13. Aquatic Ecology

Appendix 13.1

AQUATIC ECOLOGY TECHNICAL REPORT

Everton Stadium Development Limited

Bramley-Moore Dock
Aquatic Ecology Technical Report

Fish / Shellfish Ecology and Fisheries
Benthic Ecology
Marine Mammal Ecology
Sediment Chemistry

Carcinus Reference: J0581/20/01/03
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Carcinus Ltd, Wessex House, Upper Market Street, Eastleigh, Hampshire, SO50 9FD.
Tel. 023 8129 0095
https://www.carcinus.co.uk/

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	Name	Role	Date
Author	Matthew Davison Matthew Crabb Joshua Baker Lucy Shuff Rayner Piper	Director Director Marine and Freshwater Ecologist Associate Ecologist Associate Ecologist	03 January 2020 – 25 January 2021
Checked	Despina Crabb	Quality Assurance	03 January 2020
Approved	Matthew Davison (v1.3) Matthew Crabb (v1.4)	Director Director	03 January 2020 21 August 2020

This report was produced by Carcinus Ltd (Carcinus) on behalf of Everton Stadium Development Limited for the purposes of providing an aquatic ecology environmental statement in relation to the proposed Everton Stadium Development environmental impact assessment (EIA) of Bramley-Moore Dock, Liverpool. Every effort has been made to ensure the information contained within is as complete and valid as possible at the time of writing. It should be noted that additional information may have existed at the time of publication of this report that was not available, not identified or has subsequently been published after the date of this report.

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1. Introduction

Carcinus Ltd (Carcinus) was commissioned by WYG (now Tetra Tech Limited) on behalf of Everton Stadium Development Limited (the client; hereafter 'Everton') to describe baseline conditions and assess the potential environmental impacts of the proposed Everton stadium development within Bramley-Moore Dock (BMD), Liverpool on aquatic receptors. Relevant receptors included within this Technical Report are outlined below:

- Fish and shellfish ecology / Fisheries;
- Benthic ecology;
- Marine mammals; and
- Sediment chemistry.

A planning application for the proposed stadium at Bramley-Moore Dock was submitted to Liverpool City Council ('LCC') in December 2019 (LPA reference 20F/0001) and subject to statutory consultation. An application for a marine licence was also submitted to the Marine Management Organisation (MMO) in March 2020 (MMO reference: MLA/2020/00109).

Following the receipt of wider consultation feedback, the stadium design has been updated, requiring a revised application submission to be prepared. The original report submitted with the planning application has therefore been updated to address the consultation feedback and take account of further changes to the scheme and also the construction management plan ('CMP' updated by Laing O'Rourke).

Changes to the CMP are set out in Section 1.2 of this report. A comprehensive overview of the post submission consultation responses and how these are addressed in this updated report are summarised in Table 1 of Section 2 of the report.

1.1. Site Description

The application site is located at BMD in Liverpool, National Grid Reference SJ 33452 92491. BMD forms a small part of a larger dock and canal network along the River Mersey. The outlet to the Leeds and Liverpool canal is approximately 0.5 km south of the site into Stanley Dock via Collingwood Dock. The retained water level within the dock system is isolated from the tidal River Mersey via a system of lock gates at Langdon Dock, approximately 1.8 km to the north.

The site is 8.67 hectares and is bounded to the north by the United Utilities wastewater treatment plant and Sandon Half-Tide Dock, to the east by Regent Road, to the south by Nelson Dock and to the west by the River Mersey wall. The western boundary of the site is limited to the foot of the concrete crown wall, built on top of the River Mersey wall.

The application site is currently occupied by a two-storey structure that sits at the western end of the north wharf and a shed structure on the southern wharf. Both structures are unlisted and proposed to be demolished. The Hydraulic Engine House, which is Grade II Listed (referred to as Hydraulic Tower), is in the northeast corner of the site and is to be retained within the proposed scheme.

Other small structures will be demolished as shown in the demolition plan prepared by Pattern Design. Please refer to the drawings submitted with the planning application for reference.

1.1.1. Existing Dock Structures

The BMD basin is surrounded by Grade II Listed masonry dock basin walls (hereafter referred to as the BMD walls). The BMD walls are approximately 10 m in height, with a top of wall level of 6.6 m above ordnance datum (AOD) and a basin bed (floor) level of approximately -3.4 m ordnance datum (OD).

Within the northern entrance of BMD, there are existing timber lock gates which are held in the open position to maintain flow and navigation between BMD and Sandon Half-Tide Dock. Further north the two Sandon Half-Tide Dock lock entrances have been blocked off with isolation caisson structures.

There is an existing (southern) isolation structure located between BMD and Nelson Dock, which is of sheet pile construction. This was constructed in 2007 as part of the Liverpool Canal Link project and enables the water levels within Nelson Dock and the south system to be isolated from water level changes within the northern docks. At 7.5 m AOD, the crest level of the structure is higher than the surrounding ground and dock basin wall levels. There are eight 600 mm diameter pipes with sluice gates within the isolation structure, which provide hydraulic connectivity between north and south when the gates are open.

1.2. Project Description

The proposed revisions to the scheme since the submission of the planning application (LPA ref. 20F/0001) in December 2019 is provided in the Planning Statement and Environmental Statement which have been updated for the revised submission. In summary, the proposed development remains for a 52,888 seated capacity stadium with associated facilities and infrastructure.

To enable the proposed development, all buildings will be demolished except for the Grade II listed Hydraulic Tower, which will be retained. The Grade II BMD walls will also be retained and infilled, with a shallow water channel, oriented north to south, to be excavated from the infill on the western side of the dock.

A summary of the construction sequence affecting the aquatic environment is provided below:

- Installation of bubble curtain at northern BMD entrance;
- Undertake stage 1 fish removal and relocation;
- Raking of dock bed;
- Installation of silt curtain and decommissioning of bubble curtain;
- Implementation of temporary isolation structure;
- Undertake stage 2 fish removal and relocation;
- BMD basin infilled followed by stadium construction;
- Installation of permanent northern isolation structure;
- New retaining wall installed through dock infill to form the eastern edge of the new water channel;
- Infill material excavated to form the new water channel; and
- Northern isolation structure culverts opened to provide hydraulic connectively between north and south.

Only works predicted to affect the aquatic environment are considered in this chapter, as summarised from the Construction Management Plan (CMP), dock infill methodology and northern isolation structure methodology below.

1.2.1. Bubble Curtain Installation

Prior to the first stage fish removal and raking operation a bubble curtain will be installed across the northern mouth of the entrance channel between Sandon Half Tide Dock and Bramley Moore Dock. The curtain will prevent fish from re-entering the dock and disturbed dock debris from migrating into Sandon Half Tide Dock. The bubble curtains will be in place until they are replaced by a silt curtain (see Section 1.2.4).

1.2.2. Initial fish rescue

Fish rescue and translocation will take place in advance of the raking process. This is required to minimise the potential for fish mortality during the infilling process from reduced dissolved oxygen levels, loss of habitat and exposure. Every effort will be made to remove as many fish as possible, but no guarantee can be given that all fish will be caught and translocated during the rescue due to equipment limitations. Fish will be released back into the wider dock network. The methods used to remove fish will focus on those species known to be resident in BMD, including pouting, European eel and coal fish.

1.2.3. Bramley-Moore Dock Raking

It will be necessary to systematically rake the dock bed within BMD to remove any surface debris. The raking exercise is expected to move through the upper layer of unconsolidated material (fine mud / silt) within the dock bed. This process will cause agitation of the upper sediment layer which will require a minimum of a two to three-month lay period post raking to allow fine sediment material to settle.

1.2.4. Installation of silt curtain

Following completion of the raking operation, a silt curtain will be installed slightly inboard of the bubble screen. After installation, the bubble curtain will be decommissioned and removed from site. The silt curtain will service the same purpose as the bubble curtain, preventing fish from re-entering BMD and preventing migration of disturbed BMD deposits from migrating to Sandon Half Tide Dock.

1.2.5. Dock Closure

The dock must be fully enclosed prior to commencement of the filling process. The existing isolation structure at the southern end already allows a degree of hydraulic connectivity via a series of pipes. This will be replicated in a new northern isolation structure.

The northern isolation structure is proposed to be constructed between BMD and Sandon Half-Tide Dock. Eight pipes will be cast in between the two sheet piles at identical levels to the existing southern isolation structure to enable the exchange of dock water to the north and south. The initial plans called for the sheet piles to be installed by percussive piling within water, however this has subsequently changed. Instead, a temporary design solution has been developed whereby approximately 14,000 m^3 of 6F2 material and or/aggregate will be placed within the entrance channel forming a temporary bund between BMD and Sandon Half Tide dock. Use of the temporary structure mitigates the need for any 'wet' piling works as the structure can be subsequently created from the landward side post infilling.

During construction, whilst the dock is infilled and the isolation structure in place, it is likely that salinity and dissolved oxygen levels will fluctuate over time. Monitoring of flow data indicates that Nelson Dock receives significantly more input from water bodies to the south than BMD to the north. Furthermore, existing port operations downstream of the southern water body (Nelson Dock) mean that the environment is dynamic and subject to frequent changes and so any changes caused by the

isolation structure are likely to be within the natural levels of variation and stagnation caused by isolation from northern water bodies is unlikely to occur.

1.2.6. Follow-up Fish Rescue

On completion of the dock closure works, a second fish rescue and translocation exercise will be undertaken to remove any potential remaining fish from the dock waters following the same methods as previous.

1.2.7. Bramley-Moore Dock Infilling

Infilling will commence following the BuroHappold methodology (Burohappold Engineering, 2019). This involves pumping approximately 480,000 m^3 of marine won material into BMD. The lower layers will be placed using a floating spreader pontoon, which ensures accurate placement of the material onto the existing sediment. The upper layers will be placed directly via a floating pipeline from a Shoreway class Trailing Suction Hopper Dredger (TSHD). The TSHD will be moored within the lower Mersey Estuary between 300 m and 400 m from BMD at a location not affected by the tide, i.e. to prevent risk of grounding at low water.

During pumping operations, it will be necessary to abstract water directly from the Mersey to fluidise the aggregate to facilitate pumping. To mitigate entrainment of elver (juvenile European eel), the abstraction will not take place during peak migratory periods (March to April) and will only take place mid-water. Water abstraction will take place for less than two hours a day, six days a week (24 hrs/week) for a period of 10 weeks.

Water used during the pumping process will be discharged back into the Liverpool Dock (Sandon Half-Tide Dock) system by a weir system at the dock closure structure. No additional pumping capacity to discharge the water back into the River Mersey or elsewhere within the dock system is in place.

As BMD is progressively filled, the existing dock water will be naturally displaced into the dock network to the north. At the displacement location (adjacent to the isolation structure), a stilling pond will be created to slow water flow and allow any fines to settle out before being displaced. This will be created by shaping the infilled sand once it is filled to the existing dock water level. It is anticipated that there will be approximately 56,000 m^3 of discharged water every day based on four separate pumping cycles.

1.2.8. Installation of Permanent Northern Isolation Structure

A structure to permanently isolate Bramley-Moore Dock from the northern waterbodies will be installed once infilling is completed. The proposed solution involves the construction of two secant pile walls consisting of a series of reinforced concrete piles in the ‘dry’ area to the south of the temporary isolation structure that interlock to form a watertight barrier. Similar to the existing southern isolation structure, it may be necessary to use horizontal ties. Eight pipes will be cast in between the two rows of piles at identical levels to the existing southern isolation structure to enable dock water exchange to the north and south.

1.2.9. Formation of the Western Water Channel

The western channel will be formed once the area is no longer required logistically for construction of the West Stand. Sand will be excavated to reveal the original dock wall and the valve arrangements between the adjacent docks used to fill the channel. The new water channel will provide hydraulic connectivity between Sandon Half-Tide Dock and Nelson Dock. This will be a non-navigable channel with isolation structures at its northern and southern ends.

The water channel bed will be designed to be fill to 2.90 mAOD, with the maximum water level below the bottom of the pipes contained within the isolation structure to ensure any silt build up does not restrict the flow of dock water through the pipes.

1.2.10. Piling Platforms and Crane Working Platforms

Piling will be carried out from both existing quays after breaking out the surface concrete, and from the old dock basin after infilling with marine sand. No piling activities will take place in water or within the River Mersey channel itself.

1.2.11. Overground Development

Over ground development such as installation of the superstructure for the east and west stands, terracing and roofing will result in a degree of overshadowing and artificial lighting to neighbouring environs. Consideration of light / shade is provided within the following chapter.

1.3. Objectives

The specific objectives of the Aquatic Ecology Technical Report are as follows:

- Describe existing baseline conditions to characterise fish, benthic macroinvertebrate and marine mammal species and habitats within and around the development, including sediment chemistry within the Bramley-Moore Dock (see Appendix I);
- Identify and describe rare species and habitats of conservation importance or of commercial value; and
- Assess receptors using Charted Institute of Ecology and Environmental Management (CIEEM) guidelines for ecological impact assessment in the UK and Ireland (as described below).

2. Scoping & Consultation

The proposed development has undergone a comprehensive scoping assessment detailed within the Environmental Impact Assessment Scoping Report (CBRE, 2017). Aquatic ecosystems and ecological complexes were screened into the assessment as part of this process. The benthic ecology of BMD was identified as a potential receptor in relation to the marine fauna and flora inhabiting the vertical dock walls, submerged structures and soft sediment environments as well as the surrounding environs of the lower Mersey and wider Liverpool dock network. In this regard, the following considerations were outlined:

- Consideration to Invasive Non-Native Species (INNS) was screened in due to Legislation being in place under Section 14(1) of the Wildlife and Countryside Act (WCA) 1981 making it illegal to release or allow to escape any animal which is not ordinarily a resident of the UK;
- Fish receptors were screened into the assessment due to the level of disturbance to species of conservation importance such as European eel *Anguilla anguilla* that may arise from the proposed development; and
- Consideration of sediment bound contaminants such as Tributyltin (TBT), which are likely to be present in sediments due to the industrial past of the area. There is potential for these contaminants to be released into the Mersey estuary and wider marine environment during the construction process.

Consultation responses were received in relation to ecology from Natural England (NE June 2017), Environment Agency (EA June 2017), Marine Management Organisation (MMO September 2017) and Merseyside Environmental Advisory Service (MEAS June 2017). Responses highlighted the

requirement to assess potential impacts upon fish species associated with the River Mersey (i.e. Atlantic salmon), benthic invertebrates and potential introduction of invasive non-native species

No formal scoping report was produced for this project in 2019, however a meeting was held between WYG, NE and MEAS on Monday the 9th of August 2019 in order to confirm requirements of consultees in relation to this assessment. During this meeting, aquatic ecology survey effort was discussed and agreed as appropriate in principle. MEAS made no comment in relation to aquatic ecology in their consultation response (dated 21st August 2019). Consultation response received from Natural England (dated 2nd September 2019) highlights the requirement to consider the marine environment /dock waters within ecological assessment, in particular potential impacts which may affect the River Mersey during the construction phase.

Additional consultation responses were received in July / Aug 2020 from the EA, MMO and Cefas, following a review of draft ES chapters and are addressed within this ES as follows:

Table 1: July / Aug 2020 Consultation responses and how addressed within the ES.

Consultee	Comment relevant to this chapter	Where / how addressed
EA – Draft Response July 2020	More information of the fish rescue including the removal method.	Further information on the proposed fish rescue and removal methods are provided in the CMP, Appendix 4.1, ES Volume III.
	Ensure the applicant turns of the fish bubble curtain when laying membrane to give fish an opportunity to leave.	The construction methodology has evolved and installation of a membrane is now no longer proposed. A phase 1 fish removal shall take place prior to bed preparations within BMD. Once completed, bed raking will take place with the bubble curtain in place to allow vessel access to BMD. On completion, the bubble curtain shall be replaced with a silt curtain. This is considered important mitigation for the retention of resuspended sediments and possible mobilised INNS within BMD. It will therefore not be possible to allow fish species to leave during these works. A second stage fish rescue will be undertaken prior to the initial laying of aggregate.
	Request a biosecurity plan and method statement to prevent the spread of non-native species.	A Biodiversity Security Plan (BSP) incorporating a Biosecurity Risk assessment will be prepared. The pre-emptive preparation of a BSP will help flag up and address any key issues with the removal of species in this area which can support licence applications and be provided to consultees.
	New channel design details between the docks to include artificial habitat	Mitigation measures in the form of biodiversity enhancements within the

Consultee	Comment relevant to this chapter	Where / how addressed
	features to increase ecological complexities to make it easier for wildlife to colonise it (environmental net gain). Including this such as artificial cracks, crevices, reefs and or floating islands, all to go some way to mitigate for the loss of the dock.	western channel are detailed within this report. It is proposed that a habitat creation plan for the water channel is subject to an appropriate planning condition which will enable the applicant to submit relevant details for approval by Liverpool City Council (as statutory planning authority) and the Environment Agency
EA - Response Aug 2020	As this is a difficult place to catch and remove fish, to ensure their safety more information should be provided detailing the fish rescue being proposed, including the chosen method of removal. While we have previously requested this as part of a scoping opinion we believe this can still be secured, possibly by condition on any marine licence consented.	Further information on the proposed fish rescue and removal methods are provided in the CMP, Appendix 4.1, ES Volume III xxxxx
	We understand a bubble curtain will be installed at the northern water channel adjacent to Sandon Half-Tide Dock to prevent fish from entering the dock after the rescue has taken place. While this is sensible it should be turned off during the laying of membrane and infilling to provide an opportunity for any remaining fish to leave the dock.	No membrane is now proposed as part of the construction methodology. A phase 1 fish removal shall take place prior to bed preparations within BMD. Once completed, bed raking will take place with the bubble curtain in place to allow vessel access to BMD. On completion, the bubble curtain shall be replaced with a silt curtain. This is considered important mitigation for the retention of resuspended sediments and possible mobilised INNS within BMD. It will therefore not be possible to allow fish species to leave during these works. A second stage fish rescue will be undertaken prior to the initial laying of aggregate.
	In terms of underwater noise and vibration we feel the overall sensitivity of salmon to noise and its ability to disrupt their migratory behaviour may be underestimated within the application. However, the conclusion that aggregate pumping noise will not disrupt fish is accepted.	Aggregate pumping (and associated vessel movements) will be the only activity taking place within the main river channel. As such we have assessed this and on the premise that aggregate pumping noise will not disrupt fish, no significant effect is anticipated in terms of disruption to migratory behaviour.
	Invasive non-native species have a negative impact on native species and habitats and cost the British economy approximately £1.7 billion per year. The spread of certain invasive non-native	A Biodiversity Security Plan (BSP) incorporating a Biosecurity Risk assessment will be prepared. The pre-emptive

Consultee	Comment relevant to this chapter	Where / how addressed
	species is prohibited under Schedule 9 of the Wildlife & Countryside Act 1981. It is important invasive non-native species are not spread around the proposed development site, transported to other locations off site or brought on to the site from elsewhere, for example on equipment and machinery or personal protective equipment. As such we request a condition securing a biosecurity plan and method statement to be undertaken, approved prior to any works commencing within the dock and fully implemented thereafter.	preparation of a BSP will help flag up and address any key issues with the removal of species in this area which can support licence applications and be provided to consultees.
	In order to provide some mitigation for the loss of the dock as a habitat in line with our Water Framework Directive Compliance Assessment for the scheme, details of the new channel design should be provided including artificial habitat features to increase ecological complexities to make it easier for wildlife to colonise it. Examples include, but should not be limited to, artificial cracks, crevices, reefs and floating islands. All of these will go some way to providing some mitigation and could be secured by way of a condition. We would wish to review the new channel design in the future.	Mitigation measures in the form of biodiversity enhancements within the western channel are detailed within this report. It is proposed that a habitat creation plan for the water channel is subject to an appropriate planning condition which will enable the applicant to submit relevant details for approval by Liverpool City Council (as statutory planning authority) and the Environment Agency.
Cefas Fisheries – July 2020	The applicant has correctly identified fish receptors and associated potential impacts for the project. Suitable data and literature have been used to inform the assessment including site-specific surveys, and assumptions and limitations of this evidence have been acknowledged. I support the proposed mitigation measures which include removal of fish prior to infilling of BMD and conducting all piling operations in the 'dry'.	Noted – no changes made
	The Applicant has sufficiently characterised the fish ecology of BMD using a combination of desk-based review and field surveys; the latter consisted of a combined hydroacoustic and fyke netting survey, which was conducted in September 2017.	Full details of the survey methods employed, and results are presented in Appendix I.

Consultee	Comment relevant to this chapter	Where / how addressed
	It is acknowledged that fyke nets were also deployed perpendicular to the banks to capture fish for the purposes of identification and length measurement. However, it should be noted that only summary information from the surveys were presented in the ES and consequently Cefas fisheries advisors have not reviewed the survey methodology or sampling techniques, though this is probably not necessary given the survey data is supplemented with the desk-based review.	
	Additionally, data was gathered using Environment Agency (EA) compliant techniques and survey effort was agreed in principle with Natural England (NE) at a meeting held on Monday the 9th of August 2019 which discussed the aquatic ecology assessment.	Noted – no changes made
	Species from with a 2 km radius of the project have been collated from the Local Environmental Records Centre (LERC) and data held by the National Biological Network (NBN) have also been incorporated into the assessment. The commercial fisheries assessment is primarily based on the review of commercial catch data landed over a five-year period (2014-2018) from within ICES statistical rectangle 35E6, which is appropriate.	Noted – no changes made
	Several information and data sources have been used to support the fish ecology assessment and landings data have been examined to underpin the commercial fisheries assessment (see Question 1 responses). Appropriate and relevant fish receptors have been suitably assessed. Individual species' conservation designations, as well as spawning, nursery, foraging and migratory grounds and pathways have been discussed. The key fish biota found in the vicinity of the proposed stadium and River Mersey have been recognised including the migratory species Atlantic salmon *Salmo salar,* sea trout *Salmo trutta*, European	Noted – no changes made

Consultee	Comment relevant to this chapter	Where / how addressed
	eel *Anguilla anguilla*, river sea lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*, as well as the individual life stages potential sensitives. The ES recognises that bib *Trisopterus luscus* saithe *Pollachius virens*, European eel, Dover sole *Solea solea* and plaice *Pleuronectes platessa* are all found within BMD, as evidenced by the fyke net sampling. Furthermore, four fish species cited under NERC Section 413 have been recorded within 2 km of BMD; Atlantic cod *Gadus morhua*, European eel *Anguilla anguilla*, European plaice *Pleuronectes platessa* and whiting *Merlangius merlangus*. It is recognised that the ES concludes based on the fyke net sampling, that BMD was not considered a fish nursery and that the presence of European eel does not warrant special status.	
	All potential construction and operational impacts have been suitably identified and satisfactorily assessed. These include the following construction impacts: habitat disturbance; increased suspended sediment concentration (SSC); entrainment; underwater noise and vibration; changes to hydrodynamic regime; unplanned accidental spill; and release of environmentally harmful substances4, and operational impacts: net loss of habitat and light pollution / overshadowing	Noted – no changes made
	It is acknowledged that during the BMD infill process it will be necessary to pump aggregate from the TSHD via a floating pipe and that while predominantly demersal species are unlikely to be affected, elvers that could be ubiquitously distributed throughout River Mersey channel may be susceptible to entrainment by the dredger. Mitigation measures have been proposed to alleviate potential entrainment (paragraph 25). Furthermore, the ES correctly concludes that any fish caught within BMD during infill are likely to perish as a result of the	Noted – no changes made

Consultee	Comment relevant to this chapter	Where / how addressed
	process, accordingly fish rescue and netted curtain mitigation has been proposed which should reduce the likelihood of fish becoming trapped (paragraph 25).	
	Hydrological connectivity between Nelson Dock and Sandon Half-Tide Dock will be re-established and fully operational after construction. Submerged pipes installed within the western water channel will help water regulation and I agree that this will reduce environmental stress to fish and could allow recolonisation in these docks	Noted – no changes made
	Importantly, the Applicant has acknowledged the assumptions and limitations of the assessment presented in the ES. Data limitations such the seasonal and 'snapshot' nature of the fyke net survey, as well as the caveats associated with supporting material such as using broad scale maps to define and infer site-specific migratory pathways and spawning and nursery ground information, have been suitably highlighted.	Noted – no changes made
	All proposed mitigation measures are suitable and supported by Cefas fisheries advisors. Furthermore, it is recognised that various water quality parameters, including dissolved oxygen and salinity, will be actively monitored in Nelson Dock prior to and during construction. Parameters will be monitored against the established baseline to help mitigate the risk of stagnation and fish mortality.	Noted – no changes made
	Additionally, it is noted that piling can be solely conducted in 'dry' conditions as the selected construction approach will conduct all percussive piling after the dock has been drained. Several one tonne ballast bags will be placed in the water channel north of the permanent isolation structure location forming a temporary hydrological barrier that allows the stadium structure piling works to be undertaken from the landward side post infilling. Best practice piling measures will also be adopted during the	Noted – no changes made

Consultee	Comment relevant to this chapter	Where / how addressed
	construction phase; Appendix 12.1 states that "where practicable, percussive piling activities should be scheduled to avoid migration/mating periods of sensitive ecological species as advised by the project ecologist".	
	Although as many fish as possible will be rescued, it is acknowledged that the Applicant does not guarantee that all fish will be caught and translocated during the process due to equipment limitations. I support the approach that Methods will be agreed in advance with the relevant Statutory Nature Conservation Bodies (SNCBs).	Further information on the proposed fish rescue and removal methods are provided in the CMP, Appendix 4.1, ES Volume III xxxxx
Cefas Shellfisheries – June 2020	the evidence provided for this project is consistent with that submitted for operations of a similar nature. The applicant has used evidence of species present from surveys conducted at the site as well as landings data from the appropriate ICES rectangles.	Noted – no changes made
	The applicant has identified all relevant shellfish receptors, these include several species of crab, edible cockle, pink shrimp, blue mussel, and others. The applicant has correctly identified the potential impacts of the project, these include, species displacement, habitat loss and contamination. I do agree that potential impacts and therefore receptors have been assessed appropriately.	Noted – no changes made
	There is no direct mention of shellfish species within some documents. I have assumed for the purpose of this document that shellfish species are included within the tittle 'fish fauna' in document appendix 11.7. This should be clarified.	Appendix 11.7 updated to clarify
	I do not consider that any shellfish specific mitigation measure is required for this activity. Embedded mitigations already proposed for this project are sufficient	Noted – no changes made
	I do not consider any further evidence is required to support this application.	Noted – no changes made

Consultee	Comment relevant to this chapter	Where / how addressed
	I do agree with the conclusions reached in section 8.1 of appendix 11.7 that there may be some localised changes to shellfish species but that there will be no long-term impacts caused by the proposed works. I also agree with the conclusions presented with the Aquatic Ecology Technical Report.	Noted – no changes made
Cefas Dredge and Disposal – July 2020	The appendix also describes Canadian ISQGs, stating that whilst these are specific to Canada's environment, that; "In the absence of suitable alternatives, however, it has become commonplace for these guidelines to be used by regulatory and statutory bodies in the UK". This could be the case for the terrestrial environment in the UK, however, this is not the case for the marine environment and should be amended. Beyond this statement, no material justification for the inclusion of Canadian ISQGs is given. There may be a case for using these guidelines for very specific scenarios, however, their use would likely be additional only, and I do not consider the proposed works such a scenario. As such, I will not consider the applicant's interpretation using ISQGs.	Sediment data are compared against a variety of quality guidelines including the Cefas Action Levels. As stated, given the lack of equivalent environmental effect standards within the UK, these have been included to provide additional context.
	The report states that; "Where concentrations were reported at below the Limit of Detection (LOD), results were interpreted at face value". It is unclear from the report as to what "face value" means in the scientific context of regulatory assessment for the dredging and disposal of marine sediment. This should be clarified.	This has been made clear within the ES. Results reported at less than the LOD are used at the LOD value for statistical calculations such as mean.
	The report then describes each analyte group in turn (i.e. metals, tins etc). For each analyte group, the applicant assesses the mean value for each analyte against both Cefas ALs. The applicant should provide justification as to why they have only presented the mean analyte values and not the dataset in its entirety or multiple average metrics. Cefas does not base regulatory assessment for the dredging and disposal	Full results and analysis methods are presented within Appendix II

Consultee	Comment relevant to this chapter	Where / how addressed
	of marine sediment on mean values alone. In this regard, I consider the evidence provided incomplete and inappropriately interpreted. Further, without knowing the sampling regime (i.e. number of samples and depths of repeat samples) and spread of the results, it is impossible to ascertain how representative the mean value is of the sediment in question.	
	From my assessment of the report, neither the contracting laboratory for sediment chemical composition nor the testing method for each analyte have been specified. The results provided thus cannot be accurately assessed until the laboratory and testing methods used have been clarified.	Full results and analysis methods are presented within Appendix II
	I take this point to note that whilst the report references and discusses results below the LOD value for various analytes, they have not specified what the LOD values are. The LOD value is not a universal number and varies for each analyte and each laboratory. As such, along with relevant laboratory and method information, the applicant should clarify their LOD values.	Full results including LODs and analysis methods are presented within Appendix II
	In describing the properties and distribution of PAHs, the report states: "Although they can be formed from natural process such as oil seeps and forest fire, they are predominantly of anthropogenic origin." It would be more accurate to state that the entry of PAHs into the environment is partially due to human activities as the text currently implies that their formation is anthropogenic (i.e. synthetic) rather than natural. Further, it is difficult to give a confident measurement of the extent to which the environmental presence of PAHs is anthropogenic.	This text has been amended.
	The report states that; "Mean sediment concentrations of organo-tin across all Stations within BMD were compared against Cefas AL1 (Note: no AL2 exists for PAHs)". I presume the applicant is	This error has been corrected

Consultee	Comment relevant to this chapter	Where / how addressed
	referring to PAHs rather than organotins in this paragraph.	
	When describing the PAH analysis, the report cites "US EPA", which I presume refers to the USA Environment Protection Agency and their list of 16 priority PAH analytes. I presume that this means the applicant has only tested for 16 PAH analytes, rather than the 22 PAH analytes tested for in the UK under OSPAR. The applicant should clarify this and give justification as to why only 16 PAH analytes were tested for	The survey strategy and sampling was devised in 2017, in order to provide a suitable baseline for the purposes of the Marine Ecology EIA. Noting that a confidentiality agreement meant it was not possible to consult on this scope prior to the EIA documentation entering the public domain. As the sediment is being retained *in situ*, we do not consider that the missing PAH analytes will materially affect the mitigation measures or construction/infill methodology that is proposed. Therefore consider the existing testing suite to be sufficiently robust to inform our assessment.
	In Figure 5 (Bargraph detailing PAH results), the AL1 value for Dibenzo(a,h)anthracene appears to be listed as the same as all other PAH analytes (0.1 mg/kg). This is incorrect, the AL1 value for this analyte is 0.01 mg/kg. Thus, the figure is misleading. Further, as comment 16 (of this advice minute), PAH results are only presented in their mean value. I take this point to reiterate my concerns with only presenting the mean value.	Levels were taken from the following reference and were checked again prior to publication. UK Government, (2020). Marine Licensing: sediment analysis and sample plans. Available at: https://www.gov.uk/guidance/marine-licensing-sediment-analysis-and-sample-plans###Suitability%20of%20material, Accessed: 14th August 2020.
	The last y-value of Figure 5 lists "PAH Total (USEPA – 16)". Does this represent mean total PAH value per sample station? Or is this the Total Hydrocarbon Content (THC) value (note that this is a separate metric). If it is the former, has this value been controlled for different sediment characteristics in each sample station, such as dry weight, total organic content etc? I find it difficult to comprehend both what this is trying to show and its usefulness as a value.	Figure title has been updated to make more clear. The value presented is the mean concentration of total PAHs (USEPA16) across all samples.
	Whilst the ES does not refer to the analysis of Polychlorinated Biphenyls (PCBs), the appendix states that these were analysed for, and presents the results. As with other analytes, only the mean values are presented and no detail	Full results including LODs and analysis methods are presented within Appendix II. The survey strategy & sampling was devised in 2017, in order to provide a

Consultee	Comment relevant to this chapter	Where / how addressed
	concerning testing methods and LOD values are provided. Further, the applicant has only tested for the ICES 7 group of PCBs. This analyte group has an associated AL, comprising the total value of the 7 ICES identified PCBs per sample. However, it's not clear why only these seven have been tested for, and not the total 25 PCB congeners tested for in the UK under OSPAR guidelines. This should be further explained.	suitable baseline for the purposes of the Marine Ecology EIA. Noting that a confidentiality agreement meant it was not possible to consult on this scope prior to the EIA documentation entering the public domain. As the sediment is being retained in situ, we do not consider that the missing PAH analytes will materially affect the mitigation measures or construction/infill methodology that is proposed. Therefore we consider the existing testing suite to be sufficiently robust to inform our assessment.
	The report goes on to discuss the presence of BTEX and total petroleum hydrocarbons. Neither of these is relevant to UK regulation of dredge and disposal. This section then goes on to discuss dissolved oxygen content and then moves to discuss benthic assemblages.	Subsection have been added to make the document structure clearer. The survey strategy & sampling was devised in 2017, in order to provide a suitable baseline for the purposes of the Marine Ecology EIA. Noting that a confidentiality agreement meant it was not possible to consult on this scope prior to the EIA documentation entering the public domain.
	Overall, no discussion or interpretation of the results described in the above comments is made with reference to assessing the chemical risk of the sediment in question, other than brief descriptions of the analytes in question. In operations of a similar nature, I would expect at least the briefest of assessments of results presented.	Assessment of risk to water quality during dock bed preparation is included within the ES.
Cefas Benthic – July 2020	benthic ecology as a receptor is appropriately identified	Noted – no changes made
	I would expect an assessment of the overall impact to present information regarding the ubiquity of both the species and habitats that are to be directly and/or indirectly impacted by the project. Uniqueness of such features should represent one aspect of the assessment procedure (e.g. where is the nearest blue mussel population to that within the Bramley-Moore Dock?, is the	Full details of the survey methods employed, and results are presented in Appendix I. The valuation of the receptors considered in our Marine EcIA has followed the established CIEEM methodology (see section 3.2 for details). The rationale for the valuation of the benthic receptors is discussed in

Consultee	Comment relevant to this chapter	Where / how addressed
	type of habitat found within the Bramley-Moore Dock unique to the Mersey Estuary?). This information is not currently presented, indeed there is a very minimal description of the benthic ecology species and habitats within the regions of direct and indirect impacts.	section 7.1.1 and this has taken into account factors such as conservation important and the presence of Invasive Non-Native Species. These aspects have all been aggregated into an overall 'value', as required under the stated and agreed EIA Assessment Methodology. As required under the EIA Regulations, all likely significant direct & indirect impacts have been included within the scope of our assessment. Any impacts that are not included are considered to be neither significant, nor likely.
	I gather that there will be a "western channel" created as part of the scheme: the details regarding the construction of this are not evident and thus it is difficult to understand the operational impacts of the scheme.	Further information in regards to the construction of the western channel are provided in Chapters 3 and 4 in Volume II of the ES. Mitigation measures in the form of biodiversity enhancements within the western channel are detailed within this ES chapter.
	As it appears that the water quality of the Nelson Dock is likely to be impacted by the scheme, I would have expected that the baseline assessment would have included this region to allow the indirect impacts on this area to be quantified	Full details of the survey methods employed, and results are presented in Appendix I. The survey strategy & sampling was devised in 2017, in order to provide a suitable baseline for the purposes of the Marine Ecology EIA. Noting that a confidentiality agreement meant it was not possible to consult on this scope prior to the EIA documentation entering the public domain.
	I am not in total agreement with certain assessments of impact on benthic ecology. For example, I would argue that the nature conservation value of the benthos within Bramley-Moore Dock is not 'negligible' given that blue mussels are present.	Blue mussels are afforded no specific nature conservation protection, as such the assessment of negligible is considered justified. Their importance as a commercial species is noted and the lack of commercial exploitation within BMD due to prohibited classification status is made clear within the ES.
	I am unsure of the rationale behind the statement in Appendix 13.1 "low	The reference in in relation to mussels and cockles. Neither species are

Consultee	Comment relevant to this chapter	Where / how addressed
	numbers of commercially importance shellfish species were noted, however these were not expected to be targeted within the dock area", I must assume this refers to cockles and mussels, but I do not understand the notion of them not being targeted when the habitat within which they are located is to be lost as part of the project's construction.	targeted commercially within BMD due to the area being of prohibited classification. Full details of the survey methods employed, and results are presented in Appendix I. Abundance of each species is provided.
	In Appendix 13.1, Section 2 it is stated "During this meeting aquatic ecology survey effort was discussed and agreed as appropriate in principal. MEAS made no comment in relation to aquatic ecology in their consultation response (dated 21st August 2019). Consultation response received from Natural England (dated 2nd September 2019) highlights the requirement to consider the marine environment /dock waters within ecological assessment, in particular potential impacts which may affect the River Mersey during the construction phase". What is the outcome regarding this?; is there an agreement that further marine ecology survey work is considered necessary?	Effects in relation to water quality, release of INNS and noise effects on receptors within the Mersey are considered within this ES chapter. Natural England did not request any additional surveys, beyond those which has already been completed in BMD.
	From the various information sources provided for this advice request (listed above), I still cannot ascertain the spatial extent of the habitat proposed to be lost (i.e., the area of infill). This needs to be quantified to aid a more robust assessment of overall impact to be made.	The dock is currently 4.05ha in size. Once completed, the retained western channel will be 0.58ha is size.
	Appendix 13.1, which contains the more detailed information upon which the assessment of impacts is presented in the ES, provides only a very brief resume of the baseline environment. The baseline data were acquired primarily through survey work undertaken in 2017 (WYG (2017) Bramley-Moore Dock Ecological Appraisal) yet no information is presented on the design. This has significant implications regarding my overall appraisal as I am not able to make any assessment as to the reliability of this source information. The species	Full details of the survey methods employed, and results are presented in Appendix I .

