SYSAC Marina

Water Framework Directive Assessment

Aug 2020

Project Nr

579

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Client : City and Council of Swansea
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Title : SYSAC - Water Framework Directive Assessment

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1. Introduction

The Swansea SYSAC moorings are accessed from the western edge of the River Tawe and situated north of the River Tawe Barrage. The marina provides direct access to Swansea Bay and the West Glamorgan coastline. In recent times maintenance dredging has been carried out at two-yearly intervals, which has been necessary to maintain navigable depths in the area.

The Environment Department of the City and Council of Swansea (CCS), the owners of Swansea Marina occupied by the Swansea Yacht & Sub Aqua Club (SYSAC) moorings, propose to undertake maintenance dredging campaigns in the winter months of 2020/21 and 2022/23 to restore the required navigational depths. The application for a Marine Licence to dredge and/or dispose of dredge material is administered by the Marine Licensing Team (MLT) on behalf of Natural Resources Wales (NRW). A requirement of the Marine Licence Application is to undertake a Water Framework Directive (WFD) Assessment. This document outlines whether this individual pre-existing maintenance dredging activity needs further assessment to establish if it complies with the Water Framework Directive.

1.1. Legislative Background

The purpose of the WFD is to establish a framework for protecting inland surface waters, transitional waters, coastal waters and groundwaters. The EU Water Framework Directive was transposed into Welsh law as the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. The requirements of the Directive need to be considered at all stages of the river and coastal planning and development process. The framework for delivering this Directive is through the River Basin Management Plans (RBMPs). Each RBMP has been characterised into smaller management units known as ‘Water Bodies’.

A default Objective in all Water Bodies is to prevent deterioration in either the Ecological Status or, for Heavily Modified Water Bodies (HMWBs) or Artificial Water Bodies (AWBs), the Ecological Potential of the water body. Any activity which has the potential to have an impact on ecology (as defined by the Biological, physicochemical and hydromorphological Quality Elements (BQE) listed in Annex V of the Directive) will need consideration in terms of whether it could cause deterioration in the Ecological Status or Potential of a water body.

Where there are sites designated under EU legislation (e.g. the Birds or Habitats Directives, Shellfish Waters Directive), the Directive aims for compliance with any relevant standards or objectives for these sites. Therefore, where a site which is water-dependent in some way is protected by designation under another EU Directive, and the Good Ecological Status (GES) or Good Ecological Potential (GEP) targets set under the Water Framework Directive would be insufficient to meet the objectives of the other Directive, the more stringent targets would apply.

Ecological Status is expressed in terms of five status classes – high, good, moderate, poor or bad. These classes are established on the basis of specific criteria and boundaries defined against biological, physicochemical and hydromorphological elements (which are set out in Annex V of the WFD); these are shown in table 1 below.

Type	Description
Biological assessment	Uses numeric measures of communities of plants and animals (e.g. fish, macrophytes).
Physico-chemical assessment	Looks at elements such as temperature and the level of nutrients, which support the biology.
Hydromorphological quality	Looks at water flow, sediment composition and movement, continuity (rivers) and the structure of physical habitat.

Table 1: Definition of Quality Elements

The overall ecological status of a 'Water Body' is determined by whichever of these assessments is the poorer. A Water Body might achieve 'Good Status' for chemical and physicochemical assessments, but only achieve 'Moderate Status' for the biological assessment; in this case, it would be classed overall as having 'Moderate Ecological Status'. To achieve the overall aim of good surface water status, the WFD requires that surface waters be of at least GES and Good Chemical Status (GCS).

The WFD recognises that physical alterations may have been undertaken to support the use of a Water Body for a particular purpose (e.g. water storage, coast or flood defence, navigation, etc). If this reason is still valid the Water Body may be designated as an HMWB, with the requirement to achieve GEP rather than GES.

1.2. Location

The dredging site is located between the River Tawe Barrage and the new Sail Bridge walkway, on the River Tawe in Swansea, South Wales. The River Tawe Barrage was the first of its kind built in Wales and resulted in a half-tide basin being created along the lower tidal section of the River Tawe in Swansea (see figures 1 and 2).

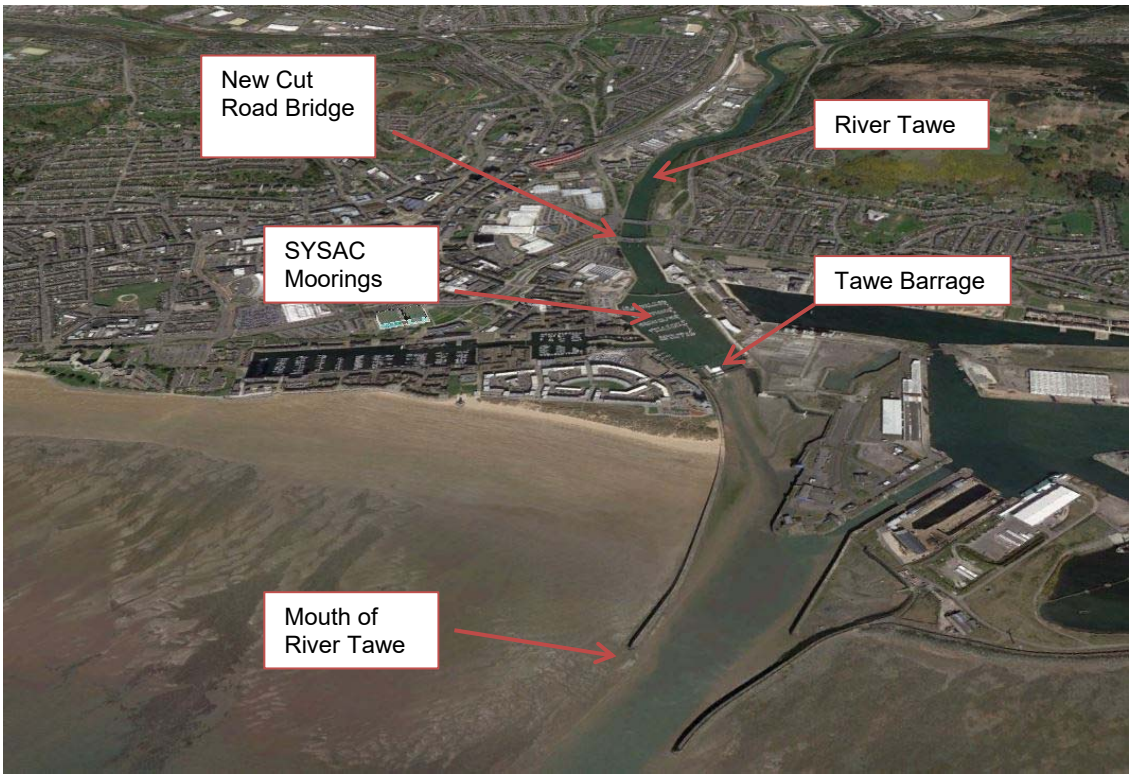

Figure 1: River Tawe, Swansea, southern aspect (source – Google Earth)

With the continual steady sedimentation in the area of the SYSAC marina, vessels moored on the pontoons have been touching bottom during the impounded phase of the tidal cycle. The yacht club generally manages this problem in the short term by moving deeper drafted vessels to areas where the natural water depth is greatest.

