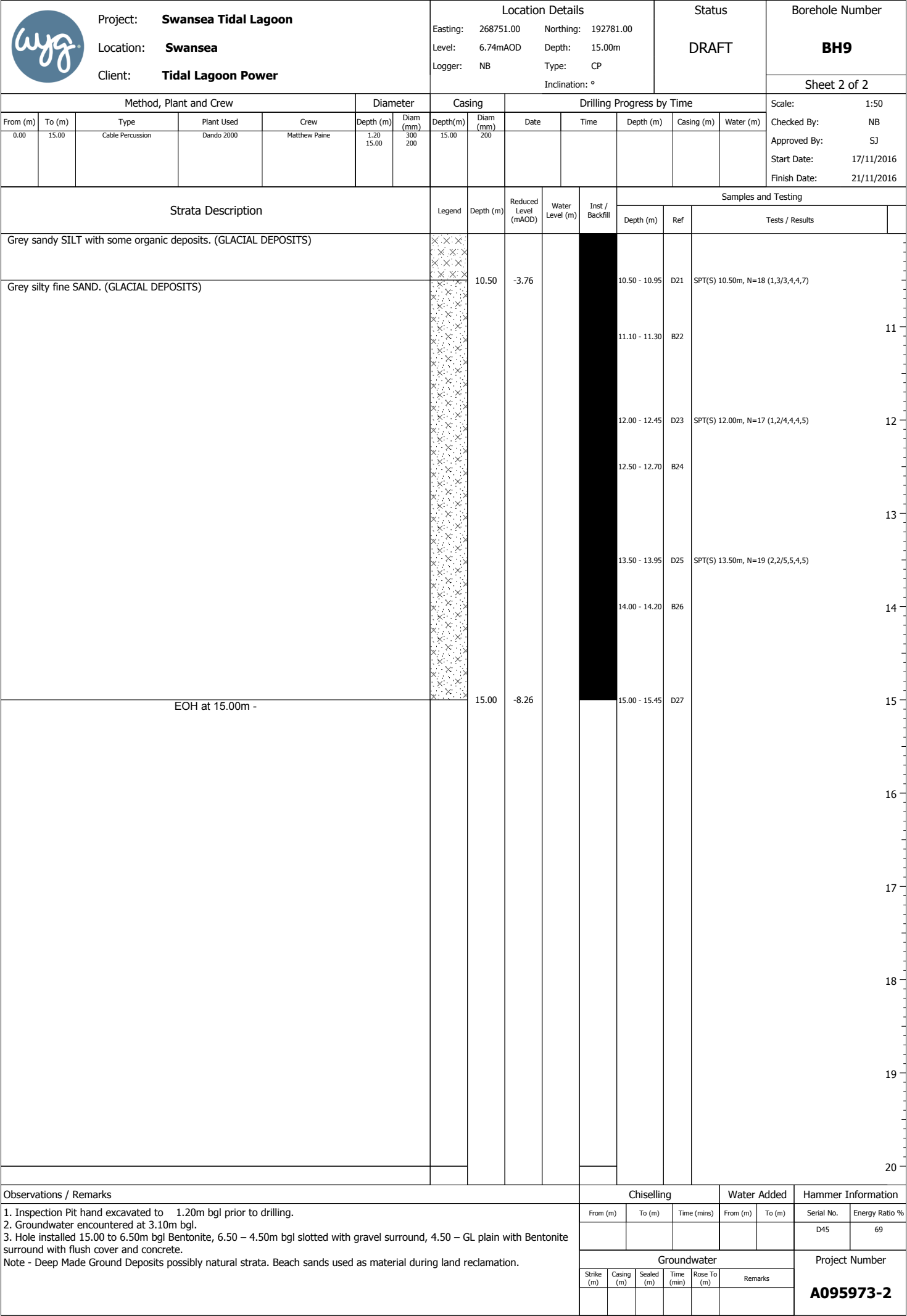
Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details						Status DRAFT		Borehole Number		
						Easting: 268782.00 Northing: 192839.00 Level: 6.69mAOD Depth: 15.45m Logger: NB Type: CP Inclination: °								BH7		
Method, Plant and Crew					Diameter		Casing		Drilling Progress by Time					Scale: 1:50		
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Date	Time	Depth (m)	Casing (m)	Water (m)	Checked By:	NB	
0.00	15.45	Cable Percussion	Dando 2000	Matthew Paine	1.20 15.00 15.45	300 200 150	15.00	200						Approved By:	SJ	
														Start Date:	22/11/2016	
														Finish Date:	23/11/2016	
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing				
												Depth (m)	Ref	Tests / Results		
MADE GROUND: Black sandy GRAVEL with COBBLES. Gravel is fine to coarse angular to sub-angular and composed of iron slag, concrete, brick and wood.													0.30 - 0.50	B1		
													0.50 - 0.80	B2	PID 0.50m, 9.5ppm	
													1.20 - 1.65	D3	SPT(S) 1.20m, N=14 (1,3/2,3,1,8)	
													1.50 - 1.70	B4	PID 1.50m, 175.0ppm	
													2.00 - 2.45	D5	SPT(S) 2.00m, N=4 (1,1/1,1,0,2)	
													2.50 - 2.70	B6		
													3.00 - 3.45	D7	SPT(S) 3.00m, N=3 (1,0/1,1,0,1)	
													3.50 - 3.70	B8	PID 3.50m, 48.4ppm	
MADE GROUND: Black coarse SAND with shells with rare iron slag. ...slight hydrocarbon odour and staining.								4.00	2.69				4.00 - 4.45	D9	SPT(S) 4.00m, N=17 (1,1/2,3,6,6)	
													4.50 - 4.70	B10		
MADE GROUND: Grey coarse SAND with shells with rare iron slag.								5.00	1.69				5.00 - 5.45	D11	SPT(S) 5.00m, N=12 (1,1/2,2,4,4)	
													5.50 - 5.70	B12	PID 5.50m, 19.5ppm	
													6.00 - 6.40	B14	SPT(S) 6.00m, N=0 (0,0/0,0,0,0)	
													6.00 - 6.45	D13		
													7.50 - 7.95	D15	SPT(S) 7.50m, N=4 (1,1/2,0,1,1) PID 7.50m, 3.4ppm	
													8.00 - 8.40	B16		
													8.60 - 8.70	B17		
													8.80 - 9.00	B18		
													9.00 - 9.45	D19	SPT(S) 9.00m, N=3 (2,0/1,1,1,0)	
													9.50 - 9.70	B20		
											</					

 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details					Status		Borehole Number			
						Easting: 268782.00 Northing: 192839.00 Level: 6.69mAOD Depth: 15.45m Logger: NB Type: CP Inclination: °					DRAFT		BH7			
													Sheet 2 of 2			
Method, Plant and Crew					Diameter		Casing		Drilling Progress by Time				Scale: 1:50			
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Date	Time	Depth (m)	Casing (m)	Water (m)	Checked By: NB		
0.00	15.45	Cable Percussion	Dando 2000	Matthew Paine	1.20 15.00 15.45	300 200 150	15.00	200						Approved By: SJ		
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing			Finish Date: 23/11/2016	
												Depth (m)	Ref	Tests / Results		
Soft grey sandy CLAY (GLACIAL DEPOSITS)								11.60	-4.91			10.50 - 10.95	D21	SPT(S) 10.50m, N=11 (1,2/3,3,2,3) PID 10.50m, 2.2ppm	11	
												11.00 - 11.20	B22			
Grey clayey SAND (GLACIAL DEPOSITS)								15.45	-8.76			12.00 - 12.45	D23	SPT(S) 12.00m, N=18 (3,3/5,4,4,5)	12	
												12.50 - 12.70	B24			
												13.50 - 13.95	D25	SPT(S) 13.50m, N=18 (2,2/4,4,5,5) PID 13.50m, 1.1ppm		
												14.00 - 14.50	B26			
												15.00 - 15.45	D27	SPT(S) 15.00m, N=16 (2,2/3,4,4,5) PID 15.00m, 0.8ppm		
EOH at 15.45m -															16	
Observations / Remarks																17
1. Inspection Pit hand excavated to 1.20m bgl prior to drilling. 2. Groundwater encountered at 3.0m bgl rising to 1.90m bgl after 20 minutes. 3. Hole installed 15.40 to 8.00m bgl Bentonite, 8.00 – 5.00m bgl slotted with gravel surround, 5.00 – GL plain with Bentonite surround with flush cover and concrete. Note - Deep Made Ground Deposits possibly natural strata. Beach sands used as material during land reclamation.																18
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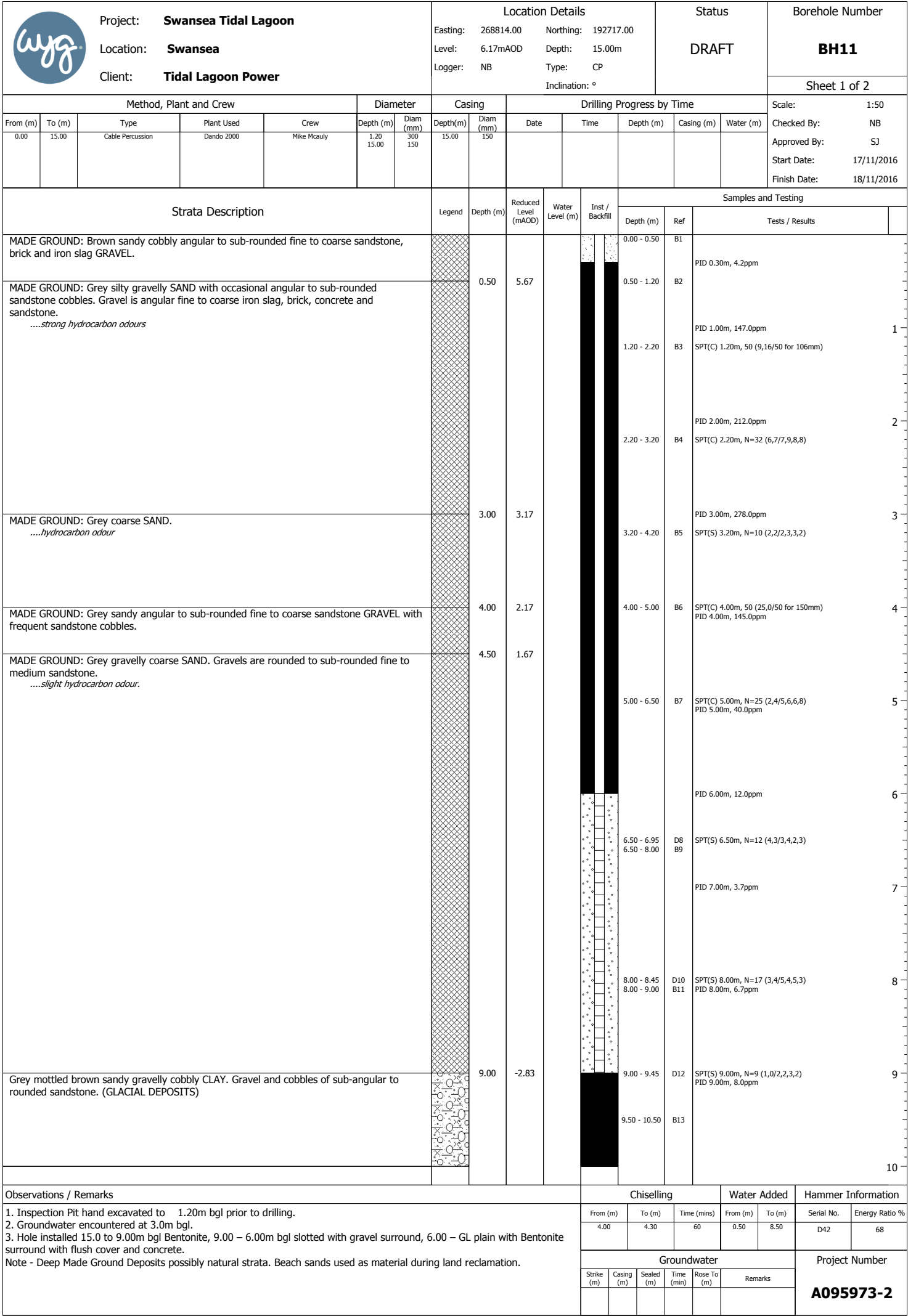
		Project: Swansea Tidal Lagoon		Location Details				Status		Borehole Number							
		Location: Swansea		Easting: 268653.00 Northing: 192712.00 Level: 6.77mAOD Depth: 10.10m Logger: NB Type: CP Inclination: °				DRAFT		BH8							
		Client: Tidal Lagoon Power		Sheet 1 of 2													
Method, Plant and Crew					Diameter		Casing		Drilling Progress by Time					Scale: 1:50			
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Date	Time	Depth (m)	Casing (m)	Water (m)	Checked By:	NB		
0.00	10.10	Cable Percussion	Dando 2000	Matthew Paine	1.20 10.10	300 200	10.10	200						Approved By:	SJ		
														Start Date:	16/11/2016		
														Finish Date:	17/11/2016		
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing					
												Depth (m)	Ref	Tests / Results			
MADE GROUND: Brown sandy angular to sub-angular fine to coarse sandstone, brick and iron slag GRAVEL. MADE GROUND: Brown slightly gravelly coarse SAND. Gravel is angular fine to medium iron slag, sandstone and brick. MADE GROUND: Light brown coarse SAND.								0.20	6.57			0.00 - 0.20	B1				
												0.20 - 0.40	B2				
								0.50	6.27			0.50 - 0.60	B3	SPT(S) 1.20m, N=7 (1,2/2,2,2,1)			
												1.20 - 1.40 1.20 - 1.65	B5 D4				
								2.30	4.47			2.00 - 2.45	D6	SPT(S) 2.00m, N=12 (1,2/3,4,3,2)			
												2.50 - 2.70	B7				
MADE GROUND: Grey coarse SAND.								4.50	2.27			3.00 - 3.45	D8	SPT(S) 3.00m, N=0 (0,0/0,0,0,0)			
												3.50 - 3.70	B9				
								5.30	1.47			4.00 - 4.45	D10	SPT(S) 4.00m, N=2 (0,0/1,0,0,1)			
												4.50 - 4.70	B11				
MADE GROUND: Grey silty coarse SAND								5.30	1.47			5.00 - 5.45	D12	SPT(S) 5.00m, N=3 (0,0/0,0,1,2)			
												5.50 - 5.70	B13				
Grey coarse SAND. (BEACH DEPOSITS)								9.00	-2.23			6.50 - 6.95	D14	SPT(S) 6.50m, N=17 (1,2/3,3,5,6)			
												7.00 - 7.40	B15				
								9.00	-2.23			8.00 - 8.45	D16	SPT(S) 8.00m, N=34 (7,12/9,9,8,8)			
												8.60 - 9.50	B17				
Grey silty sandy cobbly CLAY (GLACIAL DEPOSITS)								9.00	-2.23			9.50 - 9.70 9.50 - 9.95	B19 D18				
Observations / Remarks												Chiselling		Water Added		Hammer Information	
												From (m)	To (m)	Time (mins)	From (m)	To (m)	Serial No.
1. Inspection Pit hand excavated to 1.20m bgl prior to drilling. 2. Groundwater encountered at 3.00m bgl. 3. Hole installed 10.00 to 9.00m bgl Bentonite, 9.00 – 7.00m bgl slotted with gravel surround, 7.00m – GL plain with Bentonite surround with flush cover and concrete. Note - Deep Made Ground Deposits possibly natural strata. Beach sands used as material during land reclamation.														Project Number			
														A095973-2			
							Groundwater										
							Strike (m)	Casing (m)	Sealed (m)	Time (min)	Rose To (m)	Remarks					
							3.00	-	4	20	2.00						

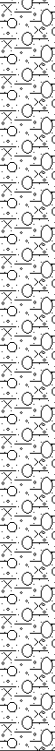


 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power		Location Details				Status		Borehole Number														
		Easting: 268751.00 Northing: 192781.00 Level: 6.74mAOD Depth: 15.00m Logger: NB Type: CP Inclination: °				DRAFT		BH9														
		Sheet 1 of 2																				
Method, Plant and Crew					Diameter		Casing		Drilling Progress by Time				Scale: 1:50									
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Date	Time	Depth (m)	Casing (m)	Water (m)	Checked By: NB								
0.00	15.00	Cable Percussion	Dando 2000	Matthew Paine	1.20 15.00	300 200	15.00	200						Approved By: SJ								
														Start Date: 17/11/2016								
														Finish Date: 21/11/2016								
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing										
												Depth (m)	Ref	Tests / Results								
MADE GROUND: Brown sandy angular to sub-angular fine to coarse sandstone, brick, concrete and iron slag GRAVEL.								0.70	6.04			0.00 - 0.20	B1	PID 0.20m, 0.0ppm								
												0.70 - 0.90	B2		PID 0.90m, 3.8ppm							
												1.00 - 1.10	B3			PID 1.10m, 3.7ppm						
												1.20 - 1.65	D4				SPT(S) 1.20m, N=15 (3,3/3,4,4,4)					
												1.70 - 1.80	B5					PID 1.70m, 14.5ppm				
												2.00 - 2.45	D6						SPT(S) 2.00m, N=13 (2,2/2,3,4,4)			
												2.50 - 2.70	B7							PID 2.50m, 12.1ppm		
												3.00 - 3.45	D8								SPT(S) 3.00m, N=8 (2,3/3,2,1,2)	
												3.50 - 3.70	B9									PID 3.50m, 11.0ppm
												4.00 - 4.45	D10									
4.50 - 4.70	B11	SPT(S) 5.00m, N=2 (0,1/1,0,0,1)																				
5.00 - 5.45	D12		SPT(S) 6.00m, N=21 (2,1/4,4,5,8)																			
5.50 - 5.70	B13			SPT(S) 9.00m, N=0 (1,1/0,0,0,0)																		
6.00 - 6.45	D14				SPT(S) 7.50m, N=37 (2,3/4,8,10,15)																	
6.50 - 6.70	B15					SPT(S) 9.00m, N=0 (1,1/0,0,0,0)																
7.50 - 7.95	D16						SPT(S) 9.00m, N=0 (1,1/0,0,0,0)															
8.00 - 8.20	B17							SPT(S) 9.00m, N=0 (1,1/0,0,0,0)														
9.00 - 9.40	B19								SPT(S) 9.00m, N=0 (1,1/0,0,0,0)													
9.00 - 9.45	D18											SPT(S) 9.00m, N=0 (1,1/0,0,0,0)										
9.70 - 9.90	B20												SPT(S) 9.00m, N=0 (1,1/0,0,0,0)									
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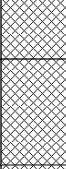
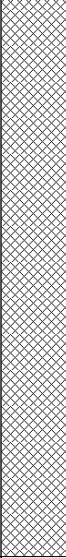
Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details						Status DRAFT		Borehole Number		
						Easting: 268843.00 Northing: 192806.00 Level: 6.21mAOD Depth: 9.50m Logger: NB Type: CP Inclination: °								BH10		
Method, Plant and Crew					Diameter		Casing		Drilling Progress by Time					Scale: 1:50		
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Date	Time	Depth (m)	Casing (m)	Water (m)	Checked By:	NB	
0.00	9.50	Cable Percussion	Dando 2000	Mike McAuly	1.20 9.00	300 150	9.00	200						Approved By:	SJ	
														Start Date:	16/11/2016	
														Finish Date:	17/11/2016	
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing				
												Depth (m)	Ref	Tests / Results		
MADE GROUND: Brown sandy cobbly angular to sub-rounded fine to coarse sandstone, brick and iron slag GRAVEL.								0.00	5.71			0.00 - 0.50	B1	PID 0.50m, 140.0ppm PID 1.00m, 258.0ppm SPT(S) 1.20m, N=14 (3,4/3,3,4,4)		
MADE GROUND: Grey coarse SAND.strong hydrocarbon odours								0.50				0.50 - 1.20	B2			
												1.20 - 1.65 1.20 - 2.20	D3 B4			
MADE GROUND: Light brown gravelly coarse SAND. Gravel is angular fine to coarse iron slag and brick.hydrocarbon odour								2.20	4.01			2.20 - 3.20	B5	PID 2.00m, 552.0ppm SPT(C) 2.20m, N=12 (1,2/2,2,5,3)		
												3.20 - 4.20	B6	SPT(C) 3.20m, N=18 (1,1/4,4,5,5)		
MADE GROUND: Grey gravelly coarse SAND. Gravel is sub-rounded to rounded fine to medium sandstone.								4.20	2.01			4.20 - 5.20	B7	SPT(C) 4.20m, N=13 (2,2/2,3,4,4) PID 4.50m, 68.0ppm		
												5.20 - 5.65 5.20 - 6.70	D8 B9	SPT(S) 5.20m, N=42 (4,7/9,12,10,11)		
MADE GROUND: Grey coarse SAND							6.00	0.21			6.00 - 6.45 6.00 - 7.50	D10 B11	SPT(S) 6.10m, N=17 (2,3/3,4,5,5)			
Black gravelly coarse SAND. Gravel is fine to medium sub-rounded to rounded sandstone with shell fragments. (BEACH DEPOSITS)							7.50	-1.29			7.50 - 8.30	B12	SPT(C) 7.50m, N=39 (5,3/5,8,11,15) PID 7.50m, 12.0ppm			
Black grey coarse SAND. (BEACH DEPOSITS)							8.30	-2.09			8.30 - 8.75 8.30 - 9.00	D13 B14	SPT(S) 8.30m, N=14 (1,2/2,4,4,4)			
Soft grey silty cobbly CLAY (FLUVIOUOLACIAL DEPOSITS)							9.00	-2.79								
EOH at 9.50m - Hole terminated at 9.50m bgl. Concerned that due to large amounts of contamination in the sands above, advancing hole into the natural clay barrier would be inadvisable.							9.50	-3.29								
Observations / Remarks										Chiselling			Water Added		Hammer Information	
1. Inspection Pit hand excavated to 1.20m bgl prior to drilling. 2. Groundwater encountered at 3.0m bgl. 3. Hole installed 9.50 to 9.00m bgl Bentonite, 9.00 – 6.00m bgl slotted with gravel surround, 6.00 – GL plain with Bentonite surround with flush cover and concrete. Note - Deep Made Ground Deposits possibly natural strata. Beach sands used as material during land reclamation.										From (m)	To (m)	Time (mins)	From (m)	To (m)	Serial No.	Energy Ratio %
															D42	68
										Groundwater						Project Number
Strike (m)	Casing (m)	Sealed (m)	Time (min)	Rose To (m)	Remarks	A095973-2										
3.00	-	-	20	2.40												

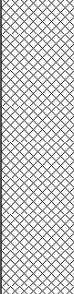
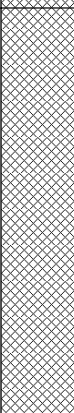


 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details Easting: 268814.00 Northing: 192717.00 Level: 6.17mAOD Depth: 15.00m Logger: NB Type: CP Inclination: °						Status DRAFT		Borehole Number BH11	
												Sheet 2 of 2			
Method, Plant and Crew					Diameter		Casing		Drilling Progress by Time					Scale: 1:50	
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Date	Time	Depth (m)	Casing (m)	Water (m)	Checked By: NB	Approved By: SJ
0.00	15.00	Cable Percussion	Dando 2000	Mike McAuly	1.20 15.00	300 150	15.00	150						Start Date: 17/11/2016	Finish Date: 18/11/2016
Strata Description						Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing				
											Depth (m)	Ref	Tests / Results		
Grey mottled brown sandy gravelly cobbly CLAY. Gravel and cobbles of sub-angular to rounded sandstone. (GLACIAL DEPOSITS)							15.00	-8.83			10.50 - 10.95 10.50 - 12.00	D14 B15	SPT(S) 10.50m, N=13 (2,2/3,5,3,2)		
											12.00 - 12.45 12.00 - 13.50	D16 B17	SPT(S) 12.00m, N=19 (1,2/4,4,5,6)		
											13.50 - 13.95 13.50 - 15.00	D18 B19	SPT(S) 13.50m, N=4 (1,0/0,1,1,2)		
											15.00 - 15.45	D20	SPT(S) 15.00m, N=4 (1,0/1,1,1,1)		
EOH at 15.00m -															
Observations / Remarks 1. Inspection Pit hand excavated to 1.20m bgl prior to drilling. 2. Groundwater encountered at 3.0m bgl. 3. Hole installed 15.0 to 9.00m bgl Bentonite, 9.00 – 6.00m bgl slotted with gravel surround, 6.00 – GL plain with Bentonite surround with flush cover and concrete. Note - Deep Made Ground Deposits possibly natural strata. Beach sands used as material during land reclamation.						Chiselling			Water Added		Hammer Information				
						From (m)	To (m)	Time (mins)	From (m)	To (m)	Serial No.	Energy Ratio %			
											D42	68			
						Groundwater					Project Number				
Strike (m)	Casing (m)	Sealed (m)	Time (min)	Rose To (m)	Remarks	A095973-2									