Consultee	Comment relevant to this chapter	Where / how addressed
	observed from the survey work are listed in Appendix 13.1 without any reference to their locations nor their abundances. This is particularly limiting regarding the knowledge that two species (cockles and the blue mussel) have potential commercial importance.	
	The presentation of the concentrations of some of the sediment contaminants in Figures 5 to 8 in Appendix 1 could be improved. The threshold concentrations for USEPA total PAHs are, for example, difficult to interpret as the total concentrations from the samples from the survey site are not presented (only single PAH concentrations).	Full results including LODs and analysis methods are presented within Appendix II.

3. Methodology

3.1. Desk Review and Survey Data

This assessment is based on data comprised of a desk review and a series of field studies. The baseline for fish, benthic invertebrates and sediment chemistry was obtained through a combination of field survey and background data, whilst the baseline for marine mammals was obtained from a desk study.

The following reports / studies are of relevance to the chapter and were reviewed as part of the assessment:

- WYG (2017) & (2020) Bramley-Moore Dock Ecological Appraisal;
- APEM (2017) People Project: Sediment Sampling (see Appendix II); and
- APEM (2017) People Project: Aquatic Ecology Survey Report (see Appendix I).

3.2. Ecological Impact Assessment

Using the baseline data gathered for the site and adjacent habitats, the aquatic ecology features were evaluated in terms of their nature conservation value using the criteria set out in the '*Guidelines for Ecological Impact Assessment in the UK and Ireland*' (CIEEM, 2018).

With respect to the assignment of a value for habitats and species within and around the application site, tabulated boundaries between different values become difficult to define with precision due to a range of factors that influence the definition of value, e.g. habitat quality, geographic location, size of population etc. Thus, the most appropriate approach is to utilise professional judgement based on available guidance, information and expertise.

The value of an ecological resource has been determined within a defined geographical context. The following frame of reference has been used: International; National; Regional; County / Metropolitan Borough; District; Local; and Zone of Influence (ZoI), e.g. project site boundary. Using this geographical context, the value of habitats or species can be assessed using the criteria outlined in Table 2.

Table 2: Guidance on determining the nature conservation value of features.

Value	Scale	Criteria
Very high	International	High importance and rarity. International scale and limited potential for substitution, e.g. Special Areas of Conservation (SAC), Special Protection Areas (SPA), Ramsar sites etc.
High	National	High importance and rarity, national or regional scale with limited potential for substitution, e.g. Sites of Special Scientific Interest (SSSI), national nature reserves etc.
Medium	Regional / County	High or medium importance and rarity, local or regional scale and (limited) potential for substitution, e.g. local nature reserves, county wildlife sites etc.
Low	District / Local	Low or medium importance and rarity, local scale, e.g. old hedges, woodland and ponds.
Negligible	Within Zone of Influence	Very low importance and rarity, local scale, e.g. areas of built development, active mineral extraction or intensive agriculture land.

The study area operates across two geographic scales, firstly the Zone of Influence (ZoI) and secondly the wider local and regional areas. The ZoI focuses on the aquatic environments contained within the developments red line boundary. The local study area incorporates the wider Liverpool dock network and the Lower Mersey with the regional study area incorporating the rest of the Mersey and coastal regions of the Irish Sea. This approach ensures that the foraging, migration range (where practicable) and spatial distribution of the key aquatic species are considered.

Once the value of an ecological resource has been determined, the significance of the effect on the resource can be assessed. The CIEEM guidelines define a significant effect in ecological terms as:

'*A significant effect is a positive or negative ecological effect that should be given weight in judging whether to authorise a project: it can influence whether permission is given or refused and, if given, whether the effect is important enough to warrant conditions, restrictions or further requirements such as monitoring*…' and '*In broad terms, significant effects encompass impacts on the structure and function of defined sites, habitats or ecosystems and the conservation status of habitats and species (including extent, abundance and distribution*).'

Following collation of the ecological baseline information outlined above, the likely effects of the proposed works were assessed, based on the project design and against the criteria provided in Table 3.

The assessment of the potential effects of the proposed works considers both on-site and off-site effects, such as those that may occur on adjacent areas of ecological value. Effects can be permanent or temporary and can include direct loss of wildlife habitats, fragmentation and isolation of habitats, disturbance to species, changes to key features and changes to the local hydrology and / or water quality.

The impacts can be either beneficial, were there is an advantageous or positive effect on the environmental resource or receptor, or adverse, where there is a detrimental or negative effect on the environmental resource or receptor. In this regard it is important to consider the magnitude of the effect in terms of size, amount, intensity and volume. To quantify magnitude, guidance stipulates quantification, where possible, in the context of the follow definitions:

- **Duration:** should be defined in relation to the ecological characteristics e.g. lifecycle as well as human timeframes. It is also important to consider the duration of an activity which may be the cause of an effect. Impacts and effects may be described as short, medium or long-term and permanent or temporary and need to be defined in months / years.

- **Frequency & Timing:** relates to the number of times an activity occurs which will influence the resulting effect. Timings of an activity should be considered in the context of critical life-stages or seasons for example fish spawning.

- **Reversibility:** should it not be possible to recover from a given effect within a reasonable timescale or if there is no possibility of action being taken to reverse the effect then the effect is deemed irreversible and permanent. A reversible effect is constituted by spontaneous recovery or counteracted by mitigation. Note that in some cases, the same activity may cause both reversible and irreversible effects.

Table 3 provides detail of how the magnitude of the impact has been assigned.

Table 3: Examples of ecological magnitude of effect.

Magnitude of effect	Example effects
Very large	• Loss of, permanent damage to or adverse effect on integrity of any part of a site of international or national importance; • Loss of a substantial part or key feature of a site of county importance; • Loss of Favourable Conservation Status (FCS) of a legally protected species; and • Loss of or damage to a population of nationally rare or scare species.
Large	• Temporary disturbance to a site of international or national importance, but no permanent damage; • Loss of or permanent damage to any part of a site of county importance; • Loss of a key feature of local importance; • A substantial reduction in the numbers of legally protected species such that there is no loss of FCS but the population is significantly more vulnerable; • Reduction in the amount of habitat available for a nationally rare or scarce species, or species that are notable at a regional or county level.
Medium	• Temporary adverse disturbance to a site of county value, but no permanent damage; • Loss of, or permanent damage to a feature with some ecological value in a local context but that has no nature conservation designation; • A minor impact on a legally protected species but no significant habitat loss or reduction in FCS; • A minor impact on populations of nationally rare or scare species or species that are notable at a regional or county level.
Small	• No effect on sites of international, national or county importance; • Temporary disturbance or damage to a small part of a feature of local importance; • Loss of or damage to land of negligible nature conservation value;

Magnitude of effect	Example effects
	• No reduction in the legally protected, nationally rare, nationally scare or notable (regional / county level) species on the site or its immediate vicinity.

The significance of an adverse effect (or a beneficial effect) is the product of the value or sensitivity of the ecological feature affected (Table 2) and the magnitude of the impact (Table 3). High levels of significance generally ascribed to large effects on features of high nature conservation value. Low levels of significance are ascribed to small effects on features of high nature conservation value or large effects on features of lower nature conservation value as shown in

.

Table 4: Ecological significance of effect.

		Magnitude of effect				
		Very Large	Large	Medium	Small	Negligible
Value of receptor	**Very high** (International)	Major	Major	[3]	Moderate	[1]
	High (National)	Major	[3]	Moderate	Minor	[2]
	Medium (County / Regional)	[3]	Moderate	Minor	[2]	Negligible
	Low (Local / District)	Moderate	Minor	[2]	Negligible	Negligible
	Negligible (Site / immediate area / Zone of Influence)	[1]	[2]	[2]	[2]	Negligible

[1] The choice between 'Moderate', 'Minor' and 'Negligble' will depend on the specifics of the impact and will be down to professional judgement and reasoning.
[2] The choice between 'Minor Significance' and 'Negligible Significance' will depend on the specifics of the impact and will be down to professional judgement and reasoning.
[3] The choice between 'Major' and 'Moderate' will depend on the specifics of the impact and will be down to professional judgement and reasoning.

n.b. 'Negligible' includes 'Neutral' and 'No Impact' assessments.

An assessment of the potential ecological effects of the proposed development is provided in the context of the aquatic ecology below. Details of the potential effects, both during construction and operation of the development, along with details of the mitigation measures proposed and the residual and cumulative ecological affect are also assessed.

4. Legislation and Policy

4.1. Legislation

The following legislation and policy have been considered in undertaking the assessment:

- Water Framework Directive (WFD);
- Marine and Coastal Access Act (2009);
- Wildlife and Countryside Act (1981);
- The Habitats Directive;
- Oslo and Paris Convention for the Protection of the Marine Environment 1992 (OSPAR);
- International Union for Conservation of Nature (IUCN);
- Countryside and Rights of Way Act (CRoW 2000);
- Marine Strategy Framework Directive (2008/56/EC);
- Natural Environment and Rural Communities (NERC) Act 2006;
- The Conservation of Habitats and Species Regulations (2017);
- Offshore Marine Conservation (Natural Habitats &c.) Regulations (2007);
- UK Post-2010 Biodiversity Framework; and
- Other Legislation, including:
    - Clean Seas Environmental Monitoring Programme (CSEMP); and
    - MARPOL 73/78.

Receptor specific legislation is also referenced under the appropriate sub-section.

4.1.1. Water Framework Directive (WFD)

The WFD is a European Union Directive (2000/60/EU) that sets out a legislative framework for the analysis, planning and management of water resources and the protection of aquatic ecosystems. EU member states are required to classify the current 'status' (or potential) of water bodies and set a series of objectives for maintaining or improving water bodies so that they maintain or reach 'good status' or 'good potential'.

4.1.2. Marine and Coastal Access Act (2009)

The MCAA provides the mechanism for improved management and protection of the marine and coastal environment. It comprises eight key elements including the establishment of the Marine Management Organisation (MMO) to operate as the competent marine planning authority in the UK; and powers to enable the designation of Marine Conservation Zones (MCZ's).

4.1.3. Wildlife and Countryside Act (1981)

The Wildlife and Countryside Act (WCA) 1981 incorporates existing legislation to implement the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and Council Directive 79/409/EEC on the conservation of wild birds (Birds Directive) in Great Britain. The WCA 1981 is the major domestic legal instrument for wildlife protection in the UK, and is the primary means by which the following are implemented:

- The Convention on the Conservation of European Wildlife and Natural Habitats ('the Bern Convention');

- The Convention on the Conservation of Migratory Species of Wild Animals ('Bonn Convention'); and
- The Council Directive 79/409/EEC on the Conservation of Wild birds (the 'Bird Directive').

The main relevant provisions of the Act are allowance for the protection of the most important habitats and species by designating Sites of Special Scientific Interest (SSSI) on the conservation of wild birds (Birds Directive) in Great Britain.

4.1.4. The Habitats Directive

The Habitats Directive (92/43/EEC) ensures the conservation of rare, threatened or endemic animal and plant species. This directive on the conservation of natural habitats and of wild fauna and flora aims to promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements and is the cornerstone of Europe's nature conservation policy with the Birds Directive and establishes an EU wide Natura 2000 ecological network of protected areas. Since 1994, all SPAs under the 'Birds Directive' are included in this ecological network.

4.1.5. Oslo and Paris Convention for the Protection of the Marine Environment 1992 (OSPAR)

OSPAR has a list of threatened and/or declining species in the NE Atlantic. Species listed are part of further work on the conservation and protection of marine biodiversity under Annex V of the OSPAR convention.

4.1.6. International Union for Conservation of Nature (IUCN)

The International Union for Conservation of Nature (IUCN) is used as a global evaluation tool to catalogue and highlight those taxa that are facing a higher risk of global extinction (IUCN, 2019). Species such as European eel *Anguilla anguilla* are designated as 'Critically Endangered', a category for taxa regarded as facing an extremely high risk of extinction in the wild. Taxon cited under 'Low Risk' by the IUCN have been evaluated, but do not qualify for the higher risk categories; they are, however, separated into three subcategories 'Conservation dependent', 'Near Threatened' and 'Least Concern'. Species such as Atlantic salmon *Salmo salar*, plaice *Pleuronectes platessa* and sea lamprey *Petromyzon marinus* are cited as 'Low Risk / Least Concern' and not currently considered to be threatened.

4.1.7. Countryside and Rights of Way (CRoW) Act 2000

Part III of the Countryside and CRoW Act 2000 deals specifically with wildlife protection and nature conservation. It requires that Government departments have regard for the conservation of biodiversity, in accordance with the Convention on Biological Diversity in 1992. In addition, it demanded that the Secretary of State published a list of living organisms and habitat types considered to be of principal importance in conserving biodiversity within each Country. These species and habitats for England were originally listed under Section 74 of the CRoW Act 2000 but are now embodied in Sections 40 and 41 of the NERC Act 2006 and are also found within the UK Biodiversity Action Plan (UK BAP). The CRoW Act 2000 also amends the WCA, by increasing the legal protection of threatened species.

4.1.8. Marine Strategy Framework Directive (2008/56/EC)

The Marine Strategy Framework Directive (MSFD) requires Member States to put in place measures to achieve or maintain 'Good Environmental Status' (GES) in their waters by 2020. Member States must produce a Marine Strategy for their waters in collaboration with other relevant Member States in the same region. Within the MSFD, eleven qualitative descriptors for determining GES are defined.

The Marine Strategy Regulations 2010, transpose Directive 2008/56/EC and are the means by which the MSFD is implemented in the UK.

4.1.9. Natural Environment and Rural Communities (NERC) Act 2006

Section 41 of the NERC Act requires the listing of habitats and species that are of principle importance for the conservation of biodiversity in England, including habitats and species in England that have been identified as priorities within the UK Biodiversity Action Plan (UKBAP).

4.1.10. The Conservation of Habitats and Species Regulations (2017)

The Conservation of Habitats and Species Regulations 2017 came into effect on 30th November 2017. The Regulations consolidate and update the Conservation of Habitats and Species Regulations 2010. The Regulations are designed to transpose Council Directive 92/43/EEC, on the conservation of natural habitats and of wild fauna and flora (EC Habitats Directive), into national law. Additionally, they transpose elements of the EU Wild Birds Directive in England and Wales. The regulations predominantly cover England, Wales and adjacent territorial sea (12 nautical miles from the mean low-water mark of a coastal state).

4.1.11. Offshore Marine Conservation (Natural Habitats &c.) Regulations (2007)

The Offshore Marine Conservation Regulations 2007 (as amended) implement the species protection requirements of the Habitats and Birds Directives offshore. The Offshore Marine Regulations apply to:

- Offshore marine areas;
- Offshore marine installations;
- Certain ships and crafts; and
- Protection is also given to species found in UK territorial (inshore) waters.

4.1.12. UK Post-2010 Biodiversity Framework

Formerly the UK Biodiversity Action Plan (BAP), the UK Biodiversity Framework is implemented at regional and local levels through local BAPs and tailored Habitat Action Plans (HAPs; for specific habitats within BAPs).

4.2. Policy

Section 38(6) of the Planning and Compulsory Purchase Act 2004 and Section 70(2) of the Town & Country Planning Act 1990 require that planning applications to be determined in accordance with the statutory development plan, unless material considerations indicate otherwise. The statutory development plan for the City of Liverpool currently comprises the Unitary Development Plan (adopted 2002).

A summary of the statutory development plan policies relevant to the application proposal and ecological matters is set out below. The following policies and guidance material are considerations which also inform the assessment:

- Liverpool Local Plan (Submission Draft, May 2018);
- National Planning Policy Framework (March 2012, updated in February 2019); and
- UK Marine Policy Statement (MPS) Defra, 2011.

The draft North West Marine Plan has been issued for consultation but has not yet been adopted (as of August 2020). The MMO state that the Marine Policy Statement is to be used until the plan is formally adopted.

5. Baseline Characterisation

5.1. Fish & Shellfish Ecology

5.1.1. Statutory Designated Sites

Nearby and adjacent designated sites are predominantly focussed on resident and migratory birds along with intertidal and coastal habitats such as embryonic sand dunes and salt marsh areas. No fish or shellfish habitats or species are included within the designated sites.

5.1.2. Site-Specific Survey

Fish population data aimed at assessing biomass, abundance and biodiversity within BMD was collected via a combined hydroacoustic and fyke netting survey in September 2017. Fish density estimates were gathered using Environment Agency (EA) compliant horizontal and vertical hydroacoustic surveying techniques outlined within the '*Peoples Project, P00001932*' APEM (2017) technical report (see Appendix I). Fyke nets were also deployed perpendicular to the banks to capture fish for the purposes of identification and length measurement.

Results from the horizontal hydroacoustic survey showed the mean density of fish within BMD to be 4.16 fish per 1,000 m^3. The highest densities were recorded in the south east and north east areas of the dock with the lowest being recorded within the north and north eastern section. The majority of tracked targets were recorded within the range of -47 to -42 dB categories equating to a fish length of between 120 and 190 mm.

Fish density data derived from the vertical hydroacoustic survey revealed the highest density of fish to be occupying the southern side of the dock. The lowest density was recorded towards the middle of the dock. Overall, fish densities within Bradley-Moore dock were reported to be relatively high at >3,000 fish per hectare observed throughout.

The most common fish species recorded within the fyke nets was pouting *Trisopterus luscus* [No. 63 in 6 nets]. This was followed by coal fish *Pollachius virens* [No. 11 in 3 nets], European (silver) eel [No. 5 in 2 nets], sole *Solea solea* [No. 1] and plaice [No. 1]. Relatively large numbers of crabs were also recorded consisting mainly of shore crab *Carcinus maenas* [No. 44 in 6 nets] and the commercial edible crab *Cancer pagurus* [No. 3 in 2 nets] and velvet swimming crab *Necora puber* [No. 1]. Other commercially important shellfish species included pink shrimp *Palaemon* sp. [No. 11 in 1 net].

Benthic fauna was also targeted using various techniques as part of the wider study (Section 5.2.2). Coincidental recordings of goby *Pomatoschistus* spp. and commercially important shellfish species consisting of edible crab, edible cockles *Cerastoderma edule* and blue mussels *Mytilus edulis* are of note.

The report concludes, that at the time of sampling, BMD was not considered a fish nursery and that the presence of European eel does not warrant special status (see Appendix I).

5.1.3. Ecological Appraisal

A comprehensive ecological appraisal of BMD was undertaken by WYG in August 2017 (WYG 2017). As part of the appraisal, a data request was made to the Local Environmental Records Centre (LERC), which focused on identifying any rare and notable species within a 2 km radius of BMD. Data held by the National Biological Network (NBN) Gateway was collated by Biobank Merseyside and summarised in the '*Biodiversity Information Report 16/06/2017*' (Biobank Merseyside, 2017).

Results of the desk-based study deem habitats capable of supporting fish but report that no fish were observed during the Phase 1 study. Numerous records of bony (teleost) fish were returned from the LERC data request. In total, four species of fish were recorded within 2 km of the dock – these consisted of Atlantic cod *Gadus morhua* (0.1 km NNE), European eel (0.1 km NNE), plaice (1.53 km WSW) and whiting *Merlangius merlangus* (0.1 km NNE). All four of these species are citied under NERC Section 41 for species of principle conservation and biodiversity importance in England.

The appraisal goes on to note that migratory (diadromous) fish species recorded within the River Mersey include Atlantic salmon, sea lamprey and river lamprey *Lampetra fluviatilis*.

The Ecological Appraisal was updated by WYG in 2019 (WYG 2020) and no material changes to the previous baseline had occurred in the intervening period.

5.1.4. Spawning and Nursery

Potential for BMD to be used as a spawning and / or nursery ground has primarily been undertaken using the charts provided in Coull et al. (1998) and Ellis et al. (2012). Whilst these are useful sources to broadly identify spawning and nursery grounds within the lower Mersey Estuary and adjoining Irish Sea, the broad areas defined in these publications do not allow for the exact definition of the boundaries, especially in relation to a discrete area such as BMD. Additionally, spawning times are given using the maximum duration of the spawning period in British waters. However, spawning durations may vary depending on location and environmental cues such as temperature.

The lower Mersey Estuary (incorporating BMD) provides spawning and nursery habitat to a wide range of commercially and ecologically important species. In total, seven species were identified as using the region for spawning and 10 for nursery, details of which are provided in Table 5. Only sandeel Ammodytidae use the region for high intensity spawning activity with herring *Clupea harengus*, cod and whiting using the region for high intensity nursery.

*Table 5: Fish identified as using the lower Mersey Estuary for spawning and nursery purposes (Source: Coull et al. 1998 and Ellis et al. 2012). *Cited within Coull et al. (1998) only with no reference given to activity level.*

Spawning			Nursery		
Species name	**Common name**	**Activity level (High / Low)**	**Species name**	**Common name**	**Activity level (High / Low)**
Ammodytidae	Sandeel	High	*Clupea harengus*	Herring	High
Gadus morhua	Cod	Low	*Gadus morhua*	Cod	High
Merlangius merlangus	Whiting	Low	*Merlangius merlangus*	Whiting	High
Pleuronectes platessa	Plaice	Low	Ammodytidae	Sandeel	Low
Scomber scombrus	Mackerel	Low	*Galeorhinus galeus*	Tope	Low
Solea solea	Sole	Low	*Lophius piscatorius*	Anglerfish	Low
Sprattus sprattus	Sprat	*N/A	*Pleuronectes platessa*	Plaice	Low
			Raja clavata	Thornback ray	Low

Spawning			Nursery		
Species name	Common name	Activity level (High / Low)	Species name	Common name	Activity level (High / Low)
			Raja montagui	Spotted ray	Low
			Solea solea	Sole	Low

A summary of seasonal spawning periods for those species known to be utilising the lower Mersey Estuary is presented in Table 6.

Table 6: Seasonal spawning periods for fish utilising the lower Mersey Estuary (Source: Coull et al. 1998 and Ellis et al. 2012). Note: shaded cells = spawning season / cells marked with an '' denote peak seasonal spawning activity.*

Species	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Sandeel												
Cod		*	*									
Whiting												
Plaice	*	*										
Mackerel					*	*						
Sole				*								
Sprat												

5.1.5. Migratory Species

Spawning and Migration

Diadromous fish will utilise the coastal waters of the Local Study Area for migration moving between their marine foraging areas and freshwater spawning grounds (or in the case of the European eel marine spawning grounds). European eel may reside for extended periods in estuarine and coastal environments to feed. This increases the chance of encountering BMD when compared to other migratory species such as Atlantic salmon that will only be present (in the lower Mersey Estuary) at certain times of year as they migrate.

Table 7 provides a guide for when diadromous fish are most likely to be migrating within the lower Mersey. Timings are dependent on environmental cues, such as temperature and water flow, that may vary year on year. Further detail of the occurrence of diadromous fish within the Study Areas is provided in the sections below.

*Table 7: Spawning and migration timings for migratory fish found within the River Mersey and surrounding catchments. Note: shaded cells = spawning season / '↑' upstream migration / '↓' downstream migration / *European eel spawn at sea, therefore their spawning season is not shown.*

Species	Development phase		Seasonal migration and spawning activity											
			J	F	M	A	M	J	J	A	S	O	N	D
Atlantic salmon	Adult	Grilse							↑	↑	↑	↑		
		Spring		↑	↑	↑	↑	↑	↑					
	Juvenile: smolt					↓	↓	↓						
Sea trout	Adult		↓	↑	↑	↑	↑	↑	↑	↑	↑	↑		↓
	Juvenile: smolt				↓	↓	↓							
*European eel	Adult									↓	↓	↓		
	Juvenile			↑	↑	↑	↑	↑						

Species	Development phase	Seasonal migration and spawning activity											
		J	F	M	A	M	J	J	A	S	O	N	D
Sea lamprey	Adult				↑	↑							
	Juvenile							↓	↓	↓			
River lamprey	Adult										↑	↑	↑
	Juvenile							↓	↓	↓			

Salmonids (Atlantic salmon & sea trout)

North-west England has 16 rivers where Atlantic salmon is present, including the River Mersey. The River Mersey along with the Weaver and Douglas are located within heavily industrialised and populated southern extent of the region. These rivers are reported to have lost their Atlantic salmon runs (migrations) during the 19th century (CSTP, 2016). As such, the River Mersey is currently not designated within the 1998 Ministerial Direction to comply with the North Atlantic Salmon Conservation Organisation (NASCO) Salmon Action Plan (SAP) for North West England (Cefas, EA & NRW, 2018).

No salmonid catch data is available for the Rive Mersey. The closest available catch data originates from the River Ribble, located approximately 30 km to the north and the River Dee, located approximately 16 km to south west. Both rivers support commercial and recreational angling activities for salmonids. Catch statistics for rod caught Atlantic salmon within the Ribble record 710 individuals in 2017, the fourth national highest of the year (EA & NRW, 2019). The fact that the Mersey does not support such activity is indicative of its low salmonid population.

Sea trout are the migratory variants of the native freshwater brown trout *Salmo trutta*. The species is known to feed within Liverpool Bay, however the River Mersey is reported to have a typically low sea trout productivity when compared to the other regional rivers of North West England (CSTP, 2016).

With efforts to improve water quality and restore freshwater habitats, Atlantic salmon were recorded in the River Mersey for the first time in many decades in 1989 (EA, 2016a). With continuing conservation efforts, the River Mersey is anticipated to reach a point whereby it will be able to once again support a stock of Atlantic salmon and sea trout (Atlantic Salmon Trust, undated).

The most likely time for Atlantic salmon to be present within the local area (lower Mersey) is during their migration. Adult salmon consist of two cohorts, those that spend one year at sea (referred to as grilse) and those that spend multiple years at sea (referred to as multi-sea winter or spring salmon). Grilse generally migrate upstream between July and October whereas spring salmon migrate between February and July. Juvenile salmon (referred to as smolt) migrate downstream between April and June.

Sea trout are known to reside within estuarine and coastal waters for extended periods to forage. However, the most likely time for them to be present within the lower Mersey is during their migration. Adults generally move upstream between February and October with a proportion of the population being able to return to sea after spawning between December and January. Juvenile sea trout (also known as smolt) migrate downstream between March and May.

European eel

River catchments in north-west England are included within the north-west River Basin District (RBD) extending from Cheshire in the south to the Lake District in the north. Little information exists to assess the current European eel stock within the north-west RBD (Defra, 2010). What information

does exist is gathered from multi-species fish population studies undertaken by the EA across 345 sites sampled on a rolling six-year programme.

Catch data recorded over the six-year programme suggests a declining presence of European eel towards the south of the north-west RBD, particularly around the city of Liverpool (Defra, 2010). Emigrating European eel (referred to as silver eel) within the north-west RBD is drastically failing the 40% return target set out in Article 9 of Regulation No. 1100/2007 transboundary Eel Management Plan (EMP). On average, just 1% of the target return compliance was achieved between 2011 and 2013 (Defra, 2015).

Based on the findings of the north-west RBD eel management plans, there appears to be a declining presence of European eel along the west coast of England. However, European eel are assumed to occur in all the rivers of the eastern Irish Sea (Lockwood, 2005), including the River Mersey. Occurrence within the lower Mersey Estuary is likely to coincide with the outward migration of silver eel between August and October and the inbound migration of juvenile eel (elvers) between February and June. Some variation will occur year to year based upon weather and tidal influence. Data from an entrainment study undertaken by the EA in 2013 at Fiddlers Ferry Power Station (situated approximately 30 km upstream from BMD) showed elvers to be present throughout March and June but were most abundant between March and April (Pers. Comm. 2019). Peak abundance during this time was found to coincide with the occurrence of spring tides (Pers. Comm. 2019).

Elvers are likely to be ubiquitously distributed upon arrival within the lower Mersey as they are reliant on oceanic currents at this stage of development. Active swimming soon develops to allow elvers to continue their upstream migration. It is therefore expected that the majority of elvers will emigrate into freshwater habitats away from BMD by the end of the summer. However, an unknown proportion of the population will remain in coastal and estuarine waters for an extended period to feed and mature. These populations are considered resident increasing the likelihood of interaction with BMD. When in the marine environment, European eels may utilise a wide range of habitats including dock basins and may reside within coastal environments for up to 25 years.

In total, five silver eels were recorded within BMD during the August 2017 site specific survey. As the five specimens recorded were all silver eel, it would suggest that these individuals were either caught during their outward spawning migration or have matured within the dock network. On that basis, it is not possible to determine the time spent within BMD.

Other migratory species

It is probable that low numbers of other migratory species may on occasion enter the lower Mersey Estuary and by default have potential to encounter BMD. However, the chances of such encounters are low given the likely population density and the effort required to reach BMD via the wider dock network.

Species such as European smelt *Osmerus eperlanus*, once abundant in the Mersey, are no longer believed to have viable populations within the Mersey and may well be extinct (Maitland, 2003a).

Sea lamprey and river lamprey may be present within the wider region of the Mersey Estuary, however little is known about the marine distribution and movement of these species. It is likely that due to their parasitic nature as adults they will sometimes be distributed in accordance to prey availability. As river lamprey feed upon on estuarine fish, this makes it more likely for the species to inhabit estuarine waters (Maitland, 2003b). Sea lamprey are known to move further offshore in pursuit of

larger fish. Prey availability within BMD is not regarded as being particularly important for river or sea lamprey.

The UK distribution of both Allis shad *Alosa alosa* and twaite shad *Alosa fallax* do not overlap with the Mersey Estuary. Allis shad were not thought to spawn in the British Isles until a study by Hillman (2003) confirmed a spawning site within the Tamar Estuary in south west England. The only known spawning stocks of twaite shad occur in Welsh rivers and on the England / Wales border in tributaries of the Severn Estuary (Carstairs, 2000). As such, the probability of either species encountering BMD is very small.

5.1.6. Rare and Notable Fish Species

Several of the fish species found within the lower River Mersey and Mersey Estuary are protected under national and international legislation. A summary of species designations in the lower Mersey (within the vicinity of BMD) is provided in Table 8. Of the 16 species listed, only five (European eel, sole, plaice, Atlantic cod and whiting) have been recorded within 2 km of BMD.