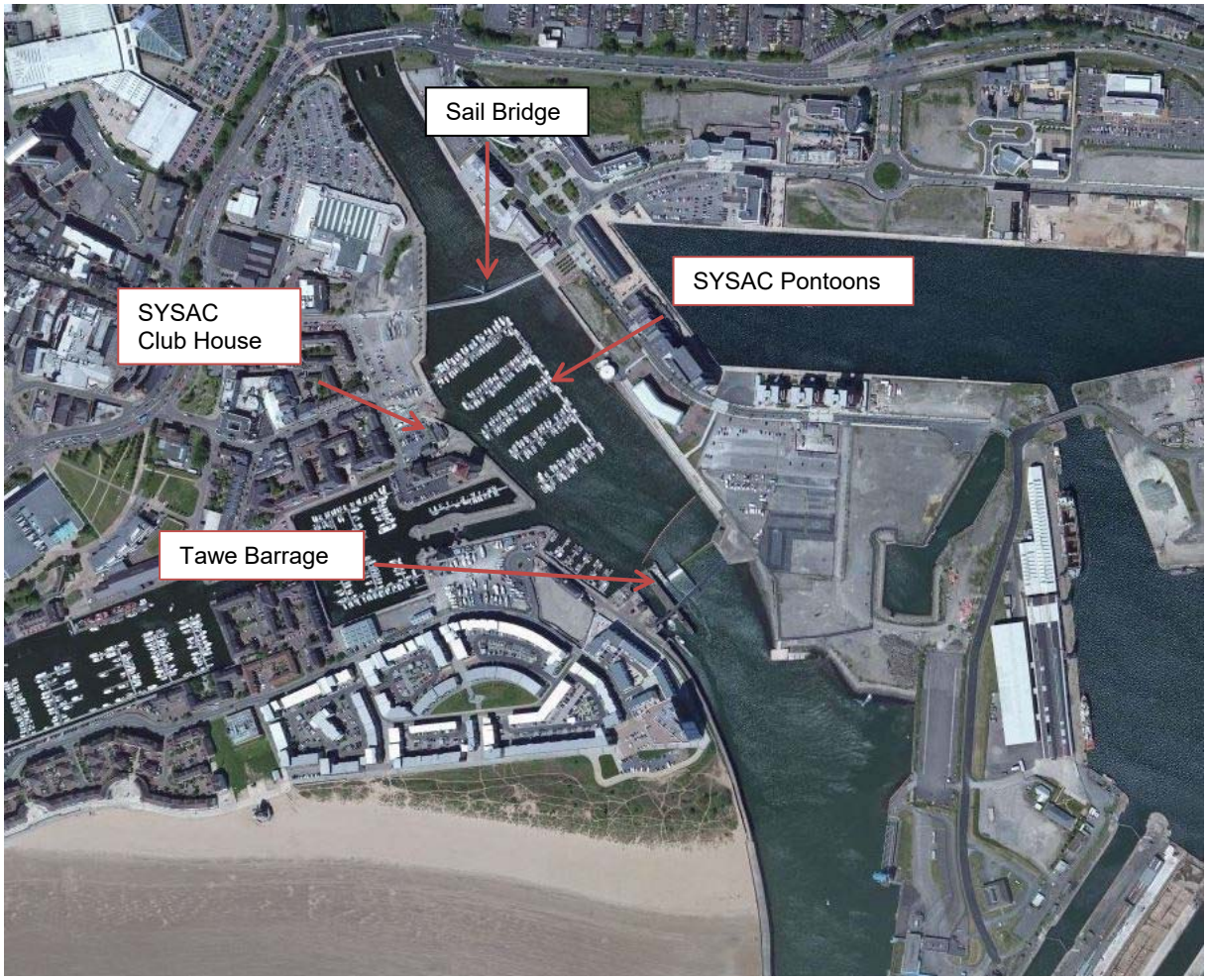

Figure 2: SYSAC Marina (Source Google Earth)

2. River Tawe Barrage Act

For the barrage to be constructed an Act of Parliament was required to permit interruption to the flow of the river. This Act is known as the River Tawe Barrage Act. Within the River Tawe Barrage Act there is a provision concerning the maintenance of navigation within the river upstream of the barrage, once completed. The specific wording of this provision is as follows:

Following construction and bringing into operation of the barrage (Work No.1) the council shall take such steps as are possible at reasonable cost to maintain at all times but without prejudice to the powers of Clause 22 (Operation of sluices and lock gates) of the Bill an adequate depth of water in the main navigation channel of the upstream river inland of the works sufficient to allow passage along the river by yachts drawing not more than 5 feet to an extent similar to that possible before construction of the works.

The above clause requires there to be a maintained depth sufficient to allow the safe navigation of vessels with a draft of 5ft (1.52m), at all times, within that part of the river that was navigable before the construction of the barrage. For safe navigation to be achieved it is normal practice to include an additional depth for under keel clearance. This extra depth is to allow for such items as squat of the vessel, seabed undulations, wash effects, drawdown, drought plus an overall safety margin.

3. Historical Dredging - Frequency, Timing and Extent

3.1. Marina Dredging

Dredging using water injection (WID) has been undertaken seven times since 2007 and been successful in its aims each time. The first campaign commenced in December 2007 as a limited short term remedial measure to improve navigable depth to a minimum depth of 1.5m below the level of the Primary Weir Crest (PWC). The second was completed in February/March 2009 and was aimed at increasing depths beyond those attained in 2007, to a minimum water depth of 2.5m. The additional depth was required to provide some additional capacity for sedimentation between dredge campaigns. The subsequent campaigns are presented in Table 2 below and as with the 2009 campaign, have all aimed to restore the available depth in the Marina area of -2.5PWC to provide capacity for natural sedimentation. The scheduling of each campaign is recommended by the CCS's dredging consultants, Anthony D Bates Partnership (ADBP), based on data from bathymetric surveys.

The volumes of material displaced/relocated during the last seven maintenance dredging campaigns are summarised below in table 2. It must be noted that not all of this material exits the dredge area, a proportion is relocated within the marina area.

Occasion	Date		Area	Method	Volume (m^3)
	Start	End			
1	18-Dec-07	20-Dec-07	As above	WID	3,164
	04-Jan-08	10-Jan-08			
2	16-Feb-09	22-Feb-09	As above	WID	14,124
3	10-Jan-11	17-Jan-11	As above	WID	14,975
4	04-Jan-13	17-Jan-13	As above	WID	15,011
5	30-Jan-15	14-Feb-15	As above	WID	15,988
6	28-Jan-17	11-Feb-17	As above	WID	14,317
7	3-Feb-19	19-Feb-19	As above	WID	18,382

Table 2: Total quantities of material displaced/relocated/dredged within the marina area.

The volume displaced in per campaign has been approximately 15,000m³. However, not all of this material exits the dredge area via the lock gate pen stocks, a proportion of the dredged material re-settleswithin the dredge area. The 2019 campaign (occasion 7), resulted in an overall increase in volume displaced compared to previous years due to the WID working in the marina lock barrel - an area included under the previous licence but not previously dredged. As table 3 presents, a significant portion of the material displaced by WID is retained within the dredge area with the remainder being transferred downriver south of the barrage, via the lock gate penstocks, on its natural course.