		Project: Swansea Tidal Lagoon		Location Details				Status		Borehole Number							
		Location: Swansea		Easting: 269113.00 Northing: 192900.00 Level: 5.88mAOD Depth: 9.00m Logger: NB Type: CP Inclination: °				DRAFT		BH12							
		Client: Tidal Lagoon Power								Sheet 1 of 1							
Method, Plant and Crew					Diameter		Casing		Drilling Progress by Time					Scale: 1:50			
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Date	Time	Depth (m)	Casing (m)	Water (m)	Checked By:	NB		
0.00	9.00	Cable Percussion	Dando 2000	Matthew Paine	1.20 9.00	300 200	9.00	200						Approved By:	SJ		
														Start Date:	24/11/2016		
														Finish Date:	25/11/2016		
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing					
MADE GROUND: Brown coarse SAND with shells and rare iron slag.								0.20	5.68			Depth (m)	Ref	Tests / Results			
												0.00 - 0.20	B1	PID 0.10m, 2.0ppm			
MADE GROUND: Black coarse SAND with shells, rare iron slag and cobbles.slight hydrocarbon odour and staining from 0.2 to 0.4m bgl.boulders from 0.4 to 0.9m bgl. strong hydrocarbon odour and black staining from 0.9 to 2.4m bgl.								0.20	5.68			0.20 - 0.40	B2	PID 0.30m, 1.7ppm			
												0.40 - 0.90	B3	PID 0.50m, 1.6ppm			
												1.20 - 1.65	D4	SPT(S) 1.20m, N=1 (1,1/0,1,0,0)			
												1.70 - 1.80	B5	PID 1.70m, 225.0ppm			
												2.00 - 2.45	D6	SPT(S) 2.00m, N=24 (2,2/3,6,7,8)			
												2.40 - 2.70	B7	PID 2.60m, 220.0ppm			
....slight hydrocarbon odour from 2.40 to 4.50m bgl.												3.00 - 3.45	D8	SPT(S) 3.00m, N=17 (3,3/4,4,4,5)			
												3.50 - 3.70	B9				
												4.00 - 4.45	D10	SPT(S) 4.00m, N=12 (2,1/2,3,3,4)			
												4.50 - 4.70	B11	PID 4.60m, 7.6ppm			
MADE GROUND: Brown coarse SAND with shells, rare iron slag and cobbles.								4.50	1.38			5.00 - 5.45	D12	SPT(S) 5.00m, N=23 (2,4/3,5,8,7)			
												5.50 - 5.70	B13				
												6.00 - 6.45	D14	SPT(S) 6.00m, N=13 (2,2/2,3,4,4)			
												6.50 - 6.70	B15	PID 6.60m, 3.4ppm			
Grey clayey SAND. Sand is coarse (FLUVIOGLACIAL DEPOSITS).								7.00	-1.12			7.00 - 7.20	B16				
												7.50 - 7.95	D17	SPT(S) 7.50m, N=19 (2,3/4,5,5,5)			
												8.00 - 8.20	B18				
EOH at 9.00m -								9.00	-3.12			9.00 - 9.45	D19	SPT(S) 9.00m, N=16 (2,2/2,4,5,5) PID 9.00m, 3.2ppm			
Observations / Remarks											Chiselling			Water Added		Hammer Information	
1. Inspection Pit hand excavated to 1.20m bgl prior to drilling. 2. Groundwater strike at 3.10m bgl rising to 1.80m bgl after twenty minutes. 3. Hole installed 9.00 to 5.00m bgl Bentonite, 5.00 – 2.00 slotted with gravel surround, 2.00 – GL plain with Bentonite surround with flush cover and concrete. Note - Deep Made Ground Deposits possibly natural strata. Beach sands used as material during land reclamation.											From (m)	To (m)	Time (mins)	From (m)	To (m)	Serial No.	Energy Ratio %
																D45	69
											Groundwater						
Strike (m)	Casing (m)	Sealed (m)	Time (min)	Rose To (m)	Remarks		A095973-2										
3.10	-	-	20	1.80													

[illegible]

	Project: Swansea Tidal Lagoon		Location Details Easting: 267091.49 Northing: 191906.96 Level: 8.51mAOD Depth: 2.40m Logger: JB Type: TP				Status DRAFT		Pit Number HP02 Sheet 1 of 1					
	Location: Swansea		Hole Information Pit Dimensions 0.50m 2.10m Orientation: ° Shoring: None Stability: Poor Plant: JCB 3CX						Groundwater				Scale: 1:25	
	Client: Tidal Lagoon Power								Strike (m)		Rose To (m)		After (mins)	
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing						
MADE GROUND: Grass over black slightly silty very gravelly fine to coarse SAND with frequent sandstone and iron slag cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick and iron slag with wood, coal and metal. MADE GROUND: Light brown clayey very gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick and iron slag.wet at 0.3m bgl, possibly surface water run-off.				0.20	8.31			0.00 - 0.20 0.00 - 1.00	ES B					
				0.55	7.96			0.50	ES					
MADE GROUND: Black slightly silty very gravelly fine to coarse SAND with frequent sandstone, iron slag and brick cobbles and boulders. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick and iron slag with wood, metal and tile.								1.00 1.00 - 2.00	ES B					
EOH at 2.40m - Trial pit terminated at 2.40m bgl.								2.00	ES					
				2.40	6.11									

	Project: Swansea Tidal Lagoon		Location Details Easting: 267121.69 Northing: 191921.15 Level: 9.20mAOD Depth: 2.35m Logger: JB Type: TP				Status DRAFT		Pit Number HP03 Sheet 1 of 1					
	Location: Swansea		Hole Information Orientation: ° Shoring: None Stability: Poor Plant: JCB 3CX						Groundwater Strike (m) Rose To (m) After (mins) Remarks				Scale: 1:25 Checked By: NB Approved By: SJ Start Date: 11/11/2016 Finish Date: 11/11/2016	
	Client: Tidal Lagoon Power								Pit Dimensions 0.50m 2.10m					
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing						
MADE GROUND: Black slightly clayey silty very gravelly SAND with frequent sandstone and iron slag cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone and slag with metal piping.				1.00	8.20			0.00 - 1.00	B					
								0.30	ES					
								0.50	ES					
MADE GROUND: Brown slightly silty very gravelly SAND. Gravel is fine to coarse sub-rounded to sub-angular fine to coarse sandstone, brick and concrete with occasional cobbles.				1.00	8.20			1.00 1.00 - 2.00	ES B					
								2.00	ES					
EOH at 2.35m - Trial pit terminated at 2.35m bgl.				2.35	6.85									
Observations / Remarks														
1. Groundwater not observed.2. Trial pit terminated at 2.35m bgl. 3. Upon completion exploratory hole backfilled with arisings.														
											Project Number A095973-2			

Project: **Swansea Tidal Lagoon**Location: **Swansea**

Client: **Tidal Lagoon Power**

Location Details

Easting: 267137.82 Northing: 191847.12

Level: 8.51mAOD Depth: 2.10m

Logger: JB Type: TP

Status

DRAFT

Pit Number

HP04

Sheet 1 of 1

Hole Information

Pit Dimensions

Orientation: 0

Shoring: None

Stability: Poor

Plant: JCB 3CX

Strata Description

Legen

Depth (m)

Reduced
LevelWater
Level (m)

Backfill

Samples and Testing

Depth (m)

Ref

Tests / Results

MADE GROUND: Grass over black slightly silty very gravelly fine to coarse SAND with frequent sandstone and iron slag cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick and iron slag with wood, coal and metal.

....very slow water seepage at 0.70m

....lens od brownish yellow silty gravelly clay at 0.90m bgl

EOH at 2.10m - Trial pit terminated at 2.40m bgl.

1

2

3

4

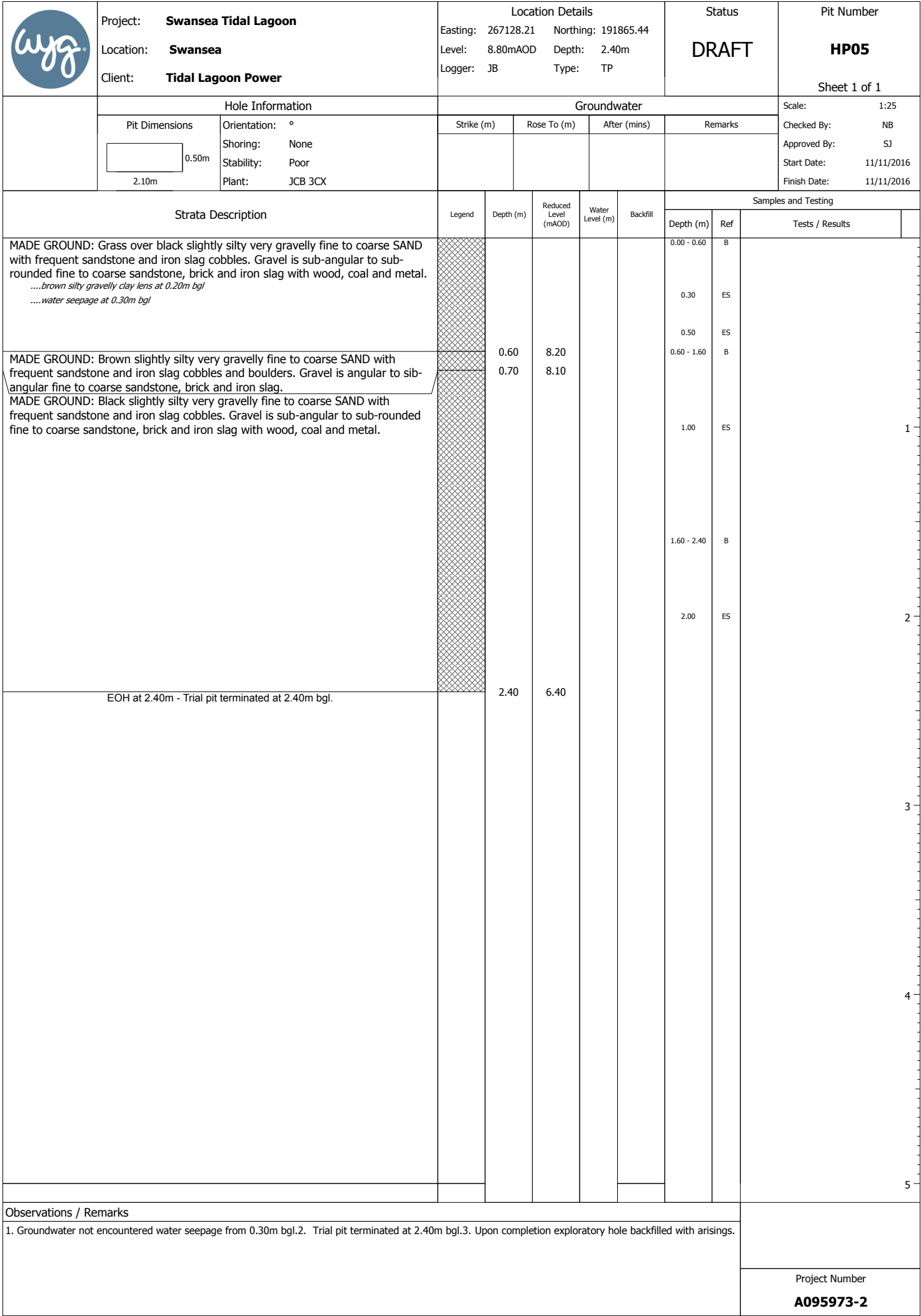
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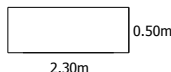
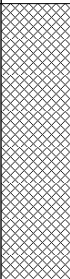
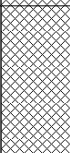
Observations / Remarks

1. Groundwater water seepage from 0.70m bgl.2. Trial pit terminated at 2.10m bgl.3. Upon completion exploratory hole backfilled with arisings.

Project Number

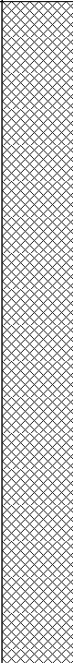
A095973-2



	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number	
	Location: Swansea		Easting: 267122.37 Northing: 191897.23				DRAFT		HP06	
	Client: Tidal Lagoon Power		Level: 8.96mAOD Depth: 2.20m Logger: JB Type: TP							
	Hole Information		Groundwater						Scale: 1:25	
	Orientation: ° Shoring: None Stability: Poor Plant: JCB 3CX		Strike (m)		Rose To (m)		After (mins)		Remarks	
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
MADE GROUND: Grass over black slightly silty very gravelly fine to coarse SAND with frequent sandstone and iron slag cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick and iron slag with wood, coal and metal. <i>.....cable at 0.80m bgl, no signal off CAT, likely mixed in with building waste. Pit moved back slightly as a precaution.</i>				1.70	7.26			Depth (m)	Ref	Tests / Results
								0.00 - 1.00	B	
								0.30	ES	
MADE GROUND: Brown slightly silty very gravelly fine to coarse SAND with frequent sandstone and iron slag cobbles and boulders. Gravel is angular to sub-angular fine to coarse sandstone, brick and iron slag.				2.20	6.76			0.50	ES	
								1.00	ES	
EOH at 2.20m - Trial pit terminated at 2.20m bgl.								1.00 - 1.70	ES B	
								1.70 - 2.20	B	
								1.80	ES	
Observations / Remarks										
1. Groundwater not encountered 2. Trial pit terminated at 2.20m bgl.3. Upon completion exploratory hole backfilled with arisings.										
			Project Number A095973-2							

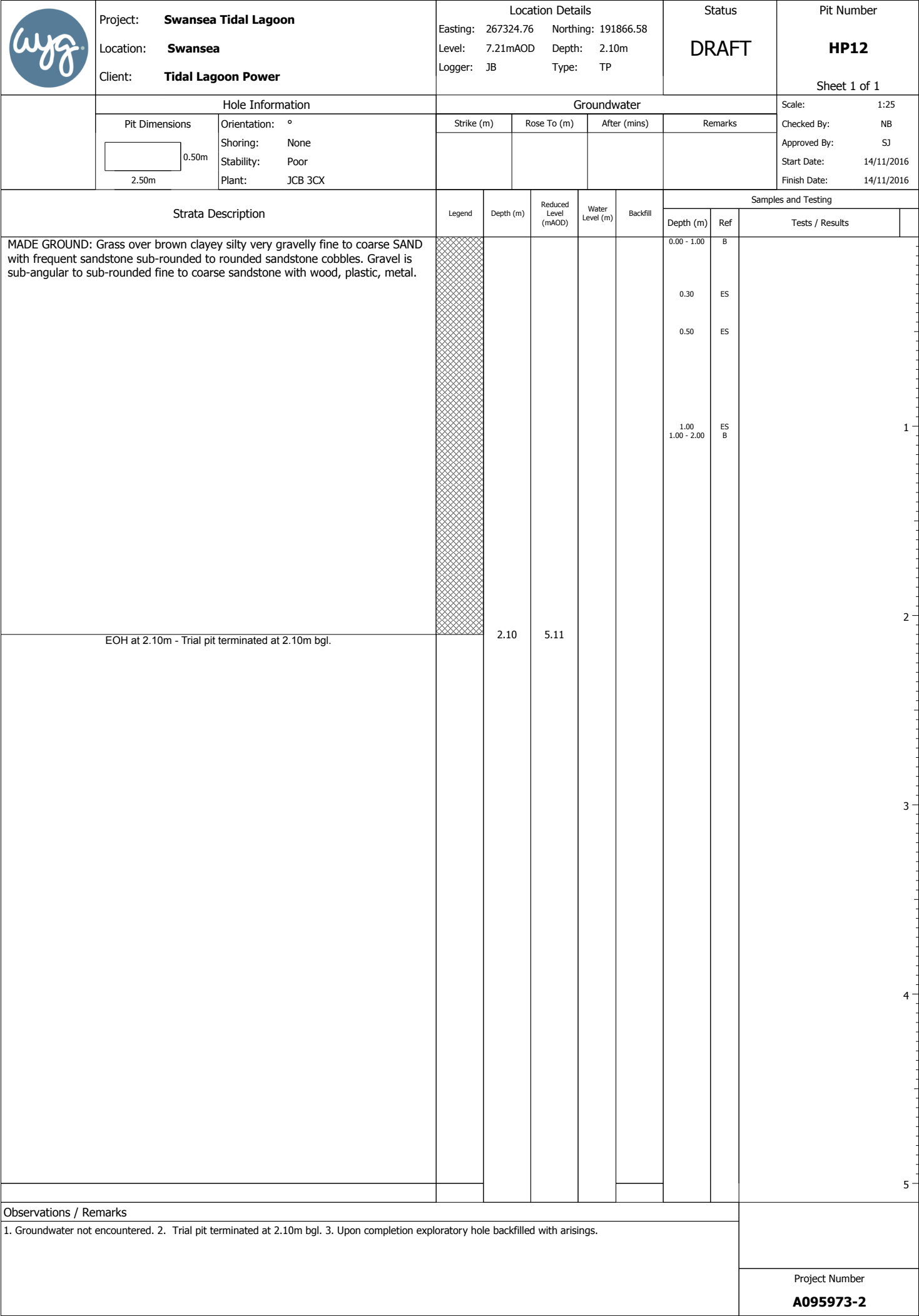
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	Project: Swansea Tidal Lagoon		Location Details Easting: 267200.05 Northing: 191839.59 Level: 8.42mAOD Depth: 2.80m Logger: JB Type: TP				Status DRAFT		Pit Number HP09		
	Location: Swansea		Client: Tidal Lagoon Power						Sheet 1 of 1		
Pit Dimensions 0.50m 2.50m	Hole Information		Groundwater						Scale: 1:25		
	Orientation: °		Strike (m)	Rose To (m)	After (mins)	Remarks		Checked By: NB			
	Shoring: None Stability: Poor Plant: JCB 3CX							Approved By: SJ Start Date: 14/11/2016 Finish Date: 14/11/2016			
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
MADE GROUND: Grass over black brown clayey silty very gravelly fine to coarse SAND with frequent sandstone and iron slag cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick and iron slag with wood, coal and metal.				2.20	6.22			Depth (m)	Ref	Tests / Results	
								0.00 - 1.00	B		
								0.30	ES		
0.50	ES										
MADE GROUND: Light brown to grey silty gravelly fine to coarse SAND with frequent sub-rounded sandstone cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone.								1.00 1.00 - 2.00	ES B		
EOH at 2.80m - Trial pit terminated at 2.80m bgl.				2.80	5.62			2.00 - 2.80	B		

[illegible]

[illegible]



Project: **Swansea Tidal Lagoon**

Location: **Swansea**

Client: **Tidal Lagoon Power**

Location Details

Easting: 267340.76

Northings: 191875.53

Level: 7.94mAOD

Depth: 2.10m

Logger: JB

Type: TP

Status

DRAFT

Pit Number

HP13

Sheet 1 of 1

Hole Information

Pit Dimensions

Orientation: °

Shoring: None

Stability:	Poor
------------	------

Plant: JCB 3CX

Strata Description

Legen

Depth (m)

Reduced
LevelWater
Level (m)

Backfill

Samples and Testing

Depth (m)

Ref

Tests / Results

MADE GROUND: Grass over brown clayey silty very gravelly fine to coarse SAND with frequent sandstone sub-rounded to rounded sandstone cobbles and boulders. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick and concrete with wood, plastic, metal, wire mesh.

MADE GROUND: Black silty very gravelly fine to coarse SAND with frequent angular to sub-rounded sandstone and brick cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick, tiles and concrete with woody fragments, metal and wire.

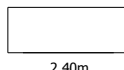
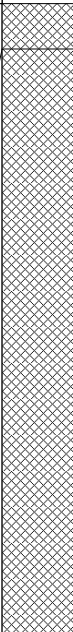
EOH at 2.10m - Trial pit terminated at 2.10m bgl.

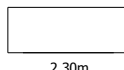
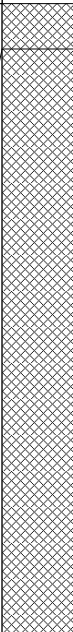
Observations / Remarks

1. Groundwater not encountered. 2. Trial pit terminated at 2.10m bgl. 3. Upon completion exploratory hole backfilled with arisings.

Project Number

A095973-2

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number	
	Location: Swansea		Easting: 267370.20 Northing: 191886.07				DRAFT		HP14	
	Client: Tidal Lagoon Power		Level: 7.95mAOD Depth: 2.10m Logger: JB Type: TP							
	Hole Information		Groundwater					Scale: 1:25		
	Pit Dimensions	Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks	Checked By: NB			
		Shoring: None					Approved By: SJ			
2.40m	0.50m	Stability: Poor					Start Date: 14/11/2016			
		Plant: JCB 3CX					Finish Date: 14/11/2016			
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
								Depth (m)	Ref	Tests / Results
MADE GROUND: Grass over brown clayey silty very gravelly fine to coarse SAND with frequent sandstone sub-rounded to rounded sandstone cobbles and boulders. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick and concrete with wood, plastic, metal, wire mesh. MADE GROUND: Black silty very gravelly fine to coarse SAND with frequent angular to sub-rounded sandstone and brick cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick, tiles and concrete with woody fragments, metal and wire. 1.85m bgl oxidized iron slag material				0.15	7.80			0.00 - 1.00	B	
								0.30	ES	
								0.50	ES	
								1.00 1.00 - 2.00	ES B	
EOH at 2.10m - Trial pit terminated at 2.10m bgl.				2.10	5.85					
Observations / Remarks										Project Number
1. Groundwater not encountered. 2. Trial pit terminated at 2.10m bgl. 3. Upon completion exploratory hole backfilled with arisings.										A095973-2

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number		
	Location: Swansea		Easting: 267381.40 Northing: 191889.67				DRAFT		HP15		
	Client: Tidal Lagoon Power		Level: 7.80mAOD Depth: 2.10m Logger: JB Type: TP								
	Hole Information		Groundwater						Scale: 1:25		
	Pit Dimensions	Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks	Checked By: NB				
		Shoring: None					Approved By: SJ				
2.30m	Stability: Poor					Start Date: 14/11/2016					
	Plant: JCB 3CX					Finish Date: 14/11/2016					
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
								Depth (m)	Ref	Tests / Results	
MADE GROUND: Grass over brown clayey silty very gravelly fine to coarse SAND with frequent sandstone sub-rounded to rounded sandstone cobbles and boulders. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick and concrete with wood, plastic, metal, wire mesh. MADE GROUND: Black silty very gravelly fine to coarse SAND with frequent angular to sub-rounded sandstone and brick cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick, tiles and concrete with woody fragments, metal and wire. 1.85m bgl oxidized iron slag material				0.15	7.65			0.00 - 0.50 0.00 - 0.50	B ES		
								0.50 - 1.00 0.50 - 1.00	B ES		
								1.00 - 2.00	B		
EOH at 2.10m - Trial pit terminated at 2.10m bgl.				2.10	5.70						
Observations / Remarks										Project Number	
1. Groundwater not encountered. 2. Trial pit terminated at 2.10m bgl. 3. Upon completion exploratory hole backfilled with arisings.										A095973-2	

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number		
	Location: Swansea		Easting:		Northing:		DRAFT		HP16		
			Level:		Depth: 0.50m						
	Client: Tidal Lagoon Power		Logger: NB		Type: TP						
			Sheet 1 of 1								
			Hole Information		Groundwater				Scale: 1:25		
Pit Dimensions m		Orientation: ° Shoring: N/A Stability: Plant:		Strike (m)		Rose To (m)		After (mins)		Remarks	
										Checked By: NB Approved By: SJ Start Date: 23/11/2016 Finish Date: 23/11/2016	
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
Brown slightly gravelly coarse SAND. Gravel is rounded, fine to coarse of mixed lithology with shells (BEACH DEPOSITS)				0.50				0.50	ES	Tests / Results	
EOH at 0.50m -											
Observations / Remarks											
1. Groundwater encountered at base of pit. 2. Environmental sample taken at 0.50m and hole backfilled with arisings.											
			Project Number A095973-2								

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wyg	Project: Swansea Tidal Lagoon						Location Details Easting: Level: Logger: NB				Northing: Depth: 0.50m Type: TP		Status DRAFT	Pit Number HP18
	Client: Tidal Lagoon Power												Sheet 1 of 1	
	Hole Information						Groundwater						Scale: 1:25	
	Pit Dimensions m		Orientation: ° Shoring: N/A Stability: Plant:				Strike (m)		Rose To (m)	After (mins)		Remarks		Checked By: NB
														Approved By: SJ
														Start Date: 23/11/2016
														Finish Date: 23/11/2016
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
Dark grey slightly gravelly coarse SAND. Gravel is rounded, fine to coarse of mixed lithology with shells (BEACH DEPOSITS)								0.50				0.50	ES	Tests / Results
EOH at 0.50m -														
Observations / Remarks														
1. Dark grey groundwater encountered from 0.25m and had an oily sheen on its surface. 2. Environmental sample taken at 0.50m and hole backfilled with arisings.														
Project Number A095973-2														

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number		
	Location: Swansea		Easting:		Northing:		DRAFT		HP20		
	Client: Tidal Lagoon Power		Level:		Depth: 0.50m						
			Logger: NB		Type: TP				Sheet 1 of 1		
	Hole Information		Groundwater				Scale: 1:25				
	Pit Dimensions m m	Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks	Checked By: NB				
		Shoring: N/A						Approved By: SJ			
								Start Date: 23/11/2016			
								Finish Date: 23/11/2016			
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
								Depth (m)	Ref	Tests / Results	
Brown slightly gravelly coarse SAND. Gravel is rounded, fine to coarse of mixed lithology with shells (BEACH DEPOSITS)				0.50				0.50	ES		
EOH at 0.50m -											
										1	
										2	
										3	
										4	
										5	
Observations / Remarks											
1. Groundwater encountered at 0.40m. 2. Environmental sample taken at 0.50m and hole backfilled with arisings.											
										Project Number	
										A095973-2	

[illegible]

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number		
	Location: Swansea		Easting:		Northing:		DRAFT		HP22		
	Client: Tidal Lagoon Power		Level:		Depth: 0.50m						
			Logger: NB		Type: TP				Sheet 1 of 1		
	Hole Information		Groundwater				Scale: 1:25				
	Pit Dimensions m m	Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks	Checked By: NB				
		Shoring: N/A						Approved By: SJ			
								Start Date: 23/11/2016			
								Finish Date: 23/11/2016			
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
								Depth (m)	Ref	Tests / Results	
Brown slightly gravelly coarse SAND. Gravel is rounded, fine to coarse of mixed lithology with shells (BEACH DEPOSITS)				0.50				0.50	ES		
EOH at 0.50m -											
										1	
										2	
										3	
										4	
										5	
Observations / Remarks											
1. Groundwater encountered at 0.45m. 2. Environmental sample taken at 0.50m and hole backfilled with arisings.											
										Project Number	
										A095973-2	

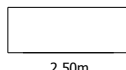
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[illegible]