*Table 8: Current conservation designations of fish species known to occur within the wider vicinity of BMD (*denotes species known to occur within 2km of BMD). (Source: JNCC, 2018; OSPAR Commission, 2008).*

Species	Conservation Designations					
	UK Biodiversity Framework	NERC Act 2006	IUCN Red List	OSPAR	EC Habitats Directive	Bern Convention
Bony fish						
*Atlantic cod	✓	✓	VU	✓		
*Plaice	✓	✓	LR / LC			
*Sole	✓	✓				
*Whiting	✓	✓	LR / LC			
Anglerfish	✓	✓	LR / LC			
Herring	✓	✓	LR / LC			
Mackerel	✓	✓	LR / LC			
Sandeel	✓	✓				
Elasmobranchs (sharks, skates and rays)						
Thornback ray			LR / NT	✓		
Spotted ray			LR / LC	✓		
Tope	✓	✓	VU			
Migratory fish						
Atlantic salmon	✓	✓	LR / LC	✓	II & IV	✓
Sea trout	✓	✓	LR / LC			
*European eel	✓	✓	CR	✓		
Sea lamprey	✓	✓	LR / LC	✓	II	✓
River lamprey	✓	✓	LR / LC		II	✓
Key: CR= Critically Endangered, EN= Endangered, VU = Vulnerable, LR = Low Risk, NT= Near Threatened, LC = Least Concern, II & IV= Annex II & IV of the Habitats Directive and ✓= Features under that designation.						

5.1.7. Commercial Fisheries

A broad overview of the commercial fish and shellfish community of the lower and outer Mersey Estuary has been completed from examination of commercial catch data landed from within the

corresponding ICES statistical rectangle 35E6. Data for the quantity (in tonnes) by species caught was available for a five-year period 2014 – 2018 from the Scottish Government (2018).

In total, 37 species were landed with representatives of demersal (bottom dwelling) and pelagic (mid-water dwelling) finfish as well as various shellfish. Most of the species landed (approximately 21) consisted of mixed demersal species such as Atlantic cod, plaice, anglerfish *Lophius piscatorius* and thornback ray *Raja clavata*. Pelagic species included herring and mackerel *Scomber scombrus*. Shellfish were represented predominantly by mollusc species such whelks *Buccinum undatum* and scallop *Pecten maximus* but also included crustacea such as lobster *Homarus gammarus* and various crab species including velvet swimming crab.

Figure 1 presents the relative catch composition of species landed in excess of one tonne for ICES rectangle 35E6. The predominant catch was formed from molluscs, mainly whelk and scallop spp. (neither have been recorded within the application site at BMD). A relatively small proportion of crab (consisting of mixed species including edible crab), shrimps, lobsters and cockles were also landed. Edible crab, cockle and shrimp have been recorded within BMD but are unlikely to contribute to the commercial stock. Similarly, plaice has also been recorded within BMD but is unlikely to contribute to the commercial stock.

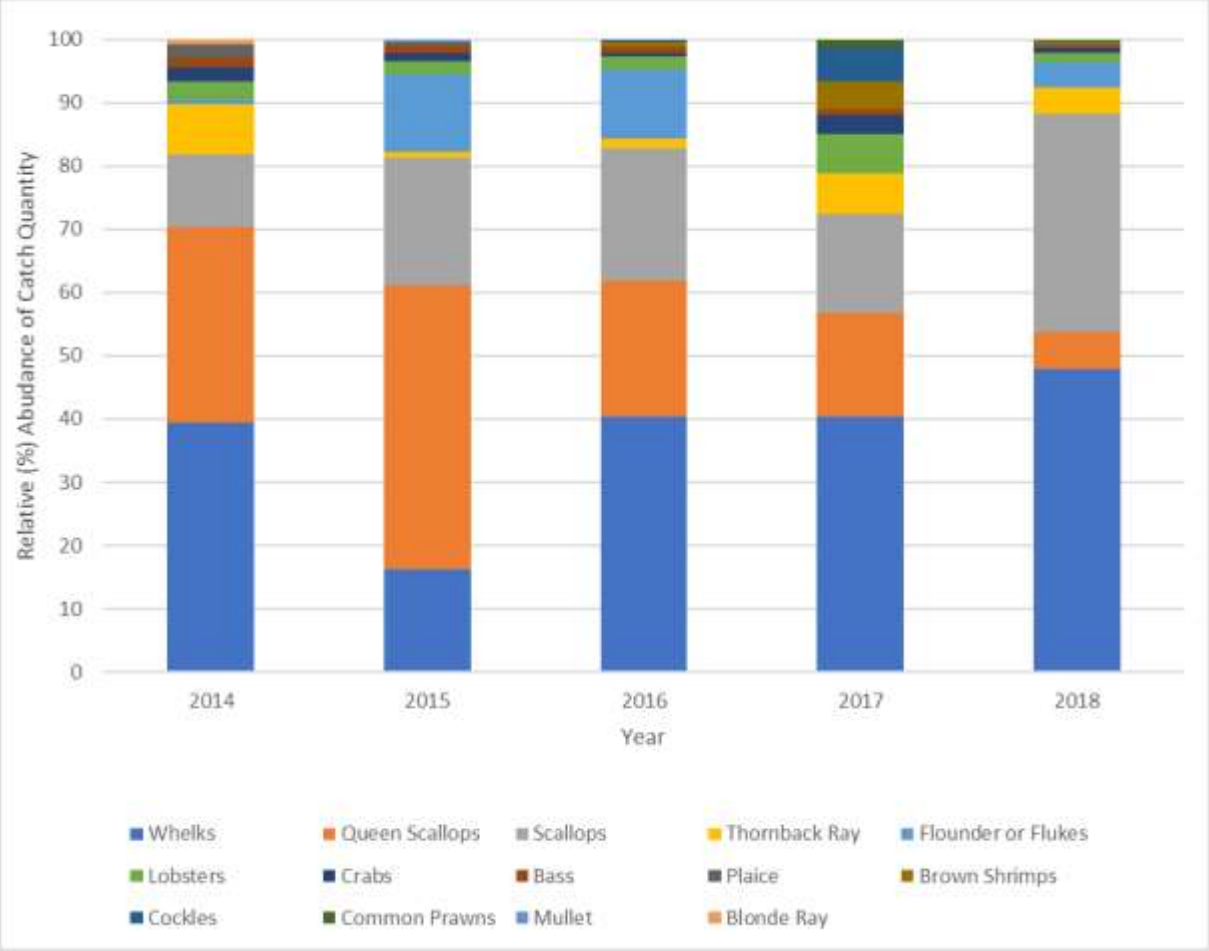


Figure 1: Relative (%) abundance of species landed in terms of quantity with a weight totalling >1 tonne within ICES 35E6 between 2014 to 2018 (Source: Scottish Government, 2018).

5.2. Benthic Ecology

5.2.1. Statutory Designated Sites

No subtidal benthic habitats or species are included within the local and regional designated sites. Nearby and adjacent designated sites are predominantly focussed on resident and migratory birds in conjunction with intertidal and coastal habitats such as embryonic sand dunes and salt marsh areas. Benthic communities form an important component of the diet of wading birds, therefore, influences from construction activities at BMD (such as relocation of benthos or inadvertent release of invasive non-native species and contaminants) may affect the availability of prey to support these populations (increased competition, community shifts).

5.2.2. Aquatic Benthic Ecology

A baseline survey was undertaken in September 2017 by APEM to characterise the aquatic environment within the BMD (see Appendix I and Appendix II. The survey methodologies and full results are presented in the Appendices and included:

- Grab sampling (macrofauna, physico-chemistry, pH, temperature and redox potential);
- Sediment chemistry, including:
    - Heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, mercury and zinc);
    - BTEX Hydrocarbons (Benzene, Toulene, Ethylbenzene and Xylene isomers);
    - Polychlorinated Biphenyls (PCBs);
    - Organotins;
    - Polycyclic Aromatic Hydrocarbons (PAHs);
    - Speciated Total Petroleum Hydrocarbons Criteria Working Group (TPH-CWG);
- Hydroacoustic and fyke net fisheries survey;
- Dive survey (output comprising video of attached biota);
- Wall scrapes and sweep net samples;
- Baited traps for mobile invertebrates; and
- Water quality profiling (depth, temperature, salinity, dissolved oxygen (DO) and pH).

Surface sediments within BMD were generally described as black or dark silt during the field campaign and were typically categorised as sandy silt through Particle Size Analysis (PSA) with pH values ranging from 5.1 to 8.1.

The chemical characteristics of the sediments are described in terms of a range of chemical parameters that are often associated with sediment due to their low solubilities in water. Unlike water quality, there are no UK Environmental Quality Standards (EQSs) for in-situ sediment quality. In the absence of UK standards, sediment chemistry data has been compared against other guidelines to provide a basic indication of the degree of contamination:

- Cefas guideline action levels for the disposal of dredged material; and
- Canadian Interim Sediment Quality Guidelines (ISQG).

UK Cefas Action Levels (ALs) can be used to make informed decisions regarding the fate of the dredged material. The UK Cefas sediment quality guidelines are divided into a lower and upper threshold level as follows:

- Action Level 1 (AL1) - Contaminant levels in dredged material below this lower threshold level are of no concern or are unlikely to influence the licensing decision; and

- Action Level 2 (AL 2) - Dredged material with contaminant levels above this higher threshold level is considered to be unsuitable for disposal at sea.

Sediments with contaminant concentrations between AL1 and AL2 would require further consideration and testing before a decision can be made regarding suitability of disposal at sea. Comparison of sediments concentrations against the Cefas ALs therefore provides an indication regarding the risk of the material to the environment

The Canadian ISQGs have been developed using observed field evidence of ecotoxicological effects of sediment contamination on benthic organisms. The guidelines comprise of two levels:

- Threshold Effect Levels (TELs); and
- Probable Effect Levels (PEL).

Concentrations below TELs rarely cause adverse biological effects and sediment concentrations greater than PELs frequently cause adverse biological effects. Where concentrations are above TEL but below PEL levels, adverse effects are deemed occasional. These ISQGs been used in the assessment of sediment quality as these guidelines provide an indication of likely toxicity of sediments to aquatic organisms. However, caution should be applied as these guidelines were designed specifically for Canada. In the absence of suitable alternatives, however, it has become commonplace for these guidelines to be used by regulatory and statutory bodies in the UK, and elsewhere, as part of a 'weight of evidence' approach.

Where concentrations were reported at below the Limit of Detection (LOD), results were interpreted at face value (at the LOD) and concentrations may be below these values although this cannot be confirmed.

Sediment - Metals

Full results, methods and LODs from the sediment analysis undertaken within BMD are presented in full within Appendix II. Mean sediment bound concentrations across BMD of all trace metals analysed were above Cefas AL1 and below AL2 (Figure 2). Mean concentrations of Arsenic, Chromium and Cadmium were between TEL and PEL levels within the dock; however, concentrations of Copper, Lead, Zinc and Mercury exceeded PEL levels (Figure 3). No ISQG levels exist for Nickel.

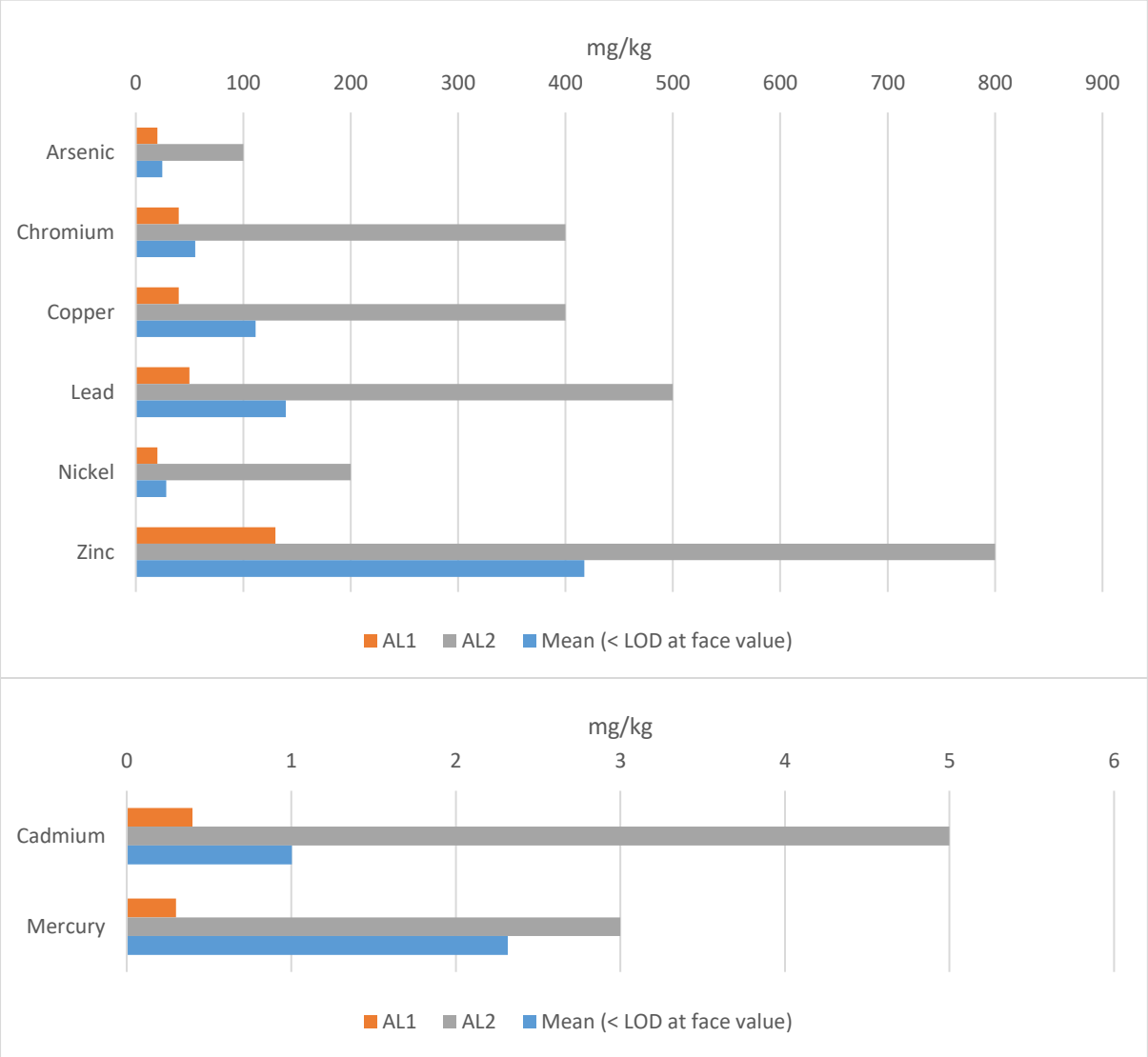


Figure 2 Mean sediment bound metal concentrations from within BMD, comparison with Cefas ALs – Sampled 26th September 2017 ('Peoples Project: Sediment Sampling – Ref LO_A100795_V1, White, Young & Green (Appendix II*).*

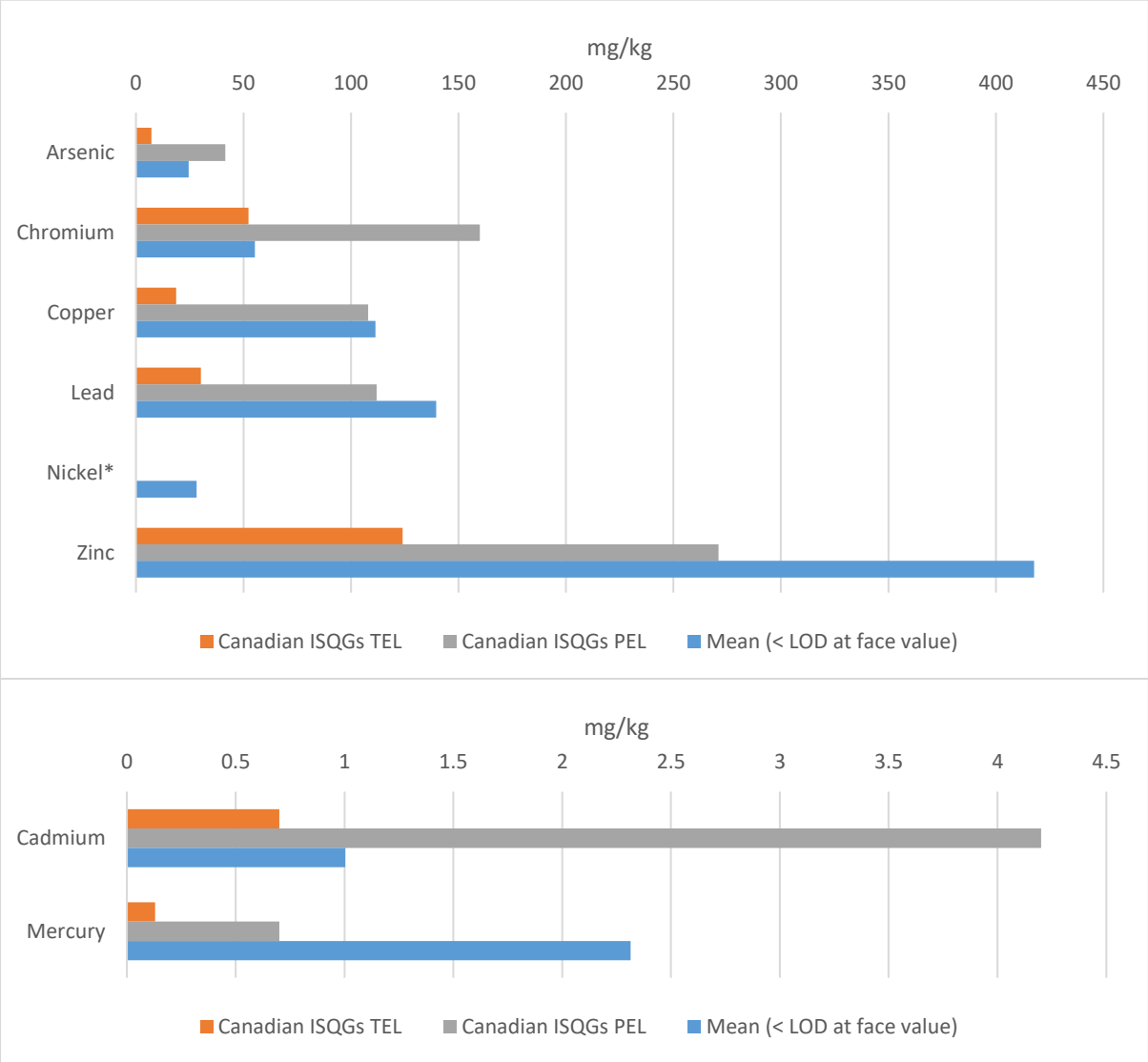


*Figure 3 Mean sediment bound metal concentrations from within BMD, comparison with ISQGs – Sampled 26th September 2017 ('*Peoples Project: Sediment Sampling – Ref LO_A100795_V1, White, Young & Green (Appendix II*). * no relevant guideline value applicable.*

Sediment – Organo-tins

Full results, methods and LODs from the sediment analysis undertaken within BMD are presented in full within Appendix II. Mean sediment concentrations of organo-tin across all Stations within BMD were compared against Cefas ALs (Figure 4). Concentrations for all compounds except for tributyl tin were reported at below Limits of Detection (LOD). High LOD levels inhibited the full interpretation of these data, specifically in relation to monobutyl tin, where the LOD exceeded AL1. Concentrations of tributyl tin exceeded AL1 at Station 3, with levels at all other Stations below AL1. Dibutyl tin concentrations were below AL1 concentration at all Stations. No ISQGs exist for the organo-tins.

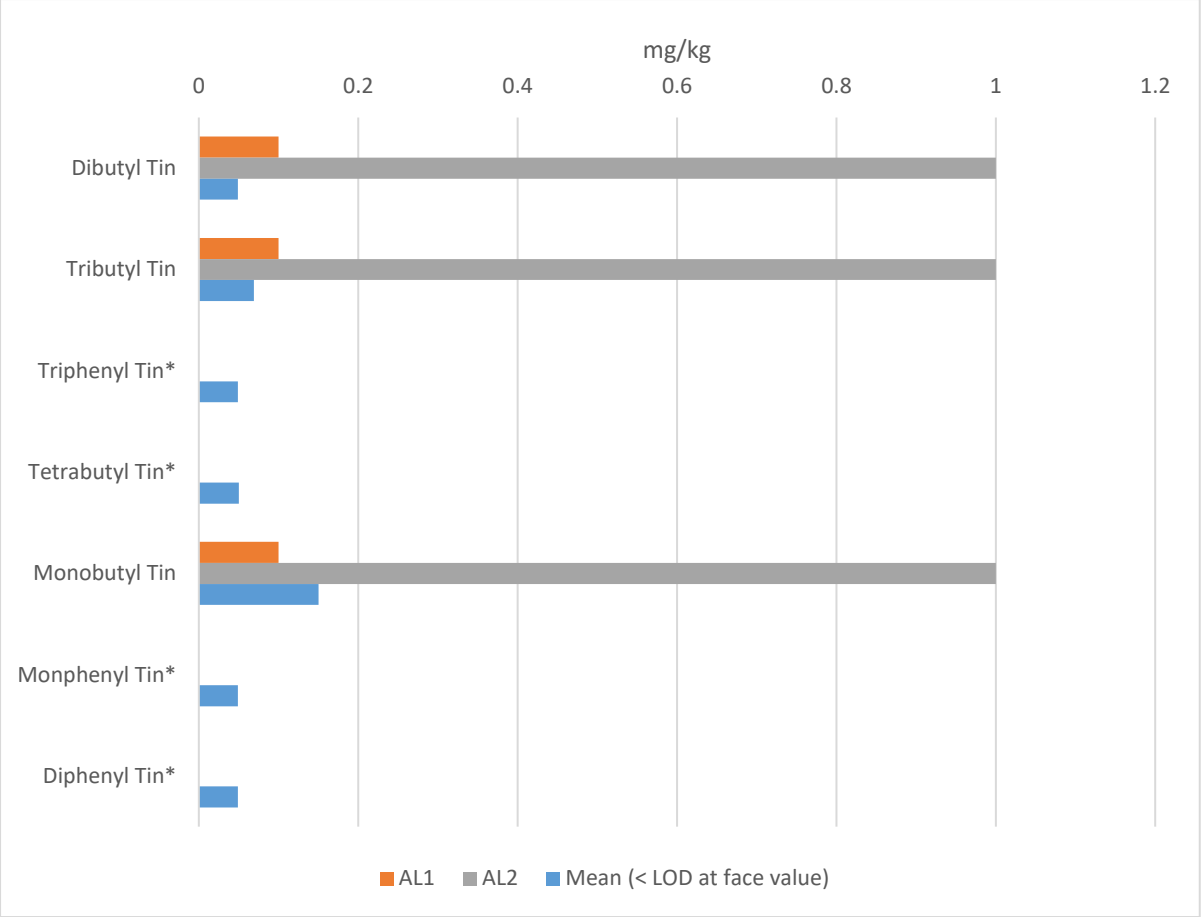


Figure 4 Mean sediment bound organo-tin concentrations from within BMD, comparison with Cefas ALs – Sampled 26th September 2017 ('Peoples Project: Sediment Sampling – Ref LO_A100795_V1, White, Young & Green (*Appendix II). * no relevant guideline value applicable.*

Sediment – Polycyclic Aromatic Hydrocarbons (PAHs)

Due to hydrophobic nature, PAHs tend to accumulate in the aquatic sediments, leading to bioaccumulation and elevated concentrations within sediments over time. Although they can be formed from natural process such as oil seeps and forest fire, they are predominantly of anthropogenic origin. The entry of PAHs into the environment is partially due to human activities. Further, it is difficult to give a confident measurement of the extent to which the environmental presence of PAHs is anthropogenic or by natural processes.

Full results, methods and LODs from the sediment analysis undertaken within BMD are presented in full within Appendix II. Sediments were analysed for the USA Environment Protection Agency (USEPA 16) list of 16 priority PAH analytes. Mean sediment concentrations of PAHs across all Stations within BMD were compared against Cefas AL1 (Note: no AL2 exists for PAHs) and ISQGs (Figure 5 and Figure

6). Mean total PAH (USEPA 16) concentrations exceeded AL1 within sediments in BMD, within concentrations of individual PAHs exceeding the relevant AL1 except for Acenaphthene.

Mean concentrations of PAHs exceeded TEL for all PAHs for which an ISQG level exists, with concentrations of Anthracene, Benzo(a)pyrene and Dibenzo(a,h)anthracene exceeding PEL when averaged (mean).

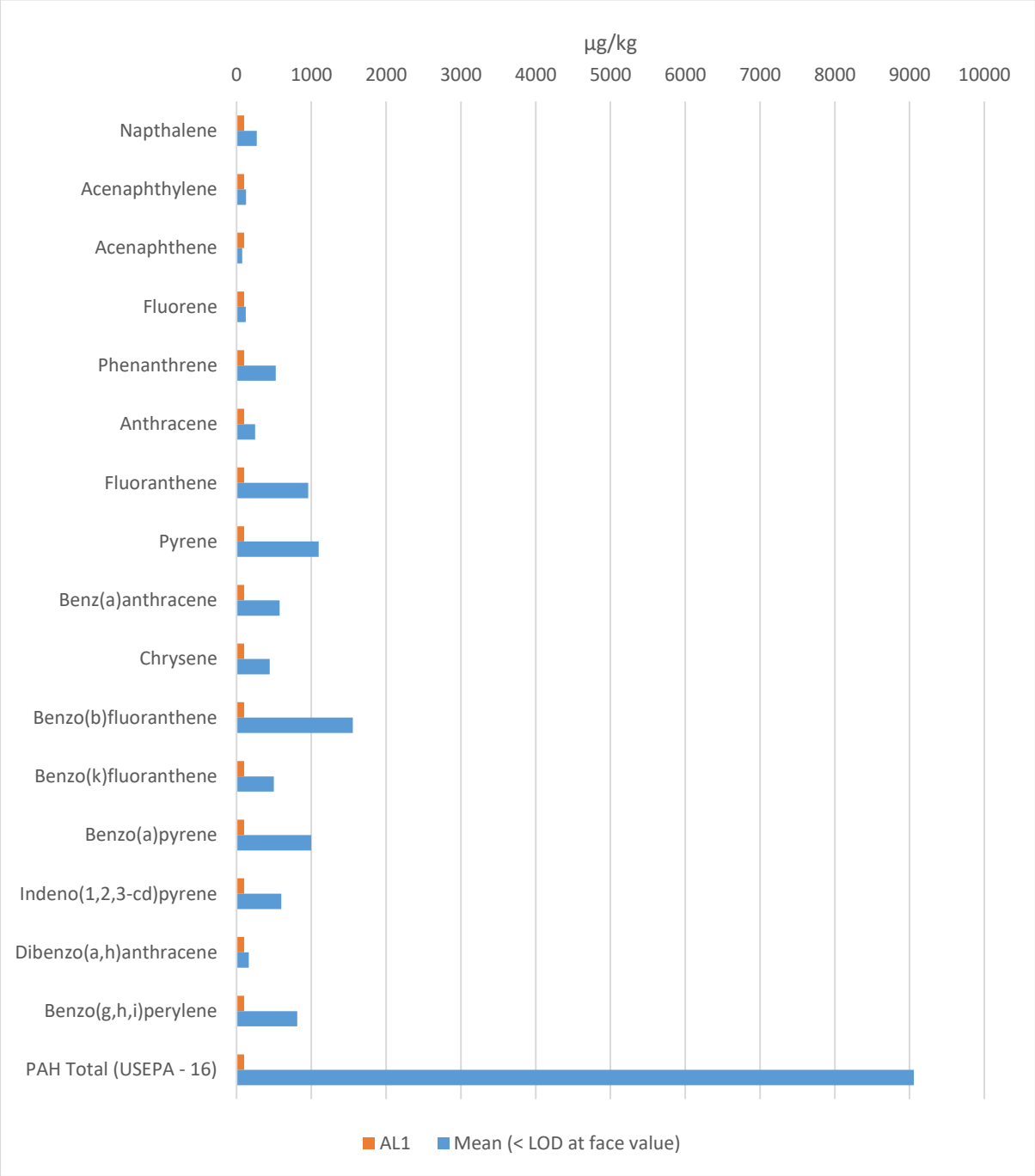


Figure 5 Mean sediment bound PAH concentrations from within BMD, comparison with Cefas ALs – Sampled 26th September 2017 ('Peoples Project: Sediment Sampling – Ref LO_A100795_V1, White, Young & Green (*Appendix II). Action Levels presented in accordance with UK Government, 2020. PAH Total is mean of sum of USEPA16 PAHs at each station.*

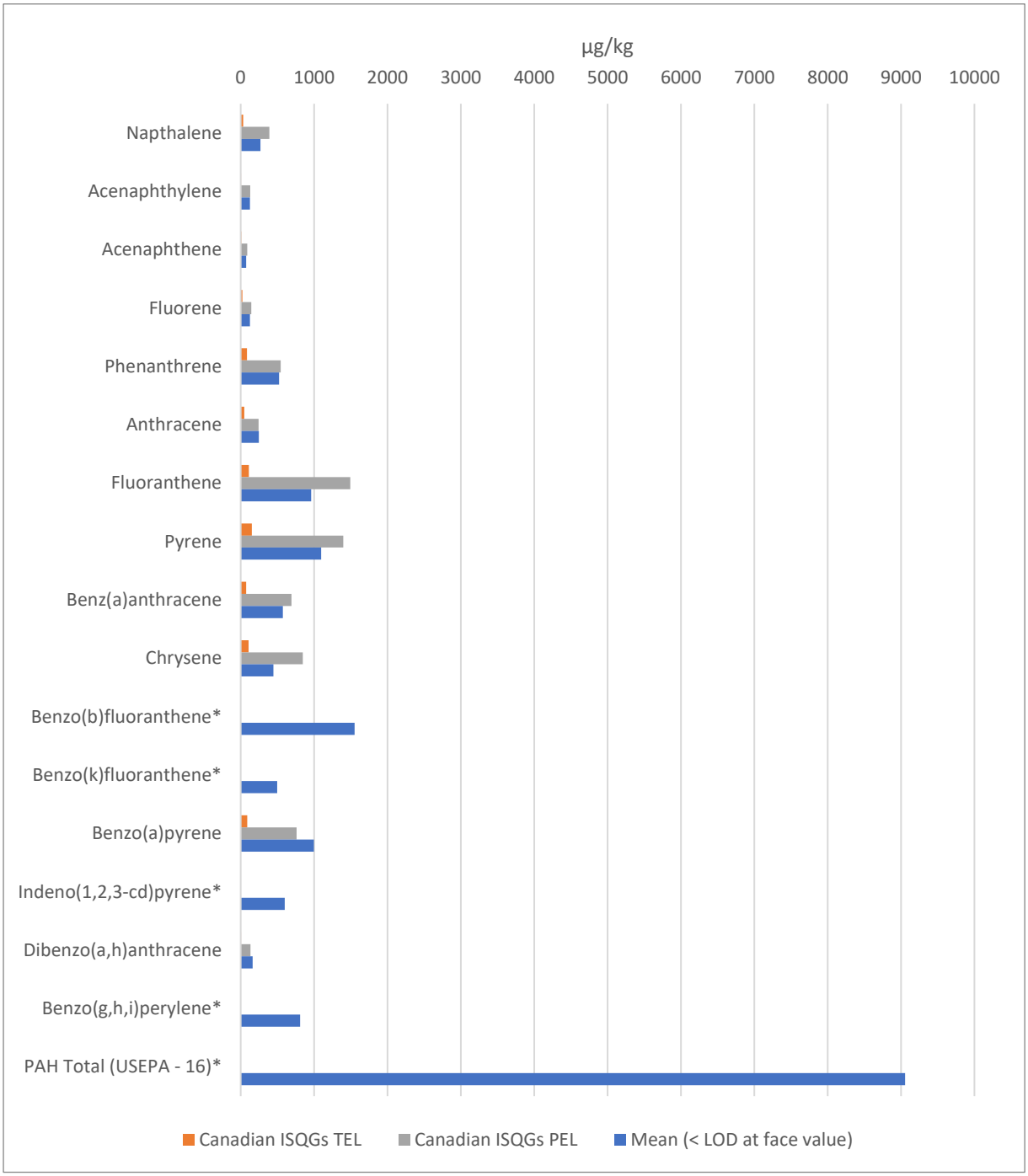


Figure 6 Mean sediment bound PAH concentrations from within BMD, comparison with ISQGs – Sampled 26th September 2017 ('Peoples Project: Sediment Sampling – Ref LO_A100795_V1, White, Young & Green (Appendix II*). PAH Total, is mean of sum of USEPA16 PAHs at each station.*

Sediment - Polychlorinated Biphenyls (PCBs)

Polychlorinated Biphenyls (PCBs) have a low solubility within water and a high affinity to suspended solids (especially those with high organic content). Due to their high solubility within fats / lipids, they can accumulate within organisms and can result in affects including endocrine disruption and immune suppression within marine organisms. Full results, methods and LODs from the sediment analysis undertaken within BMD are presented in full within Appendix II. Mean sediment concentrations of all

congeners[1] analysed (ICES 7) were compared against Cefas AL1 (no AL2 exists) and ISQGs (Figure 7 and Figure 8); concentrations exceeded AL1 and ISQG TEL but was below PEL. Note that no guidelines exist for individual congeners.