Occasion	Volume Eroded (m³)	Volume Remaining North of Barrage (m³)	Volume Relocated South of Barrage (m³)
1	3,164	861	2,303
2	14,124	11,195	2,929
3	14,975	7,099	7,876
4	16,947	7,154	9,793
5	18,834	7,395	11,439
6	16,860	7,367	9,493
7	18,382	7,136	11,246

Table 3: Historic dispersion characteristics of material eroded by WID dredging

Figure 3 below provides a visual representation of the areas eroded by the WID dredging process and the adjacent areas that accumulate material. The largest area that accumulates material is just north of the barrage. However, this is a very deep area (8m of water depth) and the material that settles here is re-eroded naturally over time.

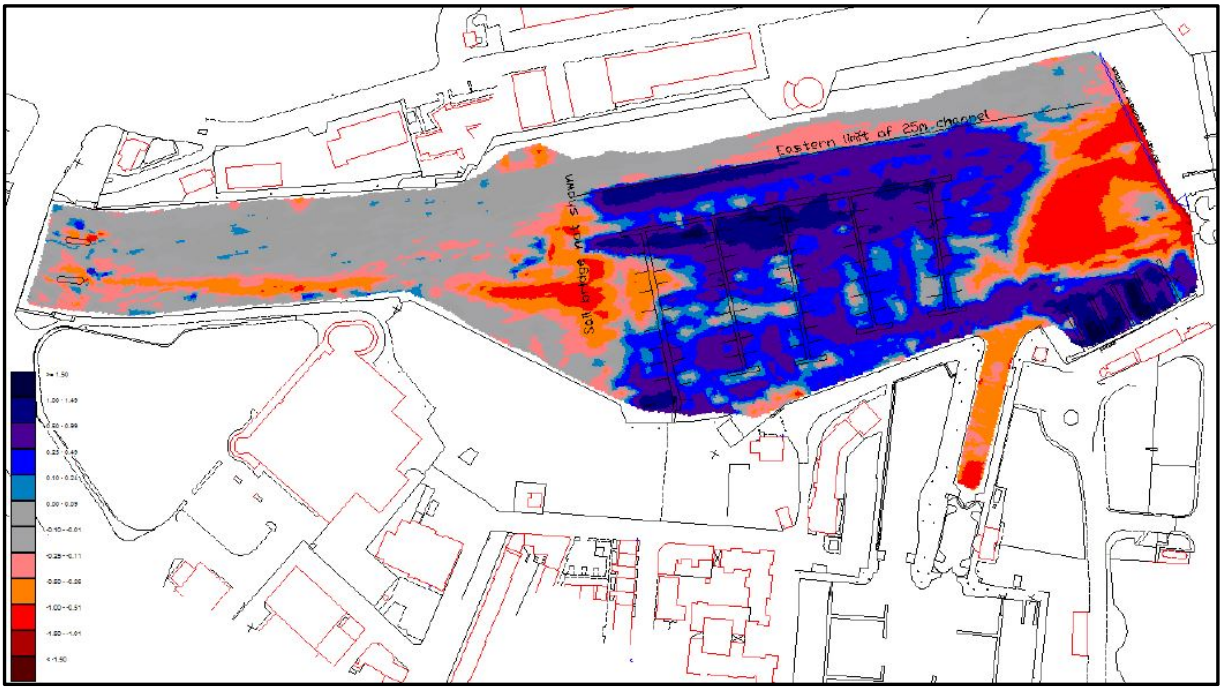

Figure 3: Areas of erosion (blue) and deposition (red) upstream of the barrage as a resultof WID dredging

3.2. Adjacent Port Dredging

Dredging also takes place periodically seaward of the proposed dredging site for the Port of Swansea and its approaches. A significant quantity of sediment used to be dredged regularly and in some years has totalled over 817,000 tonnes. The volume dredged by the Port of Swansea has diminished over time as the trade vessels using the port have reduced in both number and size. The majority of the dredging presently carried out is to provide safe navigation of tugs used in nearby Port Talbot. In the last 3 years the volume of material deposted by the Port of Swansea at the Swansea Bay offshore disposal site has been:

Year	Tonnage deposited
2017	159,670
2018	206,336
2019	231,647

It can be seen that the dredging activity that is carried out by the Port of Swansea is an order of magnitude larger than the dredging that is carried out in association with the SYSAC marina maintenance dredging activity.

4. Proposed Dredging Activity

4.1. Proposed Dredge Area

The proposed dredge area is the same as that defined for previous campaigns, as approximately outlined in figure 4. This area is in the immediate vicinity of the vessel mooring

locations and the approach to/from the lock gates on the upsteam side of the Tawe Barrage. The area also extends up to the lock gates to Swansea Marina as the lock barrel is prone to slow but steady sediment accumulation. The lock barrel does not need to be dredged on each campaign as the sedimentation rate is low. The defined area incorporates the fishing vessel pontoons located on the west side of the impouned area just upstream of the Tawe Lock gates.

Figure 4: Approximate area dredged every two years *(Image source: Google Earth)*

4.2. Dredge Design

The volume to be dredged during any dredging campaign will be affected by the siltation rate and the period since the preceding campaign. This has a direct effect on the depth of dredging required and hence volume. The most recent calculated sedimentation rate represents an average sedimentation rate of approximately 23m³/day or 8,500m³/year. Applying this to the planned two-year cycle between campaigns it is estimated that a quantity of approximately 17,000m³ may need to be relocated biennially. This equates to removing approximately 0.39m from the entire area outlined above. However, as natural siltation is not

equal over the site, accumulating more rapidly under pontoons, the dredge depth may vary between 0.1m to 0.9m.

4.3. Proposed Timing and Duration

The timing and duration of the proposed dredging activity will be similar to historical campaigns, undertaken during the winter months when boating activity in the marina and Tawe Lock use are low. This application is to cover planned campaigns in the winter months of 2020/21 and 2022/23. Each campaign is expected to last for approximately 14 days, excluding delays.

4.4. Dredging Methodology

The WID plant proposed consists of a small floating pontoon with a high volume water pump and injection arm attached. The pontoon is then manoeuvred by its own propulsion system or attached tug. The injection arm is hence passed over the area to be dredged as the pontoon is manoeuvred, the height of the injection arm is also controlled during this process (see figures 5 & 6). The system involves low-pressure water being injected into the sediments on the seabed. The low-pressure injection fluidises the sediments which will then flow as a dense fluid via natural seabed gradients towards lower bed levels. The majority of density flow is retained within the lower portion of the water column.

For this method of dredging to be successful, there has to be somewhere for the mobilised sediment to flow to. In the case of the SYSAC marina channels, approximately 0.5m deep, are dredged between the area to be dredged and the deeper water in front of the Tawe Lock. Arrangements are made for the penstocks of the lock to be left open to create a constant bed flow, during ebb tides, in the vicinity of the lock. The purpose being for the hydraulic flow through the penstocks discharge to create a continuous flow at seabed level, which will draw the fluid mud out of the upstream depression and discharge it into the downstream river flow, and hence away from the site.