	Project: Swansea Tidal Lagoon		Location Details					Status		Pit Number	
	Location: Swansea		Easting:		Northing:			DRAFT		HP25	
	Client: Tidal Lagoon Power		Level:		Depth: 0.50m						
			Logger: NB		Type: TP					Sheet 1 of 1	
	Hole Information		Groundwater						Scale: 1:25		
	Pit Dimensions m m	Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks		Checked By: NB			
		Shoring: N/A						Approved By: SJ			
								Start Date: 23/11/2016			
								Finish Date: 23/11/2016			
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
								Depth (m)	Ref	Tests / Results	
Brown slightly gravelly coarse SAND. Gravel is rounded, fine to coarse of mixed lithology with shells (BEACH DEPOSITS)				0.50				0.50	ES		
EOH at 0.50m -											
											1
											2
											3
											4
											5
Observations / Remarks											
1. Groundwater encountered from surface of sand and had a slight oily sheen on its surface. 2. Environmental sample taken at 0.50m and hole backfilled with arisings.											
										Project Number	
										A095973-2	

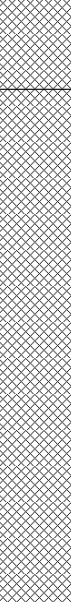
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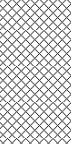
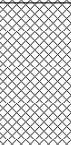
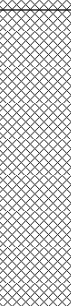


	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number	
	Location: Swansea		Easting: 266970.83 Northing: 191928.70				DRAFT		TP01	
	Client: Tidal Lagoon Power		Level: 6.15mAOD Depth: 2.80m							
			Logger: JB Type: TP						Sheet 1 of 1	
	Hole Information		Groundwater					Scale: 1:25		
	Pit Dimensions	Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks	Checked By: NB			
		Shoring: None					Approved By: SJ			
2.50m	Stability: Poor					Start Date: 10/11/2016				
	Plant: JCB 3CX					Finish Date: 10/11/2016				
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
MADE GROUND: Grass over black slightly clayey silty very gravelly fine to coarse SAND. Gravel is fine to coarse sub-angular to sub-rounded sandstone and iron slag with occasional sandstone boulders and cobbles.				0.15	6.00			0.00 - 0.15	B	
								0.00 - 0.15	ES	
MADE GROUND: Black clayey sandy angular fine to coarse sandstone GRAVEL with brick and slag cobbles.				0.70	5.45			0.20 - 0.70	B	
MADE GROUND: Yellow light brown silty fine to coarse SAND with frequent rounded sandstone cobbles and boulders.				1.10	5.05			0.50	ES	
MADE GROUND: Yellow light brown grey slightly clayey silty fine to coarse SAND with rounded sandstone cobbles becoming bouldery.				2.80	3.35			0.70 - 1.70	B	
.....many boulders at 2.60m bgl with strong hydrocarbon odour								1.00	ES	
EOH at 2.80m - Trial pit terminated at 2.80m bgl pit very unstable from 1.90m.								2.00	ES	
								2.00 - 2.80	B	
								2.60	ES	
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
Observations / Remarks										
1. Groundwater not observed 2. Trial pit terminated at 2.80m bgl pit very unstable from 1.90m. 3. Upon completion exploratory hole backfilled with arisings.										
			Project Number							
			A095973-2							

[illegible]

[illegible]

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number	
	Location: Swansea		Easting: 266950.60 Northing: 191836.80 Level: 6.78mAOD Depth: 2.00m Logger: JB Type: TP				DRAFT		TP04	
	Client: Tidal Lagoon Power									
			Groundwater					Scale: 1:25		
Hole Information			Strike (m)		Rose To (m)		After (mins)		Remarks	
Pit Dimensions 0.50m 2.20m			Orientation: ° Shoring: None Stability: Poor Plant: JCB 3CX							
									Checked By: NB Approved By: SJ Start Date: 10/11/2016 Finish Date: 10/11/2016	
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
								Depth (m)	Ref	Tests / Results
MADE GROUND: Grass over black silty very gravelly fine to coarse SAND. Gravel is fine to coarse sub-angular to sub-rounded sandstone and iron slag with occasional sandstone boulders.				0.30	6.48			0.00 - 0.30	B	
MADE GROUND: Yellow/brown slightly gravelly coarse SAND. Gravel is sub-rounded fine to coarse sandstone.								0.30 - 1.30	B	
								0.50	ES	
								1.00	ES	
			1.50 - 2.00	B						
EOH at 2.00m - Trial pit terminated at 2.0m bgl pit very unstable from 0.30m collapsed back to 1.60m bgl before photo could be taken.				2.00	4.78			2.00	ES	2
										3
										4
										5
Observations / Remarks										Project Number A095973-2
1. Groundwater not observed 2. Trial pit terminated at 2.0m bgl pit very unstable from 0.30m collapsed back to 1.60m bgl before photo could be taken. 3. Upon completion exploratory hole backfilled with arisings.										

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number		
	Location: Swansea		Easting: 267054.13 Northing: 191823.44 Level: 6.86mAOD Depth: 2.00m Logger: JB Type: TP				DRAFT		TP05		
	Client: Tidal Lagoon Power										
			Groundwater					Scale: 1:25			
Hole Information							Checked By: NB				
Pit Dimensions		Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks	Approved By: SJ				
0.50m 2.20m		Shoring: None Stability: Poor Plant: JCB 3CX					Start Date: 10/11/2016 Finish Date: 10/11/2016				
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
								Depth (m)	Ref	Tests / Results	
MADE GROUND: Grass over black silty very gravelly fine to coarse SAND. Gravel is fine to coarse sub-angular to sub-rounded sandstone and iron slag with frequent sandstone cobbles and boulders. <i>....car tyre at 0.20m bgl and rubber bands</i> <i>....water seepage at 0.40m bgl possible from surface runoff</i>				0.50	6.36			0.00 - 0.50	B		
								0.30	ES		
MADE GROUND: Light brown slightly clayey silty very gravelly fine to coarse SAND. Gravel is fine to coarse sub-angular to sub-rounded sandstone and iron slag with frequent sandstone cobbles and boulders.				1.00	5.86			0.50	ES		
								0.50 - 1.00	B		
MADE GROUND: Yellow fine to coarse SAND with some shells.				2.00	4.86			1.00 - 2.00	B		
								1.20	ES		
EOH at 2.00m - Trial pit terminated at 2.0m bgl pit very unstable from 1.00m.										1	
										2	
										3	
										4	
										5	
Observations / Remarks										Project Number A095973-2	
1. Groundwater not observed some seepage from 0.40m bgl likely from surface runoff. 2. Trial pit terminated at 2.0m bgl pit very unstable from 1.00m. 3. Upon completion exploratory hole backfilled with arisings.											

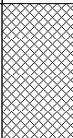
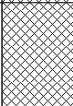
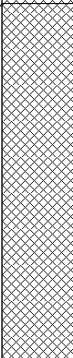
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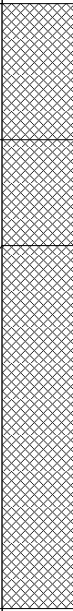
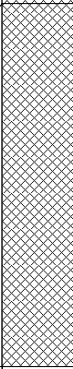
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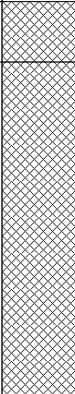
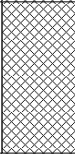
	Project: Swansea Tidal Lagoon		Location Details			Status		Pit Number		
	Location: Swansea		Easting: 267119.96 Northing: 192024.08			DRAFT		TP08		
	Client: Tidal Lagoon Power		Level: 6.95mAOD Depth: 1.50m Logger: JB Type: TP							
0.50m 2.10m	Hole Information		Groundwater					Scale: 1:25		
	Orientation: °		Strike (m)	Rose To (m)	After (mins)	Remarks		Checked By: NB		
	Shoring: None Stability: Poor Plant: JCB 3CX							Approved By: SJ Start Date: 24/11/2016 Finish Date: 24/11/2016		
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
MADE GROUND: Grass over black silty very gravelly fine to coarse SAND. Gravel is fine to coarse sub-angular to sub-rounded sandstone and iron slag with occasional sandstone cobbles and boulders with tile, wood, metal				0.40	6.55			0.00 - 0.40	B	
MADE GROUND: Black and grey slightly gravelly clayey SILT with cobbles and boulders. Gravel is fine to coarse angular to sub-angular coal and iron slag. Cobbles and boulders are angular concrete with railway sleeper.								0.30	ES	
								0.40 - 1.50	B	
								0.50	ES	
EOH at 1.50m - 2. Trial pit terminated at 1.5m bgl pit due to very large boulder being removed from pit revealing a metal pipe at 1.10m bgl.				1.50	5.45					

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number		
	Location: Swansea		Easting: 267524.80 Northing: 191935.83 Level: 6.48mAOD Depth: 2.00m Logger: JB Type: TP				DRAFT		TP09		
	Client: Tidal Lagoon Power										
			Groundwater					Scale: 1:25			
Hole Information			Strike (m)		Rose To (m)	After (mins)	Remarks		Checked By: NB		
Pit Dimensions 0.50m 2.40m			Orientation: °						Approved By: SJ		
			Shoring: None						Start Date: 15/11/2016		
			Stability: Poor						Finish Date: 15/11/2016		
			Plant: JCB 3CX								
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
								Depth (m)	Ref	Tests / Results	
MADE GROUND: Grass over black silty very gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse sandstone and iron slag with occasional sandstone and iron slag cobbles with tile, wood, metal clay piping. <i>....sand lens from 0.20 to 0.22m bgl</i>				0.30	6.18			0.00 - 0.50	B		
MADE GROUND: Light brown silty very gravelly fine to coarse SAND with frequent sandstone cobbles and boulders. Gravel is sub-angular to sub-rounded fine to coarse sandstone. <i>....pit unstable from 0.50m bgl</i>								0.20	ES		
<i>....plastic drainage run at 0.90m bgl pit moved south and continued</i>								0.50 0.50 - 0.95	ES B		
MADE GROUND: Light brown fine to coarse SAND.			0.95	5.53			1.00 - 2.00	B	1		
EOH at 2.00m - Trial pit terminated at 2.0 bgl pit due to instability.				2.00	4.48						2
										3	
										4	
										5	
Observations / Remarks										Project Number A095973-2	
1. Groundwater not observed. 2. Trial pit terminated at 2.0 bgl pit due to instability. 3. Upon completion exploratory hole backfilled with arisings.											

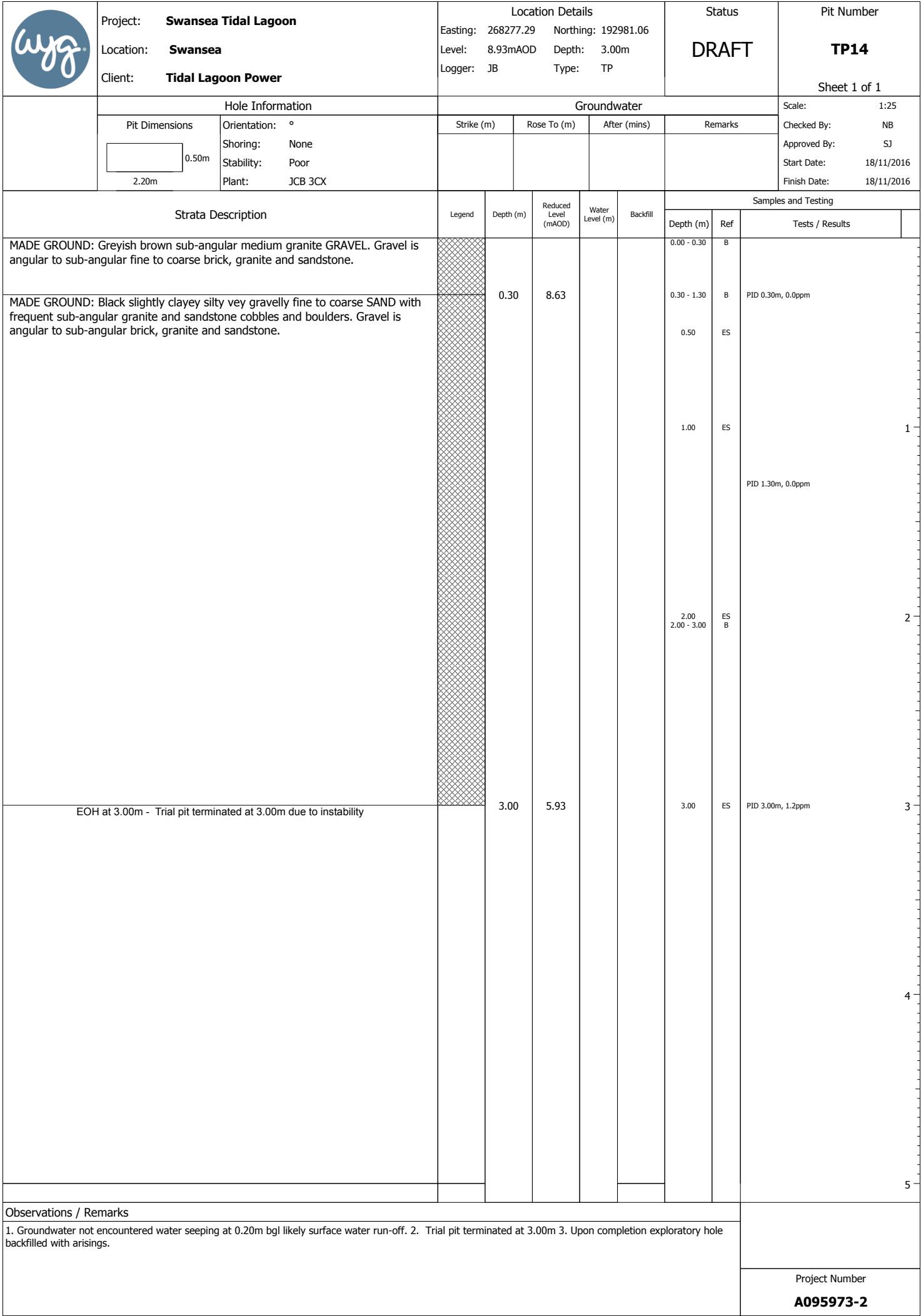
	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number		
	Location: Swansea		Easting: 267836.16 Northing: 192046.19 Level: 6.65mAOD Depth: 1.80m Logger: JB Type: TP				DRAFT		TP10		
	Client: Tidal Lagoon Power										
			Groundwater					Scale: 1:25			
Hole Information			Strike (m)		Rose To (m)	After (mins)	Remarks		Checked By: NB		
Pit Dimensions 0.50m 2.30m			Orientation: °						Approved By: SJ		
			Shoring: None						Start Date: 15/11/2016		
			Stability: Poor						Finish Date: 15/11/2016		
			Plant: JCB 3CX								
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
								Depth (m)	Ref	Tests / Results	
MADE GROUND: Grass over black silty very gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse sandstone and iron slag with occasional sandstone and iron slag cobbles with tile, wood, metal clay piping.				0.30	6.35			0.30 0.30 - 1.00 0.50	ES B ES		
MADE GROUND: Light brown to black gravelly fine to coarse SAND with occasional brick cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone.concrete hardstanding at 0.40m bgl pit moved slightly to avoid.											
MADE GROUND: Light brown fine to coarse SAND. ...water pipe at 1.0m bgl accompanied with general pit instability											
MADE GROUND: Light brown fine to coarse SAND. ...pit collapsed back to 1.70m bgl											
EOH at 1.80m - Trial pit terminated at 1.8 bgl pit due to instability.				1.80	4.85			1.00 - 1.80 1.50	B ES	1	
										2	
										3	
										4	
										5	
Observations / Remarks										Project Number A095973-2	
1. Groundwater not observed. 2. Trial pit terminated at 1.8 bgl pit due to instability. 3. Upon completion exploratory hole backfilled with arisings.											

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number	
	Location: Swansea		Easting: 268264.32 Northing: 192194.70				DRAFT		TP11	
	Client: Tidal Lagoon Power		Level: 6.49mAOD Depth: 2.00m							
			Logger: JB Type: TP						Sheet 1 of 1	
	Hole Information		Groundwater						Scale: 1:25	
	Pit Dimensions 0.50m 2.40m	Orientation: ° Shoring: None Stability: Poor Plant: JCB 3CX	Strike (m)	Rose To (m)	After (mins)	Remarks		Checked By: NB		
							Approved By: SJ			
							Start Date: 15/11/2016			
							Finish Date: 15/11/2016			
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
MADE GROUND: Grass over black silty very gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse sandstone and iron slag with occasional sandstone and iron slag cobbles with tile, wood and metal.				0.45	6.04			0.00 - 0.40	B	Tests / Results
								0.30	ES	
MADE GROUND: Light brown to black gravelly fine to coarse SAND with occasional brick cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone.concrete, wooden sleeper and wooden planks at 0.40m to 0.45m bglpit unstable from 0.60m bglsubordinate grayish red clay lens from 0.70 to 0.75m bgl				0.80	5.69			0.40 - 0.80	B	
								0.50	ES	
MADE GROUND: Light brown fine to coarse SAND.				2.00	4.49			0.80 - 2.00	B	
EOH at 2.00m - Trial pit terminated at 2.0m bgl pit due to instability.										
Observations / Remarks										
1. Groundwater not observed. 2. Trial pit terminated at 2.0m bgl pit due to instability. 3. Upon completion exploratory hole backfilled with arisings.										
			Project Number A095973-2							

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number	
	Location: Swansea		Easting: 268264.32 Northing: 192194.70				DRAFT		TP11	
	Client: Tidal Lagoon Power		Level: 6.49mAOD Depth: 2.00m							
			Logger: JB Type: TP						Sheet 1 of 1	
	Hole Information		Groundwater						Scale: 1:25	
	Pit Dimensions 0.50m 2.40m	Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks	Checked By: NB			
		Shoring: None					Approved By: SJ			
		Stability: Poor					Start Date: 15/11/2016			
		Plant: JCB 3CX						Finish Date: 15/11/2016		
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
MADE GROUND: Grass over black silty very gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse sandstone and iron slag with occasional sandstone and iron slag cobbles with tile, wood and metal.				0.45	6.04			0.00 - 0.40	B	
								0.30	ES	
								0.40 - 0.80	B	
								0.50	ES	
MADE GROUND: Light brown to black gravelly fine to coarse SAND with occasional brick cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone.concrete, wooden sleeper and wooden planks at 0.40m to 0.45m bglpit unstable from 0.60m bglsubordinate grayish red clay lens from 0.70 to 0.75m bgl			0.80	5.69			0.80 - 2.00	B		
MADE GROUND: Light brown fine to coarse SAND.										
				2.00	4.49					
EOH at 2.00m - Trial pit terminated at 2.0m bgl pit due to instability.										
										
										
Observations / Remarks										
1. Groundwater not observed. 2. Trial pit terminated at 2.0m bgl pit due to instability. 3. Upon completion exploratory hole backfilled with arisings.										
Project Number										
A095973-2										

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number					
	Location: Swansea		Easting: 268815.00 Northing: 192651.37 Level: 6.80mAOD Depth: 1.80m Logger: JB Type: TP				DRAFT		TP12					
	Client: Tidal Lagoon Power													
			Groundwater					Scale: 1:25						
Hole Information			Strike (m)		Rose To (m)		After (mins)		Remarks					
Pit Dimensions 0.50m 2.30m			Orientation: °											
Shoring: None									Checked By: NB					
Stability: Poor									Approved By: SJ					
Plant: JCB 3CX									Start Date: 17/11/2016					
									Finish Date: 17/11/2016					
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing						
								Depth (m)	Ref	Tests / Results				
MADE GROUND: Grass over brownish grey silty coarse SAND				0.20	6.60			0.20 - 1.30	B					
MADE GROUND: Light brown to grey fine to coarse SAND.								0.50	ES					
								1.00 - 1.30	ES					
MADE GROUND: Light brown coarse SAND. <i>....legacy oil pipe located at 1.30m bgl</i>			1.30	5.50	1.30 - 1.80	B								
			1.30 - 1.80	ES										
EOH at 1.80m - Trial pit terminated at 1.80m due to instability				1.80	5.00					1				
														2
														3
														4
														5
Observations / Remarks										Project Number A095973-2				
1. Groundwater not encountered 2. Trial pit terminated at 1.80m due to instability 3. Upon completion exploratory hole backfilled with arisings.4. Due to large amounts of contamination throughout no geotechnical samples could be taken														

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number			
	Location: Swansea		Easting: 268156.22 Northing: 192986.69				DRAFT		TP13			
	Client: Tidal Lagoon Power		Level: 9.05mAOD Depth: 2.40m Logger: JB Type: TP									
Hole Information			Groundwater					Scale: 1:25				
Pit Dimensions		Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks	Checked By: NB					
0.50m 2.30m		Shoring: None Stability: Poor Plant: JCB 3CX					Approved By: SJ					
							Start Date: 18/11/2016 Finish Date: 18/11/2016					
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing				
								Depth (m)	Ref	Tests / Results		
MADE GROUND: Greyish brown sub-angular medium granite GRAVEL.				0.25	8.80			0.00 - 0.25	B	PID 0.25m, 0.0ppm PID 0.60m, 0.0ppm PID 1.60m, 0.0ppm PID 2.40m, 0.0ppm PID 3.00m, 0.0ppm		
MADE GROUND: Black slightly clayey silty very gravelly fine to coarse SAND with frequent sub-angular granite and sandstone cobbles and boulders. Gravel is angular to sub-angular fine to coarse brick, granite and sandstone.								0.60	8.45		0.25 - 0.60	B
MADE GROUND: Light brown gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse sandstone.				2.00 2.00 - 2.40	ES B						2.30 2.40 - 3.00	ES B
				EOH at 2.40m - Trial pit terminated at 3.00m bgl due to instability				2.40	6.65			
Observations / Remarks												
1. Groundwater not encountered water seeping at 0.20m bgl likely surface water run-off. 2. Trial pit terminated at 3.00m bgl 3. Upon completion exploratory hole backfilled with arisings.												
			Project Number A095973-2									



Project: **Swansea Tidal Lagoon**Location: **Swansea**

Client: **Tidal Lagoon Power**

Location Details

Easting: 268550.92 Northing: 193013.87

Level: 7.37mAOD Depth: 1.60m

Logger: JB Type: TP

Status

DRAFT

Pit Number

TP15

Sheet 1 of 1

Hole Information

Pit Dimensions

Orientation: 0

Shoring: None

Stability:	Poor
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Plant: JCB 3CX

Strata Description

Legen

Depth (m)

Reduced
LevelWater
Level (m)

Backfill

Samples and Testing

Depth (m)

Ref

Tests / Results

MADE GROUND: Light brown slightly gravelly coarse SAND.

MADE GROUND: Grey fine to coarse SAND.

MADE GROUND: Black very gravelly fine to coarse SAND. Gravel is angular to sub-angular fine to coarse brick and slag.

EOH at 1.60m - Trial pit terminated at 1.60m bgl due to instability

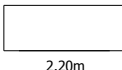
Observations / Remarks

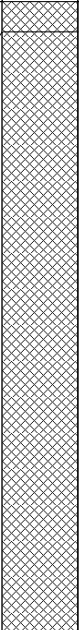
1. Groundwater encountered at 1.50m bql. 2. Trial pit terminated at 1.60m bql. 3. Upon completion exploratory hole backfilled with arisings.