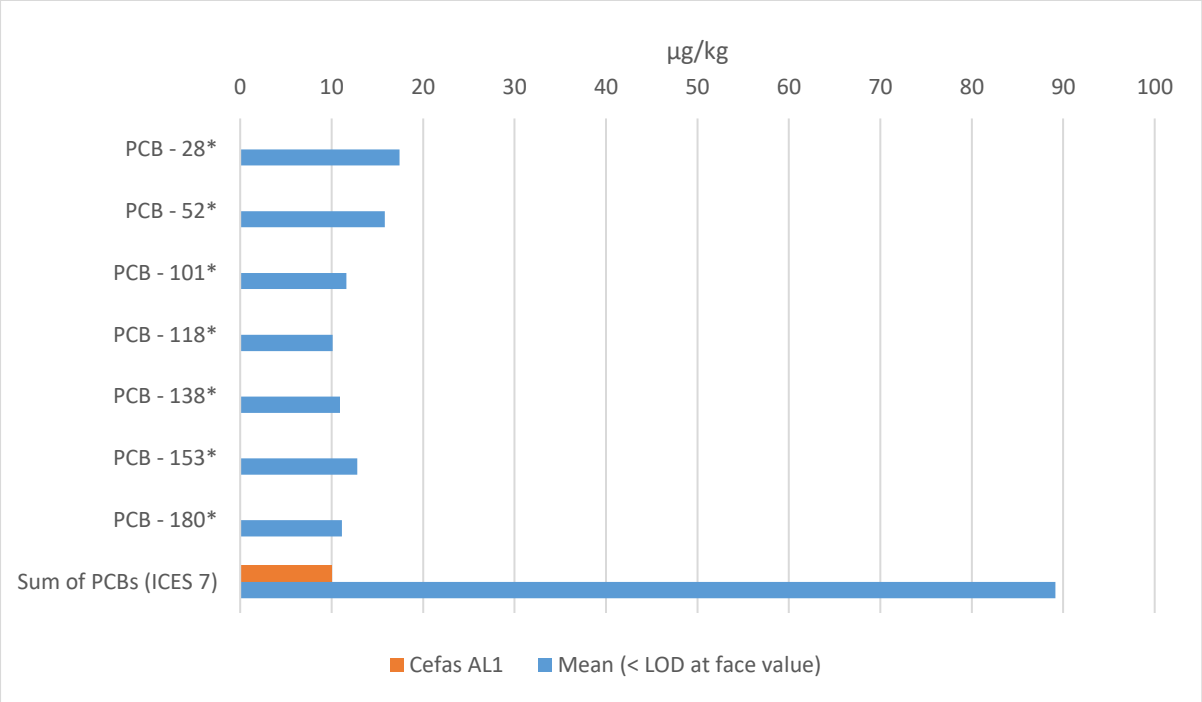
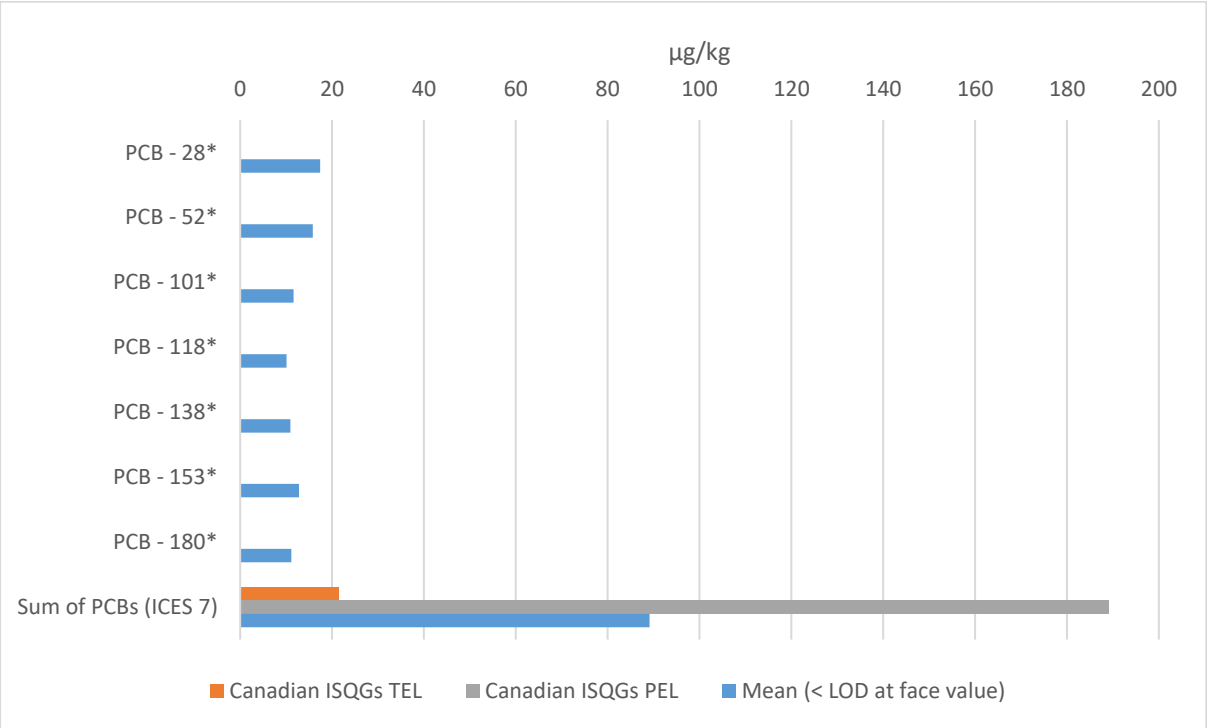


Figure 7 Mean sediment bound PCB concentrations from within BMD, comparison with Cefas ALs – Sampled 26th September 2017 ('Peoples Project: Sediment Sampling – Ref LO_A100795_V1, White, Young & Green (*Appendix II). * no relevant guideline value applicable.*



[1] Polychlorinated biphenyls (PCBs) occur in many different forms, or congeners, congener being a chemistry term to describe variants or different configurations of a common chemical structure.

Figure 8 Mean sediment bound PCB concentrations from within BMD, comparison with ISQGs – Sampled 26th September 2017 ('Peoples Project: Sediment Sampling – Ref LO_A100795_V1, White, Young & Green (Appendix II*). * no relevant guideline value applicable.*

Sediment – Benzene, Toluene, Ethylbenzene and Xylene (BTEX)

BTEX is the term used to describe a group of chemicals related to benzene. This includes a variety of compounds: toluene (methyl benzene), ethyl benzene, xylenes and benzene itself. BTEX are used in the manufacture of chemicals, rubber, plastics and in solvents, as well as in in paints and lacquers. No Cefas ALs or ISQGs exist for BTEX compounds. Full results, methods and LODs from the sediment analysis undertaken within BMD are presented in full within Appendix II. Concentrations of BTEX were typically reported to be below Limits of Detection (LOD) at most sites sampled within BMD, mean concentrations of total BTEX was below 24 µg kg^{-1} at all locations. Detectable concentrations of both Toluene and Ethylbenzene (at 9.6 µg kg^{-1}) were recorded at Station 5, located in the south west of the dock basin.

Sediment – Aliphatic and Aromatic Hydrocarbons

No Cefas ALs or ISQGs exist for the speciated Total Petroleum Hydrocarbons (TPH). Analysis was undertaken on sediment samples collected within BMD, with TPH speciated by carbon number[2]. Full results, methods and LODs from the sediment analysis undertaken within BMD are presented in full within Appendix II. Mean sediment concentrations both total aliphatic and aromatic hydrocarbons were high within the BMD (486 mg kg^{-1} and 751 mg kg^{-1} respectively), with higher carbon numbers (C12 and above) dominating.

Water Quality Observations

The water within the dock was turbid during survey operations due to suspended fines and vessel disturbance. The water quality results indicated a well oxygenated water body with slightly reduced Dissolved Oxygen (DO) at the seabed, potentially suggesting organic enrichment of the sediment. Full details of water quality sampling undertaken and results are presented in Appendix I.

Sediment – Benthic fauna

A total of 57 benthic species were identified at 12 grab stations within BMD. Annelid worms were dominant throughout; species of the genus *Tharyx* were present in all samples and were most abundant overall. Annelids also represented the highest biomass at most stations. 18 benthic taxa were considered "notable", two of which were commercially important molluscs (*Mytilus edulis*, *Cerastoderma edule*), five were identified as non-native to the UK (although none of specific concern), six were considered cryptogenic (of unresolved origin) and individuals from a further three genus' may include INNS. No species of benthic invertebrates of conservation importance were found during the aquatic surveys (Appendix I). The non-native, cryptogenic and potentially non-native species are summarised below in Table 9. *Monocorophium acheruscicum, M. insidiosum*, *Bugulina fulva* and *Polydora cornuta* are described as frequently occurring within fouling communities (Appendix I). Station 10 located in the northeast of BMD revealed both the lowest number of species and individuals; this station also yielded the second highest concentrations of total PAHs (15,700 µg kg^{-1}; highest being at Station 5, 16,500 µg kg^{-1}). The station with the highest density of individuals was station 11; the eastern most benthic sample within BMD and located closest to station 10.

[2] The carbon number is the number of carbon atoms contained within a particular molecule (for example, hexane and heptane contain six and seven carbon atoms respectively and therefore possess a carbon number of 6 and 7 respectively). For n-alkanes, the carbon number and the EC number are the same. The EC number is broadly reflective of the volatility of a compound with lower EC numbers being of high volatility.

Table 9: Summary of non-native and cryptogenic species identified during the 207 survey.

Summary of Invasive Non-Native Species	
Non-native in the UK	*Pseudopolydora paucibranchiata*
	Ammothea hilgendorfi
	Austrominius modestus
	Caprella mutica
	Styela clava
Cryptogenic	*Polydora cornuta*
	Tharyx species A
	Cossura pygodactylata
	Euchone cf. limnicola
	Monocorophium acherusicum
	Monocorophium insidiosum
	Bugulina fulva
May include invasive non-native species	*Streblospio*
	Sessilia spp
	Amathia spp

Below the waterline 11 stations were sampled along the dock wall by scientific divers. The dock walls were generally densely colonised with approximately 90% cover with less dense growth closest to the water surface. Patches of bare wall were present and were assumed to be a result of recent abrasion due to the contrast with the remainder of the wall. An algal band occurred close to the water surface with tunicates dominating the deeper sections of the wall; the most prevalent tunicate species were identified as *Ciona intestinalis* and *Ascidiella aspersa*. Whilst the INNS *Styela clava* was identified in both video footage and a scrape sample, it was considered uncommon within BMD due to the low number of observations made of this species during the survey.

Blue mussel (*M. edulis*) and the barnacle *Semibalanus balanoides* were commonly observed during the dive survey of the dock wall, along with byozoans and hydroids. Patches of sponge (including *Haliclona oculata* and *Halichondria panicea*) and tube-building polychaetes (likely *Sabella pavonina*) were also found to be present. *S. balanoides*, *M. edulis* and *A. aspersa* were present at all stations along the dock wall, and *C. intestinalis* was present at all stations except site 3.

Above the waterline, 12 scrape samples were collected from the dock wall containing a total of 23 species. The barnacle *Austrominius modestus* (INNS) was dominant above the waterline, tending to outcompete UK native barnacle species for space (Witte et al., 2010) and was identified in all scrape samples. Other taxa included *S. balanoides*, the isopod *Jaera albifrons*, the gastropod *Littorina saxatilis* and three native species of algae, bryozoan and hydroids.

A modified baited crayfish trap was used to sample mobile benthos. The shore crab (*Carcinus maenas*) was captured at all six stations and represented the most abundant species caught within the traps. Low numbers of the commercial edible crab, *Cancer pagurus*, goby (*Pomatoschistus* sp.) and prawns (*Palaemon* sp.) were also captured during the survey.

In summary, BMD contains moderately dense benthic infaunal communities (predominantly polychaetes) within the sedimentary bed, in addition to algae, barnacles, mussels and tunicates colonising the dock wall below the waterline and barnacles above it.

5.3. Marine Mammals

5.3.1. Study Area

Marine mammals are highly mobile and transitory in nature, therefore, this study has looked at the occurrence of species not only within Liverpool Bay, but also over the wider Irish Sea region. The status and activity of marine mammals known to occur at or adjacent to BMD is considered in the context of regional population dynamics at the scale of the Irish Sea, or where possible of Liverpool Bay depending on the data available for each species.

5.3.2. Summary of Relevant Legislation

All cetaceans are European Protected Species, listed on Annex IV of the 1992 Habitats Directive (as amended). The Conservation of Habitats and Species Regulations 2010 make it an offence to kill, injure, capture or disturb European marine protected species, whilst the Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007 extend the offence to areas of UK jurisdiction beyond 12 nautical miles (nm). It is now an offence under both Directives to deliberately disturb wild animals of a European Protected Species in such a way as to be likely significantly to affect: a) the ability of any significant group of animals of that species to survive, breed, rear or nurture their young; or b) the local distribution or abundance of that species (Evans 2012). Table 10 provides an overview of national and international legislation in relation to marine mammals.

Table 10: National and International Legislation relevant to Marine Mammals.

Legislation	Species	Level of protection	Details
The Berne Convention 1979	All cetaceans, grey and harbour seals	International	The Convention conveys special protection to vulnerable and endangered species. Appendix II lists 19 species of cetacean as strictly protected fauna. Appendix III lists all other cetaceans, grey and harbour seals. The Berne convention is implemented into UK law through the Wildlife and Countryside Act 1981.
The Bonn Convention 1979	All cetaceans	International	Protects migratory wild animals across all or part of their natural range, through international cooperation, focusing particularly on species threatened by extinction.
Oslo and Paris Convention for the Protection of the Marine Environment 1992 (OSPAR)	Harbour porpoise *Phocoena phocoena* as well as some large baleen whales including Bowhead and Blue.	International	OSPAR has a list of threatened and/or declining species in the NE Atlantic. Species listed are part of further work on the conservation and protection of marine biodiversity under Annex V of the OSPAR convention.
International Convention for the Regulation of	All cetacean species	International	Established the International Whaling Commission to regulate the exploitation and conservation of large whales enforcing a moratorium on commercial whaling in 1986.

Legislation	Species	Level of protection	Details
Whaling 1956			
Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) 1975	All cetacean species	International	Prohibits trade in species listed in Appendix 1 (Baleen whales, Northern Right whales and Sperm Whales) and allows for controlled trade of other cetacean species.
UK Post 2010 Biodiversity Framework	All marine mammals	International	Formerly the UK Biodiversity Action Plan (BAP), the UK Biodiversity Framework is implemented at regional and local levels through local BAPs and tailored Habitat Action Plans (HAPs; for specific habitats within BAPs).
The Conservation of Habitats and Species Regulations 2017	All cetaceans, grey and harbour seals	National	'The Habitats Regulations 2017'. Provisions of The Habitats Regulations are described further above. It should be noted that the Habitats Regulations apply onshore, within the territorial seas and to marine areas within UK jurisdiction, beyond 12 nautical miles (nm).
The Wildlife and Countryside Act 1981 (as amended)	All cetaceans	National	All cetaceans listed on Schedule 5 are fully protected within UK territorial waters. The act protects them from getting killed, injured, sold or causing destruction of a habitat which they use for shelter or protection and disturbance. Harbour porpoise, Bottle nosed dolphins and Common dolphin are listed on Schedule 6 of the Act prohibiting capture or fishing for these species.
The Countryside and Rights of Way Act (RoW) 2000	All cetaceans	National	It is an offence to intentionally or recklessly disturb any wild animal listed under schedule 5 of the Wildlife and Countryside Act.
Conservation of Seals Act 1970	Grey and harbour seals	England and Wales	This act provides closed seasons under which it is an offence to take or kill any seal except under license or in certain circumstances.

5.3.3. Existing Environment

No site-specific marine mammal surveys were carried out at BMD. The dock is accessed by a gated lock system opening to the Mersey Estuary, which inhibits marine mammals from accessing the network of docks when closed. None were seen during the 2017 site specific environmental surveys.

Two species of pinniped – the grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* and eighteen species of cetacean have been recorded in the Irish Sea region since 1975 (Evans and Anderwald 2005). The highest species diversity in the region for marine mammals is offshore around the Celtic Deep and close to the Isle of Man (DECC 2016). Thirteen cetacean species have been recorded in the Mersey, Dee and East Liverpool Bay over the past 150 years (Cooper 2008). Only five of these cetaceans are known to occur annually, these are the Harbour porpoise *Phocoena phocoena*, Bottlenose dolphin *Tursiops truncates*, short beaked common dolphin *Delphinus delphis*, Risso's dolphin *Grampus griseus* and Minke Whale *Baloenoptera acutorostrata*. The remaining species, which include Humpback whale *Megaptera novaeangliae*, Long-finned pilot whale *Globicephala melas* and white beaked dolphin *Lagenorynchus albirostris* are considered to be vagrants or occasional visitors (Hammond et al., 2005, Baines and Evans, 2009).

Of the five regularly occurring cetacean and two pinniped species within the Irish Sea only two cetaceans and a single seal species have been recorded within Liverpool Bay in recent decades. These are the cetaceans; bottle-nosed dolphin and the harbour porpoise and the pinniped grey seal (Mersey Biobank 2016, RECORD 2017, NBN 2019). This chapter focuses primarily on these three species.

5.3.4. Pinnipeds

Two species of true seal (Phocidae) are native to the UK, the grey seal and the harbour seal. The harbour seal is not known to occur in the Irish Sea region, but otherwise has a wide distribution in the UK with concentrations occurring in Scottish waters, Northern Ireland, Norfolk and the Thames estuary (Niras Consulting Ltd 2013). The nearest Natura 2000 sites with common seals as a feature are the Murlough SAC and Strangford Lough SAC located in Ireland. Any records of harbour seal in Liverpool Bay are vagrants or are potentially misidentified grey seals.

Grey Seal

Grey seals are sexually dimorphic, with males (bulls) growing to 2.1-2.3 m, weighing between 240 - 298 kg and living for 20 years. Females (cows) reach 1.8 to 2 m in length, weigh 174 – 207 kg can live in excess of 30 years and they typically have a contrasting pelage with paler ventral sides and dark dorsal side (Beck et al., 2003, Kilmova et al., 2014). Both sexes are fast agile swimmers with broad roman shaped nose and widespread nostrils (Miller and Boness 1979) making them distinguishable from the harbour seal.

The breeding season for grey seals varies depending on the population but is typically from early September to late December in the UK. Seals appear at favoured haul-out sites; females give birth, suckle the young for 3-4 weeks then mate with dominant male beach masters before returning to sea, leaving the pups to fend for themselves (Noren et al., 2008). The pup seals spend their first two years at sea foraging and can travel over 600 km during this period (Reilly, 1991).

Grey seals moult in the spring approximately 3-5 months after the breeding season. The moult can last for between 1 and 3 months, shedding and renewing fur essential to maintaining thermal regulation (Leeney et al., 2010). During the moult, seals remain hauled out and the greatest numbers of grey seals are typically observed during this time (Schop et al., 2017).
Following the two main haul-out periods of breeding and moulting, grey seals return to the water to forage. This is crucial to replace energy reserves lost whilst fasting during breeding and moulting. Their diet is commonly composed of benthic and demersal fishes such as sandeel *Ammodytes* spp., whiting and flounder *Platicthys flesus* (Hammond et al., 1994; Ridoux et al., 2007). See section 5 for further information on the abundance and distribution of these prey species. Foraging can take place close to haul out sites or in offshore waters; typically, grey seals forage close to haul out sites if food is abundant there (Thompsen et al., 1991).

Known haul out sites in Liverpool Bay are at West Hoyle bank at Hilbre Island approximately 15 km west of BMD. In the winter a small local population use haul out sites in Liverpool Bay, but this population swells in the summer months when a peak of up to 500 seals has been recorded during the moult (Niras Consultancy Ltd). Hilbre Island is an important site for Irish Sea grey seals. Seals from this haul out were tagged and their movements monitored. The southern part of Liverpool Bay was shown to be heavily used by grey seals which form part of the Irish Sea population and consists of approximately 5,000 individuals, which breed in Wales (Hammond et al., 2005).

The grey seals using Hilbre Island are a feature of the coastal Natura 2000 sites of the Dee Estuary SAC, the Morecambe Bay SAC and in the Menai Strait and Conway Bay/Y Fenai a Bae Conwy SAC, which are approximately 19 km, 65 km and 70 km from BMD respectively. The grey seal haul-out at Hilbre Island is a Grade D7 non designated feature of the Dee Estuary SAC, therefore, the conservation status of the site affords the grey seal population no additional conservation protection when away from the haul-out.

Despite the relative proximity to Hilbre Island, there are just nine records of grey seal occurring within 5 km of BMD recorded between 1955 and 2010. These anecdotal records, which show occasional visits by grey seal into the Mersey estuary are held by Mersey Biobank and RECORD (NBN 2019).

5.3.5. Cetaceans

Harbour Porpoise

The Harbour porpoise is the most commonly recorded and widely distributed cetacean in the northern Irish Sea with what appears to be a more or less continuous distribution from South-west Scotland, North Wales and North-west England including Liverpool Bay (Evans and Anderwald 2005). They are resident throughout the year in the region, with peak concentrations in southern parts of the Irish Sea recorded in late winter and spring (Evans et al., 2003).

Harbour porpoise are highly mobile cetaceans foraging upon a wide variety of small fishes including herring, sandeel, pout, poor cod *Trisopterus* spp. and goby Gobidae (Reid et al., 2003). Their feeding pattern is closely related to the tidal cycle, utilising the tidal race to herd and catch shoaling fish (RBA Ltd, 2005). Harbour porpoise follow a seasonal movement remaining inshore during the summer months and moving offshore during the winter (Santos and Pierce, 2003). This seasonal movement is likely to be due to changes in prey availability.

Harbour porpoise are thought to breed throughout the areas where they occur, mating during the summer with females giving birth 11 months later, and calving every other year. Most births occur between May and August and calves have been noted throughout the Irish Sea (Baines and Evans, 2009).

Whilst considered the most common cetacean in the region, porpoise was once much more abundant than they are today. In 1889 John Hammer, a shrimp fisherman working near the Bar Lightship, observed many hundreds of harbour porpoise in a massive moving school some three miles in length (Cooper 2008). The maximum number of harbour porpoise sighted in recent decades was up to 12 individuals off of Liverpool Pier Head, strung out across the river; the porpoise were using the tidal stream through the Narrows to ride along the river foraging (Cooper 2008, Mersey Biobank 2016).

Harbour porpoise are a coastal species known to frequent estuaries, shallow bays and tidal channels less than 200 m in depth. Most sightings occur within 10 km of the coast (RBA Ltd, 2005). Sightings are typically of individuals or small groups. Harbour Porpoises were observed during regional surveys

undertaken by DTI and BERR6. Individuals were seen to occur regularly along the north Welsh coast and in the east of Liverpool Bay in vicinity of the Operational Burbo Bank Wind Farm site and the Burbo Extension site (Niras Consulting Ltd, 2013).

The SCANS II data estimated relatively low densities of 0.2 to 0.5 harbour porpoise per km^2 in the Irish Sea (SMRU 2006). The more recent SCANS III data estimate a population of 1,056 porpoise within Block F which includes Liverpool Bay, with a mean density of 0.086 animals and a mean group size of 1. The NBN gateway has 16 records of harbour porpoise occurring within 5 km of BMD. Three of these sightings occur in the River Mersey within 2 km of BMD with the latest record from 2012 (Mersey Biobank 2016, NBN 2019).

Bottlenose Dolphin

The Bottlenose Dolphin is the second most commonly recorded cetacean in the northern Irish Sea and is likely to be the most abundant species in coastal waters (Evans and Anderwald, 2005). Bottlenose dolphins are distributed throughout the temperate and tropical seas of the world typically in coastal inshore waters, though they have been recorded in deep continental shelf waters (Reid et al., 2003). The UK bottlenose dolphins are the largest in the world with adults reaching up to 4 m in length, though more typically they are between 2.5 – 2.7 m (JNCC 2019).

They are social animals, usually occurring in groups of between two and 25 individuals. They hunt for a wide variety of prey including benthic and pelagic fish, cephalopods and shellfish (Reid et al., 2003). Peak concentrations in the Irish Sea occur in Cardigan Bay and the south-east coast of Ireland (Hammond et al., 2005). In the summer months small groups occur near the coast, but during the winter they disperse northwards forming large groups. They breed throughout their range and calves have been observed at all months of the year.

There has been a single record of one bottlenose dolphin from the River Mersey, made from the Mersey Ferry in May 2000. However, this record is unusual with this species being more typically recorded in coastal waters.

6. Evaluation and Impact Assessment: Fish & Shellfish Ecology

6.1. Potential Impacts: Construction

6.1.1. Habitat Disturbance

Habitat disturbance within BMD will occur as a result of the installation of the temporary northern isolator structure, raking process and infilling. The spatial extent of the habitat disturbance will be limited to within BMD and the area within Sandon-Half Tide Dock where the temporary northern isolation structure will be created. The TSHD, moored between 300 m and 400 m offshore, will not touch bottom and, therefore, not represent a seabed habitat disturbance.

Construction related disturbances to the dock floor will cause a highly localised, but permanent decrease in potential prey abundance for fish and shellfish. Consequently, species known to inhabit BMD such as pouting, coal fish and European eel as well as sole and plaice may be indirectly affected through a loss of foraging habitat. This loss is highly unlikely to affect the wider fish and shellfish community inhabiting the lower Mersey due to the amount of foraging habitat available in neighbouring environs.

Movement away from BMD by displaced fish and mobile shellfish, such as edible crab, will be inhibited by the northern isolator dam. Any individuals that remain within BMD during infill are highly likely to perish as a result of the process. Those that can escape or are translocated during the fish removal

process are not likely to present any increased competition for resources such as food and mating partners to the wider fish and shellfish community based on the comparatively low populous of BMD.

BMD is likely to provide a limited amount of spawning and nursery habitat to smaller species such as goby that are likely to reside within the dock. However, any direct loss on this scale is unlikely to have any effect at the population level. No other species have been shown to utilise BMD for spawning and / or nursery purposes.

The nature conservation value of the fish and shellfish species and habitats within the BMD (inside the ZoI) is considered ***high,*** given the presence of European eel and other species of nature conservation including sole and plaice.

The magnitude of impact to fish and shellfish through habitat disturbance is considered ***small,*** following the CIEEM guidance. Although permanent, effects are of a small spatial extent when compared to the extent of habitats available to these species within the wider regional and national scale. No effects on habitats or sites of international, national, or county importance are anticipated.

Fish and shellfish that become trapped within BMD during construction are expected to suffer mortality through exposure as the dock water is displaced and passively drains away during the infilling process. However, active mitigation measures (outlined below) will be implemented to rescue and translocate fish, especially those of conservation importance, i.e. European eel, prior raking with additional effort prior to infill further reducing the nature conservation value status of the receptors remaining.

The impact significance of dock infilling activities through the raking and infilling process is, therefore, assessed to be ***negligible***.

6.1.2. Increased Suspended Sediment Concentration (SSC)

Increases in suspended sediment concentrations (SSCs) will occur as a result of the raking process and during infill of BMD with marine aggregate. Raking will be a singular event occurring early and over a very short timeframe within the proposed construction window. Dissolved oxygen levels are likely to fall immediately after raking due to the resuspension of sediment bound organic materials. Infilling will consist of episodic, singular events occurring relatively early in the construction phase. Each event would temporarily cause a localised increase in SSC above ambient within BMD. Elevated SSCs within Sandon Half-Tide Dock will be mitigated through the use of stilling ponds created within the infill sand within BMD to slow the water and capture mobile sediments.

The proposed dock infill methodology states that approximately two to three months will be allowed between completion of the raking process and infilling of marine aggregate to allow for particulates to settle out of the water column. This gives an indication as to how long SSCs are likely to remain elevated within BMD. Levels in Sandon-Half Tide Dock are likely to return to normal much faster, given the increased water flow to the north where the water is being discharged.

Species caught within BMD during raking and infill are likely to incur high mortality rates due to the elevated SSC reducing the oxygen absorption ability of gills and eggs (Bash et al., 2001; Nicholls et al., 2003). Those species found outside of BMD would be expected to avoid localised areas of increased SSCs and are likely to re-occupy areas upon return of ambient conditions. Species inhabiting the lower Mersey would also be anticipated to have a high degree of natural tolerance to relatively high levels of SSC given the turbid nature of estuarine water.

Any increase in SSC as a result of the construction process is highly unlikely to affect the seasonal migration of diadromous species, such as Atlantic salmon, because of the highly localised and short-term nature of the effect.

The nature conservation value of the fish and shellfish species within the BMD (inside the ZoI) is considered ***high,*** given the presence of European eel and other species of nature conservation including sole and plaice. These species are known to inhabit areas of increased suspended sediments within their natural range and have a degree of natural tolerance to relatively high levels of SSC given the turbid nature of estuarine water within which they commonly inhabit.

The magnitude of impact to fish and shellfish through increased SSC is considered ***small*** following the CIEEM guidance, effects will be limited in spatial extent being limited to BMD, reversible and of a short term nature. No effects on habitats or sites of international, national or county importance are anticipated.

Fish and shellfish that become trapped within BMD during construction are expected to eventually suffer mortality through to increased SSC reducing oxygen absorption ability of gills and eggs. Active mitigation measures (outlined below) will be implemented to rescue and translocate fish, especially those of conservation importance i.e. European eel, prior to raking and with additional effort undertaken prior to infill.

The impact significance of increased SSC through raking and dock infilling is, therefore, assessed to be ***negligible***.

6.1.3. Underwater Noise and Vibration

Construction works within and in the vicinity of BMD have the potential to introduce sound energy into the water column, resulting from activities such as piling.

Pumping and fluidising of aggregate will create a degree of underwater noise and vibration emanating from the TSHD. Aggregate pumping will be episodic, singular events occurring relatively early in the construction phase. Pumping of fine soft sediments like sand and mud will result in low underwater noise levels compared to coarse, rocky or gravely substrates. Monitoring studies undertaken by De Jong et al. (2010) reveal that Trailing Suction Hopper Dredging (TSHD) activities for the removal of sand did not produce sounds louder than those produced by the vessel during transit between sites.

Anthropogenic (human related) underwater noise has been shown to cause widespread effects on marine organisms in relation to foraging, communication and anti-predator behaviours (Tyack, 2008; Slabbekoorn et al., 2010; Normandeau Associates Inc. 2012; Wysocki et al., 2006; Purser & Radford, 2011, Simpson et al., 2015). The species of primary concern at BMD are those which migrate through the lower Mersey Estuary to and from freshwater environments, for example Atlantic salmon and European eel.

Studies on the hearing capabilities of various fish species show there are substantial differences between auditory capabilities (Hawkins and Popper, 2017). Popper et al. (2014) grouped fish dependent on their physiology and sensitivity to sound into the four groups outlined within Table 1110.

Table 11: Grouped hearing capabilities of fish.

Group	Response parameters	Associated species
1	Fish lacking swim-bladders that are only sensitive to particle motion (kinetic energy of sound) and respond to only a narrow band of frequencies.	All flatfish, lamprey and elasmobranchs (sharks, skates and rays)
2	Fish with swim-bladders that are only sensitive to particle motion and show sensitivity to a narrow band of frequencies.	Atlantic salmon and mackerel
3	Fish with swim-bladders close to but not connected to the ear. These species are sensitive to both particle motion and sound pressure. They are sensitive to a wider range of frequencies than groups 1 and 2.	Atlantic cod and European eel
4	Fish with specialist structures linking the swim-bladder to the ear. These fish are primarily sensitive to sound pressure but may detect particle motion. They have a wide frequency range and are the most sensitive group.	Herring and shad

In the context of this assessment, the main species of concern include sea lamprey (Group 1) Atlantic salmon and sea trout (Group 2) and Atlantic cod and European eel (Group 3).

Compared with other species, including Atlantic cod and herring, Atlantic salmon are particularly insensitive to sound, lacking specialist hearing mechanisms (Hawkins & Johnstone 1978). This reduces their sensitivity and bandwidth to detect a noise stimulus, resulting in a poor ability to distinguish specific acoustic cues from background noise (Hawkins & Johnstone, 1978). The nature of Atlantic salmon hearing, therefore, suggests a subdued or lack of response to specific noise stimuli. In sea trout, no observable changes in behaviour were recorded from exposure to a percussive piling event, which created very high noise levels (average noise level 134 re 1 µPa, peak). These noise levels are far greater than those anticipated for the planned construction works in relation to BMD. Sound levels emitted by dredging typically fall within frequencies below 500 Hz that are generally in line with those expected for a cargo ship traveling at modest speed. Sound levels above 1 kHz are elevated during aggregate extraction with gravels generating higher levels than sand (Robinson et al., 2011, De Jong et al., 2010).

A comparison of noise from seven Trailing Suction Hopper Dredger (TSHD) during transiting, dredging, placement, pumping and rainbowing demonstrated that the maximum source levels for transiting exceeded that of the other activities for much of the measured frequency range (~31.5 to 63k Hz (1/3-octave). It is important to note that in this case the sediment mainly consisted of sand. The maximum broadband sound above 100 Hz was similar for all activities except 'sand placement' (de Jong et al. 2010 cited in WODA, 2013). No auditory and non-auditory related injuries have been documented for activities relating to dredging projects (except for cases involving underwater blasting prior to substrate removal by conventional dredgers) (WODA, 2013). However, if fish are exposed for long periods of time by staying within the vicinity of the dredger, low levels of damage to auditory tissues and temporary shifts in hearing thresholds may occur. WODA, (2013) describes these effects as recoverable damage with behavioural response being the most likely effect.

The nature conservation value of the fish and shellfish species within BMD and the lower Mersey (within the ZoI and local area) is considered ***high*** given the presence of migratory species such as Atlantic salmon, European eel and sea lamprey as well as other species of nature conservation including cod, sole and plaice.

The magnitude of impact to fish and shellfish through underwater noise and vibration is considered ***small*** following the CIEEM guidance with effects being temporary, reversible and of small spatial extent. No effects on habitats or sites of international, national, or county importance are anticipated.

Fish and shellfish communities of the lower Mersey are expected to elicit a degree of tolerance to underwater noise and vibration in level with the daily commercial and recreational shipping activity. Additionally, underwater noise is not anticipated to unduly exceed that of normal shipping even when pumping aggregate. With a channel width of approximately 1.5 km, passage upstream and downstream of BMD (within the Mersey) will always be possible for migratory species without the risk of barrier effects.

The impact significance of underwater noise and vibration through aggregate pumping during the infill process is, therefore, assessed to be ***negligible***.

The impact significance of underwater noise and vibration associated with contrition works pre-mitigation is assessed to be ***negligible***.

6.1.4. Changes to Hydrodynamic Regime

During construction, BMD will be infilled to allow vehicle and machinery access. As such, Nelson Dock to the south will be hydrologically isolated from the wider dock network to the north. This has the potential to alter the water quality parameters of Nelson Dock resulting in possible stagnation and fluctuations in salinity and dissolved oxygen. There is also a risk from harmful algal blooms that without water exchange, may remain in situ, causing further deterioration to water quality. However, the risk of these events occurring is minimised given the significant input to Nelson Dock from southern waterbodies.

It is anticipated that fish and shellfish assemblages of Nelson Dock would be similar to that of BMD due to the existing interconnectivity. However, given that Nelson Dock receives significantly more input from freshwater sources to the south and there is little hydrodynamic connectivity with BMD, and the species assemblage is likely comprise a more freshwater – dominated community. Upon isolation from BMD, the most probable source of water will continue to be input from southern water bodies, with some addition of surface water run-off. Over time, this may reduce salinity levels, shifting towards a more freshwater environment. Marine fish and shellfish communities trapped within Nelson Dock will become displaced and will eventually incur increased mortality, though freshwater / brackish species present within Nelson Dock are less likely to be affected given their inherent tolerance to variable brackish conditions.