Where a significant accumulation of saturated leaf mold matrix is encountered this can reduce the efficiency of the hydraulic flow. Where this is encountered the water injection nossles will be altered to increase the flow in focused areas in order to loosen and move the organic material along the seabed in order to keep the flow channels clear. This method of more focused water injection is sometimes reffered to as the mass flow technique, and is commonly used to fluidise and move more granular material.

One of two working methods will be used depending on the tidal state. On spring tides, dredging may start up to 1 hour before high water and end at low water, hence maximising the use of the natural flows over the two daily ebb tides. Alternatively, during neap tide periods, when tide levels do not overtop the weir, greater productivity can be achieved by working for a straight 12hr shift as opposed to two shifts over high tides. This is based on the fact that when the neap tide does not overtop the barrage there is no real advantage to only dredging on the ebb tides as the river's flow will remain constant throughout the tidal cycle.

Under the most recent marina licence (DML1639v1) the working method has followed the Project Specific Condition (cl. 8.8) where, '*The Licence Holder must ensure that on spring tides, dredging is only undertaken for a duration of five hours between 1 hour before high water and low water. During neap tide periods there are no tidal state restrictions on dredging.'*

Figure 5: Self-propelled water injection dredger working in SYCAC Marina

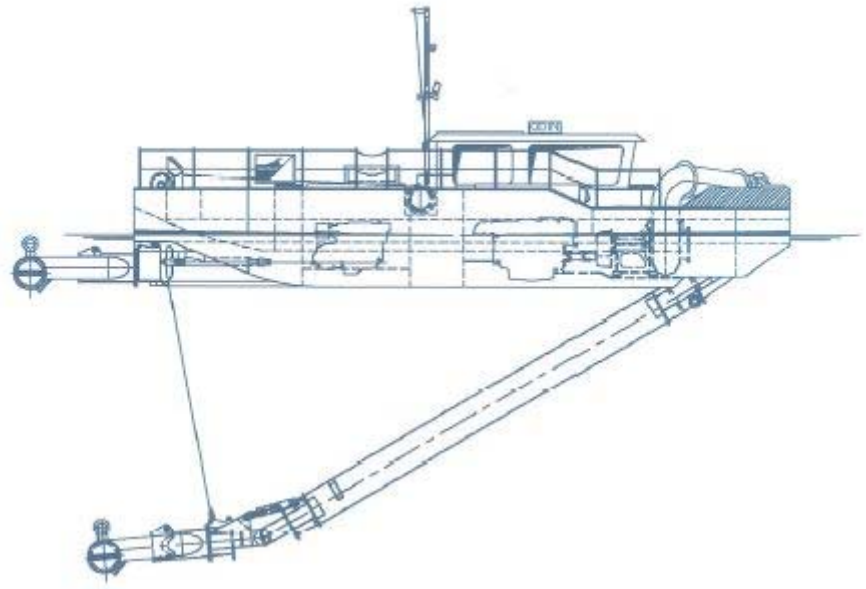

Figure 6: Water injection system schematic

5. Sediment Quality Data

5.1. Sediment Procedure

Sediment analysis has been undertaken by CCS previously to facilitate past maintenance dredging activities at the location stated in Section 4. The most recent samples, for this 2020 application, were undertaken in March 2020.

5.2. 2020 Sampling

In line with previous sediment sampling, samples have been collected and tested at different locations within the marina dredge area at the seabed surface. Results have been provided for trace metals, organotins and polycyclic aromatic hydrocarbons (PAH) tests.

5.3. Chemical Characteristics

Action levels are used as part of a 'weight of evidence' approach to assessing dredged material and its suitability for disposal at sea. In general, contaminant levels in dredged material below Action Level 1 are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above Action Level 2 is generally considered unsuitable for sea disposal. Dredged material with contaminant levels between Action Levels 1 and 2 requires further consideration of the natural and historical information before making any recommendations.

Detailed chemical analyses and results of the bed materials are provided in Appendix A. The results are generally in line with historical sampling results from the Marina Area.

6. Relevant River Basin Management Plan

The proposed dredging site is located on the River Tawe just north of the Tawe barrage. The area north of the Barrage has now been included within the Water Framework Directive Cycle 2 waterbody classification, extending from the Barrage upstream to Beaufort Weir. This area has been designated as a Heavily Modified Water Body (HMWB).

South of the barrage is also a River Tawe designated HMWB. The current ecological quality status of these areas are shown in figure 7. Some of the dispersed material from the planned WID will relocate within these areas. Table 4 highlights all of the relevant, available, ecological quality status data for the two potentially affected water bodies, River Tawe (Beaufort Weir to Barrage) and River Tawe Estuary (below barrage including docks), from National Resources Wales, Water Watch Wales data portal.

Figure 7: River Basin Management Plan with proposed dredge site location

WB_NAME	TAWE ESTUARY BELOW BARRAGE INCL DOCKS	TAWE - BEAUFORT WEIR TO BARRAGE
	WFD Transitional Waterbodies Cycle 2 Interim 2018: 25	**WFD Transitional Waterbodies Cycle 2 Interim 2018: 19**
DS_WBID		GB541005900900
WATER_CAT	Transitional	Transitional
WB_NAME	TAWE ESTUARY BELOW BARRAGE INCL DOCKS	TAWE - BEAUFORT WEIR TO BARRAGE
COUNTRY	Wales	Wales

WB_NAME	TAWE ESTUARY BELOW BARRAGE INCL DOCKS	TAWE - BEAUFORT WEIR TO BARRAGE
	WFD Transitional Waterbodies Cycle 2 Interim 2018: 25	**WFD Transitional Waterbodies Cycle 2 Interim 2018: 19**
RBD_ID	10	10
RBD_NAME	Western Wales	Western Wales
AREA_ID	0	0
AREA_NAME	NRW	NRW
CYCLE_2	REPORT NEXT RBMP	REPORT NEXT RBMP
OPCATNAME	Tawe Estuary below Barrage incl Docks	Tawe Estuary below Barrage incl Docks
MANCATNAME	Western Wales TraC	Western Wales TraC
EDIT_MADE	OC Name Req, MC Name Rules	Geometry Edit, OC Name Rules, MC Name Rules
WATERBODY_ID	GB541005900900	GB541005900901
OverallWB	Moderate	Moderate
Ecological	Moderate	Moderate
Chem	Good	Good
DrivEcoQE	Zinc, Dissolved Inorganic Nitrogen, Mitigation Measures Assessment	Mitigation Measures Assessment
Mit_Assmnt	Moderate	Moderate
Eco_Biological	High	Not Assessed
Macroalgae	High	
Macroalgae_Roll	2,015	
OppMac_Sub	High	
OppMac_Sub_Roll	2,015	
ECO_GEN	Moderate	Good
DIN	Moderate	Good
DIN_Conf	Very Certain	Very Certain
DO		High
DO_Conf		Quite Certain
ECO_HM	Not High	Not Assessed
Hydro	Not High	
Hydro_Roll	2,014	
Annex8Chem	Moderate	Not Assessed
Arsenic	High	
Arsenic_Conf	Very Certain	
Arsenic_Roll	2,015	
Copper	High	
Copper_Conf	Very Certain	
Copper_Roll	2,015	
Zinc	Moderate	
Zinc_Conf	Very Certain	
Zinc_Roll	2,015	
CHEM_PHZ	High	Not Assessed
Cadmium	High	
Cadmium_Conf	Very Certain	
Cadmium_Roll	2,015	