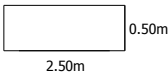
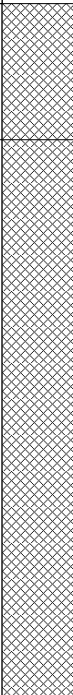
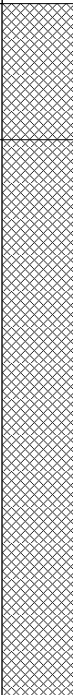
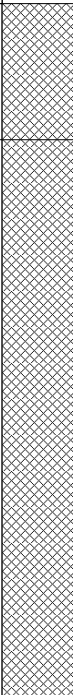
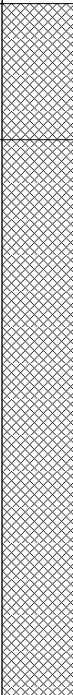
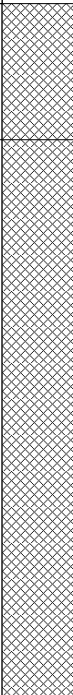
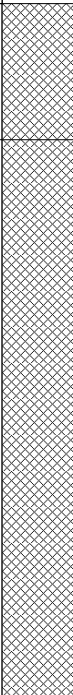
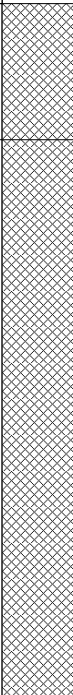
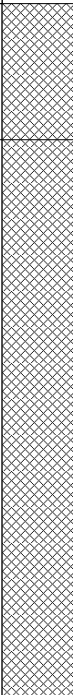
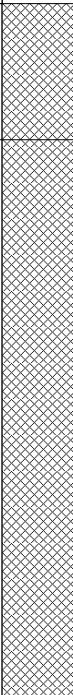
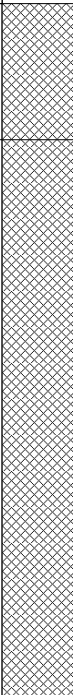
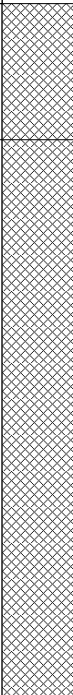
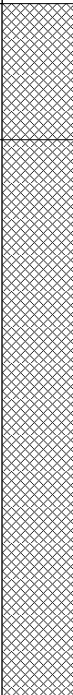
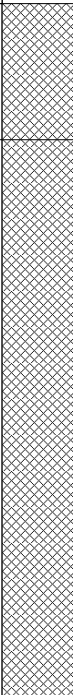
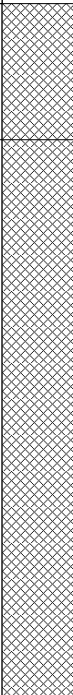
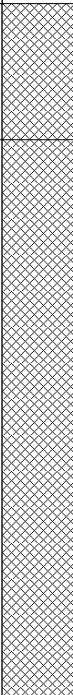
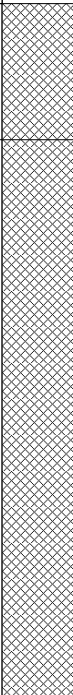
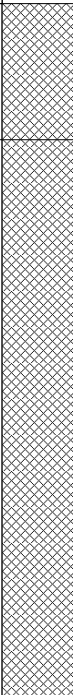
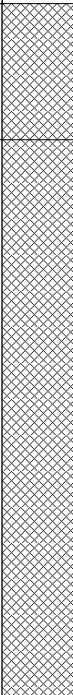
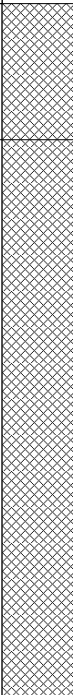
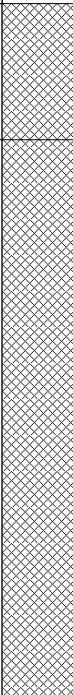
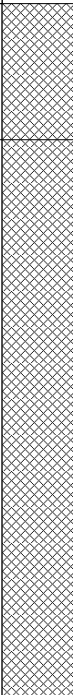
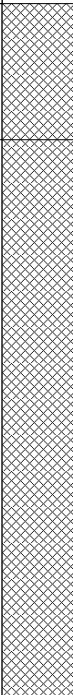
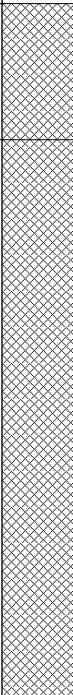
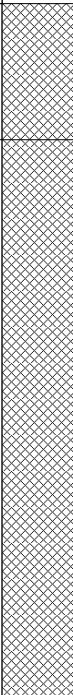
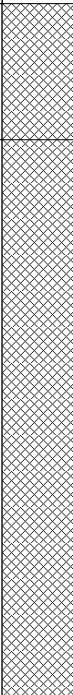
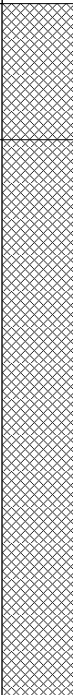
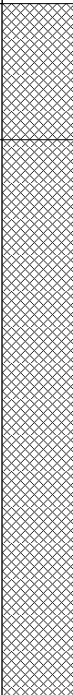
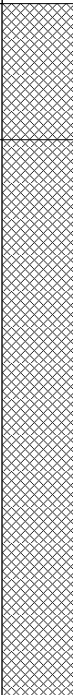
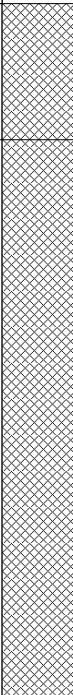
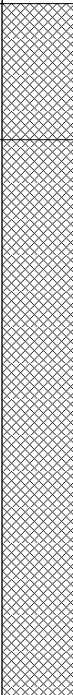
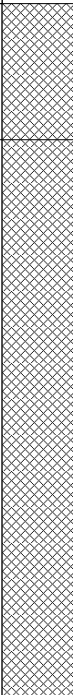
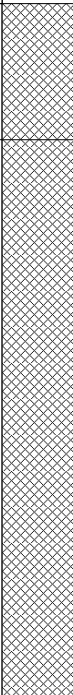
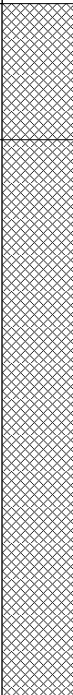
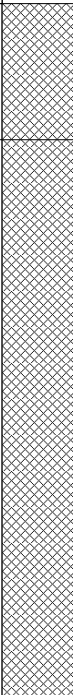
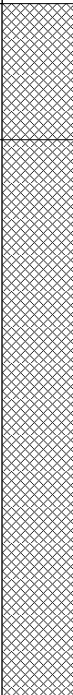
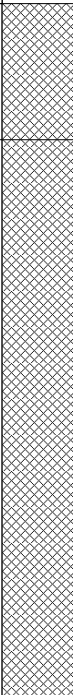
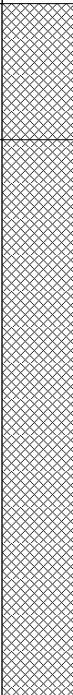
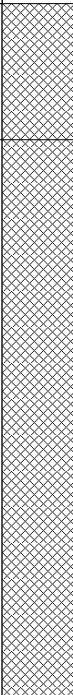
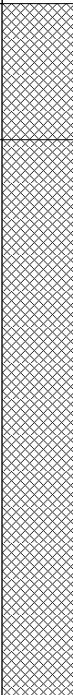
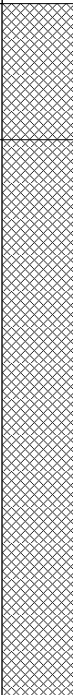
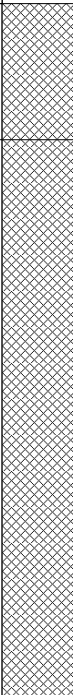
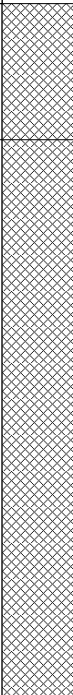
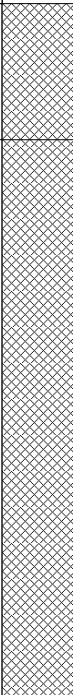
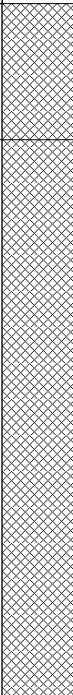
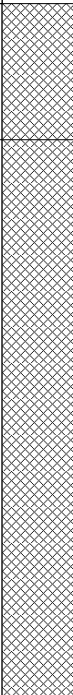
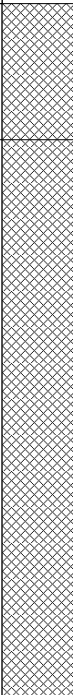
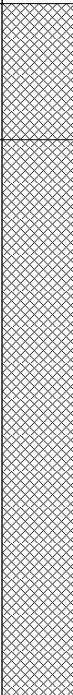
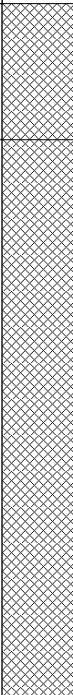
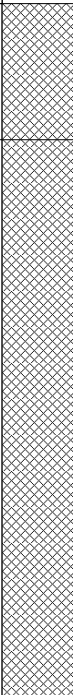
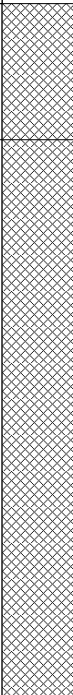
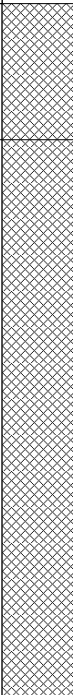
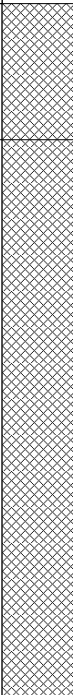
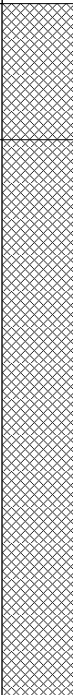
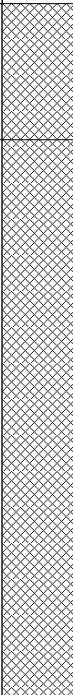
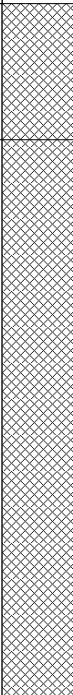
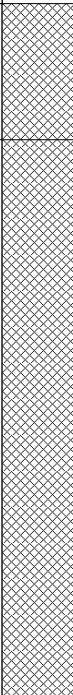
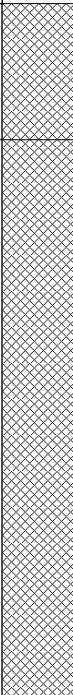
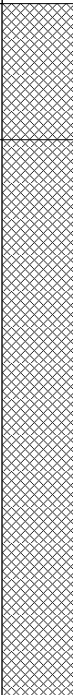
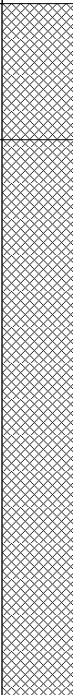
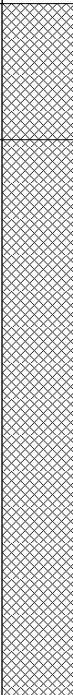
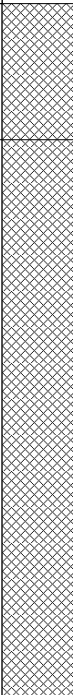
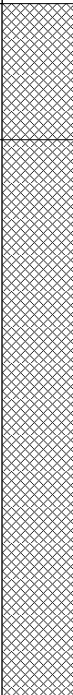
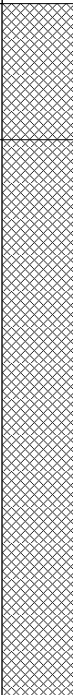
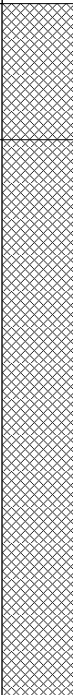
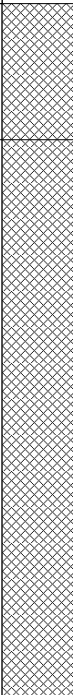
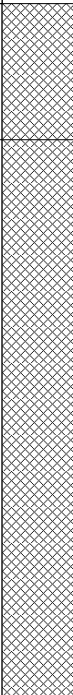
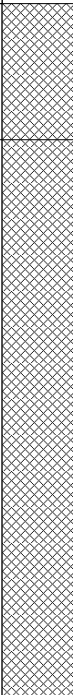
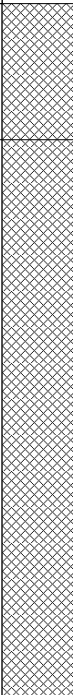
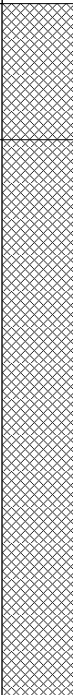
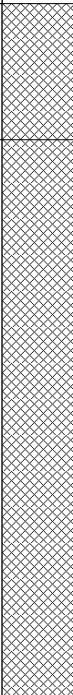
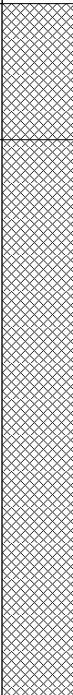
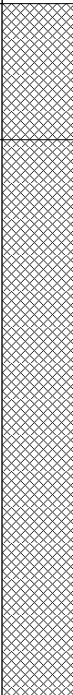
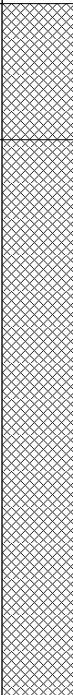
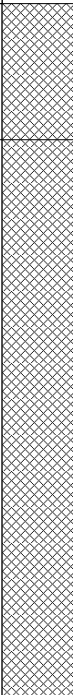
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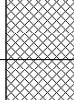
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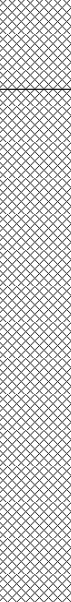
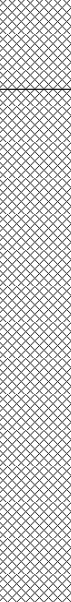
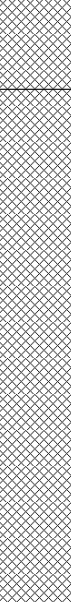
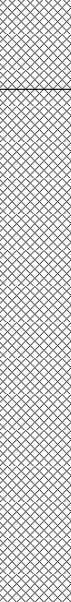
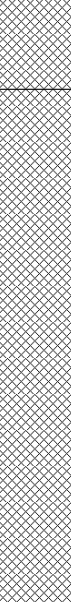
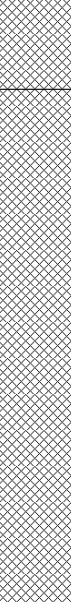
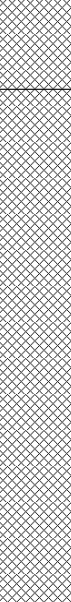
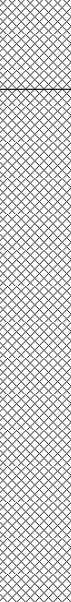
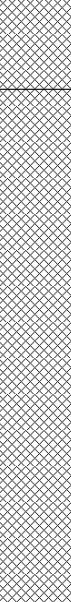
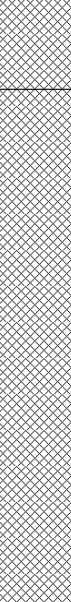
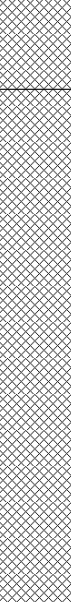
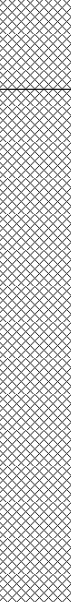
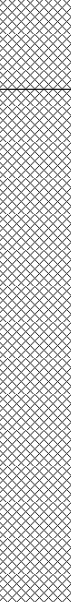
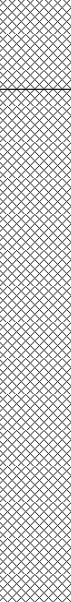
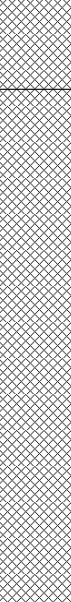
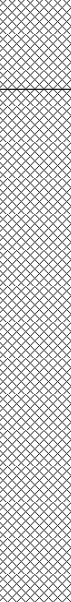
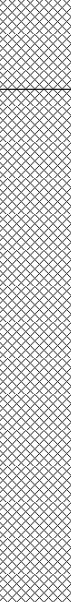
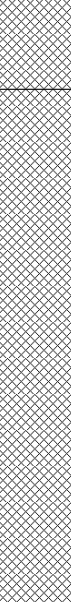
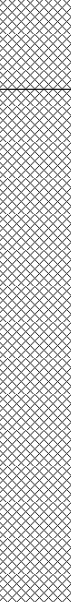
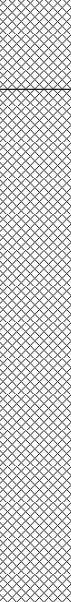
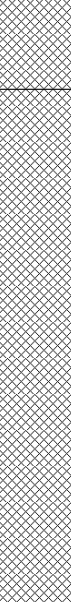
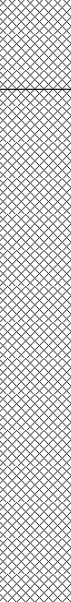
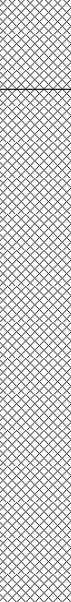
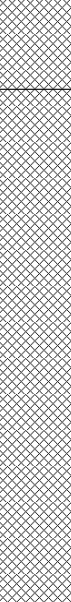
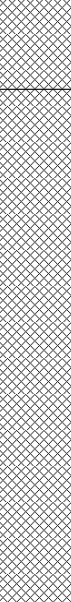
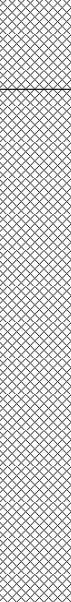
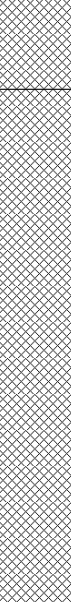
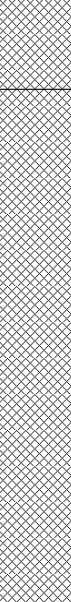
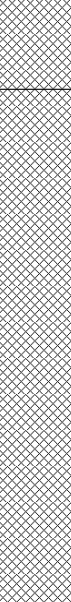
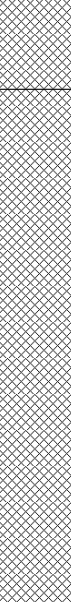
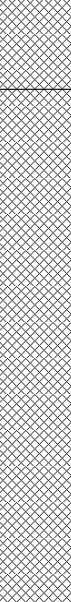
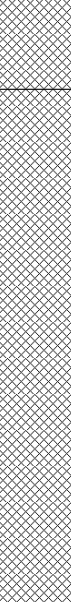
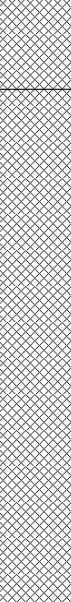
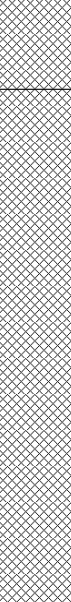
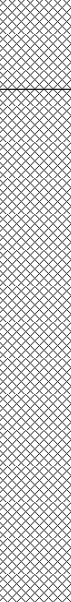
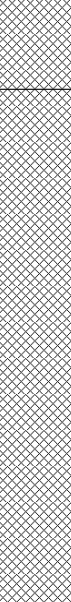
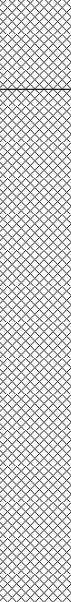
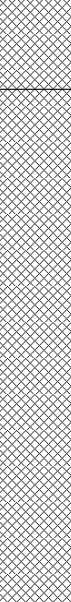
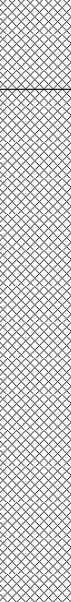
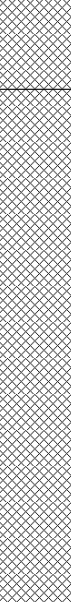
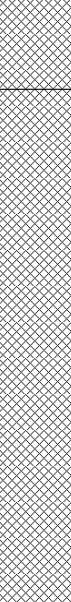
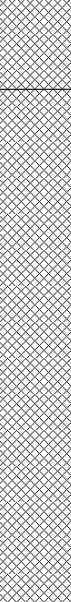
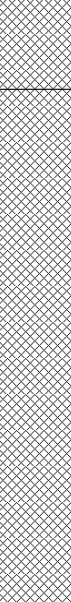
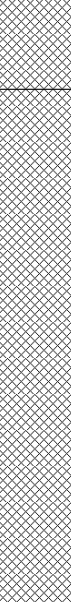
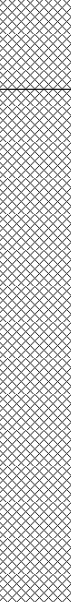
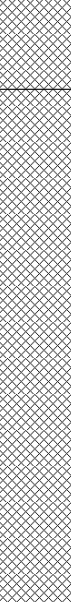
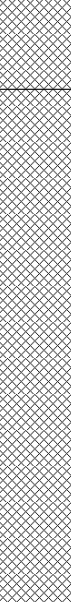
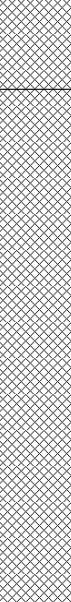
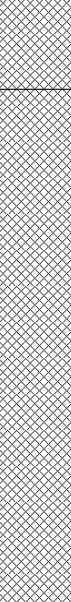
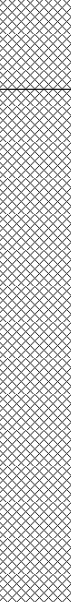
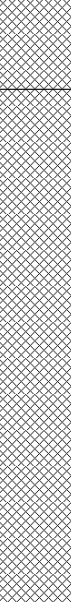
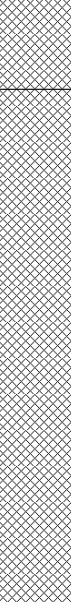
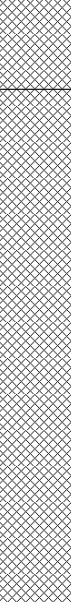
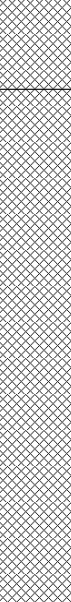
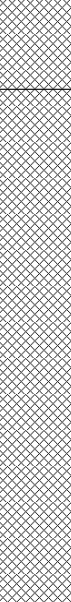
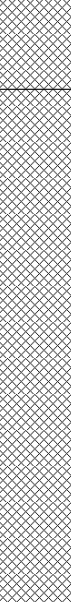
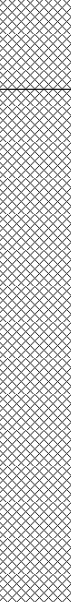
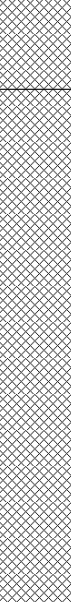
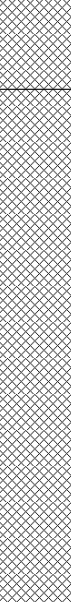
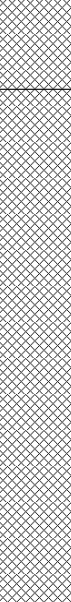
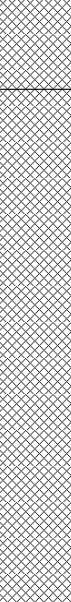
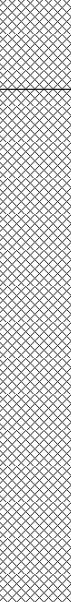
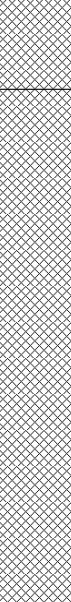
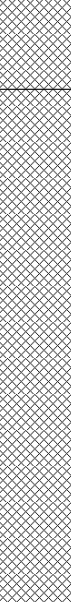
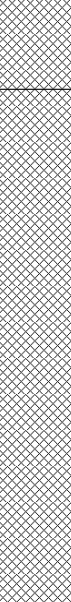
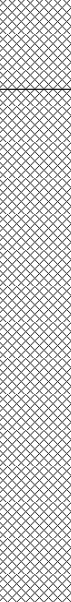
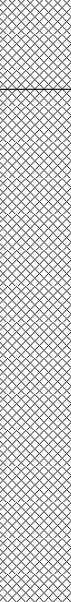
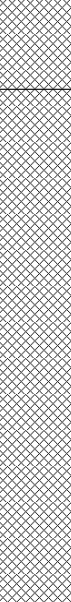
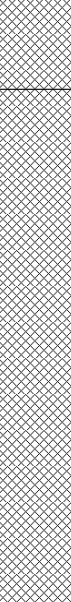
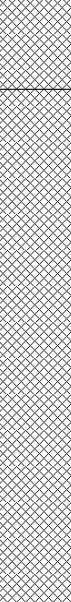
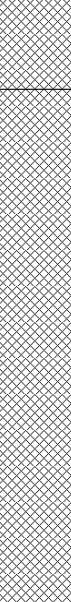
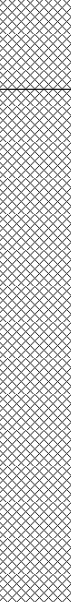
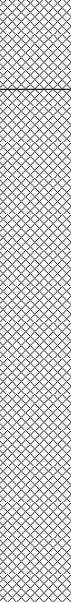
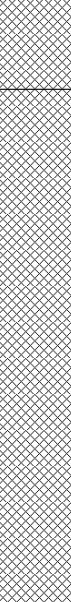
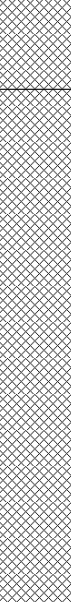
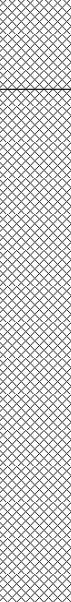
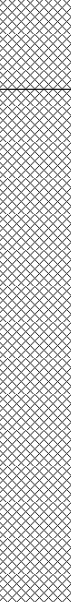
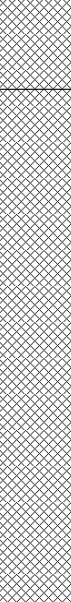
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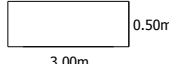
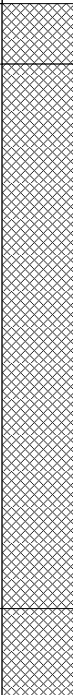
	Project: Swansea Tidal Lagoon		Location Details Easting: 268631.05 Northing: 192842.19 Level: 6.66mAOD Depth: 2.50m Logger: JB Type: TP				Status DRAFT		Pit Number TP17	
	Location: Swansea Client: Tidal Lagoon Power								Sheet 1 of 1	
	Hole Information		Groundwater						Scale: 1:25	
	Orientation: °		Strike (m)		Rose To (m)		After (mins)		Remarks	
	Shoring: None Stability: Poor Plant: JCB 3CX									
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
MADE GROUND: Greyish brown very sandy GRAVEL with cobbles and boulders. Gravel is sub-angular medium to coarse brick, tile and ship ballast. Cobbles and boulders are angular to sub-rounded sandstone and concrete.				0.40	6.26			Depth (m)	Ref	Tests / Results
MADE GROUND: Blueish grey silty SAND.				0.45	6.21					
MADE GROUND: Black mottled red silty gravelly SAND of ash with cobbles. Gravel is sub-angular to sub-rounded fine to coarse sandstone, iron slag, brick. Cobbles are sub-angular iron slag.										
EOH at 2.50m - Trial pit terminated at 2.50m bgl due to constant in flow of water causing pit instability.				2.50	4.16					
Observations / Remarks										
1. Groundwater encountered at 2.20m bgl. 2. Trial pit terminated at 2.50m bgl. 3. Upon completion exploratory hole backfilled with arisings.										
										Project Number A095973-2