Alterations in dissolved oxygen may occur as a result of stagnation (particularly during periods of hot summer weather). The effect may be exacerbated following the decomposition of seasonal algal blooms that are likely to occur in spring / summer. Reduced dissolved oxygen levels may fall below the threshold to sustain the existing fish and shellfish inhabiting the Nelson Dock resulting in mortality and foul odour.

The effects from stagnation and alterations to the water quality will occur within Nelson Dock only and will not affect the fish and shellfish assemblages inhabiting the wider dock network or the Mersey.

The nature conservation value of the fish and shellfish within Nelson Dock (within the ZoI and local area) is considered ***high,*** given the anticipated presence of European eel and other species of nature conservation including sole and plaice.

The magnitude of impact to the fish and shellfish ecology through the infilling of BMD to prevent water exchange and associated reduction in water quality is considered ***small*** following the CIEEM guidance. No effects on habitats or sites of international, national or county importance are anticipated through declining water quality within Nelson Dock whilst isolated from water exchange. Effects will be temporary and reversible, given that although the aquatic environment within BMD will be totally removed plans are to re-open connectivity with the southern dock to allow water exchange to be reinstated, however the project objective is to modify the aquatic environment within BMD to a terrestrial environment.

The impact significance of isolating BMD and Nelson Dock from water exchange and the associated reduction in water quality is, therefore, assessed to be ***negligible***.

6.1.5. Unplanned Accidental Spill and Release of Environmentally Harmful Substance

Unplanned accidental spill or release of environmentally harmful substances such as fuel, oil and lubricants, could potentially contaminate the marine environment. The most likely source of any spill / release has been identified as the trailer barge moored within the lower Mersey during the infill process. The severity of this effect on fish and shellfish receptors depends upon the quantities and nature of the spillage / release, the dilution and dispersal properties of the receiving waters and the bioavailability of the contaminant to identified species.

Fish and shellfish have varying degrees of sensitivity to a pollutant depending on the stage of their lifecycle. However, the mobility of most fish and some shellfish means that they can relocate or avoid the affected area altogether. Furthermore, it is likely that any accidental spillage and release would be rapidly dispersed due to strong tidal currents and wave action within the Mersey. As a result, any potential impact is likely to be very limited.

A Construction Environmental Management Plan (CEMP) with pollution prevention guidance will be utilised during the construction phase. This would limit the risk of accidental spillages or releases occurring and would ensure that adequate contingency is in place to resolve any incidents quickly and effectively.

The nature conservation value of the fish and shellfish species within BMD and the lower Mersey (within the ZoI and local area) is considered ***high,*** given the presence of migratory species such as Atlantic salmon, European eel and sea lamprey as well as other species of nature conservation including cod, sole and plaice.

The magnitude of impact to fish and shellfish through accidental spill / release is considered ***small*** following the CIEEM guidance. Any spills will be limited in spatial and temporal extent and risk is assessed to be low. No effects on habitats or sites of international, national or county importance are anticipated.

Control measures will be implemented via a CEMP to minimise risk of a release and to quickly manage any spill / release further reducing the possible impact to fish and shellfish communities.

The impact significance of accidental spill / release of environmentally harmful substances during construction is, therefore, assessed to be ***negligible***.

6.1.6. Entrainment

During the infill process it will be necessary to pump aggregate from the TSHD, moored within the Mersey, to BMD via a floating pipeline. To allow efficient pumping, it will be necessary to fluidise the aggregate with water abstracted directly from the lower Mersey. Onboard pumps within the TSHD will be used throughout the infilling process.

Water abstraction can lead to entrainment of organisms (namely fish) through the intake of the water pump. Once entrained, mortality is almost certain as damage may be sustained from the impellor and there is no return outlet back to the Mersey. Given the TSHD's position within the Mersey (moored approximately 300 – 400 m offshore from BMD) there is the possibility of entraining passing fish during pumping operations.

Fish commonly utilise tidal flows selectively enabling them to move up and downstream efficiently e.g. a fish moving upstream on an incoming (flood) tide may seek out the stronger flows of mid channel in order to be transported upstream to their feeding grounds. Poor swimming demersal flatfish including dab and plaice as well as juvenile fish such as elvers are known to utilise this technique. Flatfish typically returning downstream on the ebb tide whilst elvers seek refuge in slow flowing waters near the seabed and river banks to enable them to maintain their position. The greatest perceived risk would be to elvers that arrive in the lower Mersey from February to June with peak numbers occurring in March and April. As such, any individuals passing within the influence of the intake risk being entrained. As a result, no extraction is programmed to be undertaken during the peak elver migration (March and April inclusive). Note that if any abstraction is required during that period, this would be consulted and agreed with the Environment Agency In advance.

Entrainment is likely to be highly localised to the area around the water intake and will occur during the infill phase. The overall risk from entrainment is reduced given the TSHD is unlikely to pose a barrier to migration as the channel is approximately 1.5 km giving actively mobile fish species room to navigate. The risk will be further reduced by the seasonal restrictions, the short operational hours (i.e. <2 hrs per day, Mon – Sat, for 10 weeks). It should also be noted that the same process for Wellington Dock also did not require the use of intake screens to mitigate this risk. .

The nature conservation value of the fish and shellfish within the lower Mersey (the local area) is considered ***high,*** given the presence of migratory species such as Atlantic salmon, European eel and sea lamprey as well as other species of nature conservation including cod, sole and plaice.

Entrainment will only affect mid-water fish within the lower Mersey and will not affect those inhabiting BMD or the wider dock network in any way. The effect will occur over a short-term temporary basis during the infilling process.

The magnitude of impact to fish and shellfish through entrainment is considered ***small*** following the CIEEM guidance, given the limited area and temporary nature of the effect and the embedded mitigation in the form of intake screening and seasonal restriction. No effects on habitats or sites of international, national or county importance are anticipated.

The impact significance of entrainment during construction is, therefore, assessed to be ***minor adverse negligible***.

6.2. Potential Impacts: Operation

6.2.1. Net Loss of Habitat

There will be a total and permanent loss of aquatic habitat within BMD upon completion of the construction process. All fish and shellfish species that are removed from BMD during the fish rescue process will be permanently displaced into neighbouring environs within the wider dock network and / or the lower Mersey. Occupation of new alternative habitats is likely to occur quickly given the amount of available habitat. Increased resource competition by an influx of displaced individuals within surrounding habitats will be minimal given the comparatively low population size of BMD.

The nature conservation value of the fish and shellfish habitats within the BMD (inside the ZoI) is considered ***low,*** given fish rescue and removal measures in place during the construction phase. The disturbed environment is within an industrial dock and there would remain readily available habitat in neighbouring environs.

The magnitude of impact to fish and shellfish through habitat loss is considered ***small*** following the CIEEM guidance, although of a permanent nature, the scale of habitat loss is of small spatial extent, limited to that of BMD. No effects on habitats or sites of international, national, or county importance are anticipated.

Fish and shellfish that become displaced from or relocated from BMD during the operational phase are expected to quickly find suitable alternative habitats within the local area.

The impact significance of dock infilling activities through the raking and infilling process is, therefore, assessed to be ***negligible***.

6.2.2. Underwater Noise and Vibration

During operation, the only source of noise will be from the terrestrial environment during sporting events and music concerts etc. A portion of this sound will be reflected by the water surface minimising any disturbance to fish and shellfish within the vicinity. The residual sound that penetrates is not likely to cause disturbance to fish and shellfish.

The nature conservation value of the fish and shellfish within the wider dock network and lower Mersey (the local area) is considered ***medium,*** given the anticipated presence of migratory species such as Atlantic salmon, European eel and sea lamprey as well as other species of nature conservation including cod, sole and plaice. However, sensitivity to operational noise effects is considered to be ***low*** due to the ability to avoid areas of noise given the availability of a wide range of neighbouring habitats.

The magnitude of impact to fish and shellfish through operational noise and vibration is considered ***small*** following the CIEEM guidance. Effects will be temporary, intermittent, with no direct input of sound to the water column. The spatial extent of any effect is considered to be very small and limited to the immediate vicinity. No effects on sites of international, national, or county importance are anticipated.

Disturbance from operational noise is therefore not anticipated to influence the fish and shellfish community.

The impact significance of operational underwater noise and vibration is, therefore, assessed to be ***negligible***.

6.2.3. Changes to Hydrodynamic Regime

Hydrological connectivity between Nelson Dock to the south and Sandon Half-Tide Dock to the north will be re-established during operation. Continuous daily water exchange will help to prevent stagnation and improve water quality within the Nelson Dock. This will reduce environmental stress to fish and shellfish and allow recolonisation by species that may have been displaced during the construction process within Nelson Dock. Recolonisation of BMD will not be possible as the environment will have permanently transitioned from that of an aquatic habitat to a terrestrial habitat.

The nature conservation value of the fish and shellfish within BMD and Nelson Dock (within the ZoI and local area) is considered ***high,*** given the presence of European eel and other species of nature conservation including sole and plaice.

The magnitude of impact to the fish and shellfish ecology through the creation of the western channel is considered ***small*** following the CIEEM guidance. With hydraulic connectivity to the northern waterbodies re-established during operation. No effects on sites of international, national or county importance are anticipated. Effects will be permanent, given that the aquatic environment within BMD will be totally removed.

The impact significance of re-establishing water connectivity to Nelson Dock via the newly created western channel and converting BMD to a terrestrial environment is, therefore, assessed to be ***negligible***.

6.2.4. Unplanned Accidental Spill and Release of Environmentally Harmful Substance

Unplanned accidental spill or release of environmentally harmful substances could potentially contaminate the marine environment. The severity of this effect on fish and shellfish receptors depends upon the quantities and nature of the spillage / release, the dilution and dispersal properties of the receiving waters and the bioavailability of the contaminant to identified species.

Fish and shellfish have varying degrees of sensitivity to a pollutant depending on the stage of their lifecycle. However, the mobility of most fish and some shellfish means that they can relocate or avoid the affected area altogether. Furthermore, it is likely that any accidental spillage emanating from within the stadium would be contained by the drainage system and, therefore, prevented from entering the watercourse.

Given the aquatic habitats of BMD will effectively cease to exist following completion, any effect will be felt within the local area, i.e. adjoining dock network. The nature conservation value of the fish and shellfish within Sandon Half-Tide and Nelson docks are considered ***high,*** given the likely presence of European eel and other species of nature conservation including sole and plaice.

The magnitude of impact to fish and shellfish through accidental spill / release is considered ***small*** following the CIEEM guidance. Any effect will be of limited spatial and temporal extent and the risk of occurrence is low. No effects on sites of international, national, or county importance are anticipated.

Control measures will be implemented to minimise the risk of occurrence and to quickly manage any spill / release further reducing the possible impact to fish and shellfish communities.

The impact significance of accidental spill / release of environmentally harmful substances during operation is, therefore, assessed to be ***negligible***.

6.2.5. Light Pollution / Overshadowing

Installation of new infrastructure associated with project will utilise artificial night lighting around the proposed stadium and associated walkways. This is likely to cause a marginal amount of illumination to the adjoining waterways but mainly Nelson Dock. The implication of an unnatural lighting regime for fish and shellfish fauna are relatively unknown. However, artificial night lighting is considered capable of influencing foraging, shoaling, migration, and reproduction behaviours as well as altering the predation risk to fish.

It is likely that conditions created by artificial lighting will benefit visually dependant predators by enhancing their foraging opportunities. This could potentially affect small shoaling species that occur within the illuminated area from increased predation. However, the influence of artificial lighting from the proposed stadium when assessed in the context of the overall industrial use of the surrounding area is small.

The proposed stadium will also create a degree of overshadowing which will marginally reduce underwater illumination. The extent of the shaded area will alter daily with the movement of the sun and seasonally with changing sunlight hours available throughout the year. Anstey Horne have considered the potential overshadowing impacts of the proposed Bramley Moore Dock stadium on the areas which surround the stadium which include Regent Road to the east, Nelson Dock to the south, the River Mersey to the west and the industrial site to the north (Chapter 15, ES Volume II).

As the proposed stadium sits to the north of Nelson Dock within the wider Northern Docks area, minimal shadow will be cast from the proposed stadium over Nelson Dock at the spring equinox. This is due to the suns path throughout the day. As the sun rises in the east and sets in the west, the stadium will cast a shadow to the west in the morning, to the north in the middle part of the day and to the east in the evening. The shadow will be cast to its greatest extend at the winter solstice, when the sun is lowest in the sky. The opposite can be said for the summer solstice when the sun is highest in the sky and the shadows cast will be more limited. It is important to note that the shadow cast by the stadium will be transient in nature and will therefore be constantly moving throughout the course of the day. As such, there is limited potential for overshadowing to impact the Nelson Dock waterbody and associated ecological features as a result of the proposed stadium development.

Effects of shading on fish and shellfish are likely to relate to vision and associated behavioural changes such as orientation, schooling / dispersal, altered predator - prey relationships and potential migration direction change and delay.

Swimming and feeding behaviour in juvenile fish has been observed to reduce in low light conditions as their ability to see prey is limited. Most research into migratory species on the shading effects of coastal structures relate to the downstream movement of juvenile salmonids (Atlantic salmon and sea trout) and include reluctance of juveniles to pass through areas of low light. These aspects are of no concern for the current project as the area of shade will not span the width of the channel, thus allowing unobstructed transit past.

Changes in ambient light conditions will be highly localised to the lower Mersey and the adjoining Nelson and Sandon Half-Tide docks. Artificial lighting / overshadowing will occur frequently (daily) throughout the lifespan of the proposed stadium within BMD.

The nature conservation value of the fish and shellfish within the wider dock network and lower Mersey (the local area) is considered ***medium,*** given the presence of migratory species such as Atlantic

salmon, European eel and sea lamprey as well as other species of nature conservation including cod, sole and plaice.

The magnitude of impact to fish and shellfish through artificial lighting and overshadowing is considered ***small*** following the CIEEM guidance. Effects will be limited in spatial extent, intermittent and reversible. No effects on sites of international, national, or county importance are anticipated.

Influence of artificial lighting and overshadowing from the proposed stadium when considered in the context of the overall industrial use of the surrounding area is small.

The impact significance of artificial lighting and overshadowing is, therefore, assessed to be ***negligible***.

6.3. Proposed Mitigation

The above fish and shellfish assessment consider mitigation measures that have been incorporated in the proposed development as part of the design process, and other measures that are considered standard practice within the construction industry. Measures that are directly relevant to the fish and shellfish species inhabiting both the ZoI (BMD) and the local area (Liverpool dock network and lower Mersey) are discussed below.

6.3.1. Fish Rescue and Translocation

Fish rescues and translocations will take place during construction to reduce fish mortality. The first will commence prior to raking to mitigate the associated risk from increased SSC's. A second will be undertaken following the dock closure works. This is required to minimise the potential for fish mortality during the infilling process. Every effort will be made to remove as many fish as possible, but no guarantee can be given that all fish will be caught and translocated during the rescues due to equipment limitations. Fish will be released back into the wider dock network. Methods will be agreed in advance with the relevant Statutory Nature Conservation Bodies (SNCBs) to target all known fish species including pouting, European eel and coal fish known to inhabit BMD and for their effective removal and translocation during the construction phase, having the effect of reducing the nature conservation value of the fish population within BMD prior to many of the construction activities.

6.3.2. Bubble Curtain and Silt Curtain

Prior to the initial fish rescue and translocation, bubble curtains will be installed to deter fish away from the northern water channel adjacent to Sandon Half-Tide Dock. The bubble curtains will be in place until the installation of the silt curtain following raking and prior to dock closure which will provide the same mitigation. Both barriers will also provide a means to retain resuspended materials within the dock during raking and the standby time for resettlement of disturb sediments.

6.3.3. Managing Underwater Noise and Vibration

Disturbance from underwater noise and vibration will be avoided within BMD as all percussive piling activities will take place after the dock has been drained, in accordance with the schedule of works outlined in the CEMP. Furthermore, studies have shown that noise emitted from TSHD engaged in similar pumping operations do not result in sound levels greater than the vessel in transit. When viewed in the context of daily vessel traffic of the Mersey, resulting fish disturbance is anticipated to be minimal.

6.3.4. CEMP

The proposed development should develop and implement a CEMP to limit the risk of accidental spillage or release of environmentally harmful substances occurring and ensure that adequate contingency is in place to resolve any incidents quickly.

6.3.5. Abstraction Licencing

Water abstracted directly from the Mersey for use as a fluidising agent during the pumping of aggregate from the TSHD to BMD may require an abstraction licence. As part of the licence, mitigation measures will need to be demonstrated in consideration to fish. These are likely to include consideration to seasonal fish movements, including avoiding abstraction during the peak elver season running between March and April.

6.3.6. Biodiversity enhancements within newly created western channel

As detailed, the scheme proposes a new water channel between Nelson Dock to the south and Sandon Half-Tide Dock to the north. The proposed channel is to provide visual and hydrological connectivity. The Environment Agency consultation response to the MMO submission requests habitat enhancement features to be proposed in order to increase habitat complexity.

Habitat enhancement can be achieved through increasing the substrate rugosity, which provides enhanced surfaces for both mobile and sessile benthic fauna to become established. The bed of the channel may also be enhanced though the installation of further hard substrate, though soft substrate should also be retained to provide habitat for soft sediment infauna species. This will enhance overall food sources for a wide range of fish species that will remain within the Nelson Dock and Sandon Half-Tide Dock and within the new channel itself.

It is proposed that a habitat creation plan for the water channel is subject to an appropriate planning condition which will enable the applicant to submit relevant details for approval by Liverpool City Council (as statutory planning authority) and the Environment Agency.

6.4. Residual Effects

6.4.1. Net Loss of Habitat

An overall permanent net loss of fish and shellfish habitat will result because of the project. It will not be possible to directly mitigate this habitat loss due to the plans to convert the aquatic environments of BMD into that of a terrestrial environment. All existing fish and shellfish populations within BMD will either be lost or permanently displaced into the adjoining dock network or lower Mersey. However, when viewed in the context of the existing industrial environment, BMD does not represent a habitat of conservation importance. Furthermore, many fish inhabiting the dock will be translocated during the planned fish rescue. Effort will be made to target species of conservation importance such as European eel using targeted fishing apparatus such as fyke nets. As a result, the nature conservation value of the remaining fish populations is reduced and the residual effect is considered ***negligible***.

6.4.2. Light Pollution / Overshadowing

It will not be possible to fully mitigate the effects of artificial lighting and overshadowing. As such, fish communities inhabiting Nelson Dock and to a lesser extent Sandon Half-Tide Dock may incur alterations to predator prey relationships. No light spill is anticipated to reach the Mersey however a marginal amount of overshadowing will occur. As such, there is potential for marginal alterations to predator prey relationships. When viewed in the context of the wider industrialised area of the lower Mersey, the residual effect is considered ***negligible***.

6.4.3. Entrainment

Without the use of a preventative mesh, it will not be possible to fully eliminate the risk of entraining elvers. As such, some animals may be abstracted and suffer mortality. By imposing mitigation measures, such as avoiding abstraction operations in the peak migration season of March-April, the risk of entrainment can be reduced. As such, the magnitude of impact of entrainment is small, and the residual effect is considered ***minor adverse***.

6.5. Cumulative Effects

A review of 43 local projects has been undertaken to identify any potential cumulative effects, **Error! Reference source not found.**. In total, four proposed developments were identified as having potential to cause a cumulative effect with BMD: Liverpool Waters (including proposal for new Isle of Man Ferry Terminal and other commercial developments requiring dock infill works), William Jessop House development (part of the Liverpool Waters plan within Princes Dock), Liverpool Cruise Liner Terminal and Plot CO2, (a residential development forming part of the Liverpool Waters plans). Given the industrial nature of the dock network, these sites were not considered likely to cause significant impacts to the fish and shellfish assemblages inhabiting the area due to the negligible habitat and species conservation value throughout.

A standalone planning application at Plot CO2 of Liverpool Waters (reference 18F/3247) is currently pending determination. This application proposes partial infilling of the West Waterloo Dock basin, therefore, resulting in future loss of fish and shellfish habitat and further species displacement within the wider dock network (Middlemarch Environmental, 2018). Given the low conservation value of the habitats associated with the dock network, the cumulative impact of these projects is considered ***negligible*** overall.

Table 12: Screening assessment of nearby developments with the potential to cause a cumulative effect in association with BMD.

Proposed Development	Nature of Development	Potential for cumulative effect
Princes Reach, Princes Dock (Ref. 16F/1370)	34 story residential tower, situated inland away from BMD.	None.
Quay Central Plot C04 & C06, Liverpool Waters (Ref. 17F/1628)	14 story residential block, situated inland away from BMD.	None.
South Warehouse, Stanley Dock, Regent Road (Ref. 15L/2749)	Minor amendment to fabric of building, situated inland away from BMD.	None.
Tobacco Warehouse (Ref. 15F/2438)	Amendment to fabric of building, situated inland away from BMD.	None.
Fox Street Development (Ref. 16F/2252)	Residential buildings situated inland away from BMD.	None.
Merseyside Police Force HQ, St. Anne	New building situated inland away from BMD.	None.

Proposed Development	Nature of Development	Potential for cumulative effect
Street (Ref. 17F/3525)		
Manfred Street development (Ref. 16F/2755)	Student and worker accommodation situated inland away from BMD.	None.
Royal Liverpool University Hospital, Prescot St. (Ref. 13F/1599)	Building development, situated inland away from BMD.	None.
Devon Street, Moss Street, development (Ref. 14F/0874)	Student accommodation, situated inland away from BMD.	None.
Devon House, Devon street (Ref. 14F/0874)	Demolition and mixed-use development situated inland away from BMD.	None.
Gildart Street, Devon St Development (Ref. 18F/0347)	Demolition and building of residential blocks, situated inland away from BMD.	None.
Natex, Land at Norton Street, Islington (Ref. 19F/0294)	Building development works, situated inland away from BMD.	None.
The Paramount, London Rd (Ref. 13F/2947)	10 story student residence, situated inland away from BMD.	None.
Horizon Heights (Ref. 16F/1539)	Mixed purpose development, situated inland away from BMD.	None.
LJMU Campus, Copperas Hill Brownlow Hill (Ref. 18F/1410)	Student residence LJMU Campus, Copperas Hill Brownlow Hill	None.
Renshaw Hall (Ref. 18F/2751)	Mixed use development consisting of hotel and student accommodation, situated inland away from BMD.	None.
One Wolstenholme Square, 5 Parr Street & Wolstenholme Square (Ref. 17F/1982)	Building redevelopment, situated inland away from BMD.	None.
The Address at One Wolstenholme Sq (Ref. 18F/0301)	Building redevelopment, situated inland away from BMD.	None.
Strand House, 21 Strand Street (Ref. 16F/1826)	Residential development, situated inland away from BMD.	None.

Proposed Development	Nature of Development	Potential for cumulative effect
Silkhouse Court, Tithebarn Street (Ref. 16PO/0741)	Building redevelopment, situated inland away from BMD.	None.
Infinity Leeds St, Pall Mall (Refs. 17F/0340 & 19F/161)	Building redevelopment, situated inland away from BMD.	None.
Liverpool Waters (Ref. 10O/2424)	Major regeneration project involving sixty hectares of redundant docks to form cultural buildings, dock master's office and other commercial premises. Dock infilling will be required as part of the works.	Yes from: - Habitat loss / disturbance; - Increased suspended sediment; and - Potential release of INNS.
Isle of Man Ferry Terminal (Refs. 18F/3231 & 18L/3232)	Construction new Ferry Terminal for the Isle Of Man Government to replace existing ferry landing stage located at Pier Head with associated ancillary structures and associated marine equipment and works on land at Princes Half-Tide Dock with associated servicing and delivery via planned link road from Waterloo Road.	Yes from: - Habitat loss / disturbance; - Increased suspended sediment; and Potential release of INNS.
William Jessop House (Ref. 18RM/1554)	Proposed development works within Princes Dock as part of the wider Liverpool Waters scheme (outlined above).	Yes mainly from habitat disturbance.
Liverpool Cruise Liner Terminal (Refs. 17O/3230 & 19RM/1037)	Planned construction of a cruise liner terminal within Princes Parade, Liverpool on the east bank of the Mersey Estuary.	Yes from: - Potential release of INNS; and - Possible underwater noise disturbance.
Plot CO2, Liverpool Waters (Ref. 18F/3247)	Residential development of commercial space with associated partial dock infill of West Waterloo Dock. Scheme would form part of the Liverpool Waters project outlined above.	Yes from: - Habitat loss / disturbance; - Increased suspended sediment; and - Potential release of INNS.
Waterloo Rd, Paisley St, Roberts St, Greenock St (Ref. 19F/1290)	Mixed use development, situated inland away from BMD.	None.
The Metalworks Vauxhall Rd (Ref. 18F/0216)	Residential and mixed-use development, situated inland away from BMD.	None.
9-27 Freemasons Row (Ref. 17F/0874)	Residential and mixed-use development, situated inland away from BMD.	None.

Proposed Development	Nature of Development	Potential for cumulative effect
Naylor St (Ref. 18F/1035)	Land and building redevelopment situated inland away from BMD.	None.
Land between Blackstock St & Paul St (Ref. 13RM/2633)	Land redevelopment situated inland away from BMD.	None.
The Tannery Bevington Bush (Ref. 16F/3078)	Residential development situated inland away from BMD.	None.
Bevington House (Ref. 17F/1911)	Residential development situated inland away from BMD.	None.
Land bounded by Whittle St, Smith St, Kirkdale Rd (Ref. 18F/0417)	Demolition and residential development situated inland away from BMD.	None.
Rose Place (Ref. 16F/2797)	Redevelopment works situated inland away from BMD.	None.
Fox St,St Anne St (Ref. 16F/0823)	Demolition and residential development situated inland away from BMD.	None.
Copperas Hill (Ref. 19F/0454)	Demolition and construction of student accommodation situated inland away from BMD.	None.
Baltic Square (Refs. 14F/1313, 17F/2135 & 17F/3094)	Redevelopment works situated inland away from BMD.	None.
One Park Lane (Refs. 14F/1305 & 17F/2768)	Mixed use redevelopment works situated inland away from BMD.	None.
30-36 Pall Mall (Ref. 16F/2634)	Residential development situated inland away from BMD.	None.
Pall Mall Exchange (Ref. 19F/1789)	Brown site redevelopment situated inland away from BMD.	None.
Wirral Waters (Ref. 19F/1789)	Redevelopment of East Float, Wirral Waters	None, due to all proposed works being on land.
2-6 Lightbody Street (Ref 20F/1947)	Application to erect 210 residential units at land where Lightbody Street meets Great Howard Street, adjacent to Leeds to Liverpool Canal.	None, distant from BMD.
Non-material amendments to Liverpool Waters (Ref. 20NM/1801)	Non-material amendment to LW outline consent –adjusting boundary of parcel 3a/3b, re-orientate plot C01 and reducing heights of plot C01 from 12m and 44m, down to a single 11.3m to respond to the approved height of the commenced Isle of Man Ferry Terminal.	None.

Proposed Development	Nature of Development	Potential for cumulative effect
Regent Road Hotel (Ref. 20F/0217)	Demolition and re-development of site to provide 9 storey hotel with 9 storey multi-storey car park with associated access and servicing.	None.

7. Evaluation and Impact Assessment: Benthic Ecology

7.1. Potential Impacts: Construction

7.1.1. Net Loss of Habitat and Species

Total, permanent and irreversible benthic habitat loss within the BMD will occur as a result of the proposed scheme. Prior to being infilled with marine aggregate, the seabed will be raked to remove any debris and / or obstructions (Burohappold Engineering, 2019). The raking process will disrupt any sedimentary habitats, potentially causing damage to infauna and epifauna. The lower layers of infill will smother the existing benthic sedimentary habitat before infilling of the dock with marine won aggregates continues. Through the infilling process, sedentary species colonising the dock wall such as blue mussel (*M. edulis*), tunicates (*C. intestinalis*), barnacles (*S. balanoides, A. modestus*) and sponges (*H. panicea*, *H. oculata*) will become permanently smothered by aggregate or exposed as the water is displaced. They will be unable to mobilise to the sediment surface or detach and re-submerge and will therefore be lost.

The nature conservation value of the benthos and habitats within BMD (inside the ZoI) is considered ***negligible*** given the disturbed environment (industrial dock), the presence of INNS . No species of conservation importance were identified during baseline characterisation works in 2017 and low numbers of commercially importance shellfish species were noted, however these were not expected to be commercially targeted within the dock area. The area is currently classified as 'Prohibited', shellfish from these areas must not be subject to production or be harvested (FSA, 2020).

The magnitude of impact to benthic ecology through dock infilling and associated habitat and species loss is considered ***small*** following the CIEEM guidance. No effects on sites of international, national or county importance are anticipated through habitat loss associated with dock infilling, despite the total permanent and irreversible loss of habitats within the ZoI inside the dock. The spatial extent of loss is considered small in comparison to the wider habitats available within the region.

The impact significance of dock infilling and associated habitat loss is, therefore, assessed to be ***negligible***.

7.1.2. Release of Invasive or Non-native Species (INNS)

Five non-native species and species of three genus', which may include non-native species, were identified within the "notable" benthic invertebrates recovered from the sediments inside BMD (Appendix I). Furthermore, seven of the benthic taxa were considered cryptogenic, i.e. with an undefined origin. It should be noted that further INNS may be present within the dock which were not captured and identified during the survey works and may pose a greater risk to the surrounding area than those collected. During construction INNS may become dislodged from the dock wall or excavated from the substrate during debris clearance (raking). They may consequently become suspended and entrained within the water inside BMD.

During the raking process, water will be contained within BMD by the (temporary) northern bubble curtain structure and southern isolator structures mitigating the release of any INNS that may have entered suspension.

Following completion of the raking operation, a silt curtain will be installed slightly inboard of the bubble screen. Once installed, the bubble screen can be decommissioned and removed from site. The silt curtain will serve to prevent dislodged sedentary benthic fauna and disturbed dock bed deposits from displacement into the neighbouring Dock system.

A lay period of approximately two to three months will then be observed post raking to allow for particulate to settle out of the water column; dislodged sedentary benthic fauna are also expected to settle out of the water column during this period.

The nature conservation value of the benthos and habitats within the BMD (inside the ZoI) is considered ***negligible*** given the disturbed environment (industrial dock), the presence of INNS and the absence of species of conservation importance. Within the Mersey Estuary, however, are several protected areas, predominantly for wading and migratory birds. Wading birds typically forage for and consume benthic invertebrates. There is a small chance that an inadvertent release of INNS from BMD could enter the Mersey and settle within a protected area used by foraging birds. However, INNS are known to be present within the Mersey so it is impossible to quantify the effect this may have on the existing benthic communities of these regions. In this context, the nature conservation value is considered ***medium***.

The magnitude of impact to benthic ecology through dock infilling and potential release of INNS is considered ***low*** following the CIEEM guidance, however when considering the potential impacts to adjacent protected areas, a precautionary approach is recommended, assessing the magnitude to be low to medium. No effects on sites of international, national or county importance are anticipated through release of INNS into the dock network or wider environment through dock raking and infilling as these species are locally present already.

Dislodged sessile and sedimentary fauna are expected to settle out of the water column during the two-month period between raking and commencement of the infilling process, however during the raking process itself there will be limited opportunity for viable entrained individuals to relocate into adjacent water bodies through the bubble curtain and lead to changes within the benthic community structure. Those remaining on the dock wall after raking are expected to eventually suffer mortality through exposure as the dock water is displaced and passively drains away during the infilling process. At the displacement location (adjacent to the isolation structure), a stilling pond will be created to slow down the water flow, which will in turn allow any fines and displaced fauna to settle out before the water is displaced. This will be created by shaping the infilled sand once it is filled to the existing dock water level. Any remaining displaced fauna are therefore unlikely to be released into the wider environment. No species of conservation importance were identified during baseline characterisation works in 2017.

The impact significance of dock infilling activities and the associated potential release of INNS (known and unknown species) into adjacent water bodies through the raking and infilling process is, therefore, assessed to be ***negligible*** within the ZoI and ***minor*** within the local area (lower Mersey and wider dock network).

7.1.3. Changes to Hydrodynamic Regime

Temporary habitat changes may occur as a result of preventing water exchange between BMD and Nelson Dock during the construction phase. The water quality within Nelson Dock is expected to reduce as a result of reduced circulation during this period of isolation. Effects may include water stagnation and reduced dissolved oxygen content as well as foul odour, rendering the area unsuitable for habitation by the current benthic communities in both the sedimentary environment and on the dock wall. However, as Nelson Dock receives significant input from water bodies to the south, the impact of isolating Nelson Dock from BMD is expected to be minimal. However, there will likely be a gradual trend toward freshwater conditions within Nelson Dock. Water quality within Sandon Half-Tide Dock to the north of BMD is unlikely to be affected as hydrological connectivity to the wider dock network will be maintained throughout construction.

The nature conservation value of the benthos and habitats within the BMD (inside the ZoI) and Nelson Dock is considered ***negligible*** given the disturbed environment (industrial dock), the presence of INNS and the absence of species of conservation importance.

The magnitude of impact to benthic ecology through infilling BMD preventing water flow to Nelson Dock and therefore reducing water quality is considered ***small*** following the CIEEM guidance. No effects on sites of international, national or county importance are anticipated through declining water quality within BMD whilst isolated from water exchange with northern waterbodies. Effects will be temporary, given that hydrological connectivity will be re-established through the formation of the wester water channel toward the end of the construction process and effects are limited to the BMD in spatial extent.

The impact significance of isolating Nelson Dock from water exchange via the infilling of BMD and the associated reduction in water quality is, therefore, assessed to be ***negligible***.

7.1.4. Underwater Noise and Vibration

No piling operations are planned to be undertaken in water, therefore, no impacts are expected to affect aquatic benthic ecology. This construction activity is, therefore, scoped out of any further consideration as part of this assessment.

7.1.5. Overground Development

The over-ground development aspects are anticipated to occur largely upon completion of infilling the BMD. Associated impacts relating to artificial illumination and shading are, therefore, not expected to affect the aquatic benthos. This construction activity is scoped out of further consideration in this section of the assessment.