WB_NAME	TAWE ESTUARY BELOW BARRAGE INCL DOCKS	TAWE - BEAUFORT WEIR TO BARRAGE
	WFD Transitional Waterbodies Cycle 2 Interim 2018: 25	**WFD Transitional Waterbodies Cycle 2 Interim 2018: 19**
Hex_chl_cx	High	
Hex_chl_cx_Conf	Very Certain	
Hex_chl_cx_Roll	2,015	
CHEM_PR	High	Not Assessed
Lead	High	
Lead_Conf	Very Certain	
Lead_Roll	2,015	
Nickel	High	
Nickel_Conf	Very Certain	
Nickel_Roll	2,015	
CHEM_OTHER	High	Not Assessed
Drins	High	
Drins_Conf	Very Certain	
Drins_Roll	2,015	
DDT_total	High	
DDT_total_Conf	Very Certain	
DDT_total_Roll	2,015	
Pa_pa_DDT	High	
Pa_pa_DDT_Conf	Very Certain	
Pa_pa_DDT_Roll	2,015	
NRW_AREA	South West Wales	South West Wales

Table 4: River Tawe and Estuary - Cycle 2 (Iterim 2018) Transitional Water Body Information
(Data sourced from NRW Water Watch Wales, https://waterwatchwales.naturalresourceswales.gov.uk/en/)

7. Local Protected Areas

The planned dredging area does not lie within any protected aquatic area, nor does it have any protected areas adjacent to the dredging site. There are two protected aquatic areas located within 5km of the dredging site as highlighted by the orange hatching in figure 8 below. These are both Sites of Special Scientific Interest (SSSI) and their details and anticipated impacts of the planned dredging activity are discussed below.

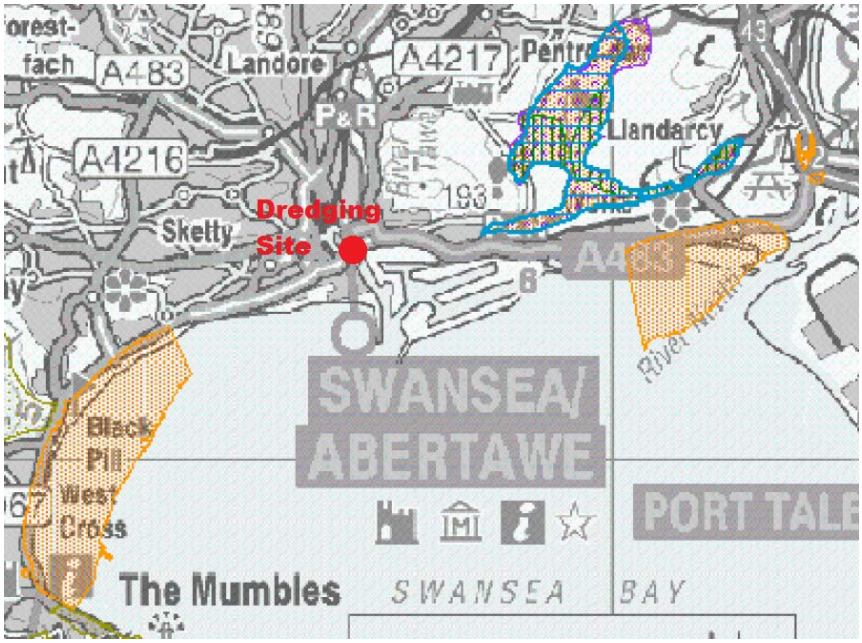

Figure 8: Location of dredging and SSSI sites

7.1. SSSI – Crymlyn Bog

Crymlyn Bog, located onshore to the North East of the dredging site (bordered by blue and hatched green in figure 8), is covered by several protection statuses such as Special Area of Conservation (SAC), National Nature Reserve (NNR), SSSI and by the RAMSAR Convention. However, as this site is over 2km from the proposed dredging site and onshore, no potential impacts are identified.

7.2. SSSI – Crymlyn Burrows

Crymlyn Burrows covers a total area of 234.52 hectares and is located to the east of the dredging site. Crymlyn Burrows is the only part of the eastern Swansea Bay coastline that has remained substantially unmodified by industrial development. The site includes examples of habitat transitions between sand-dune and saltmarsh habitats.

The impact on this site is anticipated to be zero. The direct distance between the dredging site and this SSSI is approximately 4km. However, for the sediment to be transported by local currents the distance is increased to a minimum of 5km. The general anticlockwise rotation of the marine currents within Swansea Bay means that and sediment discharged from the marina via the River Tawe is very unlikely to migrate towards this protected site.

7.3. SSSI – Blackpill Beach

Blackpill Beach covers a total area of 453.56 hectares and is located to the west of the dredging site. Blackpill beach was designated as an SSSI in 1986 in recognition of its importance for local and migratory birds. The mud and sand provide the perfect habitat for many marine invertebrates, the rich source of food on which the 150 or so species of birds, recorded there, depend.

The impact on this site is anticipated to be zero. The direct distance between the dredging site and this SSSI is approximately 3km. However, for the sediment to be transported by local currents the distance is increased to a minimum of 4.2km.

8. Potential Impact on Water Body

As discussed in Section 1 the WFD recognises that some water bodies have been physically altered, for example for navigation or flood defence, and allows for these water bodies to be designated as Heavily Modified Water Bodies (HMWB) or Artificial Water Bodies (AWB) and need to achieve good ecological potential rather than ecological status. Ecological potential means that the water body is managed to sustain the biology that can be achieved given its modified condition.

The potential effects of the proposed water injection dredging campaign are negligible. The River Tawe already contains a high suspended sediment load and the increases in suspended solids associated with the dredging activity will be temporary and within the envelope of normal background levels. The dredging activity itself only takes place over certain periods of the day, as highlighted in Section 4.5, and over a maximum period of approximately fourteen days every 2 years. Also, as previously highlighted this dredging technique has been utilised on seven occasions since 2007 with no negative effects noted. Low volumes of the dredged material will be introduced to the River Tawe South of the barrage, with a proportion of this reaching Swansea Bay but in low dilutions.

As detailed in the dredging methodology the sediment is re-fluidised and uses the local currents to continue its natural pathway should the Tawe barrage not been constructed. This practice is widely regarded internationally as a beneficial use of the material, known as sediment cell maintenance, as it retains the naturally occurring sediments in the local environment rather than removing it to a foreign environment, potentially impacting on

offshore disposal areas. This method of dredging has been previously used at this site on seven occasions with no negative impacts reported.

No groundwater bodies are likely to be impacted by the proposed works.

9. Alternative Dredging & Disposal Methods

Due to the proposed method of dredging no material is removed from the aquatic environment, therefore no disposal operation takes place. By using the WID dredging method the required depths can be maintained by regular small scale WID campaigns. Should other, more intrusive, dredging methods be employed it would make economic sense to dredge much higher volumes but probably less frequently.