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number	
	Location: Swansea		Easting: 268653.08 Northing: 192762.19 Level: 6.68mAOD Depth: 2.10m Logger: JB Type: TP				DRAFT		TP18	
	Client: Tidal Lagoon Power								Sheet 1 of 1	
	Hole Information		Groundwater					Scale: 1:25		
	Pit Dimensions 0.50m 2.30m	Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks	Checked By: NB			
		Shoring: None Stability: Poor Plant: JCB 3CX						Approved By: SJ Start Date: 17/11/2016 Finish Date: 17/11/2016		
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
MADE GROUND: Brown silty slightly gravelly fine to coarse SAND. Gravel is angular to sub-rounded fine to coarse sandstone, brick, concrete and clay pipe. MADE GROUND: Black silty very gravelly fine to coarse SAND. Gravel is angular to sub-rounded fine to coarse brick, iron slag, clay pipe and coal. electricity tile at 0.35m bgl with dead cable beneath. large quantities of ash and slag at 0.80m bgl water at base of pit rising to 1.90m bgl. Sheen on water and strong hydrocarbon odour.				0.10	6.58			0.30	ES	PID 0.80m, 1.7ppm
								0.50	ES	
								1.00	ES	
								1.90	ES	
EOH at 2.10m - Trial pit terminated at 2.1m bgl pit due to instability.				2.10	4.58					PID 1.80m, 14.9ppm
										PID 2.10m, 158.0ppm
Observations / Remarks										
1. Groundwater encountered at 2.10m bgl 2. Trial pit terminated at 2.1m bgl pit due to instability. 3. Upon completion exploratory hole backfilled with arisings. 4. Due to large amounts of contamination throughout no geotechnical samples could be taken										
			Project Number A095973-2							

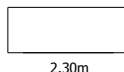
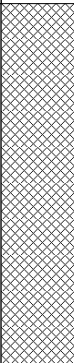
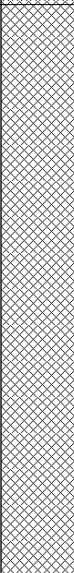
	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number	
	Location: Swansea		Easting: 268742.80 Northing: 192726.25				DRAFT		TP19	
Client: Tidal Lagoon Power		Level: 6.72mAOD Depth: 2.30m								
		Logger: JB Type: TP						Sheet 1 of 1		
	Hole Information		Groundwater					Scale: 1:25		
	Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks	Checked By: NB				
						Approved By: SJ				
Shoring: None							Start Date: 15/11/2016			
Stability: Poor							Finish Date: 15/11/2016			
Plant: JCB 3CX										
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
								Depth (m)	Ref	Tests / Results
MADE GROUND: Light grayish brown slightly silty very gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse sandstone, brick and concrete with frequent brick and concrete cobbles.				0.45	6.27			0.00 - 0.40	B	
								0.30	ES	
								0.40 - 1.40	B	
								0.50	ES	
MADE GROUND: Light brown fine to coarse SAND.pit unstable from 0.50m bgl				0.45	6.27			1.00	ES	
								1.40 - 2.30	B	
EOH at 2.30m - Trial pit terminated at 2.3m bgl pit due to instability				2.30	4.42					
				2.30	4.42					
				2.30	4.42					
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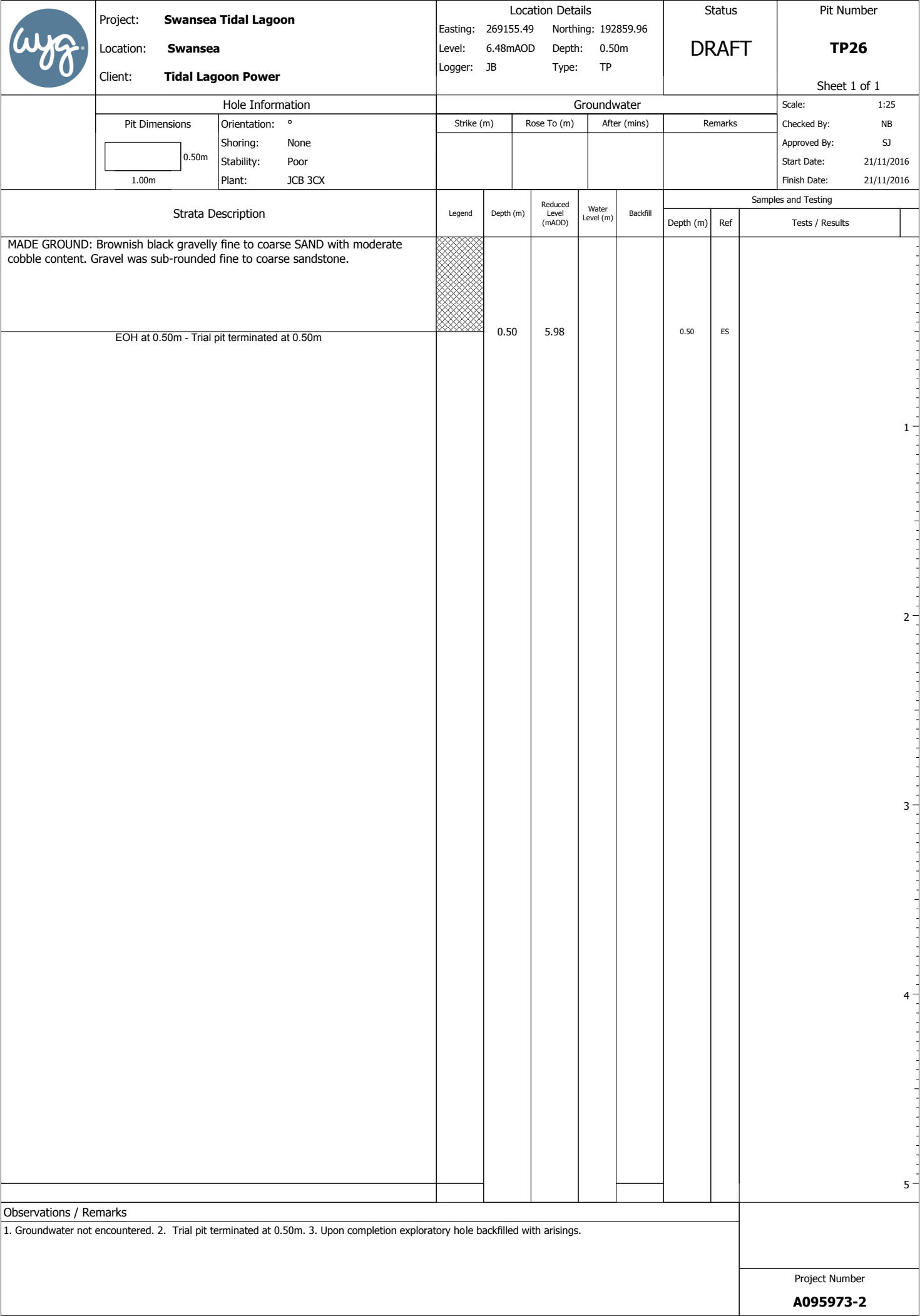
	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number	
	Location: Swansea		Easting: 268869.98 Northing: 192784.73				DRAFT		TP20	
	Client: Tidal Lagoon Power		Level: 5.89mAOD Depth: 3.20m							
			Logger: JB Type: TP						Sheet 1 of 1	
	Hole Information		Groundwater						Scale: 1:25	
	Pit Dimensions 0.50m 3.00m	Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks		Checked By: NB		
		Shoring: None						Approved By: SJ		
		Stability: Poor						Start Date: 16/11/2016		
		Plant: JCB 3CX						Finish Date: 16/11/2016		
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
MADE GROUND: Light brown to black silty very gravelly fine to coarse SAND. Gravel is angular to sub-rounded fine to coarse sandstone, brick and iron slag with occasional brick and sandstone cobbles. <i>....very strong hydrocarbon odours from 0.20m bgl</i>				0.30	5.59			0.00 - 0.30	B	PID 0.30m, 54.5ppm
								0.20	ES	
MADE GROUND: Grey silty fine SAND. <i>....very strong hydrocarbon odours</i>				0.80	5.09			0.30 - 0.80	B	PID 0.80m, 469.0ppm
								0.50	ES	
MADE GROUND: Light brown grayish silty very gravelly fine to coarse SAND. Gravel is angular to sub-rounded fine to coarse sandstone, brick, tile, concrete and sandstone with frequent angular to sub-rounded brick, concrete and sandstone cobbles.				1.40	4.49			0.80 - 1.40	B	PID 1.40m, 214.0ppm
								1.00	ES	
MADE GROUND: Grey silty gravelly fine SAND. <i>....concrete obstruction in north eastern side wall at 2.10m bgl pit extended south west to avoid</i> <i>....hydrocarbons oozing from side walls above groundwater at 3.00m bgl.</i>				3.20	2.69			1.50	ES	PID 2.40m, 213.0ppm
								2.00	ES	
								2.40	B	
								3.00	ES	
EOH at 3.20m - Trial pit terminated at 3.2m bgl.								3.40	B	PID 3.20m, 55.0ppm
Observations / Remarks										
1. Groundwater encountered at 3.00m bgl. 2. Trial pit terminated at 3.2m bgl. 3. Upon completion exploratory hole backfilled with arisings.										
Project Number A095973-2										

	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number		
	Location: Swansea		Easting: 269154.51 Northing: 192906.08 Level: 5.99mAOD Depth: 2.00m Logger: JB Type: TP				DRAFT		TP21		
	Client: Tidal Lagoon Power										
			Groundwater				Scale: 1:25				
Hole Information							Checked By: NB				
Pit Dimensions			Strike (m)				After (mins)				
Orientation: °			Rose To (m)				Remarks				
Shoring: None											
Stability: Poor											
Plant: JCB 3CX											
Pit Dimensions							Approved By: SJ				
0.50m 3.00m							Start Date: 16/11/2016				
							Finish Date: 16/11/2016				
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
								Depth (m)	Ref	Tests / Results	
MADE GROUND: Brown to dark brown silty slightly gravelly fine to coarse SAND. Gravel is angular to sub-rounded fine to coarse sandstone and iron slag.				0.30	5.69			0.20	ES	PID 0.30m, 0.3ppm	
								0.30 - 1.00	B		
								0.50	ES		
								1.00 1.00 - 2.00	ES B		
MADE GROUND: Grey black silty fine to coarse SAND.strong hydrocarbon odours from 0.30m bgl				2.00	3.99			1.80	ES	PID 0.80m, 332.0ppm	
EOH at 2.00m - Trial pit terminated at 2.00m bgl.				2.00	3.99					PID 2.00m, 281.0ppm	
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											
											

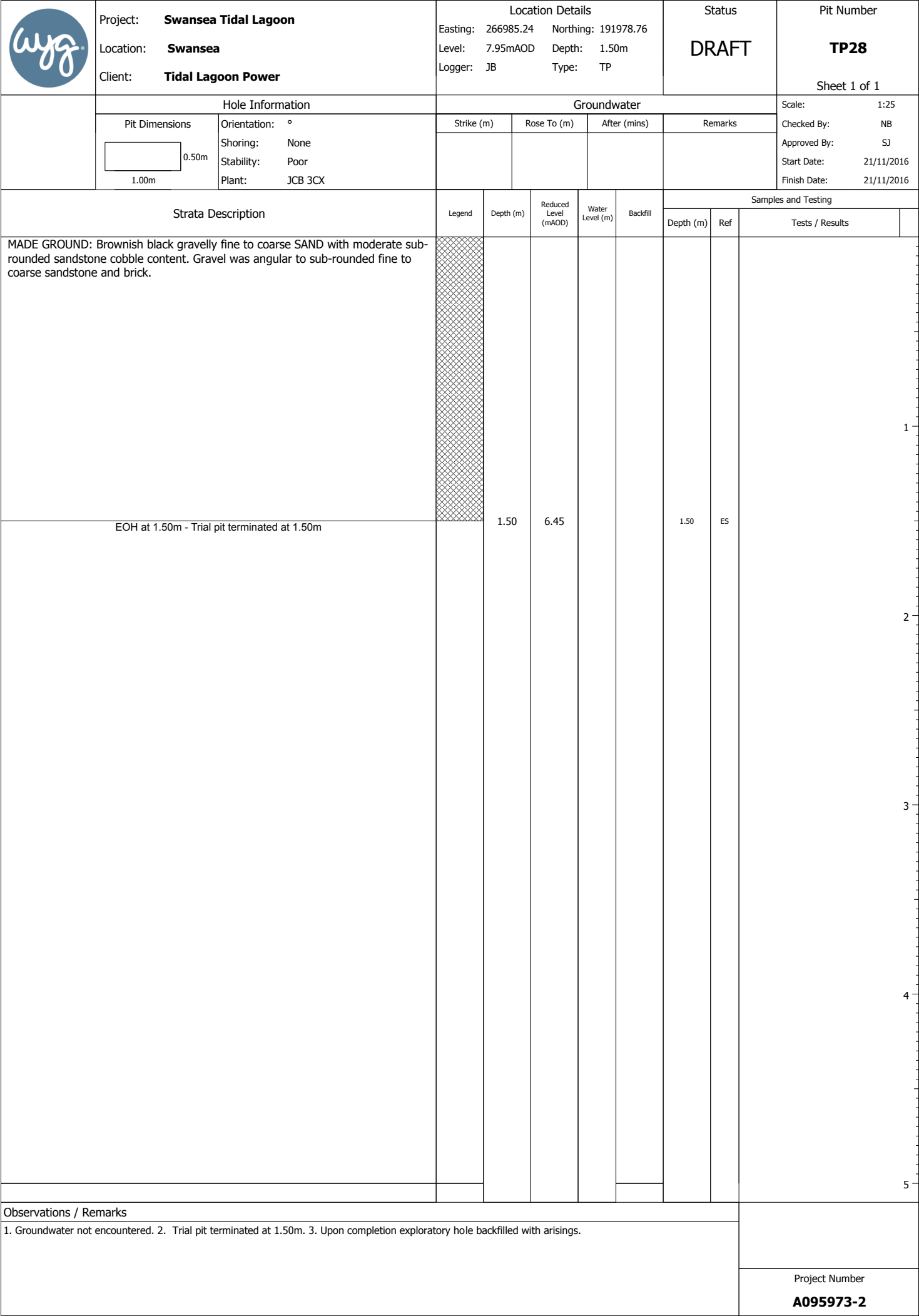
	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number		
	Location: Swansea		Easting: 269207.00 Northing: 192901.79 Level: 5.99mAOD Depth: 2.30m Logger: JB Type: TP				DRAFT		TP22		
Client: Tidal Lagoon Power										Sheet 1 of 1	
	Hole Information		Groundwater						Scale: 1:25		
	Pit Dimensions	Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks	Checked By: NB				
		Shoring: None					Approved By: SJ				
		Stability: Poor					Start Date: 16/11/2016				
Plant: JCB 3CX							Finish Date: 16/11/2016				
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
MADE GROUND: Grass over brown silty slightly gravelly fine to coarse SAND. Gravel is angular to sub-rounded fine to coarse sandstone and iron slag.				0.20	5.79			0.10	ES	PID 0.20m, 1.2ppm	
MADE GROUND: Light brown coarse SANDorange sand lens from 0.20 to 0.25m bgl								0.20 - 1.20	B		
								0.30 - 0.80	B		
								0.50	ES		
								0.80 - 1.40	B		
MADE GROUND: Grey silty fine to coarse SAND.hydrocarbon odour			2.00	3.99			1.00	ES	PID 1.00m, 1.6ppm		
EOH at 2.30m - Trial pit terminated at 3.2m bgl.							1.40 - 2.40	B			
			2.10	ES	PID 2.00m, 8.7ppm						
			2.30	3.69		2.40 - 3.20	B				
Observations / Remarks											
1. Groundwater encountered at 3.00m bgl. 2. Trial pit terminated at 3.2m bgl. 3. Upon completion exploratory hole backfilled with arisings.											
										Project Number A095973-2	

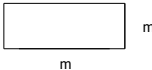
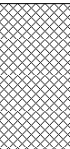
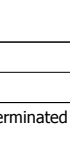
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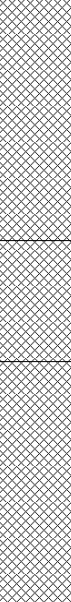
	Project: Swansea Tidal Lagoon		Location Details Easting: 269177.90 Northing: 192805.84 Level: 6.41mAOD Depth: 3.20m Logger: JB Type: TP				Status DRAFT		Pit Number TP24		
	Location: Swansea									Sheet 1 of 1	
	Client: Tidal Lagoon Power										
	Hole Information		Groundwater					Scale: 1:25			
	Orientation: °		Strike (m)	Rose To (m)	After (mins)	Remarks	Checked By: NB				
	Shoring: None Stability: Poor Plant: JCB 3CX						Approved By: SJ Start Date: 17/11/2016 Finish Date: 17/11/2016				
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
MADE GROUND: Light brown gravelly SAND. Gravel of angular to sub-angular fine to coarse brick, iron slag, concrete and sandstone with frequent brick and iron slag cobbles. <i>....grey sand lens from 1.00 to 1.45m bgl</i>				1.20	5.21			Depth (m)	Ref	Tests / Results	
								0.30	ES	PID 0.10m, 0.2ppm	
								0.50	ES		
MADE GROUND: Orangish brown to grey cobbly fine to coarse SAND. Cobbles are sub-rounded sandstone. <i>....hydrocarbon odour at 1.50m bgl</i>				1.20	5.21			1.40	ES	PID 1.20m, 32.1ppm	
								2.50	ES		
								MADE GROUND: Bluish grey fine SAND. <i>....strong hydrocarbon odour</i> EOH at 3.20m - Trial pit terminated at 3.2m			
		PID 3.40m, 464.0ppm									
Observations / Remarks			1. Groundwater encountered at 3.20m bgl. 2. Trial pit terminated at 3.2m. 3. Upon completion exploratory hole backfilled with arisings. 4. Due to large amounts of contamination throughout no geotechnical samples could be taken								
			Project Number A095973-2								

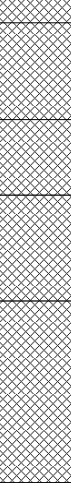


	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number		
	Location: Swansea		Easting: 267035.76 Northing: 191942.41 Level: 7.13mAOD Depth: 1.00m Logger: JB Type: TP				DRAFT		TP27		
Client: Tidal Lagoon Power										Sheet 1 of 1	
	Hole Information			Groundwater				Scale: 1:25			
	Pit Dimensions 0.50m 1.00m	Orientation: ° Shoring: None Stability: Poor Plant: JCB 3CX	Strike (m)		Rose To (m)	After (mins)	Remarks		Checked By: NB		
										Approved By: SJ	
									Start Date: 21/11/2016		
									Finish Date: 21/11/2016		
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
								Depth (m)	Ref	Tests / Results	
MADE GROUND: Brownish black gravelly fine to coarse SAND with moderate sub-rounded sandstone cobble content. Gravel was angular to sub-rounded fine to coarse sandstone and brick.											
EOH at 1.00m - Trial pit terminated at 1.00m				1.00	6.13			1.00	ES		
								</			



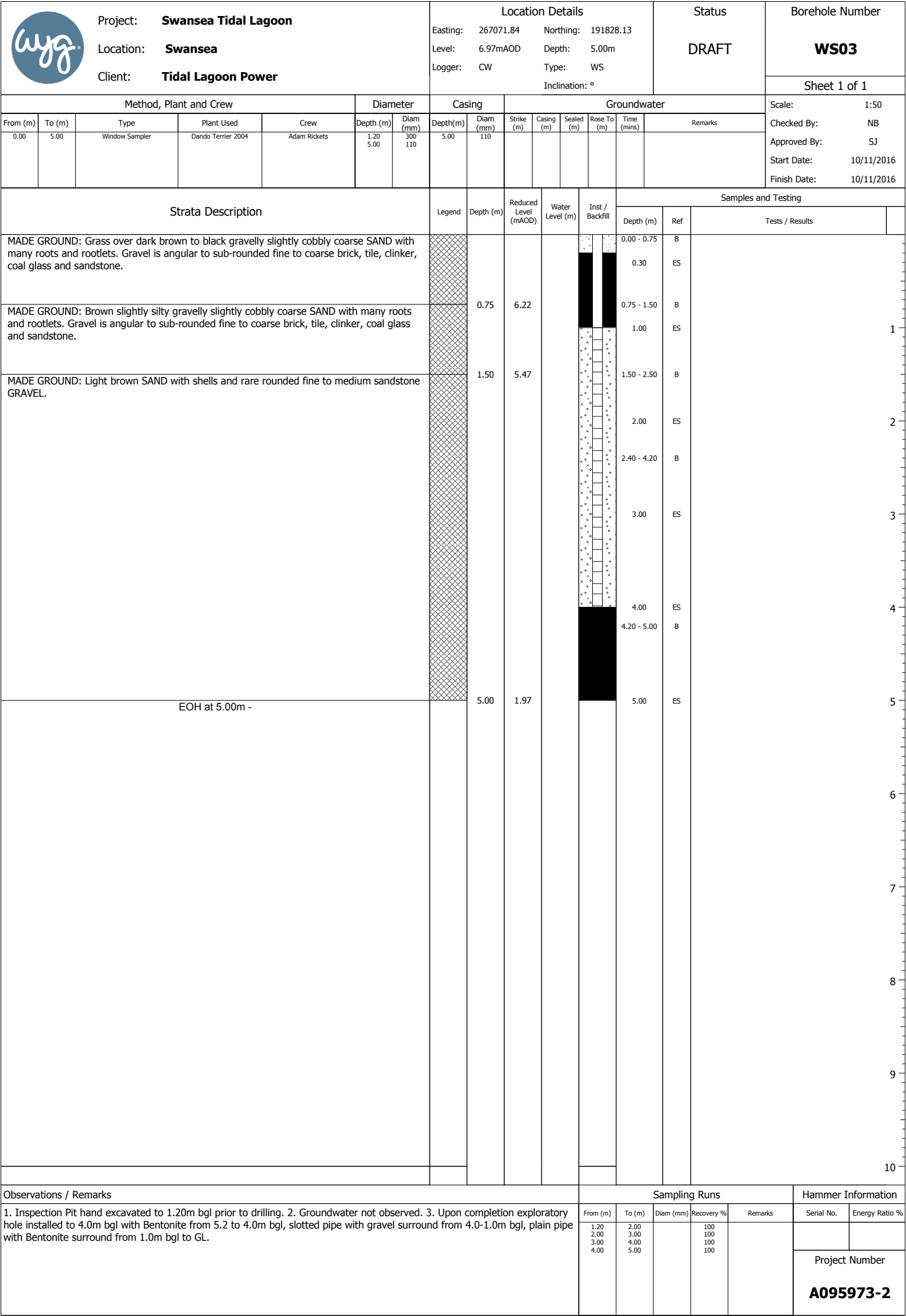
	Project: Swansea Tidal Lagoon		Location Details Easting: 267004.77 Northing: 192013.14 Level: 5.99mAOD Depth: 2.60m Logger: Type: TP				Status DRAFT		Pit Number TP29	
	Location: Swansea								Sheet 1 of 1	
	Hole Information		Groundwater						Scale: 1:25	
	Pit Dimensions	Orientation: °	Strike (m)	Rose To (m)	After (mins)	Remarks		Checked By: NB		
		Shoring:						Approved By: SJ		
		Stability:					Start Date: 21/11/2016			
		Plant:					Finish Date: 01/11/2016			
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing		
MADE GROUND: Grass over reddish brown silty very sandy GRAVEL with cobbles. Gravel is sub-angular to angular fine to coarse of iron slag. Cobbles are angular iron slag. <i>.....strong ammonia smell at 0.30m bgl</i>				0.50	5.49			0.00 - 0.50	B1	
								0.30	ES1	
MADE GROUND: Black silty very gravelly SAND with cobbles. Gravel is fine to coarse sub-angular to angular of iron slag. Cobbles are angular iron slag.				0.80	5.19			0.50 - 0.80	B2	
								0.60	ES2	
MADE GROUND: Dark brown silty very gravelly SAND. Gravel is fine to coarse sub-angular to sub-rounded brick, sandstone tile and iron slag.								0.80 - 2.00	B3	
								1.00	ES3	
EOH at 2.60m -				2.60	3.39			2.00	ES4	
								2.00 - 2.60	B4	
										
										
										
										
										
										
										
										
Observations / Remarks										
1. Slight groundwater seepage from 0.50m - slightly oily sheen on waters surface. 2. Trial pit terminated at 2.60m. 3. Upon completion exploratory hole backfilled with arisings.										
										Project Number A095973-2

	Project: Swansea Tidal Lagoon		Location Details					Status		Pit Number		
	Location: Swansea		Easting: 267043.12 Northing: 191973.37 Level: 7.00mAOD Depth: 2.00m Logger: Type: TP					DRAFT		TP30		
	Client: Tidal Lagoon Power											
			Groundwater					Scale: 1:25				
Hole Information			Strike (m)		Rose To (m)		After (mins)		Remarks		Checked By: NB	
Pit Dimensions m m			Orientation: °								Approved By: SJ	
			Shoring:								Start Date: 21/11/2016	
			Stability:								Finish Date: 21/11/2016	
			Plant:									
Strata Description			Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing				
								Depth (m)	Ref	Tests / Results		
MADE GROUND: Boggy grass cover over grey brown silty very sandy sub-angular to sub-rounded fine to coarse iron slag GRAVEL with frequent sub-angular iron slag cobbles.very hard material to excavate between ground level and 0.80m bglstrong smell of ammonia from 0.30 to 2.00m bgl				0.80	6.20							1
MADE GROUND: Black silty very gravelly SAND. Gravel is sub-angular to sub-rounded fine to coarse iron slag with frequent sub-angular iron slag cobbles.				1.20	5.80							
MADE GROUND: Yellow gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse iron slag.				2.00	5.00							
EOH at 2.00m -												2
												3
												4
												5
Observations / Remarks											Project Number A095973-2	
1. Groundwater not encountered. 2. Trial pit terminated at 2.0m. 3. Upon completion exploratory hole backfilled with arisings.												