7.2. Potential Impacts: Operation

7.2.1. Habitat Alteration

Hydrological connectivity between Nelson Dock and Sandon Half-Tide Dock will be re-established via the western water channel toward the end of the construction phase. Flow will be governed by a series of submersed pipes fitted within the dock gates between Sandon Half-Tide Dock and BMD. Variation in flow is likely to be minimal, however species such as mussel (*M. edulis*) demonstrate a wide tolerance to tidal and current flow (weak [<1 kt] to strong [3-6 kts]; Tyler-Walters, 2008). The MarESA sensitivity assessment for *M. edulis* indicates that this species has a “very low” sensitivity to changes in water flow and a “very high” recoverability to this impact (Tyler-Walters, 2008). In areas of “good water flow” they are known to colonise artificial structures in large numbers; therefore, this species has potential to recolonise wetted areas upon completion (Tyler-Walters, 2008).

The nature conservation value of the benthos and habitats within the newly created wester water channel (inside the ZoI) is considered ***negligible*** given the disturbed environment (industrial dock), the presence of INNS and the absence of species of conservation importance.

The magnitude of impact to the benthic ecology as a result of creating the western water channel is considered ***small*** following the CIEEM guidance. No effects on sites of international, national or county importance are anticipated through habitat change. Effects will be permanent and irreversible, as BMD will be permanently modified as part of the proposed scheme.

The impact significance of habitat changes within BMD and due to the creation of the western water channel is, therefore, assessed to be ***negligible***.

7.3. Proposed Mitigation

7.3.1. Habitat Loss

Marine life (except for INNS) will be removed from BMD, where possible, in line with advice from appropriate relevant authorities, such as the EA, and released into the Mersey Estuary. A bubble curtain (and later a silt curtain) will be installed at the northern entrance to BMD to prevent re-entry into BMD by marine life; this will reduce the impact of habitat loss on the species concerned.

7.3.2. Release of Contaminants

Approximately two to three months standby time will occur between the completion of raking operations and the infilling of BMD. This is to allow time for the re-suspended particulate (including remobilised contaminants) to settle back out of the water column. Once in place, the lower layers of aggregate will minimise the transfer of particulate back out into the water column. Some contaminants such as PCBs, PAHs, aliphatic and aromatic hydrocarbons, trace metals and TBT are known to strongly adsorb to particulate matter; these are, therefore, largely expected to be retained beneath the lower layers of aggregate during infilling. The BMD will be isolated from the wider dock system via a bubble curtain and subsequently a silt curtain to retain mobilised materials within BMD.

7.3.3. Release of Invasive or Non-native Species (INNS)

During the raking process, BMD will be isolated from the remainder of the dock network and the Mersey Estuary by means of a bubble curtain and subsequently a silt curtain; this will minimise the risk of inadvertent release of mobilised INNS into adjacent areas and habitats through water transfer. In addition, approximately two to three months of standby time will occur between the completion of raking operations and the infilling of BMD. This is to allow time for the re-suspended particulate and dislodged biota to settle back out of the water column. Once in place, the lower layers of aggregate will minimise the transfer of material back out into the water column, effectively trapping it beneath the lower layers of aggregate. This embedded design parameter will, therefore, minimise the risk of the release of INNS into the wider dock network and out into the Mersey Estuary.

7.3.4. Biodiversity enhancements within newly created western channel

The scheme proposes a new water channel between Nelson Dock to the south and Sandon Half-Tide Dock to the north. The proposed channel is to provide visual and hydrological connectivity. The Environment Agency consultation response to the MMO submission requests habitat enhancement features to be proposed in order to increase habitat complexity.
Habitat enhancement can be achieved through increasing the substrate rugosity, which provides enhanced surfaces for both mobile and sessile benthic fauna to become established. The bed of the

channel may also be enhanced though the installation of further hard substrate, though soft substrate should also be retained to provide habitat for soft sediment infauna species. This will enhance overall food sources for a wide range of fish species that will remain within the Nelson Dock and Sandon Half-Tide Dock and within the new channel itself.
It is proposed that a habitat creation plan for the water channel is subject to an appropriate planning condition which will enable the applicant to submit relevant details for approval by Liverpool City Council (as statutory planning authority) and the Environment Agency.

7.4. Residual Effects

7.4.1. Habitat Loss

Despite the negligible value assigned to the habitats within BMD due to the disturbed nature of the environments, presence of persistent contaminants and INNS, the habitat will be lost entirely due to the project. Habitat loss is, therefore, considered a residual effect which cannot be completely mitigated against during construction and operations. The planned removal and relocation of marine life and establishment of enhancement measures within the newly created western channel via the proposed mitigation will reduce the potential impact of this effect. In the context of the area and in terms of conservation value, this residual effect is considered ***negligible***.

7.5. Cumulative Effects

A review of 42 local projects has been undertaken to identify any potential cumulative effects, Section 6.5 **Error! Reference source not found.**. In total, four proposed developments were identified as having potential to cause a cumulative effect with BMD: Liverpool Waters (including other commercial developments requiring dock infill works and a separate proposal for new Isle of Man Ferry Terminal and), William Jessop House development (part of the Liverpool Waters plan within Princes Dock), Liverpool Cruise Liner Terminal and Plot CO2, (a standalone application for residential development at West Waterloo Dock but forming part of the Liverpool Waters plans).

A standalone planning application at Plot CO2 of Liverpool Waters (reference 18F/3247) is currently pending determination. This application proposes partial infilling of the West Waterloo Dock basin, therefore, resulting in future loss of benthic habitat and further species displacement within the wider dock network (Middlemarch Environmental, 2018). Given the negligible conservation value associated with the dock network, the cumulative impact of these projects is considered ***negligible*** overall.

8. Evaluation and Impact Assessment: Water Quality

8.1. Potential Impacts: Construction

8.1.1. Release of Contaminants

Prior to infilling with marine aggregate, the BMD dock-bed will be raked to remove any debris and / or obstructions (Burohappold Engineering, 2019). The raking process will mobilise sediments and result in the potential release of sediment bound contaminants and the partitioning of these to aqueous phases i.e., increase dissolved concentrations within the water column. The release of sediment bound organic materials and chemicals will also temporarily increase the Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) within the water column and may result in a reduction in dissolved oxygen levels. A bubble curtain will be in place during the raking process to retain remobilised materials within BMD and this will be subsequently replaced with a silt curtain following raking to ensure resuspended materials are retained. As described within Section 5.2.2 and supported by full details in Appendix II, sediment concentrations of a range of contaminants exceed environmental guideline thresholds and as such it will be important to minimise the risk of remobilised

sediments and the associated release of contaminants into the water column from impacting the adjacent waterbodies.

Following the raking process a period of two to three months standby time will be allowed for the re-suspended particulate (including remobilised contaminants) to settle back out of the water column. During this period, it is expected that any released contaminants will likely remain bound or rebind to sediments and resettle to the bed. Once in place, the lower layers of infilled aggregate will minimise the transfer of particulate back out into the water column, effectively trapping it beneath the membrane layer. Sediment bound contaminants will effectively remain trapped beneath these lower layers. These embedded design parameters will, therefore, minimise the release of sediment bound contaminants into water column and into the wider dock network and out into the Mersey Estuary during over topping of the northern isolator dam during the infill process which will be via a stilling pond arrangement to further retain materials within BMD.

The value of water quality within BMD (inside the ZoI) and the wider dock network and Mersey Estuary considered to be ***very high***, water quality underpins a wide range of national and international directives and obligations for the UK Government.

The magnitude of impact to water quality through dock infilling and associated over topping is considered ***small*** following the CIEEM guidance. No effects on water quality status within the wider dock network or Mersey Estuary are anticipated, and any changes to water quality within the ZOI are temporary and of short duration.

The impact significance of dock infilling and any associated changes to water quality are therefore, assessed to be ***negligible***.

8.2. Potential Impacts: Operation

None anticipated.

8.3. Proposed Mitigation

As described within Section 7.3.2.

8.4. Residual Effects

None anticipated.

8.5. Cumulative Effects

A review of 42 local projects has been undertaken to identify any potential cumulative effects, Section 6.5**Error! Reference source not found.**. In total, four proposed developments were identified as having potential to cause a cumulative effect with BMD: Liverpool Waters (including other commercial developments requiring dock infill works and a separate proposal for new Isle of Man Ferry Terminal), William Jessop House development (part of the Liverpool Waters plan within Princes Dock), Liverpool Cruise Liner Terminal and Plot CO2, (a residential development forming part of the Liverpool Waters plans). Of these, Plot CO2 and Liverpool Waters propose partial infilling of the West Waterloo Dock basin, therefore, resulting in the potential to temporarily affect water quality within West Waterloo Dock. Given the negligible impact significance of the impacts associated with the proposed development in terms of water quality and the transient and temporary nature of effects, the cumulative impact of these projects is considered ***negligible*** overall.

9. Evaluation and Impact Assessment: Marine Mammals

9.1. Potential Impacts: Construction

9.1.1. Underwater Noise and Vibration

Marine mammals emit and detect sound for a wide variety of purposes including detecting prey items, locating conspecifics and to navigate. Southall et al. (2007) grouped marine mammals into functional groups depending on their auditory capabilities, dividing cetaceans into low, mid and high frequency, whilst seals were treated differently with respect to whether they were in water or air. These groups are relevant to noise impacts (Table 12).

Table 13: Functional hearing groups of marine mammals, their auditory bandwidth and species present in the Irish Sea (modified from Southall et al., 2007).

Functional hearing group	Estimated bandwidth	Species
Low frequency cetaceans	7 Hz to 22kHz	Minke whale *Balaenoptera acutorostrata*
Mid-frequency cetaceans	150 Hz to 160 kHz	Bottlenose dolphin *Tursiops truncatus*
High-frequency cetaceans	200 Hz to 180 kHz	Harbour porpoise *Phocoena phocoena*
Pinnipeds in air	75 Hz to 75 kHz	Grey seal *Halichoerus grypus*
Pinnipeds in water	75 Hz to 30 kHz	Grey seal *Halichoerus grypus*

Various construction works will emit sound into the underwater environment during the construction period. The pumping of aggregates from the TSHD to BMD during infill is the greatest source of underwater noise, which could potentially impact marine mammals in close vicinity to the TSHD.

Dredging generates underwater sound during sediment excavation, transportation and placement. This can originate through a variety of sources including movement of material, engine and mechanical sound, propellers, pumps, cutting and digging of material. The unloading of the aggregate from the TSHD to BMD is likely to emit sound into the underwater environment. A study by De Jong et al (2010) measured underwater sound from seven TSHD's during construction work at the Port of Rotterdam. The study recorded maximum source levels from different dredging activities including transit, placement, pumping and dredging. The results showed that the various activities did not produce louder sounds than those produced by the barge transiting between the dredging area and the placement site (De Jong et al., 2010, Robinson et al., 2011). Underwater sound caused by these activities was typically of low frequency, with strongest sound below 1 kHz (De Jong et al. 2010). The Port of Rotterdam construction used similar aggregate to the proposed works at BMD consisting mainly of sand (De Jong et al., 2010). Extraction of coarse gravel generates higher sound levels by about 5 dB at frequencies above 1 kHz than sand (Robinson et al. 2011). Sound source levels typically range from 168 to 186 dB re 1 µPa (Genesis 2011) and so are within the hearing frequencies of the three marine mammals known to occur, albeit occasionally, within proximity of BMD.

Anthropogenic underwater sound (from construction activities etc.) may increase physiological stress and induce behavioural changes in marine mammals. It can also reduce available habitat and lead to displacement from breeding or feeding grounds (Tougaard, 2003; Thomsen, 2006). Intense exposure to intense pulsed sound, especially from seismic surveys, pile driving and underwater explosions, may also lead directly to impaired hearing. Experimental data show harbour porpoise is less tolerant of noise than other marine mammals (Lucke et al., 2008).

The nature conservation value of marine mammal species within the lower Mersey (local area) is considered ***medium,*** given the potential presence of nature conservation species such as grey seal, harbour porpoise and bottlenose dolphin.

The increased noise and activity during the transfer of material from the TSHD to BMD could lead to behavioural and stress related reactions (e.g. avoidance of foraging areas), especially due to marine mammals' acute hearing capabilities. A strong behavioural avoidance reaction could occur up to 500 m from the source of TSHD pumping noise, and any potential disturbance might occur up to 7 km away. However, there is still a large area available for marine mammals to avoid any areas of disturbance, therefore, the magnitude of this impact upon marine mammals is assessed to be ***small***.

Hearing damage is unlikely to occur at the sound frequencies and intensities associated with aggregate pumping or from the increased shipping activity in the Mersey Navigation. Marine mammals are already exposed to high densities of shipping and the associated noise effects off North Wales leading to the Mersey, as well as considerable gas infrastructure and offshore wind farms in Liverpool Bay, and may exhibit habituation to these noise levels. Therefore, impact significance is assessed to be ***negligible***.

9.1.2. Potential Collision Risk

The presence of the TSHD and displacement of other vessels in proximity of BMD presents the potential for death or injury to marine mammals due to collision. However, it is considered highly unlikely that collisions will occur as the TSHD will be moored up for much of the time. Furthermore, the TSHD typically moves at slow speeds and marine mammals are highly mobile and able to avoid slow vessels.

The nature conservation value of marine mammal species within the lower Mersey (local area) is considered ***medium,*** given the potential presence of nature conservation species such as grey seal, harbour porpoise and bottlenose dolphin.

The elevated noise associated with the discharge of the marine aggregates will alert marine mammals to the presence of the vessel. Given the proximity of the TSHD to the Mersey navigation channel, the TSHD is only likely to make a minor contribution to the overall vessel activity in the wider study area. The magnitude of the effect is predicted to be highly localised and close to the existing Mersey navigation channel. The impact will be short term and intermittent over the construction period. The magnitude of the effect is, therefore, considered to be ***small.***

Evidence of mortal injury from boat collisions in marine mammals is rare (CSIP, 2011) and typically involves high speed craft. Out of nearly 500 post-mortems of harbour porpoise conducted in the UK between 2005 and 2010 only 0.8% were attributed to vessel collisions. Therefore, the overall impact significance is assessed as ***negligible***.

9.1.3. Unplanned Accidental Spill and Release of Environmentally Harmful Substance

Accidental release of pollutants from the TSHD during construction may have a negative effect on marine mammals. Pollutants could include diesel, sewage, antifouling biocides and leachates from dredged sediments. The magnitude of the impact depends on the nature of the pollution incident, but a TSHD has limited potential for accidental loss of contaminants, which are primarily contained within the hydraulics, gearbox and fuel tank. As such, any spillage would likely be short lived, relatively small and would be immediately diluted and rapidly dispersed if not contained and cleaned up.

The nature conservation value of marine mammal species within the lower Mersey (local area) is considered ***medium,*** given the potential presence of nature conservation species such as grey seal, harbour porpoise and bottlenose dolphin.

The magnitude of this impact upon marine mammals is ***small***. Even in the unlikely event that a spillage did occur, the infrequency of records and low numbers of marine mammals involved mean the overall impact significance is ***negligible*** at in respect of marine mammals (all species).

9.2. Potential Impacts: Operation

9.2.1. Underwater Noise and Vibration

Sound will be omitted from the stadium during its operation originating from sporting events, music concerts and other entertainment events. The source of this sound will be terrestrial and much of this is likely to be reflected by the water surface with minimal noise transferred to the water column. As such, any effect from underwater noise and vibration on marine mammals is highly unlikely to occur and can effectively be screened out at this stage.

9.3. Proposed Mitigation

There is no indication that the BMD provides critical habitat or prey to support marine mammals. No significant effects were identified for marine mammal receptors. Nonetheless, disturbance to marine mammals should be minimised. Given the proximity of BMD to grey seal haul-outs at West Hoyle sandbank near Hilbre Island, and the use of Liverpool Bay by harbour porpoise and occasional bottlenose dolphin, work should be completed as quickly as possible, and, where possible, high speed vehicles and ducted propeller use should be avoided to reduce the risk of collision and corkscrew injuries.

9.4. Residual Effects

No significant impacts on marine mammals were identified for the proposed works at BMD. Overall, impacts on marine mammals were assessed as ***negligible***. None of the impacts are of a scale that requires mitigation. Confidence in this assessment was considered as medium; the uncertainty is relating to some knowledge gaps regarding underwater noise propagation and the presence of species. Data on cetaceans' abundance are insufficient to identify population trends with confidence for most species in most regions.

9.5. Cumulative Effects

No significant cumulative effects were identified for marine mammals (all species) originating in cumulation with the proposed works at BMD and any other developments within the area.

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11. Appendix I - APEM (2017) Project Blue – November 2017. Scientific Report P00001932 for WYG Environment Planning Transport

Project Blue

WYG Environment Planning Transport Ltd

APEM Ref P00001932

November 2017

R Moore, M Jowett, C Ashelby

Client:	WYG Environment Planning Transport Ltd
Address:	Arndale Court Otley Road Headingley Leeds LS6 2UJ
Project reference:	P00001932
Date of issue:	30 November 2017

Project Director:	Dr Michael Dobson
Project Manager:	Rob Moore
Other:	Mark Jowett, Chris Ashelby

APEM Ltd
Riverview
A17 Embankment Business Park
Heaton Mersey
Stockport
SK4 3GN

Tel: 0161 442 8938
Fax: 0161 432 6083

Registered in England No. 02530851

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1. Introduction

1.1 Background

WYG Environment Planning Transport Ltd commissioned APEM to undertake a series of aquatic surveys at Bramley-Moore Dock in Liverpool. The work was carried out in relation to the potential redevelopment of the site as a new football stadium for Everton Football Club. The aim of the surveys were to determine the environmental status of the dock as little is currently known about the aquatic ecology in the dock, and to establishing if invasive non-native species (INNS) were present.

1.2 Project objectives

WYG commissioned APEM to undertake the following survey work:

- Take 12 grab samples of sediment, analysed to the lowest practicable taxonomic level and calculate the Major Taxonomic Group (MTG) biomass for macrobenthic invertebrates.
- Take 10 grab samples of sediment to be analysed in-situ for temperature, pH and redox potential. Photograph and describe the samples, and hand them to a WYG operative on site for further analysis.
- Undertake a hydroacoustic fisheries survey and fyke netting survey in order to obtain baseline data on the fish population, including species and approximate population size.
- Survey the benthic community on the walls below the waterline and carry out a video survey of the attached biota on the walls using a scientific dive team.
- Collect 12 wall scrape samples of the benthic community on the walls above the waterline. In addition, take 12 wall scrapes and 12 sweep net samples below the waterline to be analysed if the underwater video survey fails to produce video of sufficient quality due to poor visibility.
- Set six baited traps to quantitatively sample mobile invertebrates.
- Carry out 10 water quality profiles and measure depth, transparency, temperature (°C), salinity (ppt), conductivity (mS), dissolved oxygen (DO) (in mg/l and percent saturation) and pH at 1 m depth intervals throughout the water column.

The surveys were completed in the last week of September 2017. This report presents the methods that were used for completing the surveys and the survey results.

2. Methodology

2.1 Benthic invertebrates in sediment

We collected sediment samples for benthic invertebrate analysis from 12 sampling sites shown in Figure 2-1.

Figure 2-1 Sampling sites for benthic invertebrates in sediment

The samples were collected by lowering a 0.0225 m^2 Eckman grab from the survey vessel (Figure 2-2).

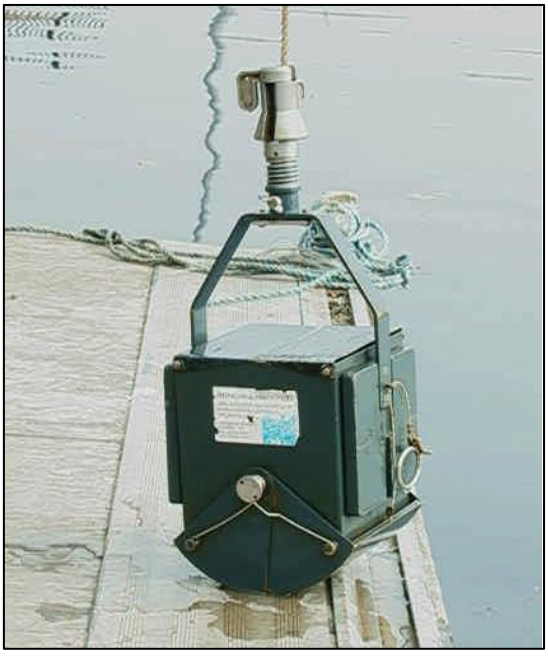

Figure 2-2 0.0225m^2 Eckman grab

The grab samples were used for benthic invertebrate analysis and for physico-chemical analysis (Section 2.2). Samples containing less than half the grab volume were considered inadequate and were rejected. Three attempts were made at each sampling station to collect a valid sample. If it was not possible to collect a suitable sample the sampling point was moved slightly to a site where a sample could be collected. Samples were transferred to a suitable container and fixed with 4% buffered formaldehyde solution in seawater, labelled inside and outside, and transported to APEM's specialist marine biology laboratory for analysis.

It is commonplace when carrying out benthic invertebrate sampling for the environmental regulators to ask for replicates, therefore the sampling strategy used 12 sampling points. The dock was separated approximately into quarters with three samples positioned along four transects (i.e. 4 x 3 = 12 samples). The three samples from each transect were then grouped together as replicates for analysis. There were some constraints to collecting samples due to operational activity in the dock at the time of the surveys, therefore sampling some points had to be relocated in order to collect samples.

2.2 Sediment quality

We collected 10 sediment samples using the 0.025m^2 Eckman grab as described in Section 2.1. The sampling points are shown in Figure 2-3. The samples of surface sediment were transferred into plastic bags and placed within a clearly labelled 1L plastic tub. The samples were photographed and tested in-situ for temperature, pH and redox potential before being handed to a WYG technician for further analysis.

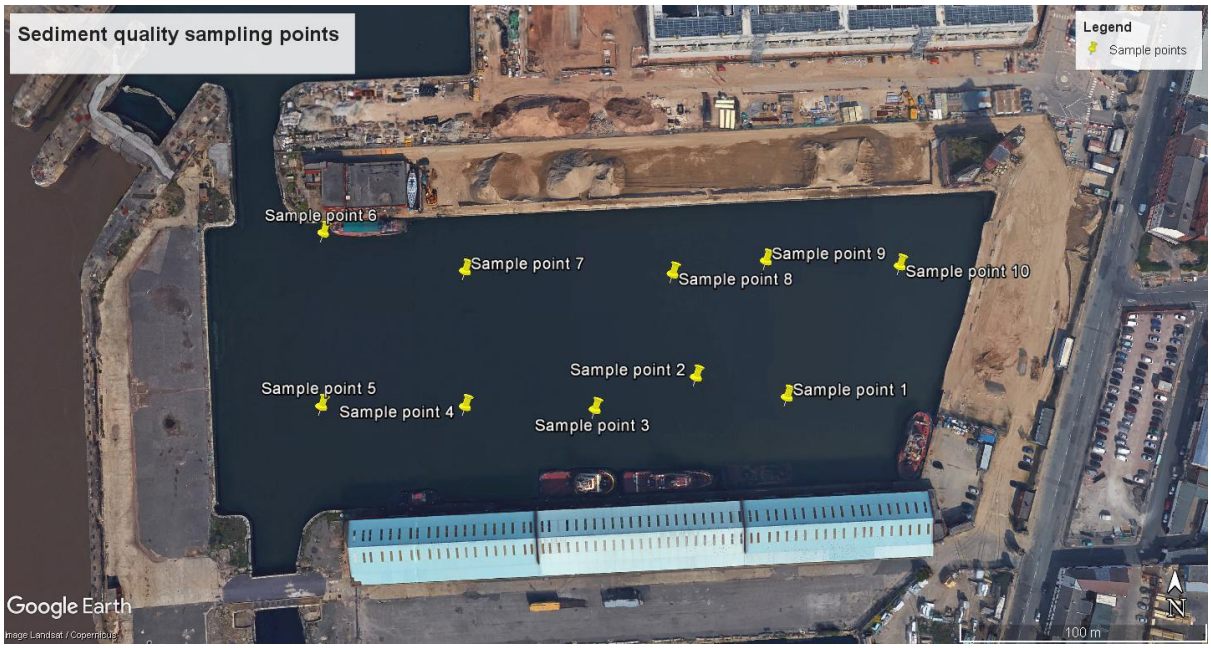

Figure 2-3 Sediment sampling points

2.3 Fisheries surveys

APEM undertook mobile fisheries hydroacoustic surveys of Bramley- Moore Dock to collect fish population data within the dock. The hydroacoustic fisheries survey was undertaken

during favourable conditions for sampling and a survey log has been included in Appendix III.

Note, density estimates from horizontal surveying and vertical surveying both provide an indication of biomass, but they cannot be directly compared to one another. The surveys were undertaken using APEM's Biosonics DTX 200 kHz echosounder connected to a 6° circular split beam scientific grade transducer. Positional data was acquired via a differential global positioning system (DGPS) receiver, connected directly to the Biosonics echosounder. All survey equipment was mounted on our survey vessel. In order to maximise data coverage, fish surveys were undertaken using two different transducer orientations to collect in the horizontal and vertical aspect. As a result the survey captured fish data across the dock using horizontal scanning and throughout the water column via vertical scanning. The transducer was mounted on the starboard side of the vessel and toward to the bow, with the depth dependent on application (horizontal or vertical scanning). The transducer was pre-calibrated following the manufacturer's guidelines via the deployment of a tungsten sphere of known target strength (TS) -39.5 dB. The survey vessel speed was maintained using a boat mounted Garmin GPS.

Prior to conducting the survey, the survey route was pre-programmed using GIS. Survey routes were determined for both the horizontal and vertical scanning surveys. The horizontal surveys were planned so that the boat navigated around the perimeter of the dock, with the beam scanning perpendicular to the dock wall, collecting data across the dock. The vertical scanning surveys were planned using systematic east to west transects across the dock (Figure 2-4). The total survey track distance was greater than six times the square root of the survey area in order to satisfy the Environment Agency's (EA) minimum survey threshold criterion for hydroacoustic surveys of still waters.

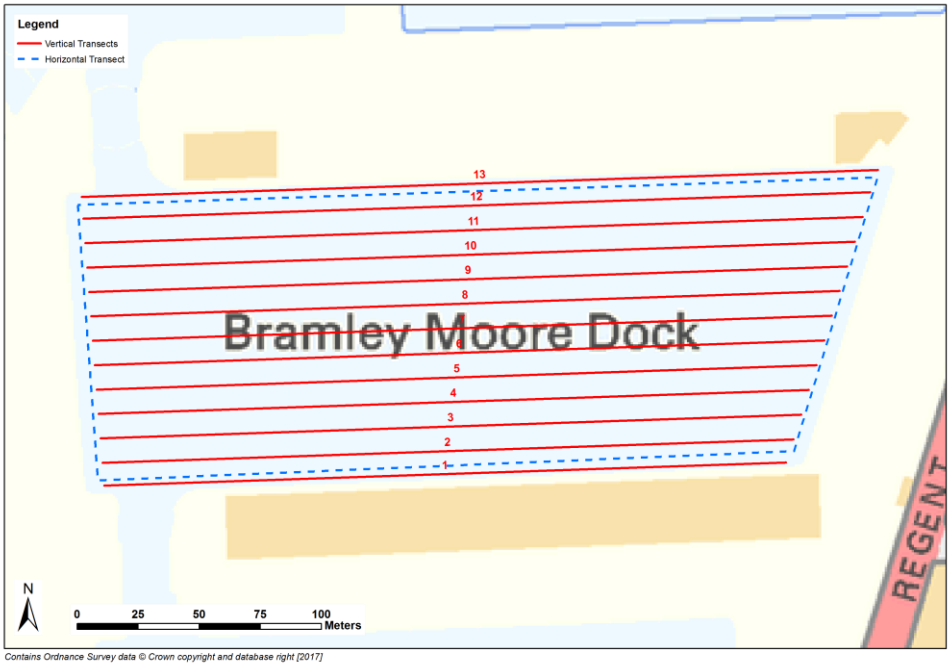

Figure 2-4 Hydroacoustic fish survey plan

The fisheries survey was conducted after dark as fish are more readily distinguished by the acoustic technique at night; furthermore, interference and fish avoidance from boat activity is minimised (Duncan & Kubecka, 1993, Guillard *et al.*, 1994). The survey commenced at least one hour after sunset which is in accordance with the EA guidelines. The survey log is provided in Appendix III.

The survey was completed by maintaining a speed of approximately 4 km hour^{-1}. Data were collected on a field ruggedised Panasonic Toughbook laptop, using Biosonics Visual Acquisition (Version 6) software. The data collection parameters are recommended by the EA for both the horizontal and vertical surveys, these are shown in Appendix III.

Data were processed using the Balk Lindem program Sonar5 Pro (Version 6.0.2). The data were post processed using the parameters summarised in Appendix III. Automatic bottom detection was applied to each echogram and manually adjusted to accurately determine the data range prior to analysing each file. In terms of the horizontal survey, the bottom was determined as the opposite dock wall / bank, whilst for the vertical survey, the bottom was determined as the bed level in the dock.

A minimum volume sampled selection criterion was applied for each file output with results from sections with sampling volumes less than 1000m^3 being discounted[1]. One echogram file was collected around the perimeter of the dock and split into 50m sections[2], and reported based on the volume density estimate of tracked single echo detections (SED) that were classified as fish targets.

For vertical surveying, spatial density estimates were reported for each transect independent of its length. In addition, vertical fish density calculations were undertaken using the "Winfield table" method, such that overall density is derived from the sum of estimates from multiple depth layers in the water column. This approach tends to eliminate bias that can arise created by estimates from the surface waters where the transducer beam volume is at its smallest.

The fyke net surveys were carried out using four pairs of nets deployed in the dock to provide sufficient coverage. Two fyke nets were used in conjunction and were joined by a 'curtain' of net that encourages fish to swim into the hoop entrance. Two net funnels within the hooped nets form a 'throat' that fish can enter, but find it hard to exit. Fish were then trapped within either holding area until the nets were retrieved. The net is set taught, usually positioned perpendicular to bank or shore by use of anchors and buoys. The nets were set in the afternoon and retrieved in the morning of the following day. The fish were identified, measured and released back into the dock.

2.4 Benthic community on the walls below the waterline and the scientific dive survey

Wall scrapes below the waterline were collected in order to be semi-qualitatively analysed if the dive survey failed to produce a video recording of sufficient quality due to poor visibility. The general community on the wall was visually described and large, easily identified

[1] Low sampling volumes may arise from areas where the surface or bottom interface limits the usable range of the echogram or simply where the channel width is reduced.
[2] This distance represents the minimum elementary distance sampling unit (EDSU) being the length of cruise track along which the acoustic measurements are averaged to give one sample.

animals and algae were recorded. An emphasis was placed on detecting any INNS present in the community. Wall scrape samples were taken following Worsfold (1998) using a 0.01 m2 sampling device (Figure 2-5). The samples were transferred to a container and fixed with 4% buffered formaldehyde solution in seawater before being transported to our laboratory. The samples were later sieved in the laboratory over a 0.5 mm sieve.

Figure 2-5 Wall sampling device for benthic invertebrates

The scientific dive survey team (from James Fisher Marine Services Ltd) produced a video recording of the dock walls. The video was used to help describe the benthic communities present on the walls and at various water depths. The diver collected samples of benthic invertebrates using hand tools. The samples were transferred to a container and fixed with 4% buffered formaldehyde solution in seawater before being transported to our laboratory. The samples were semi-qualitatively analysed to describe the benthic community on the dock walls below the waterline.

2.5 Benthic community on the walls at or above the waterline

Sampling was carried out to collect additional samples of benthic invertebrates at and above the waterline. One semi-quantitative scrape sample was collected using a standard 25 x 25cm sweep net fitted with a 1.0mm mesh net at a depth of approximately 0.5-1m. A semi-quantitative (three arm's length sweep) sample was also be collected from the water column near the dock wall.

Where dense epibiotic growth, or difficult to identify specimens or species of interest were encountered, qualitative samples were taken for subsequent analysis. These qualitative samples were manually removed from the substrate with APEM staff taking care to ensure that this will not lead to spread of INNS through fragmentation (e.g. in the case of some macroalgae).

2.6 Baited trap survey for mobile invertebrates

Baited traps were deployed in order to quantitatively sample mobile benthic invertebrates. A modified crayfish trap was used for this survey (Figure 2-6). The standard trap has a coarse mesh which would result in many smaller organisms being lost during sampling and retrieval of the trap. We therefore covered the trap in a finer mesh to more adequately retain smaller organisms such as scavenging amphipods and cirolanid isopods.

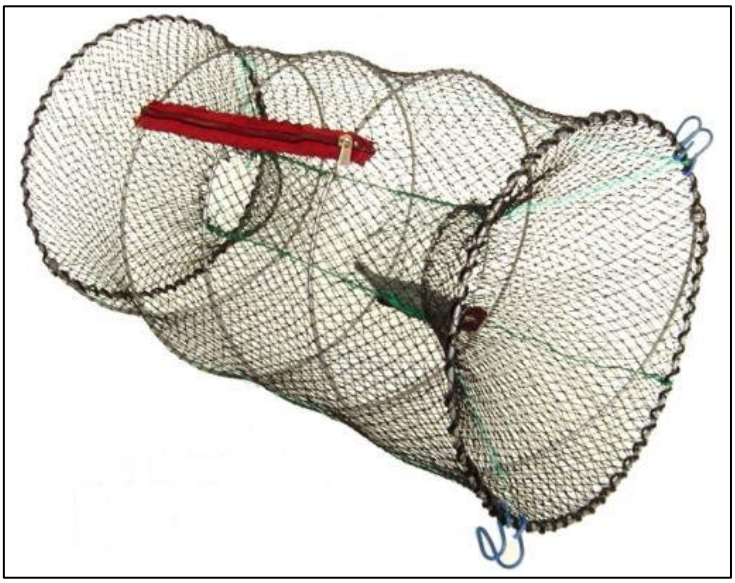

Figure 2-6 Crayfish trap

There are now several non-native species of crab in Britain and trapping should present an effective means of detecting them, if present. The traps were located sufficiently far from the edge of the dock to prevent interference by third parties.