The recovery of the material from the aquatic environment would also have very substantial cost implications. Substantially larger dredging plant would be required to excavate the sediment. Ancillary plant would also be required for transportation of the dredged material to a remote disposal site, the nearest of which is 10km out into Swansea Bay. The cost of implementing such a process could increase the dredging costs considerably. Alternatively, beach nourishment or land reclamation is not feasible due to the very fine nature of the sediment.

Alternative disposal to land has been considered, but the spoil would have to be dewatered or dried and transferred by truck via busy roads through a densely populated area. If spoil was not dewatered then trucks would be needlessly transferring seawater along with the spoil to a land-based waste facility. The high potential for spills during the transfer from the vessel to the truck and from truck spillages on roads will have a consequential additional environmental impact. An alternative site for dewatering operations and recovery would also be required as the required space is not available on-site; such a site has not been identified.

10. Conclusions

The proposed pre-existing method of maintaining the marina navigational channels and berths is considered to be the most economic and environmentally sustainable option available.

The volumes being dredged and relocated within the dynamic environment are considered to be minor. The frequency and duration of operations are also minimal. The restricted dredging

hours each day also ensures that the volume of material relocated daily is limited, promoting a trickle charge regime of the local coastal areas.

The proposed dredging processes are established pre-existing techniques with no reported impacts on the local environment, including local river basins, coastal waters or third parties. It is concluded that the proposed dredging will not cause a non-temporary deterioration in status at water body level or otherwise affect the ability of the water body to achieve either its WFD objectives or relevant water-related protected area objectives.

Appendix A – Seabed Surface Soil Sample Analysis 2020

Including sample locations and diagram

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

Test Report ID	**MAR00588**
Issue Version	1
Customer	Swansea Council, Room 401, City & County of Swansea, The Guildhall, Swansea, SA1 4PE
Customer Reference	Swansea Marine Sediment Testing
Date Sampled	02-03-Mar-20
Date Received	09-Mar-20
Date Reported	27-Mar-20
Condition of samples	Frozen Satisfactory

Authorised by: Marya Hubbard

Position: Laboratory Manager

Any additional opinions or interpretations found in this report, are outside the scope of UKAS accreditation.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR00588
Issue Version	1
Customer Reference	Swansea Marine Sediment Testing

		Units	% M/M	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)
		Method No	SOCOTEC Env Chem*	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01
		Accreditation	UKAS/MMO	MMO	MMO	MMO	MMO	MMO
			Total Organic Carbon	45mm	31.5mm	22.4mm	16mm	11.2mm
Client Reference:	SOCOTEC Ref:	Matrix	-	-5.5	-5.0	-4.5	-4.0	-3.5
Site 3a	MAR00588.001	Sediment	7.30	0.52	1.04	0.69	2.61	0.70
Site 6a	MAR00588.003	Sediment	4.05	0.00	0.00	0.00	0.12	0.21
Site 9a	MAR00588.005	Sediment	14.1	0.00	0.00	0.00	0.19	0.37
Site 10a	MAR00588.006	Sediment	6.70	0.00	0.00	0.00	0.18	0.11

* See Report Notes

		Units	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)
		Method No	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01
		Accreditation	MMO	MMO	MMO	MMO	MMO	MMO
			8mm	5.6mm	4mm	2.8mm	2mm	1.4mm
Client Reference:	SOCOTEC Ref:	Matrix	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5
Site 3a	MAR00588.001	Sediment	1.01	0.67	0.65	0.52	0.50	0.55
Site 6a	MAR00588.003	Sediment	0.20	0.19	0.17	0.16	0.12	0.11
Site 9a	MAR00588.005	Sediment	0.99	1.18	1.84	2.34	2.45	2.44
Site 10a	MAR00588.006	Sediment	0.10	0.35	0.25	0.24	0.23	0.24

		Units	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)
		Method No	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01
		Accreditation	MMO	MMO	MMO	MMO	MMO	MMO
			1mm	707µm	500µm	353.6µm	250µm	176.8µm
Client Reference:	SOCOTEC Ref:	Matrix	0.0	0.5	1.0	1.5	2.0	2.5
Site 3a	MAR00588.001	Sediment	0.44	1.80	0.47	3.38	3.43	5.80
Site 6a	MAR00588.003	Sediment	0.12	0.01	1.49	4.04	5.25	14.39
Site 9a	MAR00588.005	Sediment	1.85	6.20	7.18	7.63	8.10	10.33
Site 10a	MAR00588.006	Sediment	0.28	0.48	1.75	3.69	4.29	14.11

		Units	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)
		Method No	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01
		Accreditation	MMO	MMO	MMO	MMO	MMO	MMO
			125µm	88.39µm	63µm	44.2µm	31.3µm	22.1µm
Client Reference:	SOCOTEC Ref:	Matrix	3.0	3.5	4.0	4.5	5.0	5.5
Site 3a	MAR00588.001	Sediment	8.92	8.44	9.60	9.38	8.09	7.00
Site 6a	MAR00588.003	Sediment	19.89	14.62	9.03	5.99	4.33	3.59
Site 9a	MAR00588.005	Sediment	9.88	6.75	4.97	4.23	3.83	3.65
Site 10a	MAR00588.006	Sediment	17.33	11.62	8.34	6.49	5.07	4.43

Certificate of Analysis

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		Units	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)
		Method No	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01
		Accreditation	MMO	MMO	MMO	MMO	MMO	MMO
			15.6µm	11µm	7.8µm	5.5µm	3.9µm	2.75µm
Client Reference:	SOCOTEC Ref:	Matrix	6.0	6.5	7.0	7.5	8.0	8.5
Site 3a	MAR00588.001	Sediment	5.75	4.89	3.89	2.93	1.98	1.25
Site 6a	MAR00588.003	Sediment	3.07	2.79	2.44	2.04	1.52	1.04
Site 9a	MAR00588.005	Sediment	3.25	2.79	2.24	1.72	1.17	0.72
Site 10a	MAR00588.006	Sediment	3.82	3.64	3.29	2.75	2.00	1.31

		Units	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)
		Method No	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01
		Accreditation	MMO	MMO	MMO	MMO	MMO	MMO
			1.95µm	1.38µm	0.98µm	0.69µm	0.49µm	0.34µm
Client Reference:	SOCOTEC Ref:	Matrix	9.0	9.5	10.0	10.5	11.0	11.5
Site 3a	MAR00588.001	Sediment	0.75	0.50	0.39	0.33	0.29	0.24
Site 6a	MAR00588.003	Sediment	0.68	0.47	0.38	0.33	0.30	0.26
Site 9a	MAR00588.005	Sediment	0.42	0.27	0.21	0.18	0.16	0.14
Site 10a	MAR00588.006	Sediment	0.80	0.54	0.44	0.39	0.35	0.31