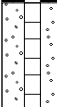
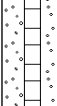
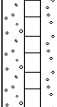
	Project: Swansea Tidal Lagoon		Location Details				Status		Pit Number	
	Location: Swansea		Easting: 267050.30 Northing: 192009.95 Level: 7.10mAOD Depth: 1.60m Logger: Type: TP				DRAFT		TP31	
Client: Tidal Lagoon Power								Sheet 1 of 1		
Pit Dimensions m m	Hole Information		Groundwater				Scale: 1:25			
	Orientation: °		Strike (m)	Rose To (m)	After (mins)	Remarks	Checked By: NB			
	Shoring:						Approved By: SJ			
Stability:						Start Date: 21/11/2016				
Plant:						Finish Date: 21/11/2016				
Strata Description		Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Backfill	Samples and Testing			
MADE GROUND: Boggy grass over grey sandy GRAVEL. Gravel is sub-angular medium to coarse sandstone, iron slag and brick.			0.08	7.02			Depth (m)	Ref	Tests / Results	
MADE GROUND: Dark brown silty very gravelly SAND. Gravel is sub-angular to sub-rounded fine to coarse brick, sandstone tile and iron slag.			0.40	6.70						
MADE GROUND: Black silty very gravelly SAND with cobbles. Gravel is sub-angular to angular fine to coarse of iron slag. Cobbles are angular iron slag.			0.65	6.45						
MADE GROUND: Light reddish grey very sandy GRAVEL. Gravel is fine to coarse sub-angular brick and sandstone.			1.00	6.10						
MADE GROUND: Black very sandy GRAVEL. Gravel is sub-angular fine to coarse brick and sandstone. <i>.....frequent pockets of yellow fine gravel that crumbles in hand (sulphur smell - ES4 is representative).</i>			1.60	5.50						
EOH at 1.60m -										
Observations / Remarks										
1. Slight groundwater seepage from 0.20m - slight oily sheen upon water surface. 2. Trial pit terminated at 1.60m. 3. Upon completion exploratory hole backfilled with arisings.										
		Project Number A095973-2								

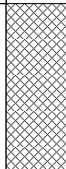
Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details						Status		Borehole Number				
						Easting: 267041.64 Northing: 191913.24 Level: 6.46mAOD Depth: 5.00m Logger: CW Type: WS Inclination: °						DRAFT		WS01				
																Sheet 1 of 1		
Method, Plant and Crew					Diameter		Casing		Groundwater						Scale: 1:50			
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks	Checked By: NB	Approved By: SJ	Start Date: 10/11/2016	Finish Date: 10/11/2016
0.00	5.00	Window Sampler	Dando Terrier 2002	Adam Rickets	1.20 5.00	300 110	4.00	110										
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing						
												Depth (m)	Ref	Tests / Results				
MADE GROUND: Grass over dark brown to black gravelly slightly cobbly coarse SAND with many roots and rootlets. Gravel is angular to sub-rounded fine to coarse brick, tile, iron slag, coal glass and sandstone.								0.50	5.96			0.00 - 0.50	B					
MADE GROUND: Light brown slightly gravelly coarse SAND with many roots and rootlets. Gravel is very rare angular to sub-angular fine to coarse iron slag and brick.												0.30	ES					
												0.60 - 1.20	B					
												1.00	ES					
												1.20 - 2.00	B					
												2.00	ES					
												2.20 - 3.00	B					
												3.00	ES					
												3.20 - 3.70	B					
MADE GROUND: Soft bluish grey slightly silty slightly sandy CLAY.												3.70	2.76					
.....rounded sandstone cobble at 4.20m bgl																		
.....becoming gravelly from 4.75 to 5.00m bgl							5.00	1.46			5.00	ES						
EOH at 5.00m -																		
Observations / Remarks												Sampling Runs			Hammer Information			
1. Inspection Pit hand excavated to 1.20m bgl prior to drilling. 2. Groundwater not observed. 3. Upon completion exploratory hole installed to 4.0m bgl with Bentonite from 5.2 to 4.0m bgl, slotted pipe with gravel surround from 4.0-1.0m bgl, plain pipe with Bentonite surround from 1.0m bgl to GL.												From (m)	To (m)	Diam (mm)	Recovery %	Remarks	Serial No.	Energy Ratio %
												1.20	2.00		100			
												2.00	3.00		100			
												3.00	4.00		90			
												4.00	5.00		20			
												Project Number						
												A095973-2						

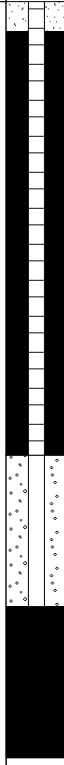
Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details						Status DRAFT		Borehole Number		
						Easting: 267010.72 Northing: 191863.05 Level: 6.91mAOD Depth: 5.00m Logger: CW Type: WS Inclination: °								WS02		
														Sheet 1 of 1		
Method, Plant and Crew					Diameter		Casing		Groundwater						Scale: 1:50	
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks	Checked By: NB	
0.00	5.00	Window Sampler	Dando Terrier 2003	Adam Rickets	1.20 5.00	300 110	4.00	110	3.00	-	3	2.40	20		Approved By: SJ	
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing				
												Depth (m)	Ref	Tests / Results		
MADE GROUND: Concrete								0.30	6.61				0.60 - 1.00 0.70	B ES		
MADE GROUND: Brown slightly silty gravelly SAND with rare cobbles of iron slag. Gravel is angular to sub-angular fine to coarse, iron slag, brick and shell.																
MADE GROUND: Brown slightly silty sandy GRAVEL. Gravel is rounded to angular fine to coarse of brick, tile, iron slag and metal bar. ...becoming clayey between 1.30-1.65 ...becoming slightly clayey 1.65-4.05																
MADE GROUND: Light brown coarse SAND with shells and rare iron slag fragments.								4.05	2.86			4.05 - 5.00 4.50	B ES			
EOH at 5.00m -								5.00	1.91							



[illegible]

 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details Easting: 267701.46 Northing: 191999.21 Level: 6.60mAOD Depth: 5.00m Logger: CW Type: WS Inclination: °						Status DRAFT		Borehole Number WS05			
								Sheet 1 of 1									
Method, Plant and Crew					Diameter		Casing		Groundwater						Scale: 1:50		
From (m) 0.00	To (m) 5.00	Type Window Sampler	Plant Used Dando Terrier 2006	Crew Adam Rickets	Depth (m) 1.20 5.00	Diam (mm) 300 110	Depth(m) 4.00	Diam (mm) 110	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks	Checked By: NB	Approved By: SJ	
															Start Date: 15/11/2016	Finish Date: 15/11/2016	
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing					
												Depth (m)	Ref	Tests / Results			
MADE GROUND: Brown to black gravelly SAND. Gravel is angular to sub-angular fine to coarse glass brick, tile and iron slag with roots and rootlets.								0.55	6.05				0.00 - 0.50	B			
MADE GROUND: Brown to black gravelly SAND with COBBLES. Gravel is angular to sub-angular fine to coarse glass brick, tile and iron slag.													0.30	ES			
													0.50 - 1.20	B			
MADE GROUND: Light brown coarse SAND with rare shell and iron slag fragments.								1.20	5.40				1.00	ES	1		
													1.20 - 2.00	B			
													2.00	ES			
													2.00 - 3.00	B			
													3.00	ES	2		
													3.00 - 3.40	B			
....from 3.60m to 5.00m bgl strong hydrocarbon odour - black then becoming grey in colour.													4.00	ES	3		
													4.00 - 5.00	B			
EOH at 5.00m -							5.00	1.60						5.00	ES	4	
																	5
																	6
																	7
																	8
																	9
																	10
Observations / Remarks 1. Inspection Pit to 1.20m bgl. 2. Groundwater not observed. 3. Upon completion exploratory hole will installed 5.0 - 4.0m bgl bentonite, 4.0 to 1.0m bgl slotted pipe with gravel surround, 1.0m bgl to GL plain pipe with bentonite surround with concrete and flush cover.												Sampling Runs				Hammer Information	
From (m) 1.20 2.00 3.00 4.00	To (m) 2.00 3.00 4.00 5.00	Diam (mm)	Recovery % 125 100 100 100	Remarks	Serial No.	Energy Ratio %											
					Project Number A095973-2												

 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details						Status DRAFT		Borehole Number WS06																																																																																																																																																																																																																																																																																																																																																																																																																												
						Easting: 268167.90 Northing: 192163.05 Level: 6.43mAOD Depth: 5.00m Logger: CW Type: WS Inclination: °								Sheet 1 of 1																																																																																																																																																																																																																																																																																																																																																																																																																												
						Method, Plant and Crew					Diameter		Casing		Groundwater					Scale: 1:50																																																																																																																																																																																																																																																																																																																																																																																																																						
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks		Checked By: NB																																																																																																																																																																																																																																																																																																																																																																																																																										
0.00	5.00	Window Sampler	Dando Terrier 2007	Adam Rickets	1.20 5.00	300 110	4.00	110	3.00	-	3	2.90	20			Approved By: SJ																																																																																																																																																																																																																																																																																																																																																																																																																										
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing																																																																																																																																																																																																																																																																																																																																																																																																																														
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MADE GROUND: Brown to black sandy GRAVEL & COBBLES. Gravel is angular to sub-angular fine to coarse glass brick, tile and iron slag with roots and rootlets.								1.10	5.33			0.00 - 1.00	B			1																																																																																																																																																																																																																																																																																																																																																																																																																										
MADE GROUND: Light brown coarse SAND with rare shell and iron slag fragments.												0.30	ES																																																																																																																																																																																																																																																																																																																																																																																																																													
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EOH at 5.00m -							5.00	1.43							5																																																																																																																																																																																																																																																																																																																																																																																																																											
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 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details Easting: 268535.30 Northing: 192412.09 Level: 6.69mAOD Depth: 5.00m Logger: CW Type: WS Inclination: °						Status DRAFT		Borehole Number WS07			
								Sheet 1 of 1									
Method, Plant and Crew					Diameter		Casing		Groundwater						Scale: 1:50		
From (m) 0.00	To (m) 5.00	Type Window Sampler	Plant Used Dando Terrier 2008	Crew Adam Rickets	Depth (m) 1.20 5.00	Diam (mm) 300 110	Depth(m) 4.00	Diam (mm) 110	Strike (m) 3.00	Casing (m) -	Sealed (m) 3	Rose To (m) 2.90	Time (mins) 20	Remarks		Checked By: NB	
															Approved By: SJ	Start Date: 14/11/2016	
																Finish Date: 14/11/2016	
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing					
												Depth (m)	Ref	Tests / Results			
MADE GROUND: Brown to black sandy GRAVEL. Gravel is angular to sub-rounded fine to coarse concrete, brick, sandstone and iron slag with roots and rootlets.								0.60	6.09			0.00 - 0.30	B	PID 0.30m, 0.0ppm			
												0.30 - 0.60	ES B				
MADE GROUND: Light brown coarse SAND with rare shell and iron slag fragments.												0.60 - 1.20	B				PID 0.60m, 0.3ppm
.....slight hydrocarbon odour from 1.20 to 2.00m bgl												1.00	ES				
												1.20 - 2.00	B				PID 1.20m, 0.3ppm
												1.50	ES				
.....hydrocarbon odour from 2.00 to 3.00m bgl												2.00 - 3.00	B				PID 2.00m, 3.0ppm
												2.50	ES				
.....from 3.40m to 5.00m bgl strong hydrocarbon odour sand becoming black in colour.												3.00 - 5.00	B				PID 3.00m, 27.0ppm
												3.50	ES				
							4.50	ES	PID 5.00m, 141.0ppm								
EOH at 5.00m -							5.00	1.69									
Observations / Remarks 1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 3.00m bgl rising to 2.90m after 20 minutes. 3. Upon completion exploratory hole installed 5m to 4m bgl Bentonite, 4m to 3.00m bgl slotted with gravel surround, 3.00m to GL plain with Bentonite surround includes flush cover and concrete.												Sampling Runs				Hammer Information	
From (m) 1.20 2.00 3.00 4.00	To (m) 2.00 3.00 4.00 5.00	Diam (mm)	Recovery % 125 100 80 25	Remarks	Serial No.	Energy Ratio %											
					Project Number A095973-2												

Project: **Swansea Tidal Lagoon**

Location: **Swansea**

Client: **Tidal Lagoon Power**

Location Details

Easting:	268237.09	Northing:	193000.62
Level:	9.03mAOD	Depth:	5.00m
Logger:	CW	Type:	WS
		Inclination:	°

Status

DRAFT

Borehole Number

WS08

Sheet 1 of 1

Method, Plant and Crew

From (m)	To (m)	Type	Plant Used	Crew
0.00	5.00	Window Sampler	Dando Terrier 2009	Adam Rickets

Diameter

From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)
0.00	5.00	Window Sampler	Dando Terrier 2009	Adam Rickets	1.20 5.00	300 110

Casing

From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)
0.00	5.00	Window Sampler	Dando Terrier 2009	Adam Rickets	1.20 5.00	300 110	4.00	110

Groundwater

From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks	Checked By:	NB
0.00	5.00	Window Sampler	Dando Terrier 2009	Adam Rickets	1.20 5.00	300 110	4.00	110							Approved By:	SJ
															Start Date:	17/11/2016
															Finish Date:	17/11/2016

Scale:	1:50
Checked By:	NB
Approved By:	SJ
Start Date:	17/11/2016
Finish Date:	17/11/2016

Strata Description

MADE GROUND: Grey slightly sandy angular coarse GRAVEL of granite.
MADE GROUND: Brownish black sandy angular to sub-rounded fine to coarse brick, granite, iron slag, glass and coal GRAVEL with wood fragments.

MADE GROUND: Brownish black sandy angular to sub-rounded fine to coarse brick, granite, iron slag, glass and coal GRAVEL with wood fragments.

MADE GROUND: Brown coarse SAND.

MADE GROUND: Black sandy angular fine to coarse brick and iron slag GRAVEL.

MADE GROUND: Light greyish brown gravelly coarse SAND. Gravel is sub-rounded to rounded sandstone with shells.

EOH at 5.00m -

Samples and Testing

[illegible]

Observations / Remarks

1. Inspection Pit to 1.20m bgl. 2. Groundwater not encountered. 3. Upon completion exploratory hole backfilled with Bentonite from 5.00m to 3.80m bgl, slotted pipe with gravel surround from 3.80m to 1.00m bgl and plain pipe from 1.00m bgl to GL with flush cover and concrete.

Sampling Runs

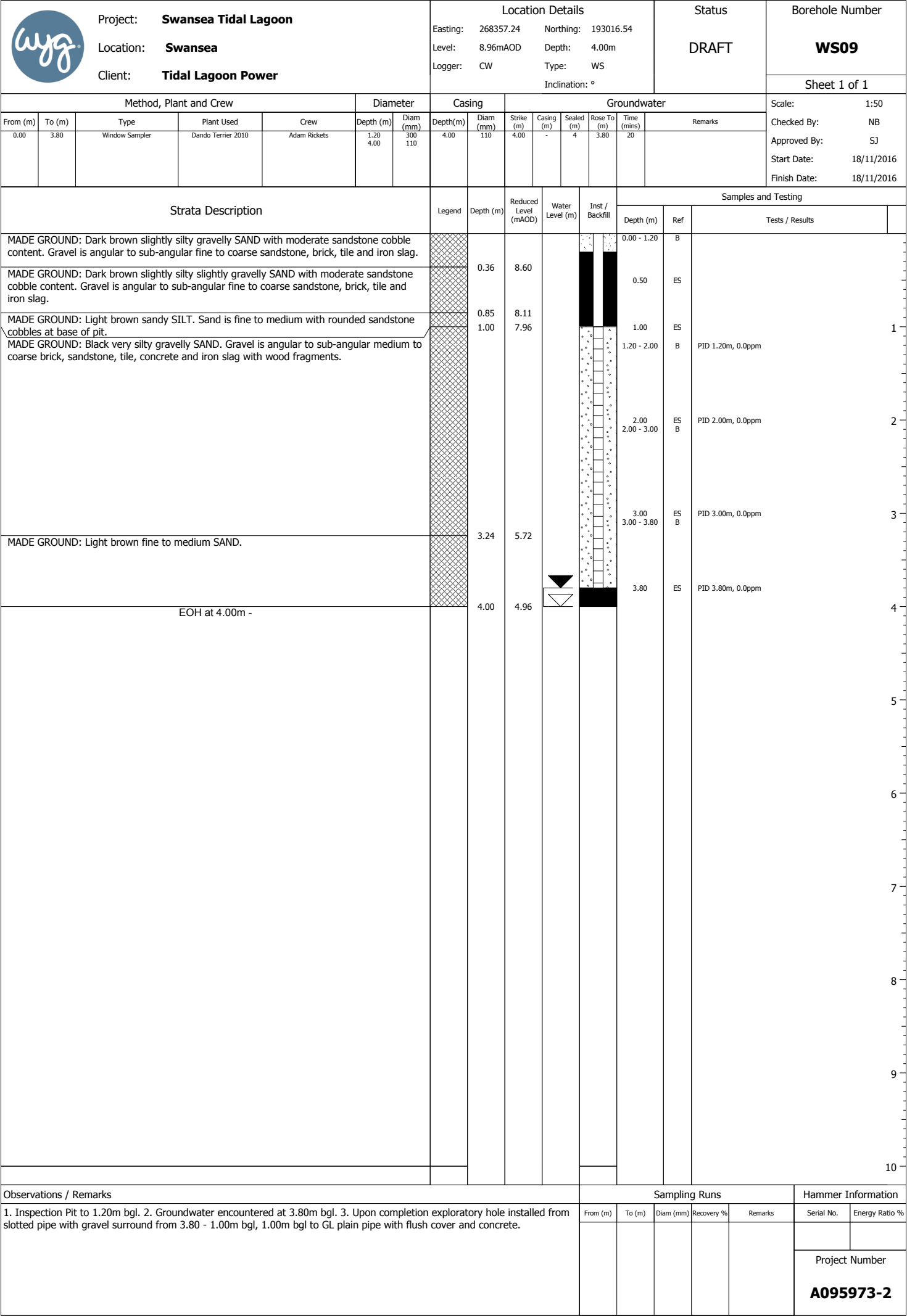
From (m)	To (m)	Diam (mm)	Recovery %	Remarks
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2.00	3.00		100	
3.00	4.00		100	
4.00	5.00		75	

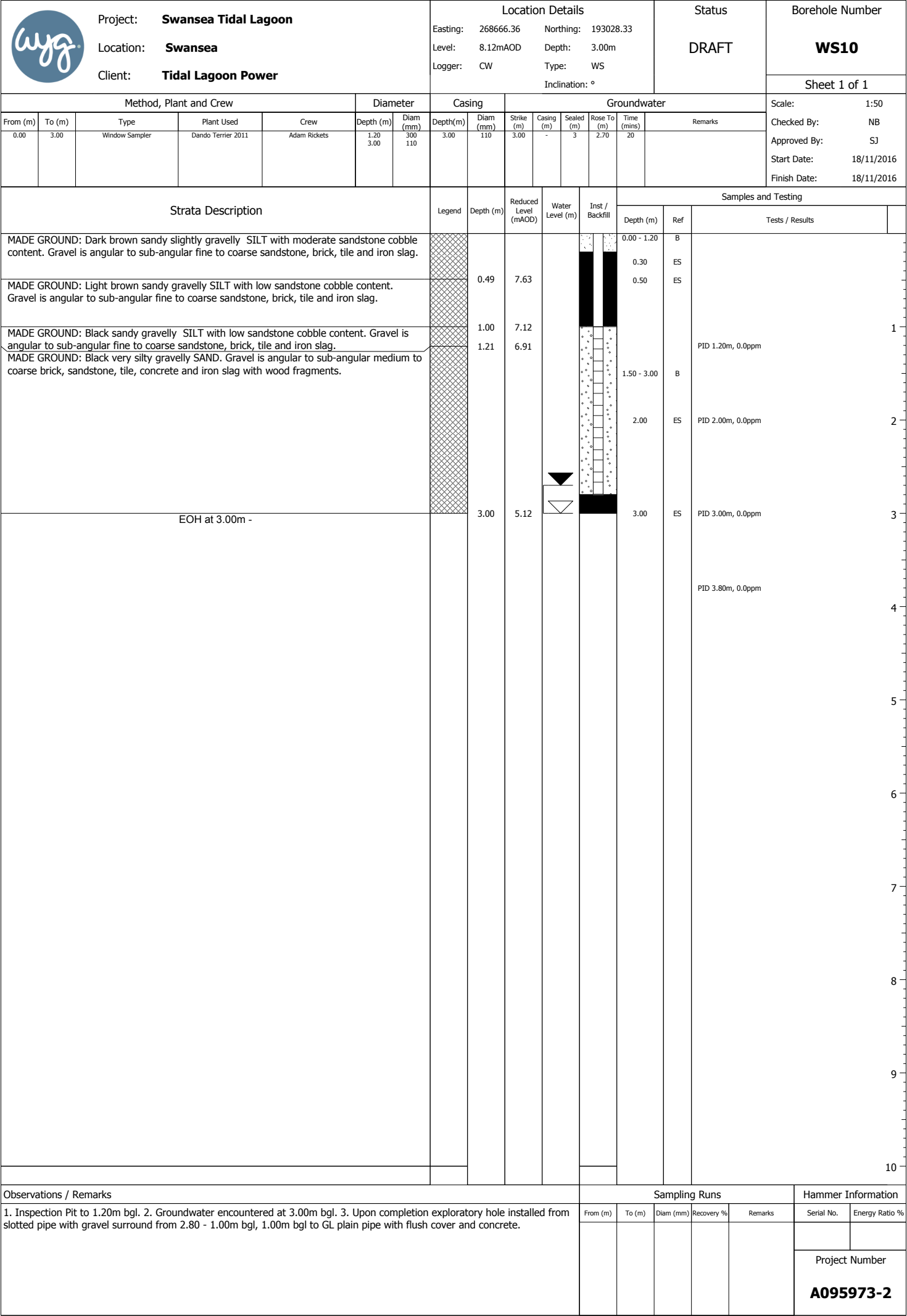
Hammer Information

Serial No.	Energy Ratio %

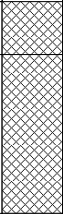
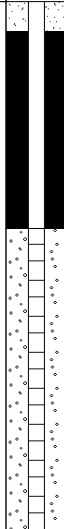
Project Number

A095973-2







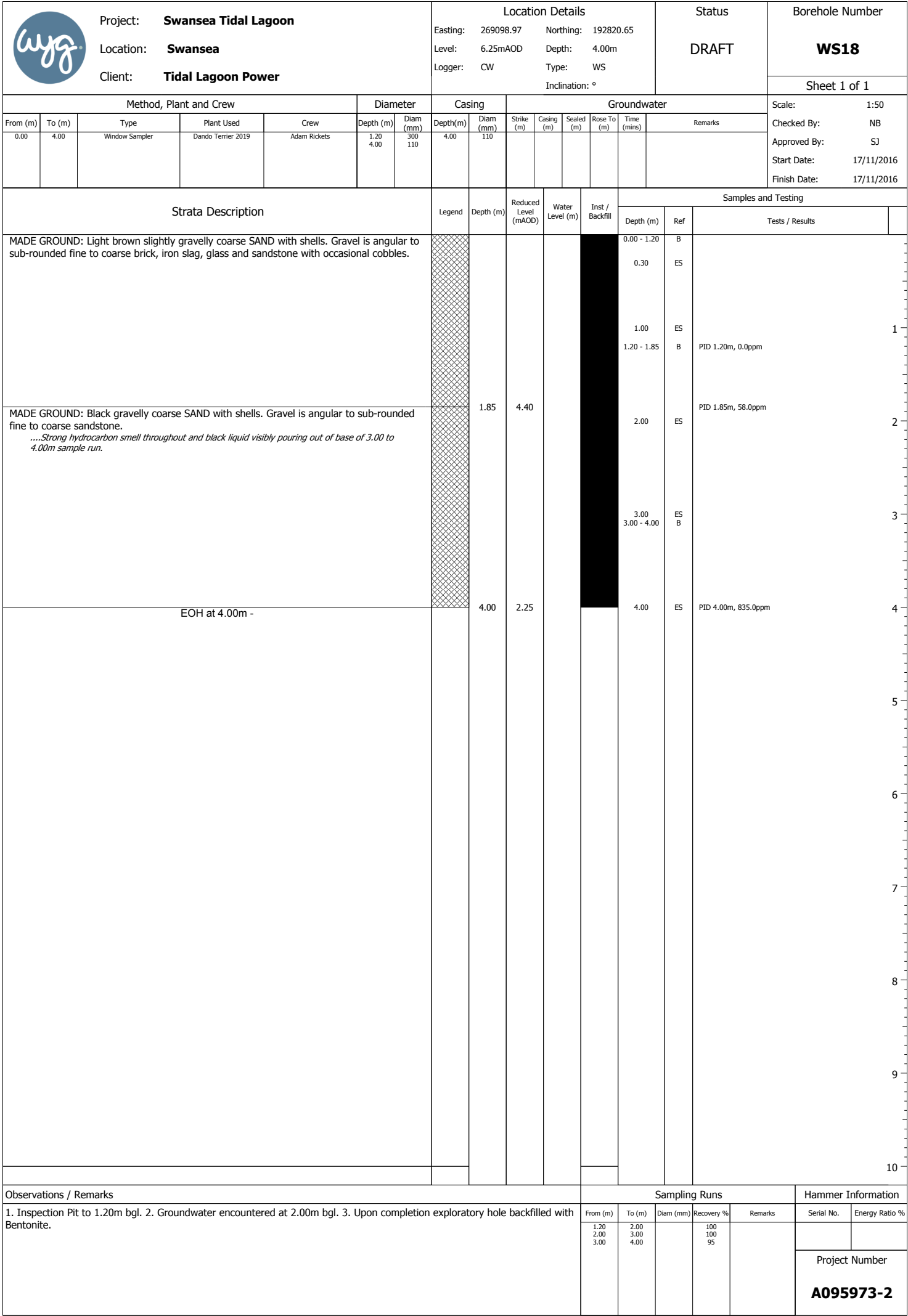
 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details Easting: 268515.59 Northing: 192818.27 Level: 6.22mAOD Depth: 4.00m Logger: CW Type: WS Inclination: °						Status DRAFT		Borehole Number WS12			
								Sheet 1 of 1									
Method, Plant and Crew					Diameter		Casing		Groundwater						Scale: 1:50		
From (m) 0.00	To (m) 4.00	Type Window Sampler	Plant Used Dando Terrier 2013	Crew Adam Rickets	Depth (m) 1.20 4.00	Diam (mm) 300 110	Depth(m) 4.00	Diam (mm) 110	Strike (m) 1.95	Casing (m) -	Sealed (m) 2	Rose To (m) 1.75	Time (mins) 20	Remarks		Checked By: NB	
															Approved By: SJ	Start Date: 15/11/2016	Finish Date: 15/11/2016
Strata Description						Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing						
MADE GROUND: Brown sandy angular to sub-angular fine to coarse with occasional iron slag and brick cobbles. Gravel is fine sub-rounded sandstone, brick, concrete and iron slag.							0.35	5.87			0.00 - 0.30	B	Tests / Results		1		
MADE GROUND: Black to brown gravelly SAND. Gravel is angular fine to coarse brick, tile and vesicular white putty.							0.30	ES			PID 0.30m, 0.0ppm		0.50 - 1.20	B		PID 1.20m, 0.0ppm	
MADE GROUND: Brown sandy slightly silty angular fine to coarse GRAVEL							1.40	4.82			1.00	ES	PID 2.00m, 19.1ppm			1.20 - 2.00	B
EOH at 4.00m -							4.00	2.22			2.00	ES B	PID 4.00m, 8.4ppm		2		
							2.00 - 3.00	ES B			PID 3.00m, 4.3ppm		3.00	ES B	PID 4.00m, 8.4ppm		3
							4.00	ES			PID 4.00m, 8.4ppm		4.00	ES	PID 4.00m, 8.4ppm		4
																5	
																6	
																7	
																8	
																9	
																10	
Observations / Remarks 1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 1.95m bgl. 3. Upon completion exploratory hole installed 3.50m to 1.50m bgl slotted with gravel surround, 1.50m to GL plain with Bentonite surround includes flush cover and concrete.										Sampling Runs				Hammer Information			
From (m) 1.20 2.00 3.00		To (m) 2.00 3.00 4.00		Diam (mm)	Recovery % 100 65 75	Remarks		Serial No.	Energy Ratio %								
								Project Number A095973-2									