Six baited traps were used at sampling locations positioned in order to be away from the operational vessels using the dock during the survey (Figure 2-7).

Figure 2-7 Baited trap sampling points

Each baited trap was weighted with a dive weight to ensure it remained in place and a buoy was attached to mark the position. The traps were baited with fresh, chopped fish. On retrieval the contents of each trap were emptied into a large bucket. The organisms were counted and returned to the water.

2.7 Water quality profiles

The water quality in the dock was surveyed from the same 10 sampling points used for sediment quality sampling (Section 2.2). We recorded the depth and measured the water temperature, dissolved oxygen, pH, salinity and conductivity at 1m depth intervals using a YSI multi-parameter probe. A Secchi disk was used to measure the water transparency at each sampling point.

2.8 Laboratory data processing

Samples were processed according to APEM's in-house Standard Operating Procedures (SOP's) and in full compliance with National Marine Biological Analytical Quality Control Scheme (NMBAQC) guidance (Worsfold et al., 2010).

Taxa were identified to the lowest practicable taxonomic level, usually species level, using appropriate taxonomic literature. The NMBAQC Scheme has produced a Taxonomic Discrimination Protocol (TDP) (Worsfold et al., 2010) which gives guidance on the most appropriate level to which different marine taxa should be identified, and this guidance was followed for laboratory analyses. Therefore certain taxonomic groups (e.g. insect larvae, nematodes, and certain oligochaetes), may be identified to higher taxonomic levels following the TDP. Where required, specimens were compared with material maintained in the laboratory reference collection.

At least one example of each taxon recorded from the surveys was set aside for inclusion in APEM's in-house reference collection. This collection acts as a permanent record of the biota recorded from each project and can be revisited at a later date should new evidence (e.g. description of a new, closely related species) call an original identification into question.

Taxonomic nomenclature follows the World Register of Marine Species (WoRMS), except where more recent revisions are known to supersede WoRMS. Any notable taxa recorded from the survey such as rare or protected species (Bratton, 1991; Sanderson, 1996; Betts, 2001; Chadd & Extence, 2004), non-native taxa (e.g. Eno et al., 1997; Reise et al., 1999; Goulletquer et al., 2002; Wolff, 2005; Gollasch & Nehring, 2006; Minchin, 2007; Minchin et al., 2013) or potentially un-described species in the dataset have been highlighted.

2.8.1 Univariate techniques

The DIVERSE component of Primer would be used to calculate the following univariate statistics for each sample: total number of taxa (S) and individuals (N), Margalef's index (d: species richness), Pielou's index (J′: evenness), Shannon-Wiener (H'(loge), diversity) and Simpson's dominance index (1-λ'). In the interest of consistency, colonial taxa such as bryozoans and hydroids would be included when calculating the total number of taxa, but excluded from the calculation of the total number of individuals and other diversity indices.

3. Results

3.1 Benthic invertebrates in sediment

The 12 sediment samples were analysed for benthic invertebrates and the complete dataset is presented in Appendix I. The samples included some notable species, including INNS (Table 3-1).

Table 3-1 Notable species of benthic invertebrates

Code	Taxa ID	Qualifiers	Notes
P0753	*Polydora cornuta*		Cryptogenic
P0773	*Pseudopolydora paucibranchiata*		Non-native in the UK; possible first UK record
P0798	*Streblospio*		May include non-native species
P0847	*Tharyx* species A		May be *T. robustus* Blake & Goransson, 2015; Cryptogenic
P0871	*Cossura pygodactylata*		Cryptogenic; Representative of organic enrichment
P0906	*Capitella*		Representative of organic enrichment
P1277	*Euchone* cf. *limnicola*		Cryptogenic; Taxonomy yet to be resolved
P1494	*Tubificoides diazi*	aggregate	(Previously included as *T. pseudogaster* agg.)
Q0022	*Ammothea hilgendorfi*		Non-native in the UK
R0015	*Sessilia spp*	juvenile	May include non-native species
R0068	*Austrominius modestus*		Non-native in the UK
S0606	*Monocorophium acherusicum*		Cryptogenic
S0612	*Monocorophium insidiosum*		Cryptogenic
S0640	*Caprella mutica*		Non-native in the UK
W1696	*Mytilus edulis*	juvenile	Commercially important
W1961	*Cerastoderma edule*	adult and juvenile	Commercially important
Y0137	*Amathia spp*		May include non-native species
ZD0104	*Styela clava*		Non-native in the UK

The table in Appendix I shows that fifty-seven benthic taxa were identified from the 12 grab samples. All samples were numerically dominated by annelid worms. The most abundant taxon was *Tharyx 'species A'* which was present in all samples and had a total combined of 756 individuals (33% of the total number of countable organisms in the grab samples). The tube worm *Melinna palmata* was the only other taxon to be found in all samples and was the third most abundant taxon overall after *Streblospio*. Non-countable (e.g. algae) or colonial (e.g. bryozoans, hydroids) taxa accounted for 8 (14%) of the taxa.

The lowest number of taxa (11) was found in Grab 10 and Grab 2 had the highest number of taxa (28 — Table 3-2). The greatest density of individuals was found in Grab 11 with 26,359 m^{-2} whilst Grab 10 had the lowest density with 1,689 m^{-2}. Margalef's Species Richness varied from 2.40 in Grab 12 to 4.32 in Grab 5. Pielou's Evenness varied from 0.55 in Grab 11 (low evenness primarily influenced by large numbers of *Tharyx 'species A'* in relation to other taxa) to 0.93 in Grab 7 (high evenness due to similarly low numbers of most taxa). The Shannon Wiener Diversity indicated low diversity in Grab 12 with a value of 1.56. The highest value was found in Grab 7. Simpson Diversity varied from 0.65 in Grab 11 to 0.92 in Grab 7.

Table 3-2 Univariate statistics for the benthic invertebrates in sediment samples

Sample	Total No. Taxa	Mean density (individuals per m^2)	Margalef's Species Richness (D)	Pielou's Evenness (J')	Shannon Wiener Diversity (H') log_e	Simpson Diversity (1-λ')
Grab_01	15	14,802	2.41	0.62	1.67	0.74
Grab_02	28	14,002	4.00	0.69	2.20	0.84
Grab_03	14	5,378	2.71	0.62	1.62	0.68
Grab_04	13	6,490	2.41	0.74	1.90	0.81
Grab_05	18	2,267	4.32	0.82	2.37	0.86
Grab_06	19	5,912	3.68	0.67	1.97	0.75
Grab_07	15	1,956	3.44	0.93	2.46	0.92
Grab_08	17	8,579	3.04	0.66	1.87	0.75
Grab_09	16	9,290	2.43	0.80	2.11	0.84
Grab_10	11	1,689	2.47	0.90	2.07	0.87
Grab_11	25	26,359	3.13	0.55	1.68	0.65
Grab_12	12	4,312	2.40	0.63	1.56	0.69
Minimum	**11**	**1,689**	**2.40**	**0.55**	**1.56**	**0.65**
Maximum	**28**	**26,359**	**4.32**	**0.93**	**2.46**	**0.92**

Faunal biomass was dominated by annelids at most stations (Table 3-3) with the highest value for annelids being from Grab 3, where large numbers of the tubeworm *Melinna palmata* were found. Biomass in Grab 6 was dominated by 'Others' and primarily influenced by the sea anemones (*Actiniaria and Edwardsiidae*) found in this sample. In grab 11 a single large cockle (*Cerastoderma edule*) contributed to molluscs being the dominant taxon in terms of biomass and also this grab having the highest total biomass; the lowest total biomass was in Grab 5.

Table 3-3 Blotted wet weight biomass (mg) for each major group

	Grab 1	Grab 2	Grab 3	Grab 4	Grab 5	Grab 6	Grab 7	Grab 8	Grab 9	Grab 10	Grab 11	Grab 12
Annelida	190.2	400.6	992.4	237.6	14.9	361.3	120.7	61.2	141.1	42.5	335.0	232.7
Crustacea	-	1.5	-	-	-	-	-	-	0.1	-	0.1	-
Mollusca	0.1	39.3	2.1	0.5	0.7	921.5	123.5	108.5	10.4	102.5	7617.6	51.7
Echinodermata	-	-	-	-	-	-	-	0.1	-	-	-	-
Others	-	10.9	-	0.3	28.1	2033.4	0.3	0.1	0.1	-	0.1	-

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3.2 Sediment quality

The sediment quality results are presented in Table 3-4. Sediment samples were successfully collected on the first or second attempt and all samples consisted of black or darkly coloured silty material. Some lighter coloured material was present on top of most of the samples. There does not appear to be an obvious reason for the presence of the lighter material. The samples from sites 2,3 and 4 contained empty snail shells. Sediment pH ranged from being acidic at sample point 2 to slightly alkaline at sampling point 3, but it was generally of neutral quality; this suggests some localised contamination at sampling point 2. The redox potential showed that the results were within a normal range of values for surface sediments.

Table 3-4 Sediment quality results

Site No.	Sample attempt (1,2,3)	Depth (m)	Sample description	Temperature (°C)	pH	Redox (mV)
1	1	7	Black fine silt	16.0	7.9	-103
2	2	7	Dark silt with dead snails	15.2	5.1	-161
3	2	7	Black fine silt with dead snails	15.1	8.1	-132
4	2	7	Black fine silt with dead snails	15.0	8.0	-136
5	1	8	Black fine silt with a layer of brown silt on top 2cm	15.3	6.2	-133
6	1	8	Dark silt with thin brown surface layer 2 or 3mm	15.4	6.1	-133
7	1	7	Dark silt with thin brown surface layer 2 or 3mm	15.5	6.8	-86
8	1	7	Dark silt with thin brown surface layer 2 or 3mm	15.4	7.0	-154
9	1	7	Dark silt with thin brown surface layer 2 or 3mm	15.5	7.1	-99
10	1	7	Dark silt with thin brown surface layer 2 or 3mm	15.4	7.8	-41

3.3 Fisheries surveys

3.3.1 Horizontal survey results

The fish densities per 50m are presented in Figure 3-1. The fish densities per 50m section are also presented spatially in Figure 3-2, providing a spatial context to help with the interpretation of the results.

Data were collected above a threshold of -56 dB, with fish density estimates computed being compliant with the EA standard cut-off threshold of -50 dB, equating approximately to an 85

mm fish in horizontal aspect. The horizontal survey data shows the majority of acoustic targets were found between the -50 to -40 dB range (equivalent to 85 mm to 240 mm sized fish).

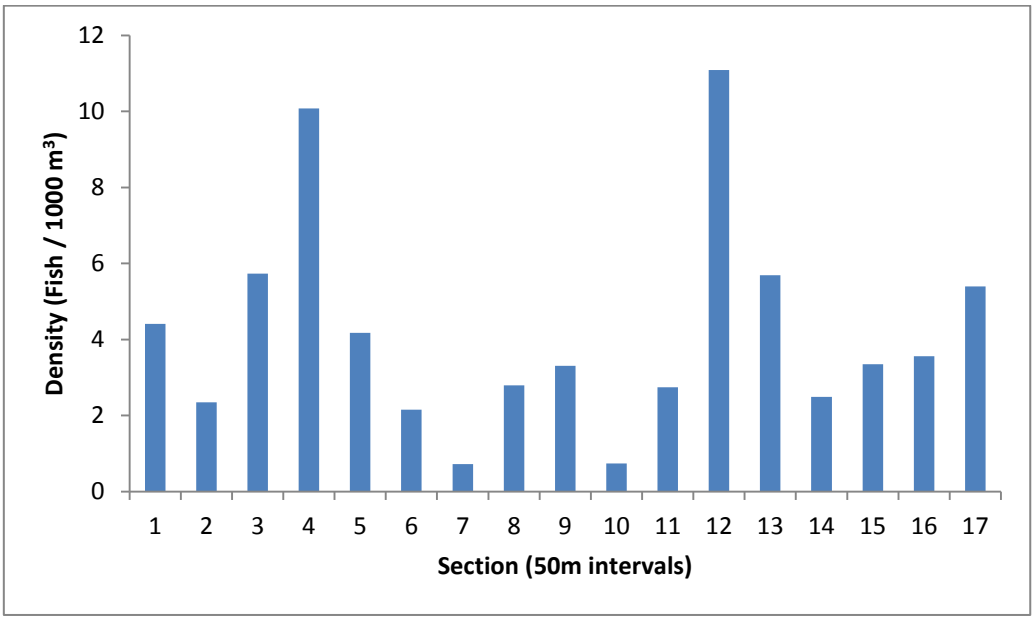

Figure 3-1 Fish densities per 50m section from horizontal scanning

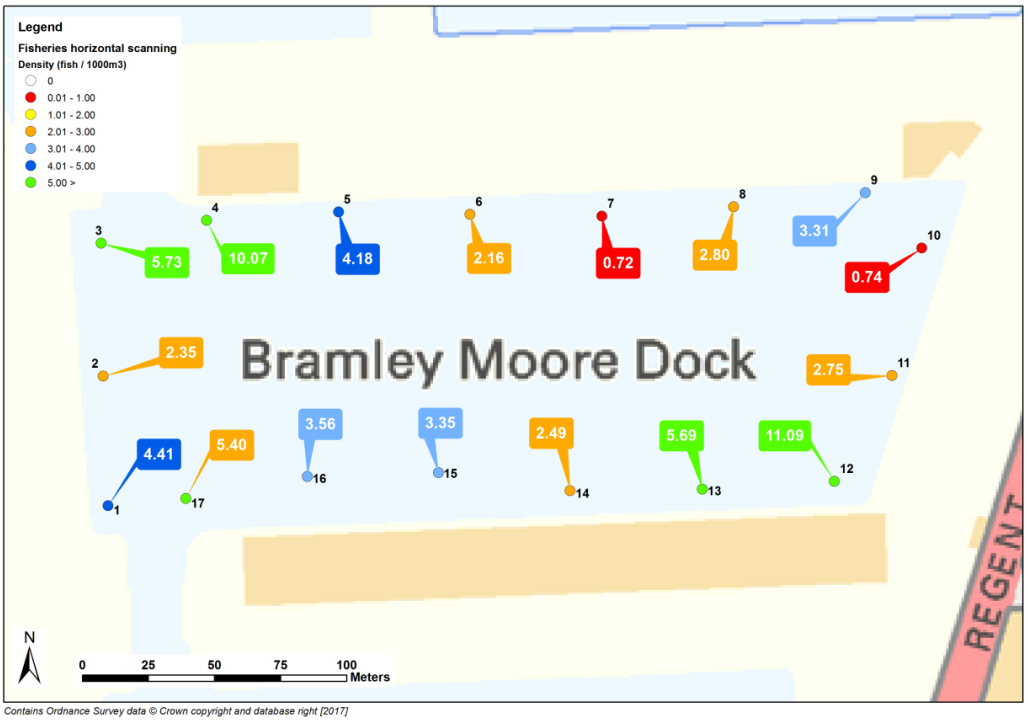

Figure 3-2 Fish densities per 50 m section from horizontal scanning

The mean fish density was 4.16 fish/1000 m^3, with a maximum density of 11.09 fish/1000 m^3 and a lowest density of 0.72 fish/1000 m^3. The highest densities were observed in the south east and north west areas of the dock, the lowest densities were in the north and north eastern section of the dock.

The TS (target strength) distribution of all tracked targets is shown in Figure 3-3. The majority of targets were between -47 and -42 dB class categories, equivalent to 12 to 19 cm size fish. The greatest numbers of targets per TS category were between -45 to -44 dB, equivalent to 14 to 16 cm fish. No fish were recorded beyond the -35 dB category, which is equivalent to a 39 cm size fish.

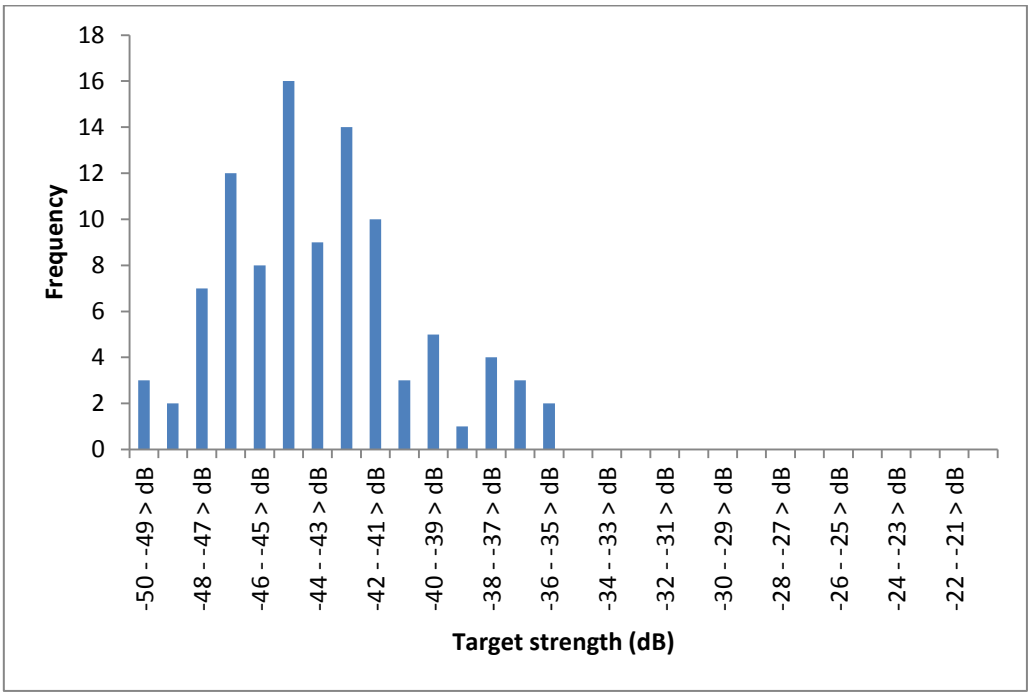

Figure 3-3 TS distribution of tracked fish from horizontal scanning survey

3.3.2 Vertical survey results

The results from the vertical survey are presented by transect (Figure 3-4). The highest density was observed along transect 1 (9541.40 fish/ha^{-1}), along the southern side of the dock and the lowest density was observed along transect 5 (4204.40 fish/ha^{-1}) toward the middle of the dock (transect 12 was along the northern side of the dock). The fish densities from the vertical data were relatively high across the dock with densities greater than 3000 fish/ha^{-1} observed throughout. The mean fish density per transect was 5634.08 fish/ha^{-1}.

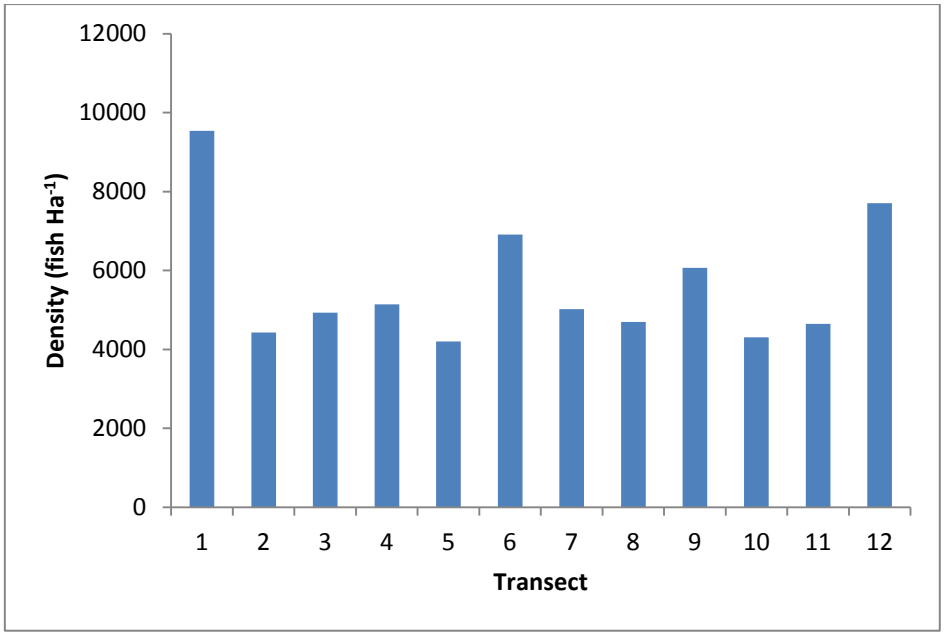

Figure 3-4 Fish density estimates by transect number from vertical scanning survey

The distribution in TS (equivalent to size class) has been calculated as per the EA standard TS range for vertical surveying. The peak TS range in the survey zone was found to be between the range -65 to -52 dB, equivalent to 10 to 39 mm fish. The lowest quantity in size class distribution of fish observed in the survey zone were in the > -37 dB range, equivalent to fish greater than 250 mm in size (Table 3-5 and Figure 3-5).

Table 3-5 Tracked fish detected in the survey zone by vertical surveying

TS class	-65 to -52	-52 to -45	-45 to -37	>-37
Equivalent class (mm)[3]	10–39	40–99	100–249	> 250
Mean density (fish ha^{-1})	3862.10	1486.75	271.19	14.04
Standard deviation	1015.48	704.32	210.85	34.44
Coefficient of variance	0.26	0.47	0.78	2.45
95% confidence interval	482.72	334.80	100.23	16.37

[3] Dorsal aspect TS to length relationship, after Love (1971) – See Appendix III.

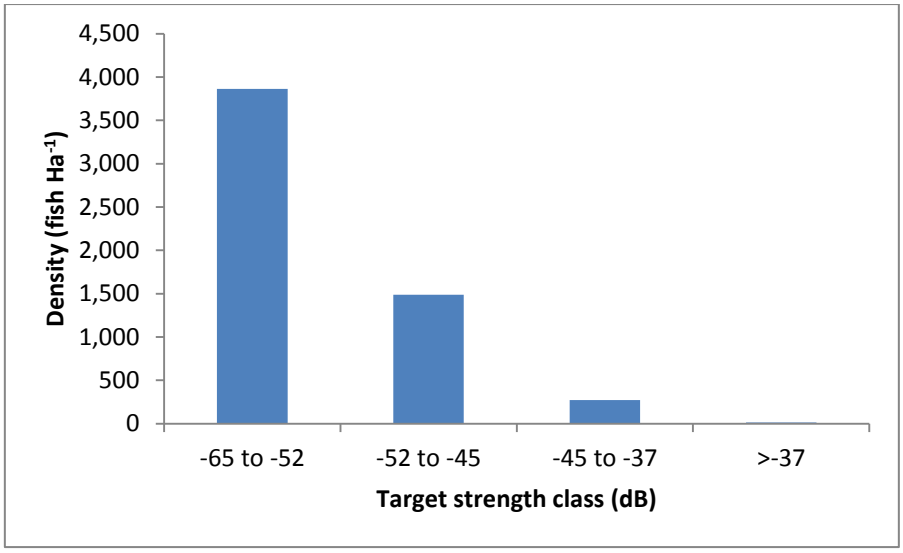

Figure 3-5 Fish density estimates by TS class range from vertical scanning survey

3.3.3 Fyke net survey

The majority of fish captured were pouting (*Trisopterus luscus*) which appear to be very numerous in the dock. There were also a large number of crabs present and the most numerous was the common shore crab (*Carcinus maenas)* (Table 3-6).

Table 3-6 Fyke net survey results

Species	Frequency	Length (mm)		Comments	Net no.					
		Min	Max		1	2	3	4	5	6
Trisopterus luscus	63	108	262	Pouting	18	8	2	7	24	4
Pollachius virens	11	100	168	Coal fish	5				1	5
Palaemon sp	11	n/a	n/a	Prawn	11					
Anguilla anguilla	5	300	800	Eel (silver)	2			3		
Solea solea	1	n/a	160	Sole					1	
Pleuronectes platessa	1	n/a	121	Plaice	1					
Carcinus maenas	44	n/a	n/a	Shore crab	12	2	9	6	4	11
Cancer pagurus	3	n/a	n/a	Edible crab		2			1	
Necora puber	1	n/a	n/a	Swimming crab		1				

3.4 Benthic community on the walls below the waterline and the scientific dive survey

The water was generally turbid due to silt and vessels operating in the dock which made the video difficult to review. For this reason, identification to species level for much of the fouling community was often not possible. Therefore, the additional samples collected have been semi-qualitatively analysed to aid with the interpretation of the video data.

Throughout the video the diver provided estimates of the coverage of marine growth on the walls. All the walls were covered with a dense growth and it was generally >90% covered, although the diver observed that growth was less dense nearer the surface. Some large

areas of bare stone wall were observed. Given the dense growth in the surrounding areas it is assumed that the growth in these areas had been recently abraded.

Nearer the surface a clear algal band was observed whereas the deeper areas were dominated by tunicates (sea squirts). In much of the video it was not possible to identify these with certainty, but where they were identifiable the dominant species were *Ciona intestinalis* and *Ascidiella aspersa*. These species were also present in the diver scrape samples and it is assumed that many of the unidentifiable tunicates in the video belonged to these two species. A further, non-native, sea squirt, *Styela clava* was noted from a single scrape sample and a single time in the video footage. This species is highly distinctive and would have been readily identified in the video so it is assumed that it is genuinely uncommon in the dock.

Edible mussels (*Mytilus edulis*) were common throughout the dock as well as erect bryozoans and hydroids which were ubiquitous. In several areas tubeworms (most likely *Sabella pavonina*) were present as were discrete patches of sponge (*Haliclona oculata* was the only sponge species identified with certainty from the video, but *Halichondria panicea* was also found in the samples; however, there were other patches of sponge that were not either of these species). The data from the dive survey is summarised along with the abundance for the organisms that were identified in Table 3-7.

Table 3-7 Dive survey results and analysis showing a semi-quantitative data summary

Taxon	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Porifera	R										
Halichondria panicea						O		R			
Haliclona oculata		R					R				R
Austrominius modestus			R				R				
Semibalanus balanoides	R	C	C	R	O	R	O	A	R	R	R
Carcinus maenas									R		
Mytlius edulis	R	O	A	R	O	O	F	A	F	R	R
Bugulina fulva									R		
Styela clava					R						
Ciona intestinalis	F	O		F	F	C	O	C	R	F	R
Ascidiella aspersa	F	O	F	O	R	R	O	O	C	F	R
Aglaothamnion								R			

Key: C = common, A = abundant, F = frequent, O = occasional, R = rare

3.5 Benthic community on the walls at or above the waterline

The complete dataset for the wall-scrape samples is provided in Appendix II. Twenty-three taxa were identified from the 12 wall scrape samples. The most abundant taxon was the barnacle *Austrominius modestus* which was present in all samples and had a total abundance of 5,238 individuals (63% of all countable individuals in the wall scrape samples). The records of Sessilia (juvenile), which was also recorded in all samples, most likely also largely refer to this species, although a second barnacle species, *Semibalanus balanoides*, was also recorded from four samples. Isopods of the *Jaera albifrons* species complex were also abundant in the wall-scrape samples with particularly high numbers being recorded in WS 6, and high numbers of the rough periwinkle *Littorina saxatilis* were recorded at some stations. Non-countable (e.g. algae) or colonial (e.g. bryozoans, hydroids) taxa accounted for 8 (35%) of the taxa.

The lowest number of taxa (5) was found in WS 4 and WS 7, whilst WS 3 had the highest number of taxa (13) (Table 3-8). The greatest density of individuals was found in WS 7 with 145,200/m2 whilst WS 4 had the lowest density with 4,900/m2. Margalef's Species Richness varied from 0.51 in WS 4 to 1.34 in WS 8. Pielou's Evenness varied from 0.31 in WS 1 (low evenness primarily influenced by large numbers of barnacles and few other taxa) to 0.69 in WS 7 and WS 9 (high evenness due to high numbers of most taxa). The Shannon Wiener Diversity indicated low diversity in WS 4 with a value of 0.51 and the highest diversity in WS 9. Simpson Diversity varied from 0.28 in WS 1 to 0.63 in WS 9.

Table 3-8 Univariate statistics for the wall-scrape samples

Sample	Total No. Taxa	Mean density (individuals per m^2)	Margalef's Species Richness (D)	Pielou's Evenness (J')	Shannon Wiener Diversity (H') loge	Simpson Diversity (1-λ')
WS 1	8	45,400	0.82	0.31	0.55	0.28
WS 2	12	24,400	0.91	0.48	0.87	0.42
WS 3	13	23,900	1.10	0.55	1.07	0.53
WS 4	5	4,900	0.51	0.46	0.51	0.28
WS 5	10	23,100	0.92	0.62	1.12	0.57
WS 6	10	112,900	1.00	0.57	1.19	0.63
WS 7	5	145,200	0.55	0.69	1.12	0.58
WS 8	11	80,800	1.34	0.50	1.15	0.58
WS 9	6	131,000	0.70	0.69	1.23	0.63
WS 10	7	53,300	0.80	0.47	0.85	0.42
WS 11	8	61,600	0.93	0.58	1.13	0.55
WS 12	7	120,300	0.70	0.51	0.91	0.43
Minimum	**5**	**4,900**	**0.51**	**0.31**	**0.51**	**0.28**
Maximum	**13**	**145,200**	**1.34**	**0.69**	**1.23**	**0.63**

3.6 Mobile benthic invertebrates

The data for the mobile invertebrate survey is presented in Table 3-9. The most common organisms captured were various crab species, with the most abundant being the shore crab (*Carcinus maenas*).

Table 3-9 Mobile benthic invertebrate data summary

Species	Frequency	Comments	Trap number.					
			1	2	3	4	5	6
Carcinus maenas	35	Shore crab	5	6	11	2	4	7
Carcinus pagurus	3	Edible crab			1	1		1
Pomatoschistus sp.	5	Goby	3		1			1
Palaemon sp.	6	Prawn	2	2	1		1	

3.7 Water quality profiles

The full results for water quality profile sampling are shown in Appendix IV. The water depth in the dock at the sampling points ranged from 6.1 to 8.4m, with the deepest water located in north west corner at the dock entrance. The shallowest point was at the southern boundary recorded at sampling point 4. Water transparency varied from 1.8m to 2.2m.

The water temperature was slightly lower at the bottom compared to the surface although the difference wasn't significant (<1.0°C) and indicates that the water was not stratified at the time of sampling.

The concentration of DO varied by a small amount between sampling points, but the most significant difference was between levels at the surface and those closest to the bottom. This possibly indicates that the sediment is having some influence on levels of DO near the water/sediment boundary, indicating the sediment might be organically enriched.

The values for pH did not vary significantly between sampling points or with depth. The pH level at site 1 showed a small variation compared to the other sites, with slightly lower values recorded in the first 2m.

The salinity concentrations were slightly lower in the surface waters compared to deeper samples, the values were lower than typical seawater concentrations for the UK indicating either some freshwater influence or the influence of the Mersey estuary. The conductivity value at site 5 on the western side of the dock was slightly lower at the surface, compared to the other sites.

4. Summary

There were no species of benthic invertebrates of conservation importance recorded during the aquatic surveys.

Edible cockles (*Cerastoderma edule*) and juvenile mussels (*Mytilus edulis*) were found in the samples. Mature mussels were also recorded from the lower wall scrap samples and noted in the diver video footage. Both these species have commercial value and support commercial fisheries in the UK but are assumed not to be commercially fished in the dock.

Five non-native species (INNS) were recorded from the samples: the spionid polychaete *Pseudopolydora paucibranchiata*, the sea spider *Ammothea hilgendorfi*, the barnacle *Austrominius modestus*, the skeleton shrimp *Caprella mutica* and the sea-squirt *Styela clava*. Of these the barnacle *A. modestus* was the most abundant with most of the remaining species being recorded only in low numbers. The record of *P. paucibranchiata* is potentially the most interesting of these INNS. The species most commonly recorded as *P. paucibranchiata* from U.K. waters is actually a closely related undescribed species (V. Radashevsky, pers. comm.) whereas the true *P. paucibranchiata* is native to Japan and has recently been recorded from the Netherlands (Faasse, 2016). The specimens in this project match the true *P. paucibranchiata*. As far as we know this species has not yet been formally reported from the UK and the records from this survey are likely the first confirmed occurrence of the species in UK waters.

Several other taxa which were identified to higher taxonomic level in this study, due to known taxonomic issues or the condition of the specimens, may contain INNS. These were *Streblospio*, Sessilia (juvenile) and *Amathia*. There are known INNS in the UK from each of these higher taxa and it cannot be ruled out that the specimens from this survey were the INNS. As discussed above the majority of the individuals recorded as Sessilia (juvenile) are likely to be *A. modestus* which is a known INNS.

As well as the INNS recorded, a further seven taxa are recorded as cryptogenic. A cryptogenic species is one that cannot be proven to be either native nor non-native, but whose distribution would suggest that it is non-native. Of these *Tharyx* 'species A' was the most abundant. This species may be identical with the recently described *T. robustus* but at this time this cannot be confirmed since the description of *T. robustus* does not include some characters that are evident in specimens from the U.K. The two species of *Monocorophium* as well as *Bugulina fulva* and *Polydora cornuta* are frequently found amongst fouling communities.

The fisheries hydroacoustic survey shows there are large numbers fish living in the dock and which should be removed before redevelopment. The fish were generally in the smaller size categories with the horizontal data suggesting that most fish were between 12 to 19 cm in size. The most common fish species recorded from the fyke net surveys was *T. luscus* (Pouting). The dock is not considered to be a fish nursery and the presence of eels does not mean that the dock has special status.

Water quality data shows there was some minor spatial variation for some water quality parameters at Bramley-Moore Dock. Overall, the water quality data indicates a well oxygenated body of water with normal values for the parameters measured. There was some evidence of contaminated sediment at sampling point 2.