		Units	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)	% (at 0.5phi intervals)
		Method No	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01	*SUB_01
		Accreditation	MMO	MMO	MMO	MMO	MMO	MMO
			0.24µm	0.17µm	0.12µm	0.09µm	0.06µm	0.04µm
Client Reference:	SOCOTEC Ref:	Matrix	12.0	12.5	13.0	13.5	14.0	14.5
Site 3a	MAR00588.001	Sediment	0.20	0.15	0.11	0.07	0.03	0.00
Site 6a	MAR00588.003	Sediment	0.22	0.18	0.14	0.09	0.04	0.00
Site 9a	MAR00588.005	Sediment	0.11	0.08	0.06	0.04	0.02	0.00
Site 10a	MAR00588.006	Sediment	0.26	0.21	0.16	0.10	0.04	0.01

		Units	% (at 0.5phi intervals)
		Method No	*SUB_01
		Accreditation	MMO
			<0.04µm
Client Reference:	SOCOTEC Ref:	Matrix	>14.5
Site 3a	MAR00588.001	Sediment	0.00
Site 6a	MAR00588.003	Sediment	0.00
Site 9a	MAR00588.005	Sediment	0.00
Site 10a	MAR00588.006	Sediment	0.00

Certificate of Analysis

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Test Report ID	MAR00588
Issue Version	1
Customer Reference	Swansea Marine Sediment Testing

		Units	mg/Kg (Dry Weight)							
		Method No	SOCOTEC Env Chem*							
		Limit of Detection	0.5	0.04	0.5	0.5	0.015	0.5	0.5	2
		Accreditation	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Arsenic (As)**	**Cadmium (Cd)**	**Chromium (Cr)**	**Copper (Cu)**	**Mercury (Hg)**	**Nickel (Ni)**	**Lead (Pb)**	**Zinc (Zn)**
Site 3a	MAR00588.001	Sediment	23.1	1.97	27.0	53.5	0.10	86.6	56.0	385
Site 6a	MAR00588.003	Sediment	19.9	1.08	27.1	46.8	0.06	62.2	48.8	259
Site 9a	MAR00588.005	Sediment	13.3	1.08	38.2	31.7	0.04	40.5	26.7	208
Site 10a	MAR00588.006	Sediment	20.4	1.32	39.8	48.2	0.12	59.4	49.7	263
Certified Reference Material SETOC 774 (% Recovery)			106	99	92	107	101	101	99	107
QC Blank			<0.5	<0.04	<0.5	<0.5	<0.015	<0.5	<0.5	<2

* See Report Notes

Certificate of Analysis

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Test Report ID	MAR00588
Issue Version	1
Customer Reference	Swansea Marine Sediment Testing

		Units	mg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	0.001	0.001
		Accreditation	MMO	MMO
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Dibutyltin (DBT)**	**Tributyltin (TBT)**
Site 3a	MAR00588.001	Sediment	<0.005	<0.005
Site 6a	MAR00588.003	Sediment	<0.005	<0.005
Site 9a	MAR00588.005	Sediment	<0.005	<0.005
Site 10a	MAR00588.006	Sediment	<0.005	<0.005
Certified Reference Material BCR-646 (% Recovery)			117	99
QC Blank			<0.001	<0.001

* See report notes

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SOCOTEC

Test Report ID MAR00588
Issue Version 1
Customer Reference Swansea Marine Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**ACENAPTH**	**ACENAPHY**	**ANTHRACN**	**BAA**	**BAP**	**BBF**
Site 3a	MAR00588.001	Sediment	94.9	28.8	138	548	578	677
Site 6a	MAR00588.003	Sediment	29.1	19.0	55.3	267	318	331
Site 9a	MAR00588.005	Sediment	100	17.4	146	638	594	665
Site 10a	MAR00588.006	Sediment	54.4	18.7	72.6	290	340	411
Certified Reference Material CRM180013 1941b (% Recovery)			76	87	66	65	60	88
QC Blank			<1	<1	<1	<1	<1	<1

~ Indicates result is for an In-house Reference Material as
no Certified Reference Materials are avaliable.
For full analyte name see method summaries

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS/MMO	UKAS/MMO	UKAS/MMO	MMO	MMO	MMO
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**BENZGHIP**	**BEP**	**BKF**	**C1N**	**C1PHEN**	**C2N**
Site 3a	MAR00588.001	Sediment	378	502	309	147	314	137
Site 6a	MAR00588.003	Sediment	202	251	148	56.2	148	48.4
Site 9a	MAR00588.005	Sediment	373	516	293	115	355	112
Site 10a	MAR00588.006	Sediment	255	312	178	80.0	162	66.8
Certified Reference Material CRM180013 1941b (% Recovery)			60	84	87	78	81	100
QC Blank			<1	<1	<1	<1	<1	<1

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	MMO	MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**C3N**	**CHRYSENE**	**DBENZAH**	**FLUORANT**	**FLUORENE**	**INDPYR**
Site 3a	MAR00588.001	Sediment	104	631	104	1140	92.4	407
Site 6a	MAR00588.003	Sediment	61.6	279	52.9	447	33.4	223
Site 9a	MAR00588.005	Sediment	87.1	907	94.0	1460	96.0	385
Site 10a	MAR00588.006	Sediment	48.3	364	70.6	556	47.5	273
Certified Reference Material CRM180013 1941b (% Recovery)			100	84	97	80	51	66
QC Blank			<1	<1	<1	<1	<1	<1

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	mg/Kg
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/305
		Limit of Detection	1	1	1	1	1
		Accreditation	UKAS/MMO	MMO	UKAS/MMO	UKAS/MMO	MMO
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**NAPTH**	**PERYLENE**	**PHENANT**	**PYRENE**	**THC**
Site 3a	MAR00588.001	Sediment	105	203	658	893	392
Site 6a	MAR00588.003	Sediment	56.7	106	224	374	286
Site 9a	MAR00588.005	Sediment	96.9	231	784	1200	438
Site 10a	MAR00588.006	Sediment	58.4	114	324	448	262
Certified Reference Material CRM180013 1941b (% Recovery)			62	61	77	71	111~
QC Blank			<1	<1	<1	<1	<1

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

Test Report ID MAR00588
Issue Version 1
Customer Reference Swansea Marine Sediment Testing

REPORT NOTES

Method Code	Sample ID	The following information should be taken into consideration when using the data contained within this report
*SUB_01	MAR00588.001-008	Analysis was conducted by an approved subcontracted laboratory.
SOCOTEC Env Chem*	MAR00588.001-008	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
ASC/SOP/301	MAR00588.001-008	The matrix of this sample has been found to interfere with the result for this test. The sample has therefore been diluted, but in doing so, the detection limit for this test has been elevated.
ASC/SOP/303/304	MAR00588.001-008	Chrysene is known to coelute with Triphenylene and these peaks can not be resolved in the PAHSED UKAS accredited method. Chrysene and Triphenylene are resolved for MMO but this is currently not UKAS accredited therefore Chrysene is reported without this acccreditation.