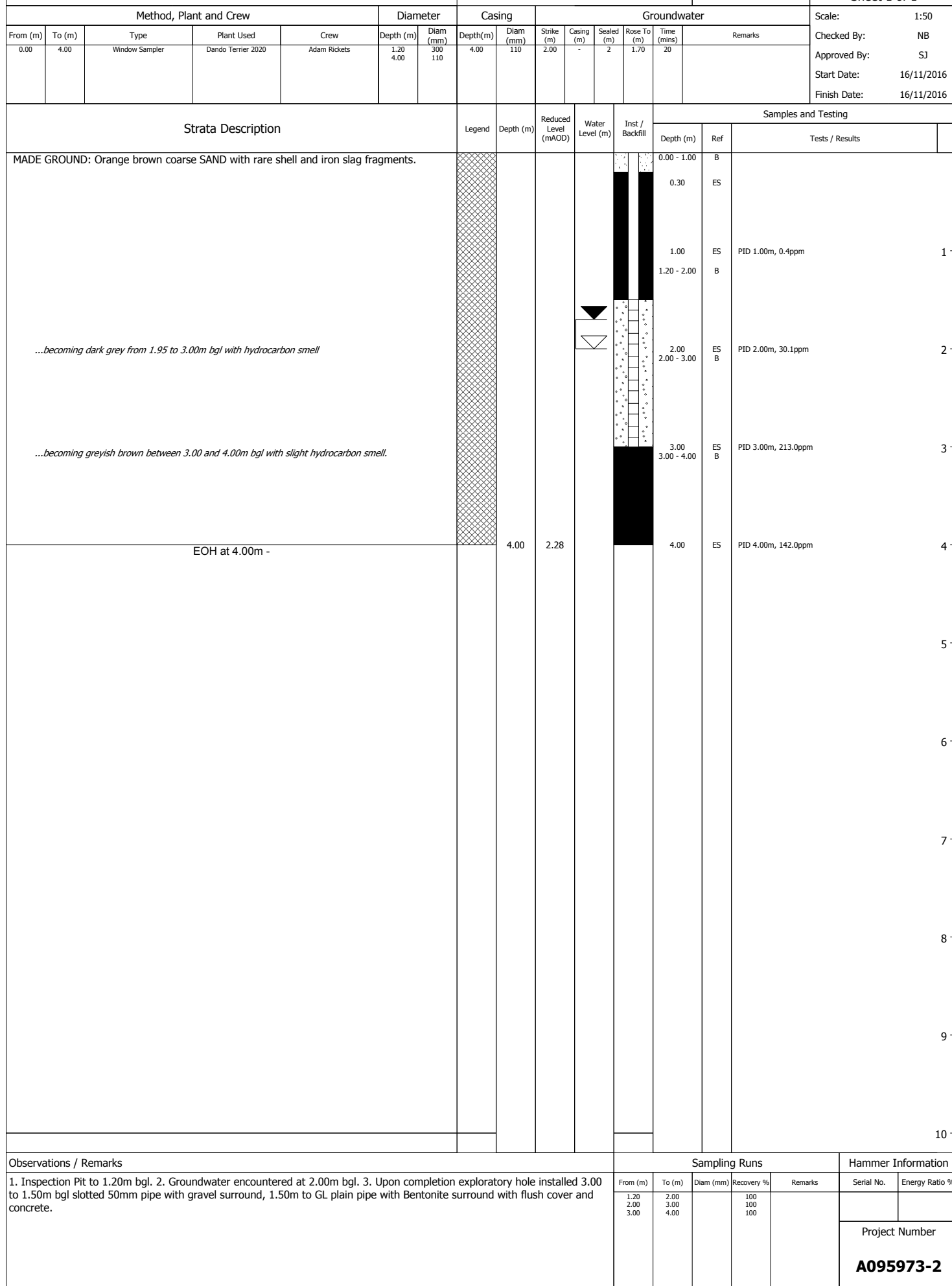
 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details Easting: 268573.87 Northing: 192735.01 Level: 6.68mAOD Depth: 4.00m Logger: CW Type: WS Inclination: °						Status DRAFT		Borehole Number WS14			
								Sheet 1 of 1									
Method, Plant and Crew					Diameter		Casing		Groundwater						Scale: 1:50		
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks	Checked By: NB		
0.00	4.00	Window Sampler	Dando Terrier 2015	Adam Rickets	1.20 4.00	300 110	4.00	110							Approved By: SJ		
															Start Date: 15/11/2016		
															Finish Date: 15/11/2016		
Strata Description						Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing						
MADE GROUND: Brown to black sandy GRAVEL with rare angular to sub-angular fine to coarse iron slag and brick cobbles. Gravel is sub-rounded fine sandstone, brick, concrete, iron slag and a metal bar. ...Strong hydrocarbon smell throughout strata, with free hydrocarbon product visible at base of 2.00 to 3.00m run.							1.50	5.18			Depth (m)	Ref	Tests / Results				
											0.00 - 1.00	B	PID 0.30m, 0.1ppm				
MADE GROUND: Dark grey to black GRAVEL of mudstone with abundant wrotten wood pieces and pockets of clay.							1.50	5.18			0.50	ES					
											1.00	ES			1		
							1.50	5.18			1.80 - 2.00	B					
											2.00	ES	PID 2.00m, 783.0ppm		2		
							1.50	5.18			2.00 - 3.00	B					
											3.00	ES	PID 3.00m, 385.0ppm		3		
							1.50	5.18			3.00 - 4.00	B					
											4.00	ES	PID 4.00m, 61.5ppm		4		
EOH at 4.00m -							4.00	2.68			4.00	ES					
							4.00	2.68									
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							4.00	2.68									

[illegible]

Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details						Status DRAFT		Borehole Number				
						Easting: 268951.74 Northing: 192862.45 Level: 6.55mAOD Depth: 4.00m Logger: CW Type: WS Inclination: °								WS16				
																Sheet 1 of 1		
Method, Plant and Crew					Diameter		Casing		Groundwater					Scale: 1:50				
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks	Checked By: NB			
0.00	4.00	Window Sampler	Dando Terrier 2017	Adam Rickets	1.20 4.00	300 110	4.00	110	3.00	-	3	2.80	20		Approved By: SJ			
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing						
												Depth (m)	Ref	Tests / Results				
MADE GROUND: Grey brown gravelly coarse SAND with occasional iron slag and brick cobbles. Gravel is sub-rounded fine sandstone, brick and iron slag.								0.75	5.80			0.00 - 0.70	B	PID 0.70m, 0.0ppm		1		
MADE GROUND: White grey gravelly putty like material. Gravel is angular fine to coarse iron slag.												0.30	ES					
MADE GROUND: Black gravelly SAND. Gravel is angular fine to coarse iron slag.												1.00	ES					
MADE GROUND: Black gravelly SAND. Gravel is angular fine to coarse iron slag.												1.20 - 1.80	B					
												1.50	ES					
MADE GROUND: Black grey angular fine to coarse iron slag GRAVEL.slight hydrocarbon odour												2.00 - 3.00	B			PID 1.80m, 0.0ppm		2
MADE GROUND: Black grey angular fine to coarse iron slag GRAVEL.slight hydrocarbon odour												2.50	ES					
												MADE GROUND: Brown coarse SAND with shells.						
EOH at 4.00m -																		
																	PID 4.00m, 2.9ppm	
												5						
												6						
												7						
												8						
												9						
												10						
Observations / Remarks												Sampling Runs			Hammer Information			
1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 3.00m bgl rising to 2.40m after 20 minutes including blowing sands. 3. Upon completion exploratory hole installed 4.0m to 2.00m bgl slotted with gravel surround, 2.00m to GL plain with Bentonite surround includes flush cover and concrete.												From (m)	To (m)	Diam (mm)	Recovery %	Remarks	Serial No.	Energy Ratio %
												1.20	2.00		125			
												2.00	3.00		55			
												3.00	4.00		80			
												Project Number						
												A095973-2						

Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details						Status DRAFT		Borehole Number WS17							
						Easting: 269012.78 Northing: 192882.44 Level: 7.09mAOD Depth: 4.00m Logger: CW Type: WS Inclination: °								Sheet 1 of 1							
						Method, Plant and Crew					Diameter		Casing		Groundwater					Scale: 1:50	
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks	Checked By: NB						
0.00	4.00	Window Sampler	Dando Terrier 2018	Adam Rickets	1.20 4.00	300 110	4.00	110	3.00	-	3	2.90	20		Approved By: SJ						
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing			Tests / Results						
												Depth (m)	Ref								
MADE GROUND: Brown slightly gravelly slightly silty SAND with occasional COBBLES of brick and sandstone. Gravel is angular fine to coarse and composed of glass, brick, iron slag and wood pieces.								1.70	5.39				0.10 - 0.80	B	PID 0.80m, 0.2ppm	1					
													0.50	ES							
MADE GROUND: Coarse GRAVEL of concrete.													1.50	ES							
MADE GROUND: Dark brown to grey slightly sandy slightly silty GRAVEL. Gravel is fine to medium, angular to sub-rounded and includes iron slag, sandstone, brick and metal wire.slight hydrocarbon odour													2.00 - 3.00	B							
								1.90	5.19				2.50	ES	PID 3.00m, 17.1ppm	3					
MADE GROUND: Light brown coarse SAND with rare shell and iron slag fragments.hydrocarbon odour													3.00 - 4.00 3.05	B ES							
													4.00	ES							
EOH at 4.00m -								4.00	3.09				4.00	ES	PID 4.00m, 18.9ppm	4					
																					5
																					6
																					7
																					8
																					9
																					10
Observations / Remarks												Sampling Runs			Hammer Information						
1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 3.00m bgl rising to 2.80m after 20 minutes. 3. Upon completion exploratory hole installed 3.80m (blowing sands took hole back to 3.80m) to 1.00m bgl slotted with gravel surround, 1.00m to GL plain with Bentonite surround includes flush cover and concrete.												From (m)	To (m)	Diam (mm)	Recovery %	Remarks	Serial No.	Energy Ratio %			
												1.20 2.00 3.00	2.00 3.00 4.00		88 65 100						
																		Project Number			
						A095973-2															







Easting:	269197.47	Northing:	192802.71
Level:	6.32mAOD	Depth:	4.00m
Logger:	CW	Type:	WS
		Inclination:	°

DRAFT

WS20

Sheet 1 of 1

[illegible]

Observations / Remarks

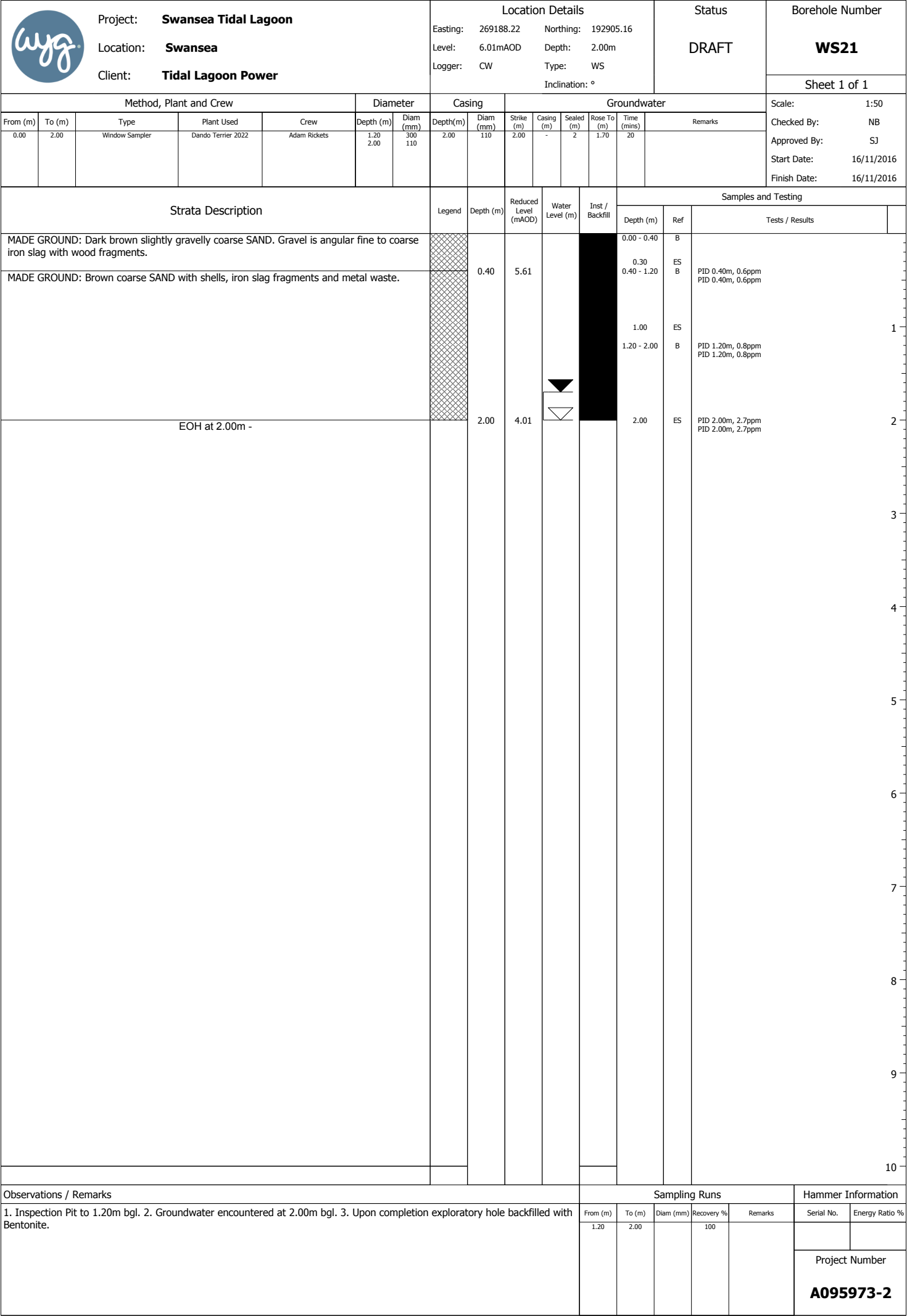
1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 3.00m, back to 2.90m bgl after 20 minutes. 3. Upon completion exploratory hole installed to 3.6m bgl with Bentonite from 4.0 to 3.6m bgl, slotted pipe with gravel surround from 3.6-1.0m bal, plain pipe with Bentonite surround from 1.0m bal to GL.

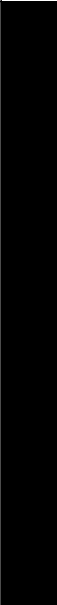
Sampling Runs

From (m)	To (m)	Diam (mm)	Recovery %	Remarks
1.20	2.00		100	
2.00	3.00		50	
3.00	4.00		100	

Hammer Information

Serial No.	Energy Ratio %
Project Number	
A095973-2	



Method, Plant and Crew					Diameter		Casing		Groundwater							Scale:	1:50
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks	Checked By:	NB	
0.00	4.00	Window Sampler	Dando Terrier 2023	Adam Rickets	1.20 4.00	300 110	4.00	110	4.00	-	4	3.60	20		Approved By:	SJ	
															Start Date:	21/11/2016	
															Finish Date:	21/11/2016	
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing					
												Depth (m)	Ref	Tests / Results			
MADE GROUND: Blackish dark brown slightly silty sandy angular to sub-angular fine to coarse iron slag, brick, concrete and sandstone GRAVEL with moderate cobble content.								1.85	4.45			0.30	ES				
												1.00	ES				
MADE GROUND: Light brown coarse SAND with rare shell and iron slag fragments. ...slight hydrocarbon occur from 3.00 to 4.00m bgl								4.00	2.30			2.00	ES				
												2.00 - 3.00	B				
												3.00	ES				
EOH at 4.00m -								4.00	2.30			4.00	ES				



Project: **Swansea Tidal Lagoon**

Location: **Swansea**

Client: **Tidal Lagoon Power**

Location Details

Easting:	268172.12	Northing:	192153.19
Level:	6.41mAOD	Depth:	4.00m
Logger:	CW	Type:	WS
		Inclination:	°

Status

DRAFT

Borehole Number

WS24

Sheet 1 of 1

Method, Plant and Crew

From (m)	To (m)	Type	Plant Used	Crew
0.00	4.00	Window Sampler	Dando Terrier 2025	Adam Ricketts

Diameter

From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)
0.00	4.00	Window Sampler	Dando Terrier 2025	Adam Rickets	1.20 4.00	300 110

Casing

From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)
0.00	4.00	Window Sampler	Dando Terrier 2025	Adam Rickets	1.20 4.00	300 110	4.00	110

Groundwater

From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks
0.00	4.00	Window Sampler	Dando Terrier 2025	Adam Rickets	1.20 4.00	300 110	4.00	110	3.00	-	3	2.70	20	

Scale: 1:50

Checked By:	NB
Approved By:	SJ
Start Date:	21/11/2016
Finish Date:	21/11/2016

Strata Description

MADE GROUND: Blackish dark brown slightly silty sandy angular to sub-angular fine to coarse iron slag, brick, concrete and sandstone GRAVEL with moderate cobble content.

MADE GROUND: Brown coarse SAND with shells and rare iron slag fragments.

...slight hydrocarbon odour from 3.00 to 4.00m bal

EOH at 4.00m -

Lege

MADE GROUND: Blackish dark brown slightly silty sandy angular to sub-angular fine to coarse iron slag, brick, concrete and sandstone GRAVEL with moderate cobble content.	
MADE GROUND: Brown coarse SAND with shells and rare iron slag fragments. ...slight hydrocarbon odour from 3.00 to 4.00m bgl	

Depth (m)

MADE GROUND: Blackish dark brown slightly silty sandy angular to sub-angular fine to coarse iron slag, brick, concrete and sandstone GRAVEL with moderate cobble content.	
MADE GROUND: Brown coarse SAND with shells and rare iron slag fragments. slight hydrocarbon odour from 3.00 to 4.00m bgl	0.85

Reduced
Level

MADE GROUND: Blackish dark brown slightly silty sandy angular to sub-angular fine to coarse iron slag, brick, concrete and sandstone GRAVEL with moderate cobble content.		
MADE GROUND: Brown coarse SAND with shells and rare iron slag fragments. <i>....slight hydrocarbon odour from 3.00 to 4.00m bgl</i>		0.85

Water
Level (m)

MADE GROUND: Blackish dark brown slightly silty sandy angular to sub-angular fine to coarse iron slag, brick, concrete and sandstone GRAVEL with moderate cobble content.	
MADE GROUND: Brown coarse SAND with shells and rare iron slag fragments. slight hydrocarbon odour from 3.00 to 4.00m bgl	0.85

Inst /
Backfill

MADE GROUND: Blackish dark brown slightly silty sandy angular to sub-angular fine to coarse iron slag, brick, concrete and sandstone GRAVEL with moderate cobble content.	
MADE GROUND: Brown coarse SAND with shells and rare iron slag fragments. slight hydrocarbon odour from 3.00 to 4.00m bgl	0.85

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[illegible]

Samples and Testing

MADE GROUND	DEPTH (m)	THICKNESS (m)	TEST RESULTS	SOIL TYPE	SOIL CLASSIFICATION
MADE GROUND: Blackish dark brown slightly silty sandy angular to sub-angular fine to coarse iron slag, brick, concrete and sandstone GRAVEL with moderate cobble content.	0.00 - 0.80			B	
	0.50			ES	
MADE GROUND: Brown coarse SAND with shells and rare iron slag fragments.	1.20 - 2.00			B	
	1.50			ES	
	2.00 - 3.00			B	
...slight hydrocarbon odour from 3.00 to 4.00m bgl					
EOH at 4.00m -	4.00	2.41			

Observations / Remarks

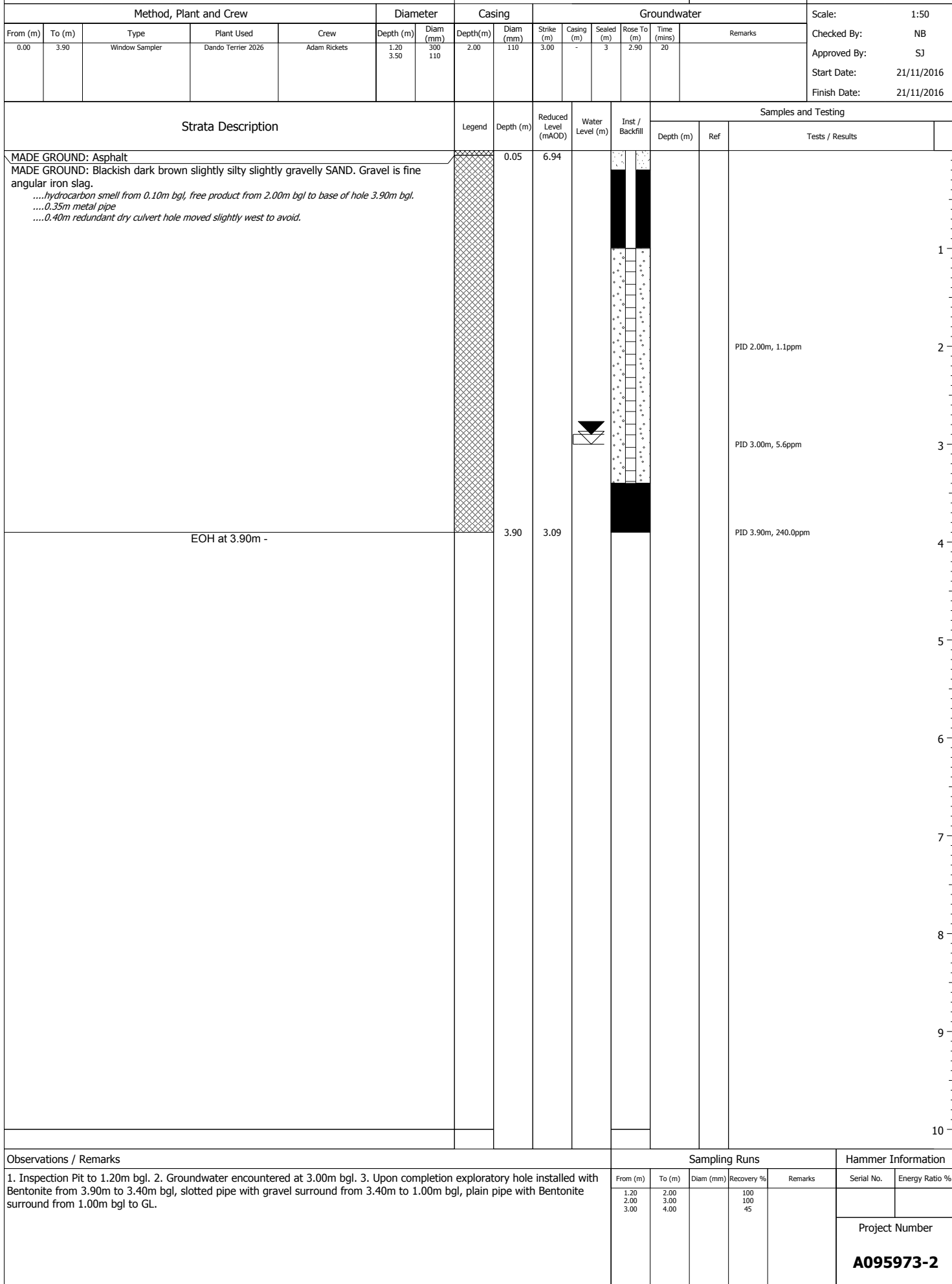
1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 3.00m bgl. 3. Upon completion exploratory hole backfilled with Bentonite.

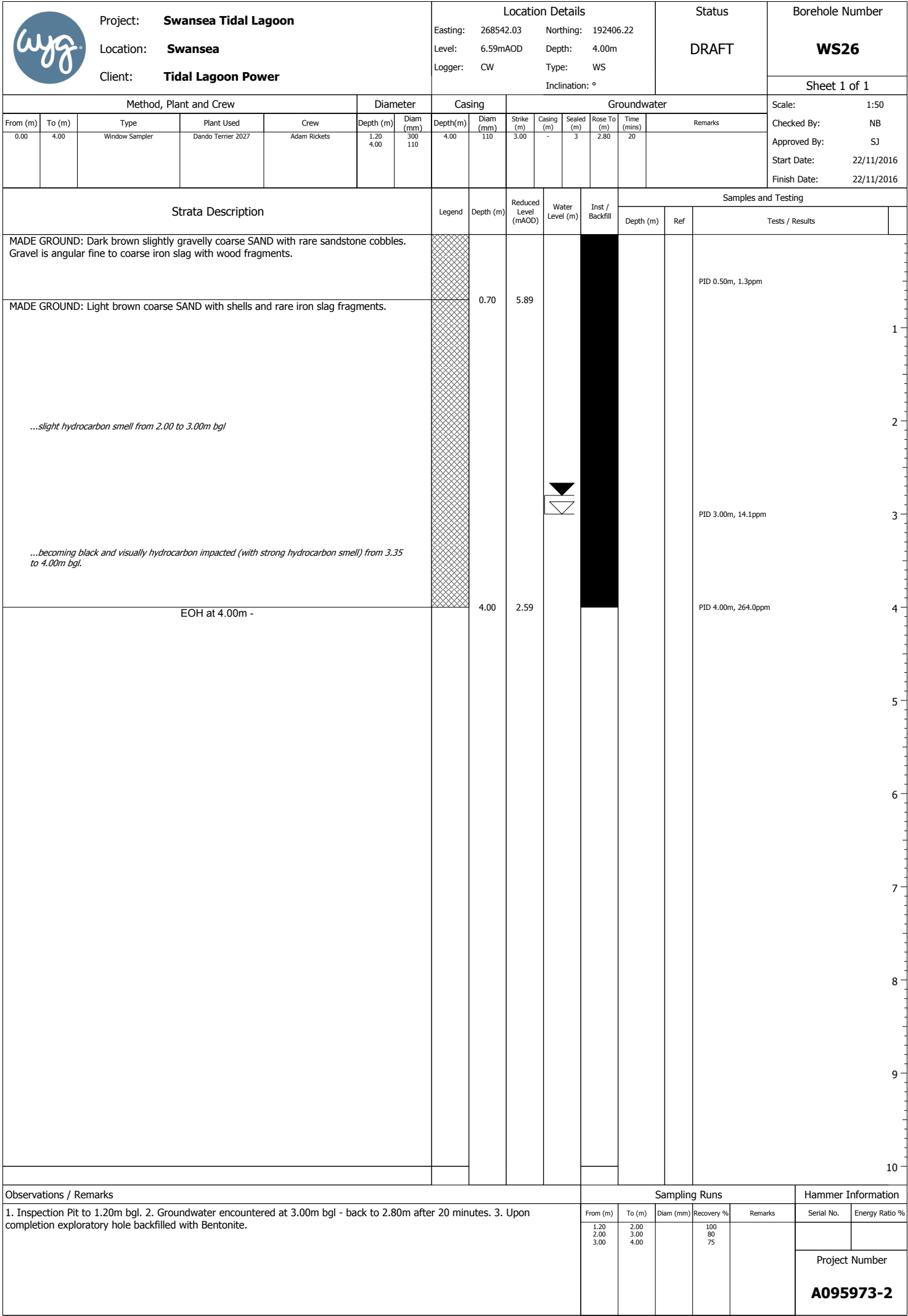
Sampling Runs

1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 3.00m bgl. 3. Upon completion exploratory hole backfilled with Bentonite.	From (m)	To (m)	Diam (mm)	Recovery %	Remarks
	1.20	2.00		100	
	2.00	3.00		80	
	3.00	4.00		10	
	4.00	5.00		80	

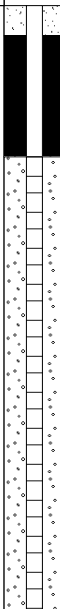
Hammer Information

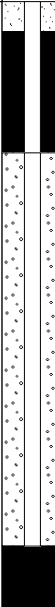
1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 3.00m bgl. 3. Upon completion exploratory hole backfilled with Bentonite.	From (m)	To (m)	Diam (mm)	Recovery %	Remarks	Serial No.	Energy Ratio
	1.20	2.00		100			
	2.00	3.00		80			
	3.00	4.00		10			
	4.00	5.00		80			
						Project Number	
						A095973-2	

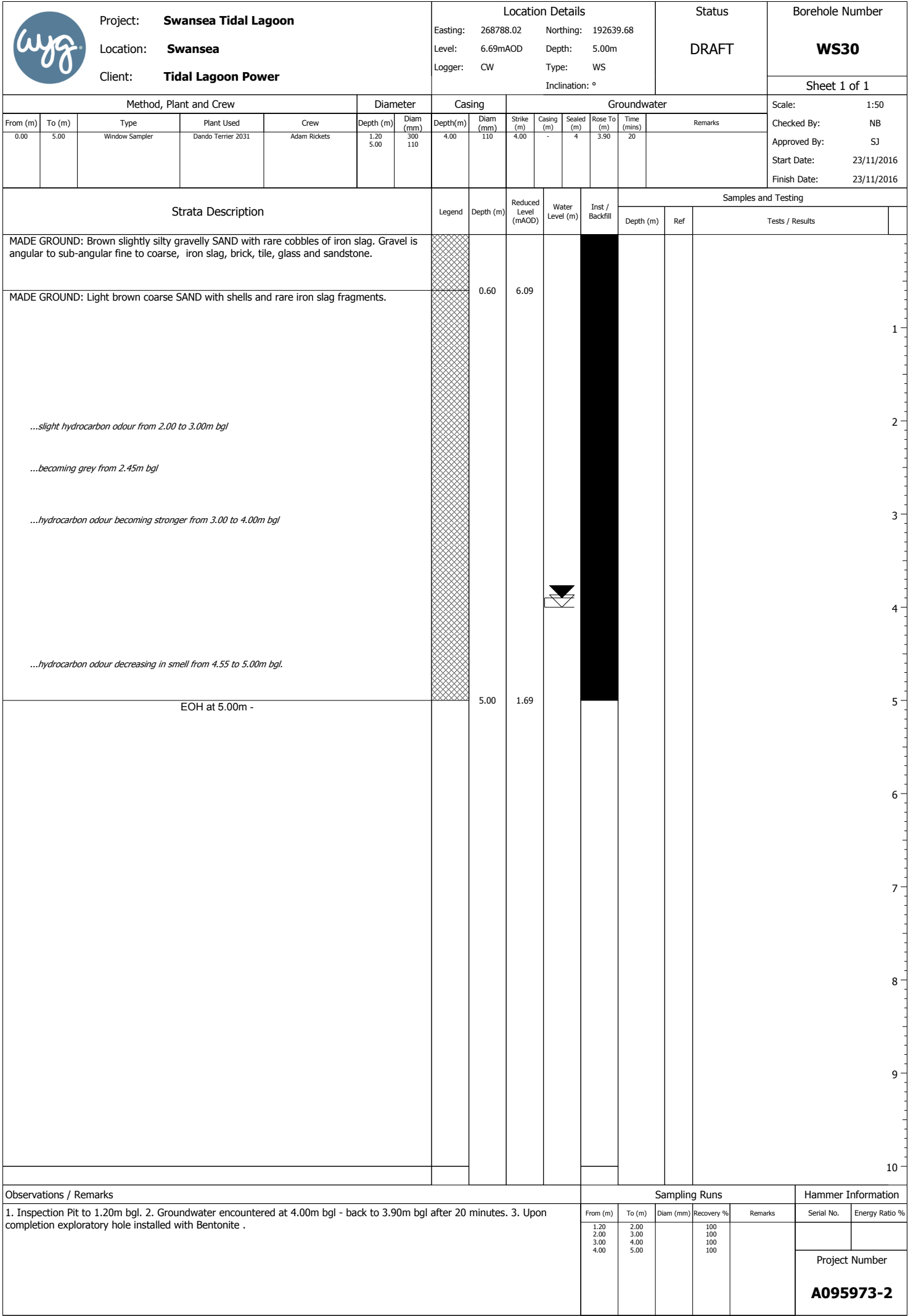




 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details Easting: 268686.02 Northing: 192554.78 Level: 6.76mAOD Depth: 5.00m Logger: CW Type: WS Inclination: °						Status DRAFT		Borehole Number WS27					
								Sheet 1 of 1											
Method, Plant and Crew					Diameter		Casing		Groundwater						Scale: 1:50				
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks		Checked By: NB			
0.00	5.00	Window Sampler	Dando Terrier 2028	Adam Rickets	1.20 5.00	300 110	4.00	110	4.00	-	4	3.80	20			Approved By: SJ			
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing				Tests / Results			
												Depth (m)	Ref						
MADE GROUND: Black to brown slightly silty gravelly SAND with rare cobbles of iron slag. Gravel is angular to sub-angular fine to coarse, iron slag, brick, tile, glass and sandstone.								0.90	5.86			1.50	ES			PID 0.50m, 0.1ppm	1		
MADE GROUND: Light brown coarse SAND with shells and rare iron slag fragments.slight hydrocarbon smell throughout - visual hydrocarbon contamination 4.65-5.00m bgl (free product observed).														2.00 - 3.00	B			PID 0.80m, 0.1ppm	
																		PID 1.20m, 6.3ppm	
																		PID 2.00m, 5.8ppm PID 2.00m, 6.3ppm	
																		PID 3.00m, 5.8ppm PID 3.00m, 7.1ppm	
EOH at 5.00m -							5.00	1.76			4.00				PID 4.00m, 10.1ppm	4			
															PID 5.00m, 458.0ppm				
																	5		
																		6	
																		7	
																		8	
																		9	
																		10	
Observations / Remarks 1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 4.00m bgl - back to 3.80m bgl after 20 minutes. 3. Upon completion exploratory hole installed with Bentonite .												Sampling Runs				Hammer Information			
						From (m)	To (m)	Diam (mm)	Recovery %	Remarks	Serial No.	Energy Ratio %							
						1.20	2.00		100										
						2.00	3.00		95										
						3.00	4.00		100										
						4.00	5.00		90										
												Project Number A095973-2							

Wyg Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details						Status DRAFT		Borehole Number		
						Easting: 268696.05 Northing: 192545.15 Level: 6.48mAOD Depth: 5.00m Logger: CW Type: WS Inclination: °								WS28		
																Sheet 1 of 1
Method, Plant and Crew					Diameter		Casing		Groundwater						Scale: 1:50	
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks	Checked By: NB	
0.00	5.00	Window Sampler	Dando Terrier 2029	Adam Rickets	1.20 5.00	300 110	5.00	110	4.00	-	4	3.90	20		Approved By: SJ	
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing				
												Depth (m)	Ref	Tests / Results		
MADE GROUND: Grass over black to brown slightly silty slightly gravelly SAND with rare cobbles of iron slag. Gravel is angular to rounded fine to medium, iron slag, brick, tile, glass and sandstone.								1.32	5.16			1.50	ES1			
MADE GROUND: Light brown coarse SAND with shells and rare iron slag fragments.																
...becoming orange brown from 2.60m bgl																
...slight hydrocarbon smell from 2.00 to 3.70m bgl with visual hydrocarbon contamination from 3.70m								5.00	1.48							
EOH at 5.00m -																
Observations / Remarks							Sampling Runs						Hammer Information			
1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 4.00m bgl. 3. Upon completion exploratory hole installed with Bentonite from 4.50m (blowing sands 5.00- 4.50) to 4.00m bgl, slotted pipe with gravel surround from 4.00m to 1.00m bgl, plain pipe with Bentonite surround from 1.00m bgl to GL.							From (m)	To (m)	Diam (mm)	Recovery %	Remarks	Serial No.	Energy Ratio %			
							1.20	2.00		75						
							2.00	3.00		85						
							3.00	4.00		95						
							4.00	5.00		50			Project Number			
													A095973-2			

 Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details Easting: 268782.05 Northing: 192645.43 Level: 6.71mAOD Depth: 4.00m Logger: CW Type: WS Inclination: °						Status DRAFT		Borehole Number WS29			
								Sheet 1 of 1									
Method, Plant and Crew					Diameter		Casing		Groundwater						Scale: 1:50		
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks		Checked By: NB	
0.00	4.00	Window Sampler	Dando Terrier 2030	Adam Rickets	1.20 4.00	300 110	4.00	110	4.00	-	4	3.80	20			Approved By: SJ	
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing					
MADE GROUND: Black to brown slightly silty gravelly SAND with rare cobbles of iron slag. Gravel is angular to sub-angular fine to coarse, iron slag, brick, tile, glass and sandstone.								0.55	6.16			Depth (m)	Ref	Tests / Results			
MADE GROUND: Light brown coarse SAND with shells and rare iron slag fragments.																	
EOH at 4.00m -								4.00	2.71								
																	1
																	2
																	3
																	4
																	5
																	6
																	7
																	8
																	9
																	10
Observations / Remarks 1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 4.00m bgl. 3. Upon completion exploratory hole installed with Bentonite from 4.00m (blowing sands 4.00 - 3.60) to 3.60m bgl, slotted pipe with gravel surround from 3.60m to 1.00m bgl, plain pipe with Bentonite surround from 1.00m bgl to GL.											Sampling Runs				Hammer Information		
From (m)	To (m)	Diam (mm)	Recovery %	Remarks	Serial No.	Energy Ratio %											
1.20	2.00		100														
2.00	3.00		80														
3.00	4.00		100														
							Project Number A095973-2										



Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details						Status DRAFT		Borehole Number WS31			
						Easting: 268874.39 Northing: 192732.52 Level: 6.82mAOD Depth: 5.00m Logger: CW Type: WS Inclination: °											
						Sheet 1 of 1											
Method, Plant and Crew					Diameter		Casing		Groundwater						Scale: 1:50		
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks	Checked By: NB		
0.00	5.00	Window Sampler	Dando Terrier 2032	Adam Rickets	1.20 5.00	300 110	4.00	110	4.00	-	4	3.90	20		Approved By: SJ		
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing				Finish Date: 23/11/2016	
												Depth (m)	Ref	Tests / Results			
MADE GROUND: Dark brown slightly silty gravelly SAND with rare cobbles of iron slag. Gravel is angular to sub-angular fine to coarse, iron slag, brick, tile, glass and sandstone.								0.75	6.07			0.00 - 0.70	B	PID 0.70m, 0.3ppm	1		
MADE GROUND: Light brown coarse SAND with shells and rare iron slag fragments.												0.10 - 0.40	B1				
												0.30	ES1				
												0.40 - 0.60	B2				
												0.50	ES				
												0.65 - 1.00	B3				
												0.70 - 1.20	B				
												1.00	ES				
												1.00	ES3				
												1.00 - 1.60	B4				
1.20 - 2.00	B																
1.40	ES4																
.....visually hydrocarbon impacted (black - strong smell) from 2.50 to 3.00m bgl.							2.00	ES	PID 2.00m, 7.9ppm	2							
							visually hydrocarbon impacted (grey) from 3.00 to 4.20m bgl.							2.60	ES	PID 3.00m, 751.0ppm	3
														3.50	ES		
														visually hydrocarbon impacted (black) from 4.20 to 5.00m bgl.			
EOH at 5.00m -							5.00	1.82			5.00	ES	PID 5.00m, 882.0ppm	5			
															6		
															7		
															8		
															9		
															10		

Observations / Remarks										Sampling Runs				Hammer Information		
1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 4.00m bgl - back to 3.90m bgl after 20 minutes. 3. Upon completion exploratory hole installed with Bentonite from 5.00m to 4.00m bgl, slotted pipe with gravel surround from 4.00m to 1.00m bgl, plain pipe with Bentonite surround from 1.00m bgl to GL.										From (m)	To (m)	Diam (mm)	Recovery %	Remarks	Serial No.	Energy Ratio %
										1.20	2.00		125			
										2.00	3.00		100			
										3.00	4.00		100			
										4.00	5.00		100			
										Project Number						
										A095973-2						

Project: **Swansea Tidal Lagoon**

Location: **Swansea**

Client: **Tidal Lagoon Power**

Location Details

Easting:	268880.35	Northing:	192726.64
Level:	6.77mAOD	Depth:	5.00m
Logger:	CW	Type:	WS
		Inclination:	°

Status

DRAFT

Borehole Number

WS32

Sheet 1 of 1

Method, Plant and Crew

From (m)	To (m)	Type	Plant Used	Crew
0.00	5.00	Window Sampler	Dando Terrier 2033	Adam Rickets

Diameter

From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)
0.00	5.00	Window Sampler	Dando Terrier 2033	Adam Rickets	1.20 5.00	300 110

Casing

From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)
0.00	5.00	Window Sampler	Dando Terrier 2033	Adam Rickets	1.20 5.00	300 110	4.00	110

Groundwater

From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks
0.00	5.00	Window Sampler	Dando Terrier 2033	Adam Rickets	1.20 5.00	300 110	4.00	110	4.00	-	4	3.90	20	

Scale: 1:50

Checked By:	NB
Approved By:	SJ
Start Date:	23/11/2016
Finish Date:	23/11/2016

Strata Description

Lege

Depth (m)

Reduced
LevelWater
Level (m)Inst /
Backfill

Samples and Testing

[illegible]

Observations / Remarks

1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 4.00m bgl - back to 3.90m bgl after 20 minutes. 3. Upon completion exploratory hole installed with Bentonite .

Sampling Runs

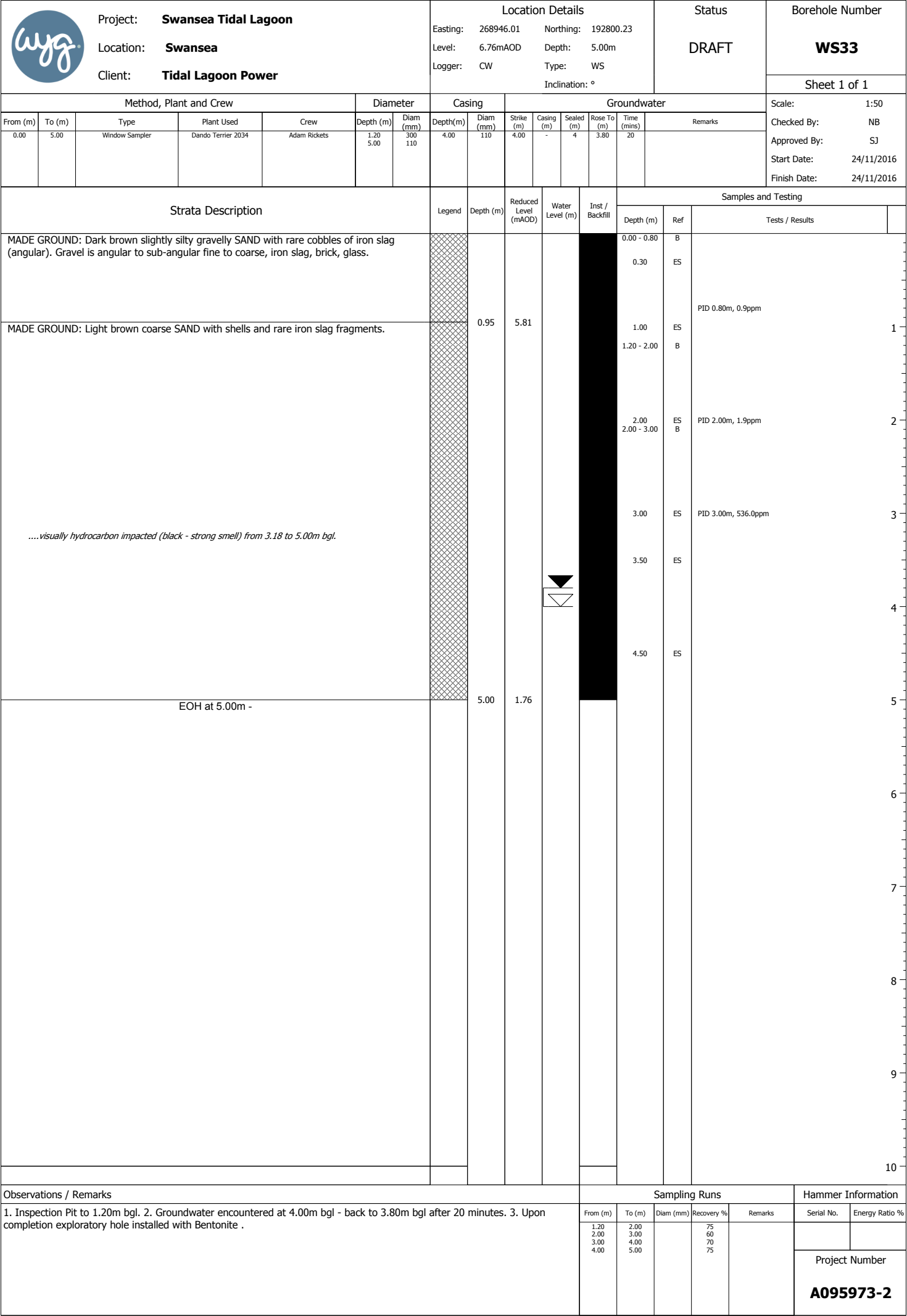
From (m)	To (m)	Diam (mm)	Recovery %	Remarks
1.20	2.00		100	
2.00	3.00		75	
3.00	4.00		100	
4.00	5.00		75	

Hammer Information

Serial No.	Energy Ratio %
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Project Number	
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A095973-2



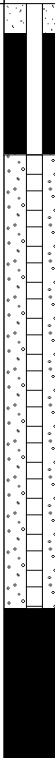
Project: Swansea Tidal Lagoon Location: Swansea Client: Tidal Lagoon Power						Location Details						Status DRAFT		Borehole Number WS34							
						Easting: 268953.52 Northing: 192792.95 Level: 6.66mAOD Depth: 5.00m Logger: CW Type: WS Inclination: °								Sheet 1 of 1							
						Method, Plant and Crew					Diameter		Casing		Groundwater					Scale: 1:50	
From (m)	To (m)	Type	Plant Used	Crew	Depth (m)	Diam (mm)	Depth(m)	Diam (mm)	Strike (m)	Casing (m)	Sealed (m)	Rose To (m)	Time (mins)	Remarks	Checked By: NB						
0.00	5.00	Window Sampler	Dando Terrier 2035	Adam Rickets	1.20 5.00	300 110	5.00	110	3.00	-	3	2.90	20		Approved By: SJ						
Strata Description							Legend	Depth (m)	Reduced Level (mAOD)	Water Level (m)	Inst / Backfill	Samples and Testing			Tests / Results						
												Depth (m)	Ref								
MADE GROUND: Dark brown slightly silty gravelly SAND with rare cobbles of iron slag. Gravel is angular to sub-angular fine to coarse, iron slag, brick, glass and sandstone								2.00	4.66			0.20 - 0.70	B	PID 0.70m, 0.0ppm	1						
.....large plastic lid at 0.60m												0.40	ES								
												1.00	ES								
												1.40 - 1.95	B								
												1.95	ES								
MADE GROUND: Light brown coarse SAND with shells and rare iron slag fragments.													5.00			1.66		2.00 - 3.00	ES B	PID 1.95m, 0.9ppm	2
.....visually hydrocarbon impacted (black - strong smell) from 3.18 to 5.00m bgl.																		3.00	ES	PID 3.00m, 2.3ppm	3
																		3.50	ES		
																		4.50	ES	PID 4.50m, 635.0ppm	4
																		EOH at 5.00m -			
Observations / Remarks												Sampling Runs			Hammer Information						
1. Inspection Pit to 1.20m bgl. 2. Groundwater encountered at 4.00m bgl - back to 3.80m bgl after 20 minutes. 3. Upon completion exploratory hole installed with Bentonite from 5.00m to 4.00m bgl, slotted pipe with gravel surround from 4.00m to 1.00m bgl, plain pipe with Bentonite surround from 1.00m bgl to GL.												From (m)	To (m)	Diam (mm)	Recovery %	Remarks	Serial No.	Energy Ratio %			
												1.20	2.00		100						
												2.00	3.00		75						
												3.00	4.00		100						
												4.00	5.00		90						
												Project Number									
												A095973-2									



Plate 1

HP1



Plate 2

HP1

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CF24 0AD

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Ground Technologies & Investigation



Project :
Swansea Tidal Lagoon

Client: Tidal Lagoon (Swansea Bay) Plc

Project No.: A095973-2

Date: Dec 2016



Plate 3

HP2



Plate 4

HP2

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Ground Technologies & Investigation



Project :
Swansea Tidal Lagoon

Client: Tidal Lagoon (Swansea Bay) Plc

Project No.: A095973-2

Date: Dec 2016



Plate 5

HP3



Plate 6

HP3

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Ground Technologies & Investigation



Project :
Swansea Tidal Lagoon

Client: Tidal Lagoon (Swansea Bay) Plc

Project No.: A095973-2

Date: Dec 2016



Plate 7

HP4



Plate 8

WS03HP4

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Ground Technologies & Investigation



Project :
Swansea Tidal Lagoon

Client: Tidal Lagoon (Swansea Bay) Plc

Project No.: A095973-2

Date: Dec 2016



Plate 9

HP5



Plate 10

HP5

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Environmental Consultancy
Ground Technologies & Investigation

Project :
Swansea Tidal Lagoon

Client: Tidal Lagoon (Swansea Bay) Plc

Project No.: A095973-2

Date: Dec 2016



Plate 11

HP6



Plate 12

HP6

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Swansea Tidal Lagoon

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Plate 13

HP7



Plate 14

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Plate 15

HP8



Plate 16

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Plate 17

HP9



Plate 18

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Plate 19

HP10



Plate 20

H10

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Plate 21 HP11



Plate 22 H11

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Plate 23

HP12



Plate 24

HP12

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Plate 25

HP13



Plate 26

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Plate 27

HP14



Plate 28

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Plate 29

HP15



Plate 30

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Plate 31

HP16



Plate 32

HP17

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Plate 33

HP18



Plate 34

HP19

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Plate 35

HP20



Plate 36

HP21

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Plate 37

HP22



Plate 38

HP23

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Plate 39

HP24



Plate 40

HP25

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Plate 41

HP26

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Plate 43

TP1



Plate 44

TP1

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Plate 45

TP2



Plate 46

TP2

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Plate 47

TP3



Plate 48

TP3

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Plate 49

TP4



Plate 50

TP4

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Plate 51

TP5



Plate 52

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Plate 53

TP6



Plate 54

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Plate 55

TP7



Plate 56

TP7

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Plate 57

TP8



Plate 58

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Plate 59

TP9



Plate 60

TP9

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Plate 61

TP10



Plate 62

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Plate 63

TP11



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Plate 65

TP12



Plate 66

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Plate 67

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Plate 69

TP14



Plate 70

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Plate 71

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Plate 73

TP16



Plate 74

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