DEVIATING SAMPLE STATEMENT

Deviation Code	Deviation Definition	Sample ID	Deviation Details. The following information should be taken into consideration when using the data contained within this report
D1	Holding Time Exceeded	N/A	N/A
D2	Handling Time Exceeded	N/A	N/A
D3	Sample Contaminated through Damaged Packaging	N/A	N/A
D4	Sample Contaminated through Sampling	N/A	N/A
D5	Inappropriate Container/Packaging	N/A	N/A
D6	Damaged in Transit	N/A	N/A
D7	Insufficient Quantity of Sample	N/A	N/A
D8	Inappropriate Headspace	N/A	N/A
D9	Retained at Incorrect Temperature	N/A	N/A
D10	Lack of Date & Time of Sampling	N/A	N/A
D11	Insufficient Sample Details	N/A	N/A
D12	Sample integrity compromised or not suitable for analysis	N/A	N/A

Certificate of Analysis

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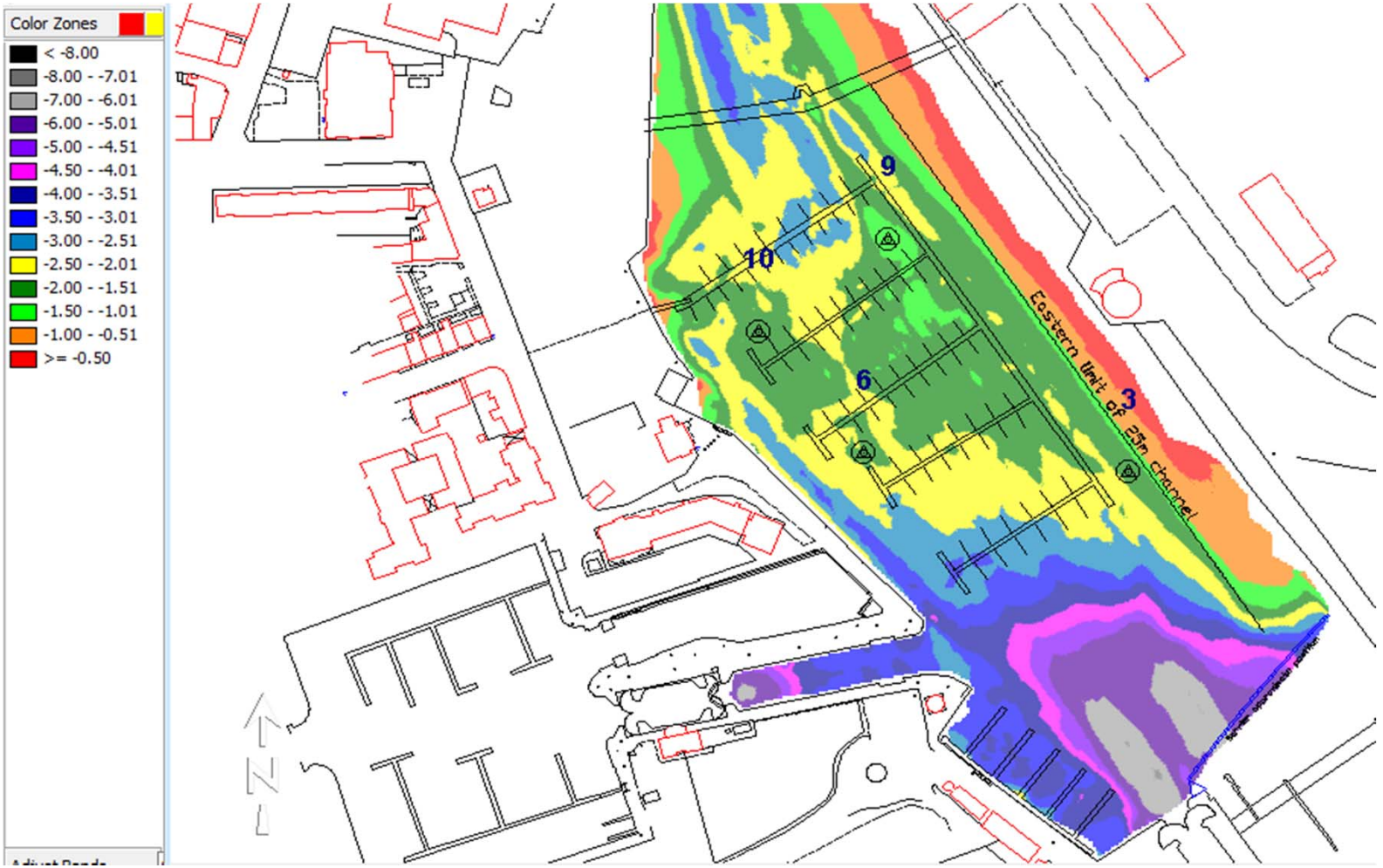
Test Report ID	MAR00588
Issue Version	1
Customer Reference	Swansea Marine Sediment Testing

Method	Sample and Fraction Size	Method Summary
Particle Size Analysis	Wet Sediment	Wet and dry sieving followed by laser diffraction analysis.
Total Organic Carbon (TOC)	Air dried	Carbonate removal and sulphurous acid/combustion at 1600°C/NDIR.
Metals	Air dried	Aqua-regia extraction followed by ICP analysis.
Organotins	Wet Sediment	Solvent extraction and derivatisation followed by GC-MS analysis.
Polyaromatic Hydrocarbons (PAH)	Wet Sediment	Solvent extraction and clean up followed by GC-MS analysis.
Total Hydrocarbon Content (THC)	Wet Sediment	Ultra-violet fluorescence spectroscopy

Analyte Definitions

Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name
ACENAPTH	Acenaphthene	C2N	C2-naphthalenes	THC	Total Hydrocarbon Content
ACENAPHY	Acenaphthylene	C3N	C3-naphthalenes	AHCH	alpha-Hexachlorcyclohexane
ANTHRACN	Anthracene	CHRYSENE	Chrysene	BHCH	beta-Hexachlorcyclohexane
BAA	Benzo[a]anthracene	DBENZAH	Diben[ah]anthracene	GHCH	gamma-Hexachlorcyclohexane
BAP	Benzo[a]pyrene	FLUORANT	Fluoranthene	DIELDRIN	Dieldrin
BBF	Benzo[b]fluoranthene	FLUORENE	Fluorene	HCB	Hexachlorobenzene
BEP	Benzo[e]pyrene	INDPYR	Indeno[1,2,3-cd]pyrene	PPDDE	p,p'-Dichorodiphenyldicloroethylene
BENZGHIP	Benzo[ghi]perylene	NAPTH	Naphthalene	PPDDT	p,p'-Dichorodiphenyltrichloroethane
BKF	Benzo[k]fluoranthene	PERYLENE	Perylene	PPTDE	p,p'-Dichorodiphenyldicloroethane
C1N	C1-naphthalenes	PHENANT	Phenanthrene		
C1PHEN	C1-phenanthrene	PYRENE	Pyrene		

Name	OS East	OS North	WGS84 Lat	WGS84 Long
3	**266412.9**	**192758.1**	**51 37 2.2976 N**	**003 55 47.1332 W**
6	**266297.9**	**192766.7**	**51 37 2.4766 N**	**003 55 53.1223 W**
9	**266308.2**	**192863.7**	**51 37 5.6227 N**	**003 55 52.7164 W**
10	**266252.3**	**192821.7**	**51 37 4.2178 N**	**003 55 55.5654 W**



Depth colours shown are relative to the Primary Weir Crest of the barrage. Target dredge depth is -2.50mPWC so yellow and green areas need to be dredged