5. References

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Appendix I – Benthic invertebrate grab sample data

Taxa ID	Qualifiers	Grab 1	Grab 2	Grab 3	Grab 4	Grab 5	Grab 6	Grab 7	Grab 8	Grab 9	Grab 10	Grab 11	Grab 12
Porifera		-	-	-	-	-	-	-	-	-	-	-	-
Actiniaria		-	1	-	-	-	1	-	-	-	-	-	-
Edwardsiidae		-	-	-	1	-	2	-	1	-	-	1	-
Fecampia erythrocephala	eggs	-	-	-	-	-	-	-	-	-	P	P	-
Cerebratulus		-	-	-	-	1	-	-	-	-	-	-	-
Nematoda		-	2	-	-	1	2	-	-	-	-	2	-
Pedicellina		-	-	-	-	-	-	P	-	-	-	P	-
Barentsia		-	-	-	-	-	-	-	-	P	-	-	-
Harmothoe impar	aggregate	-	2	1	-	1	-	-	-	-	-	-	-
Sthenelais boa		-	-	Frag.	-	-	-	-	-	-	-	-	-
Hypereteone foliosa		-	-	-	-	1	-	-	-	-	-	-	-
Oxydromus flexuosus		1	1	-	-	2	-	-	-	-	-	-	-
Syllidia armata		1	45	3	-	7	-	-	1	6	-	3	-
Exogone naidina		-	1	-	-	-	-	-	-	-	-	-	-
Myrianida		-	-	-	-	1	-	-	-	-	-	-	-
Nereididae	juvenile	-	3	-	-	-	-	-	-	-	-	-	-
Hediste diversicolor		-	-	-	-	2	-	-	-	-	-	-	-
Nephtys	juvenile	1	-	-	-	-	-	-	1	-	-	-	-
Nephtys hombergii		1	5	1	-	-	3	3	1	2	4	2	-
Aonides oxycephala		-	-	-	-	-	-	-	-	-	-	1	-
Polydora cornuta		2	3	1	2	17	1	1	1	-	-	-	1
Pseudopolydora paucibranchiata		45	11	11	36	4	2	-	29	6	1	45	9

Pygospio elegans		-	-	-	1	-	-	-	-	-	-	-	-
Streblospio		134	85	11	36	-	3	-	17	38	-	41	-
Chaetozone gibber		8	12	-	8	-	3	2	9	26	5	4	4
Cirriformia	juvenile	-	-	-	5	-	-	3	-	-	-	-	-
Cirriformia tentaculata		-	-	-	-	1	-	-	2	-	-	-	-
Tharyx species A		92	74	16	7	3	18	5	87	63	7	337	47
Cossura pygodactylata		3	15	1	2	-	6	5	7	17	3	36	3
Capitella		-	1	-	-	-	-	-	-	-	-	6	-
Heteromastus filiformis		-	-	-	-	-	1	-	-	-	-	-	-
Melinna palmata		24	18	65	38	2	63	7	4	10	3	27	25
Euchone cf. limnicola		8	1	6	4	3	5	-	6	2	-	7	1
Tubificoides benedii		5	3	-	-	-	6	-	-	-	-	11	-
Tubificoides diazi	aggregate	7	24	2	4	-	12	3	3	19	2	46	2
Ammothea hilgendorfi		-	-	-	-	1	-	-	-	-	-	-	-
Anoplodactylus virescens		-	1	-	-	-	-	1	-	2	-	-	-
Sessilia	juvenile	-	-	-	-	-	-	-	-	-	-	-	-
Austrominius modestus		-	-	-	-	-	-	-	-	-	-	2	1
Semibalanus balanoides		-	-	-	-	-	-	-	-	-	-	-	-
Copepoda		-	-	-	-	-	-	-	-	-	-	2	-
Ascidicola rosea	?	-	-	-	-	-	-	1	-	-	-	-	-
Leucothoe lilljeborgi		-	-	-	-	-	-	-	-	1	-	-	-
Apohyale		-	-	-	-	-	-	-	-	-	-	-	-

prevostii													
Microdeutopus gryllotalpa		-	-	-	-	-	-	-	-	-	-	-	-
Monocorophium acherusicum		-	1	-	-	-	-	-	-	-	-	-	-
Monocorophium insidiosum		-	-	-	-	-	-	-	-	-	-	-	-
Caprella mutica		-	-	-	-	-	-	-	-	-	-	-	-
Jaera albifrons	aggregate	-	-	-	-	-	-	-	-	-	-	-	-
Chironomidae	larva	-	-	-	-	-	-	-	-	-	-	-	-
Chironomidae	pupa	-	-	-	-	-	-	-	-	-	-	-	-
Dolichopodidae	larva	-	-	-	-	-	-	-	-	-	-	-	-
Littorina littorea		-	-	-	-	-	-	-	-	-	-	-	-
Littorina saxatilis		-	-	-	-	-	-	-	-	-	-	-	-
Peringia ulvae		1	1	1	-	-	1	3	-	4	2	2	-
Mytilus edulis	juvenile	-	3	-	-	1	-	-	-	-	-	-	1
Parvicardium exiguum		-	2	-	-	-	1	3	2	-	1	-	-
Cerastoderma edule		-	-	-	-	-	1	-	-	-	-	1	-
Cerastoderma edule	juvenile	-	-	1	-	-	-	-	-	-	-	1	-
Abra nitida		-	-	1	2	1	2	6	21	13	10	15	2
Scrobicularia plana	juvenile	-	-	-	-	-	-	-	-	-	-	1	-
Corbula gibba		-	-	-	-	-	-	-	-	-	-	-	1
Nolella		-	-	-	-	-	-	-	-	-	-	-	-
Walkeria uva		-	-	-	-	-	-	-	-	-	-	-	-
Amathia		-	P	-	-	-	-	-	-	-	-	-	-
Einhornia crustulenta		-	P	-	-	-	-	-	-	-	-	-	-
Bugulina fulva		-	P	-	-	-	-	-	-	P	-	P	-
Cryptosula		-	-	-	-	-	-	-	-	-	-	-	-

pallasiana													
Amphiuridae	juvenile	-	-	-	-	-	-	-	1	-	-	-	-
Ascidiacea	Colonies	-	P	-	-	-	-	-	-	-	-	-	-
Ciona intestinalis		-	-	-	-	2	-	-	-	-	-	-	-
Styela clava		-	-	-	-	-	-	1	-	-	-	-	-
Elachista fucicola		-	-	-	-	-	-	-	-	-	-	-	-
Fucus spiralis		-	-	-	-	-	-	-	-	-	-	-	-
Ulva		-	-	-	-	-	-	-	-	-	-	P	-

Appendix II – Benthic invertebrate wall scrape data

Taxa ID	Qualifiers	WS 1	WS 2	WS 3	WS 4	WS 5	WS 6	WS 7	WS 8	WS 9	WS 10	WS 11	WS 12
Porifera		-	P	-	-	P	-	-	-	-	-	-	-
Actiniaria		-	-	-	-	-	-	-	-	-	-	-	-
Edwardsiidae		-	-	-	-	-	-	-	-	-	-	-	-
Fecampia erythrocephala	eggs	-	-	-	-	-	-	-	-	-	-	-	-
Cerebratulus		-	-	-	-	-	-	-	-	-	-	-	-
Nematoda		-	-	-	-	-	-	-	-	-	-	-	-
Pedicellina		-	-	-	-	-	-	-	-	-	-	-	-
Barentsia		-	-	-	-	-	-	-	-	-	-	-	-
Harmothoe impar	aggregate	-	-	-	-	-	-	-	-	-	-	-	-
Sthenelais boa		-	-	-	-	-	-	-	-	-	-	-	-
Hypereteone foliosa		-	-	-	-	-	-	-	-	-	-	-	-
Oxydromus flexuosus		-	-	-	-	-	-	-	-	-	-	-	-
Syllidia armata		-	-	-	-	-	-	-	-	-	-	-	-
Exogone naidina		-	-	-	-	-	-	-	-	-	-	-	-
Myrianida		-	-	-	-	-	-	-	-	-	-	-	-
Nereididae	juvenile	-	-	-	-	-	-	-	-	-	-	-	-
Hediste diversicolor		-	-	-	-	-	-	-	-	-	-	-	-
Nephtys	juvenile	-	-	-	-	-	-	-	-	-	-	-	-
Nephtys hombergii		-	-	-	-	-	-	-	-	-	-	-	-
Aonides oxycephala		-	-	-	-	-	-	-	-	-	-	-	-
Polydora cornuta		-	-	-	-	-	-	-	-	-	-	-	-
Pseudopolydora		-	-	-	-	-	-	-	-	-	-	-	-

paucibranchiata													
Pygospio elegans		-	-	-	-	-	-	-	-	-	-	-	-
Streblospio		-	-	-	-	-	-	-	-	-	-	-	-
Chaetozone gibber		-	-	-	-	-	-	-	-	-	-	-	-
Cirriformia	juvenile	-	-	-	-	-	-	-	-	-	-	-	-
Cirriformia tentaculata		-	-	-	-	-	-	-	-	-	-	-	-
Tharyx species A		-	-	-	-	-	-	-	-	-	-	-	-
Cossura pygodactylata		-	-	-	-	-	-	-	-	-	-	-	-
Capitella		-	-	-	-	-	-	-	-	-	-	-	-
Heteromastus filiformis		-	-	-	-	-	-	-	-	-	-	-	-
Melinna palmata		-	-	-	-	-	-	-	-	-	-	-	-
Euchone cf. limnicola		-	-	-	-	-	-	-	-	-	-	-	-
Tubificoides benedii		-	-	-	-	-	-	-	-	-	-	-	-
Tubificoides diazi	aggregate	-	-	-	-	-	-	-	-	-	-	-	-
Ammothea hilgendorfi		-	-	-	-	-	-	-	-	-	-	-	-
Anoplodactylus virescens		-	-	-	-	-	-	-	-	-	-	-	-
Sessilia	juvenile	63	10	17	7	33	76	122	85	72	47	26	48
Austrominius modestus		379	183	158	41	143	602	848	489	708	397	393	897
Semibalanus balanoides		-	-	-	-	-	2	-	1	8	-	2	-
Copepoda		-	-	2	-	3	-	-	-	-	-	-	-
Ascidicola rosea	?	-	-	-	-	-	-	-	-	-	-	-	-
Leucothoe lilljeborgi		-	-	-	-	-	-	-	-	-	-	-	-

Apohyale prevostii		1	5	22	-	11	156	43	55	35	9	54	41
Microdeutopus gryllotalpa		-	-	1	-	-	-	-	-	-	-	-	-
Monocorophium acherusicum		-	-	-	-	-	-	-	-	-	-	-	-
Monocorophium insidiosum		-	9	-	-	-	1	-	-	-	-	-	-
Caprella mutica		-	-	-	-	-	-	-	2	-	-	-	-
Jaera albifrons	aggregate	-	35	37	-	39	285	68	163	174	8	110	121
Chironomidae	larva	6	-	-	1	-	-	-	4	-	-	-	-
Chironomidae	pupa	1	-	-	-	-	-	-	-	-	-	-	-
Dolichopodidae	larva	1	-	-	-	2	3	-	1	-	-	-	-
Littorina littorea		-	-	-	-	-	4	-	1	-	1	5	5
Littorina saxatilis		3	-	-	-	-	-	371	7	313	71	26	91
Peringia ulvae		-	-	-	-	-	-	-	-	-	-	-	-
Mytilus edulis	juvenile	-	2	2	-	-	-	-	-	-	-	-	-
Parvicardium exiguum		-	-	-	-	-	-	-	-	-	-	-	-
Cerastoderma edule		-	-	-	-	-	-	-	-	-	-	-	-
Cerastoderma edule	juvenile	-	-	-	-	-	-	-	-	-	-	-	-
Abra nitida		-	-	-	-	-	-	-	-	-	-	-	-
Scrobicularia plana	juvenile	-	-	-	-	-	-	-	-	-	-	-	-
Corbula gibba		-	-	-	-	-	-	-	-	-	-	-	-
Nolella		P	P	P	P	P	P	-	-	-	-	-	-
Walkeria uva		-	-	P	-	-	-	-	-	-	-	-	-
Amathia		-	-	-	-	-	-	-	-	-	-	-	-
Einhornia crustulenta		-	P	-	-	-	-	-	-	-	-	-	-
Bugulina fulva		-	-	-	-	-	-	-	-	-	-	-	-

Cryptosula pallasiana		-	P	P	-	-	-	-	-	-	-	-	-
Amphiuridae	juvenile	-	-	-	-	-	-	-	-	-	-	-	-
Ascidiacea	Colonies	-	-	-	-	-	-	-	-	-	-	-	-
Ciona intestinalis		-	-	-	-	-	-	-	-	-	-	-	-
Styela clava		-	-	-	-	-	-	-	-	-	-	-	-
Elachista fucicola		-	-	P	-	-	-	-	-	-	-	-	-
Fucus spiralis		-	P	P	-	P	-	-	-	-	-	-	-
Ulva		P	P	P	P	P	P	-	P	-	P	P	P

Appendix III – Fisheries survey logs and raw data

Hydroacoustic survey log

Project Number:	P00001932
Project Name:	Project Blue – Bramley Moore Dock
Survey Date:	27/09/2017
Survey Team:	TNM, JW
Survey vessel	Zodiac
Sunset	18:47
Survey Start Time:	21:08
Survey End Time:	23:08
Air Temp (°C):	11.6
Water Temp. (°C):	15.2
Water pH:	8.5
Weather Conditions:	8/8 cloud cover, cool and showers

Data collection and processing parameters

Parameter	Horizontal Survey	Vertical Survey
Boat speed:	4 km hour^{-1}	4 km hour^{-1}
Ping rate:	10 pings per second	10 pings per second
Pulse duration:	0.2 ms	0.2 ms
Target strength threshold:	-56 dB	-71 dB
Time varied gain:	40logR	40logR
Transducer depth:	0.7 m	0.3 m
Transducer range:	100 m	12 m
Transducer angle:	90°	180°

Fisheries hydroacoustics post processing parameters

Parameter	Horizontal Survey	Vertical Survey
Minimum target size:	-50 dB	-65 dB
Minimum echo length[4]:	0.75	0.75
Maximum echo length[4]:	1.25	1.25
Maximum gain compensation:	3 dB	3 dB
Maximum phase deviation:	0.8^{o}	0.8^{o}
Peak suppression:	Off	Off
Output method:	Trace counting, Auto Tracker Auto tracking parameters: Min track length: 3 pings Max ping gap: 2 pings Gating range: 0.1m	Trace counting, Auto Tracker Auto tracking parameters: Min track length: 3 pings Max ping gap: 2 pings Gating range: 0.1m
Analysis range:	1 – 100 m	1 – 10 m
Output unit:	Fish / $1000m^{-3}$	Fish / Ha

[4] Relative to the transmitted pulse

TS to length relationships

Horizontal:

TS	Standard length (cm)
-50	8.54
-49	9.46
-48	10.47
-47	11.60
-46	12.84
-45	14.22
-44	15.75
-43	17.44
-42	19.31
-41	21.39
-40	23.68
-39	26.22
-38	29.04
-37	32.16
-36	35.61
-35	39.43
-34	43.66
-33	48.35
-32	53.54
-31	59.29
-30	65.65
-29	72.70
-28	80.51
-27	89.15
-26	98.72
-25	109.32

-24	121.05
-23	134.05
-22	148.44
-21	164.37
-20	182.02

Based on a TS to length relationship for stunned, cyprinids and perch, insonified in all aspects, using a 200 kHz transducer. Taken from Kubecka and Duncan (1998).

Vertical:

TS	Standard length (cm)
-66	0.79
-65	0.89
-64	1.01
-63	1.14
-62	1.28
-61	1.45
-60	1.63
-59	1.84
-58	2.08
-57	2.35
-56	2.65
-55	2.98
-54	3.37
-53	3.80
-52	4.29
-51	4.83
-50	5.45
-49	6.15
-48	6.94
-47	7.83
-46	8.83
-45	9.97
-44	11.24
-43	12.68
-42	14.31
-41	16.14
-40	18.21
-39	20.54

-38	23.17
-37	26.14
-36	29.49
-35	33.27
-34	37.53
-33	42.34

Based on a the TS to length relationship for stunned, roach, carp, bream, perch, and trout insonified in dorsal aspect using a 120kHz transducer (After Love, 1971) and adapted to a 200kHz transducer by Biosonics inc.

Appendix IV – Water quality profiles raw data

Depth	Site: 1	Depth: 8.3m	Transparency: 1.9m		Date: 26/9/2017 Time:13:00		
	Parameters						
	Temperature (°C)	Dissolved oxygen (% saturation)	Dissolved oxygen (mg/l)	pH	Salinity (PPT)	Conductivity (uS/cm)	Conductivity (SPC – uS/cm)
Surface	15.4	84.5	7.16	7.47	26.98	42003	34251
1	15.3	85.3	7.19	7.76	27.19	42267	34320
2	15.1	80.6	6.85	7.83	27.21	42366	34326
3	15.1	78.1	6.64	7.88	27.25	42356	34305
4	15.0	76.8	6.58	7.93	27.25	42371	34306
5	15.0	76.8	6.55	7.96	27.26	42388	34313
6	15.0	75.5	6.48	7.99	27.28	42240	34315
7	15.0	74.4	6.40	8.02	27.29	42422	34321
8	15.0	75.6	6.44	8.08	27.31	42489	34335
Depth	Site: 2	Depth: 8.2m	Transparency: 1.9m		Date: 26/9/2017 Time:13:10		
	Parameters						
	Temperature (°C)	Dissolved oxygen (% saturation)	Dissolved oxygen (mg/l)	pH	Salinity (PPT)	Conductivity (uS/cm)	Conductivity (SPC – uS/cm)
Surface	15.5	84.3	7.16	8.21	26.85	41788	34169
1	15.4	81.6	7.01	8.22	27.17	41218	34382
2	15.2	82.7	7.00	8.22	27.23	42343	34319
3	15.1	74.4	6.37	8.21	27.24	42357	34305
4	15.0	76.0	6.52	8.22	27.26	42385	34311
5	15.0	75.9	6.49	8.22	27.28	42401	34316
6	15.0	71.9	6.14	8.23	27.28	42418	34321
7	15.0	74.1	6.32	8.24	27.30	42434	34322
8	15.0	72.9	6.27	8.24	27.32	42459	34337

Depth	Site: 3	Depth: 7.5m	Transparency: 1.9m		Date: 26/9/2017 Time:13:20		
	Parameters						
	Temperature (°C)	Dissolved oxygen (% saturation)	Dissolved oxygen (mg/l)	pH	Salinity (PPT)	Conductivity (uS/cm)	Conductivity (SPC – uS/cm)
Surface	15.5	83.9	7.13	8.28	26.47	41394	34821
1	15.4	85.6	7.19	8.28	27.17	42256	34374
2	15.2	76.7	6.55	8.29	27.21	43212	34354
3	15.1	77.0	6.59	8.29	27.26	42373	34321
4	15.0	76.4	6.53	8.28	27.26	42391	34305
5	15.0	75.6	6.48	8.28	27.29	42422	34329
6	15.0	74.4	6.30	8.28	27.30	42441	34328
7	15.0	72.3	6.30	8.28	27.32	42467	34332
8							
Depth	Site: 4	Depth: 6.1m	Transparency: 1.8m		Date: 26/9/2017 Time:13:30		
	Parameters						
	Temperature (°C)	Dissolved oxygen (% saturation)	Dissolved oxygen (mg/l)	pH	Salinity (PPT)	Conductivity (uS/cm)	Conductivity (SPC – uS/cm)
Surface	15.4	84.0	7.18	7.07	25.38	39820	32646
1	15.2	85.2	7.11	8.28	27.13	42180	34366
2	15.2	79.8	6.81	8.29	27.24	42345	34310
3	15.0	72.2	6.36	8.30	27.26	42383	34310
4	15.0	73.8	6.31	8.29	27.26	42393	34311
5	15.0	75.5	6.41	8.29	27.27	42396	34301
6	15.0	71.6	6.32	8.29	27.31	42456	34328
7							
8							

Depth	Site: 5	Depth: 7.7m	Transparency: 2.1m		Date: 26/9/2017 Time:13:40		
	Parameters						
	Temperature (°C)	Dissolved oxygen (% saturation)	Dissolved oxygen (mg/l)	pH	Salinity (PPT)	Conductivity (uS/cm)	Conductivity (SPC – uS/cm)
Surface	15.4	91.4	8.07	8.36	22.84	36626	29765
1	15.4	89.1	7.35	8.01	26.92	41693	33998
2	15.2	77.6	6.69	8.31	27.17	42231	32464
3	15.1	77.6	6.66	8.30	27.27	42368	34299
4	15.0	75.7	6.43	8.30	27.29	42411	34327
5	15.0	71.9	6.16	8.28	27.29	42433	34321
6	15.0	74.6	6.40	8.31	27.31	42452	34333
7	15.0	76.0	6.49	8.30	27.33	42495	34547
8							
Depth	Site: 6	Depth: 8.4m	Transparency: 1.9m		Date: 26/9/2017 Time:13:50		
	Parameters						
	Temperature (°C)	Dissolved oxygen (% saturation)	Dissolved oxygen (mg/l)	pH	Salinity (PPT)	Conductivity (uS/cm)	Conductivity (SPC – uS/cm)
Surface	15.7	90.2	7.70	8.26	24.68	38887	31959
1	15.6	88.5	7.34	8.24	27.16	42164	34478
2	15.3	77.9	6.73	8.34	27.26	42359	34407
3	15.1	75.6	6.57	8.33	27.26	42381	34315
4	15.0	71.5	6.14	8.33	27.27	42399	34315
5	15.0	74.2	6.34	8.33	27.29	42421	34329
6	15.0	74.3	6.35	8.33	27.30	42499	34322
7	15.0	75.3	6.45	8.32	27.34	42495	34251
8	15.0	73.4	6.35	8.32	27.36	42522	34362

Depth	Site: 7	Depth: 6.7m	Transparency: 1.9m		Date: 27/9/2017 Time:13:00		
	Parameters						
	Temperature (°C)	Dissolved oxygen (% saturation)	Dissolved oxygen (mg/l)	pH	Salinity (PPT)	Conductivity (uS/cm)	Conductivity (SPC – uS/cm)
Surface	15.2	82.8	7.04	8.02	26.95	41840	34054
1	15.1	81.7	6.96	8.13	27.05	42076	34121
2	15.1	79.1	6.77	8.17	27.15	42236	34208
3	15.1	79.2	6.76	8.10	27.17	42239	34213
4	15.1	79.5	6.77	8.21	27.17	42244	34213
5	15.1	78.0	6.72	8.23	27.21	42308	34257
6	15.0	78.8	6.71	8.24	27.25	42361	34308
7							
8							
Depth	Site: 8	Depth: 7.8m	Transparency: 2.0m		Date: 27/9/2017 Time:13:10		
	Parameters						
	Temperature (°C)	Dissolved oxygen (% saturation)	Dissolved oxygen (mg/l)	pH	Salinity (PPT)	Conductivity (uS/cm)	Conductivity (SPC – uS/cm)
Surface	15.1	80.0	6.87	8.29	27.21	42170	34200
1	15.1	80.0	6.24	8.29	27.12	42184	36204
2	15.1	79.4	6.77	8.30	27.14	42327	34247
3	15.1	79.4	6.75	8.30	27.22	42824	34291
4	15.1	78.0	6.64	8.30	29.22	42317	34301
5	15.1	78.8	6.71	8.31	27.22	42318	34306
6	15.1	78.5	6.68	8.31	27.24	42353	34328
7	15.1	77.7	6.62	8.32	27.23	42348	34324
8							

Depth	Site: 9	Depth: 7.7m	Transparency: 2.2m		Date: 27/9/2017 Time:13:20		
	Parameters						
	Temperature (°C)	Dissolved oxygen (% saturation)	Dissolved oxygen (mg/l)	pH	Salinity (PPT)	Conductivity (uS/cm)	Conductivity (SPC – uS/cm)
Surface	15.1	78.5	6.67	8.32	27.25	42362	34341
1	15.1	77.2	6.62	8.31	27.24	42366	34330
2	15.1	77.5	6.60	8.32	27.25	42359	34322
3	15.1	76.5	6.56	8.32	27.24	42361	34316
4	15.1	77.2	6.62	8.33	27.25	42411	34317
5	15.1	76.8	6.54	8.33	27.25	42369	34313
6	15.0	76.8	6.56	8.33	27.26	43479	34208
7	15.0	76.7	6.54	8.33	27.25	42380	34310
8							
Depth	Site: 10	Depth: 7.3m	Transparency: 1.8m		Date: 27/9/2017 Time:13:30		
	Parameters						
	Temperature (°C)	Dissolved oxygen (% saturation)	Dissolved oxygen (mg/l)	pH	Salinity (PPT)	Conductivity (uS/cm)	Conductivity (SPC – uS/cm)
Surface	15.1	77.6	6.60	8.33	27.25	42166	34357
1	15.1	76.9	6.56	8.32	27.25	42366	34340
2	15.1	76.2	6.53	8.32	27.25	43469	34337
3	15.1	76.4	6.51	8.33	27.25	42383	34336
4	15.1	76.2	6.53	8.33	27.25	42366	34326
5	15.1	76.8	6.52	8.33	27.25	42368	34338
6	15.1	76.8	6.52	8.33	27.25	42364	34235
7	15.1	76.2	6.53	8.33	27.25	42374	34304

12. Appendix II - Peoples Project: Sediment Sampling – Ref: LO_A100795_V1

Our Ref: LO_A100795_V1

Everton Football Club
c/o Jonathan Williams,
Gardiner & Theobald LLP,
Merchant Exchange,
17-19 Whitworth Street West,
Manchester,
M1 5WG
25th October 2017

Dear Sirs

RE: PROJECT BLUE: SEDIMENT SAMPLING

WYG and APEM attended site on the 26th September 2017. As part of APEMs wider commission ten sediment samples were obtained from the base of Bramley Moore Dock using a 0.025m^2 Ekman grabber. The sample locations were surveyed in, given a unique identifier and surface water parameters were recorded (temperature, pH and redox). The samples were photographed and described. The sample descriptions, photographs and parameters are appended as Appendix A.

The samples were recovered into appropriate containers and sent to ALS Laboratory in Hawarden. The samples were tested for the following:

- Heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, mercury and zinc);
- BTEX Hydrocarbons (Benzene, Toulene, Ethylbenzene and Xylene isomers);
- Polychlorinated Biphenyls (PCBs);
- Organotins;
- Speciated Total Petroleum Hydrocarbons Criteria Working Group (TPH-CWG); and,
- Particle Size Analysis.

The samples were tested in line with the laboratory's accreditation. The particle size results identified that the samples would be appropriate for MCERTs accreditation. The laboratory results are appended as Appendix B. A sample location plan is also appended.

Yours sincerely

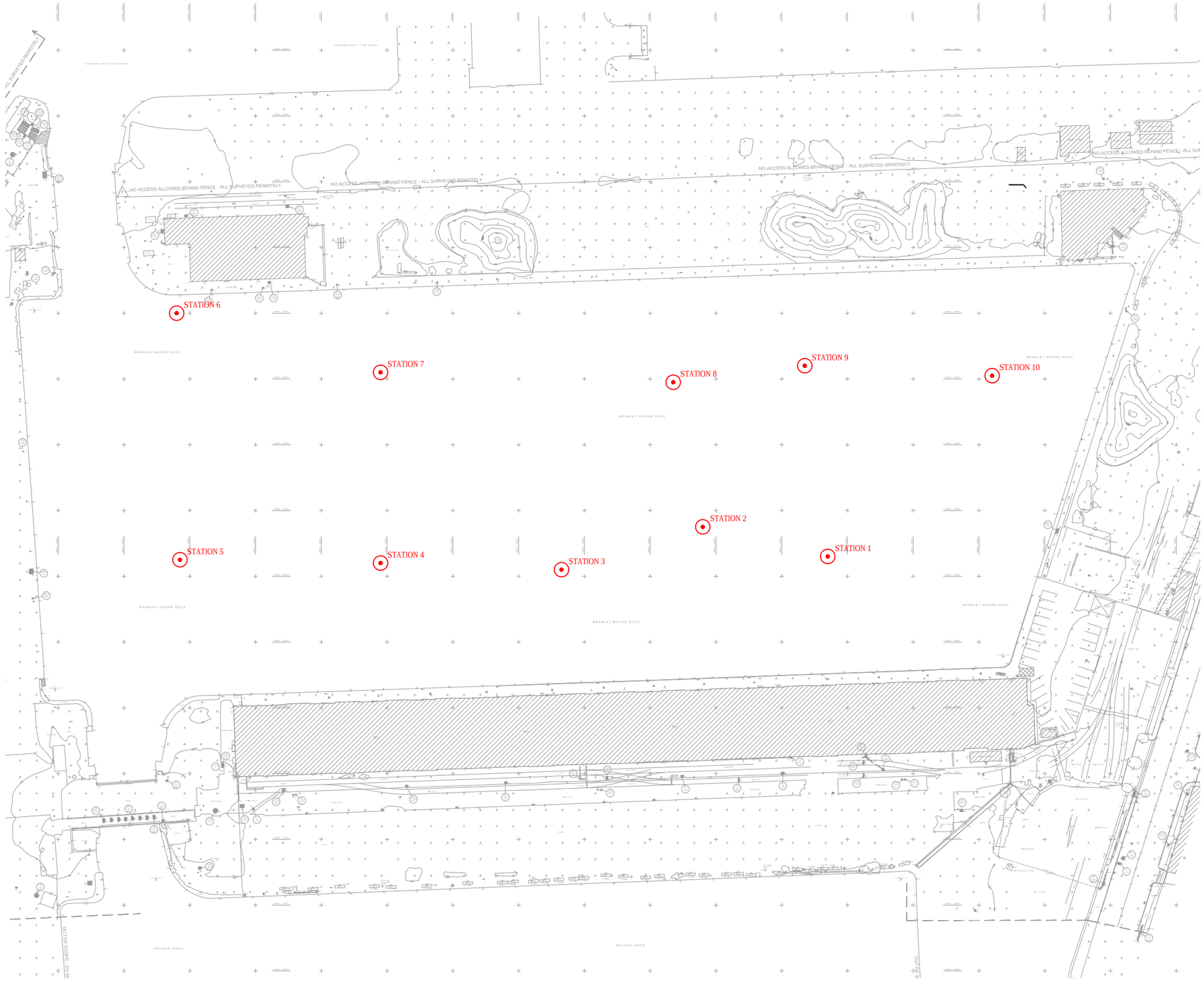
CMartin

Caroline Martin
Associate
WYG Environment Planning Transport Limited

Quay West at MediaCityUK, Trafford Wharf Road, Trafford Park, Manchester, M17 1HH
Tel: +44 (0)161 872 3223 Fax: +44 (0)161 872 3193
Email: caroline.martin@wyg.com Website: www.**wyg**.com

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

N



KEY

SAMPLE LOCATION

0 12.5 25 37.5 50 62.5 m

SCALE 1:1250

REV	DESCRIPTION	BY	CHK	APP	DATE

Client:

EVERTON FOOTBAL CLUB C/O
GARDINER & THEOBALD LLP

QUAY WEST at MediaCity UK
TRAFFORD WHARF ROAD
TRAFFORD PARK
MANCHESTER
M17 1HH
TEL: +44 (0)161 872 3223
FAX: +44 (0)161 872 3193
e-mail: manchester@wyg.com

Project: A100795

BRAMLEY MOOR DOCK,
LIVERPOOL

Drawing Title:

SAMPLE LOCATION PLAN

Scale @ A3	Drawn Date	Checked Date	Approved Date
1:1,250	JT 25.10.17		

Project No.	Office	Type	Drawing No.	Revision
A100795	MAN	N	01	

Appendix A: Sample Information

Parameter	Result
Location (National Grid Reference)	333534, 392466
Date and time sample taken	26/09/17, 10:28 am
Depth below water level (m)	7
Temperature (°C)	16.0
pH	7.88
Redox (Mv)	-103
APEM sample description	Black fine SILT
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259495

Station Number: 1

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795

Date: October 2017

Parameter	Result
Location (National Grid Reference)	333496, 392475
Date and time sample taken	26/09/17, 10:42 am
Depth below water level (m)	7
Temperature (°C)	15.2
pH	5.14
Redox (Mv)	-161
APEM sample description	Dark SILT with dead snails
Description using Particle Size Distribution (PSD)	Slightly sandy and gravelly SILT
Sample Reference	16259513

Station Number: 2

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795

Date: October 2017

Parameter	Result
Location (National Grid Reference)	333453, 392462
Date and time sample taken	26/09/17, 10:57 am
Depth below water level (m)	7
Temperature (°C)	15.1
pH	8.14
Redox (Mv)	-132
APEM sample description	Black fine SILT with dead snails
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259520

Station Number: 3

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795

Date: October 2017

Parameter	Result
Location (National Grid Reference)	333398, 392464
Date and time sample taken	26/09/17, 11:03 am
Depth below water level (m)	7
Temperature (°C)	15.0
pH	7.96
Redox (Mv)	-136
APEM sample description	Black fine SILT with dead snails
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259526

Station Number: 4

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795

Date: October 2017

Parameter	Result
Location (National Grid Reference)	333337, 392465
Date and time sample taken	26/09/17, 11:20 am
Depth below water level (m)	8
Temperature (°C)	15.3
pH	6.19
Redox (Mv)	-133
APEM sample description	Black fine SILT with a layer of brown silt on top 2cm
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259535

Station Number: 5

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795 **Date:** October 2017

Parameter	Result
Location (National Grid Reference)	333336, 392540
Date and time sample taken	26/09/17, 11:50 am
Depth below water level (m)	8
Temperature (°C)	15.4
pH	6.11
Redox (Mv)	-133
APEM sample description	Dark SILT with thin brown surface layer (2-3mm)
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259544

Station Number: 6

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795 **Date:** October 2017

Parameter	Result
Location (National Grid Reference)	333398, 392522
Date and time sample taken	26/09/17, 11:59 am
Depth below water level (m)	7
Temperature (°C)	15.5
pH	6.77
Redox (Mv)	-86
APEM sample description	Dark SILT with thin brown surface layer (2-3mm)
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259554

Station Number: 7

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795

Date: October 2017

Parameter	Result
Location (National Grid Reference)	333487, 392519
Date and time sample taken	26/09/17, 12:06 pm
Depth below water level (m)	7
Temperature (°C)	15.4
pH	6.97
Redox (Mv)	-154
APEM sample description	Dark SILT with thin brown surface layer (2-3mm)
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259560

Station Number: 8

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795 **Date:** October 2017

Parameter	Result
Location (National Grid Reference)	333527, 392524
Date and time sample taken	26/09/17, 12:26 pm
Depth below water level (m)	7
Temperature (°C)	15.5
pH	7.05
Redox (Mv)	-99
APEM sample description	Dark SILT with thin brown surface layer (2-3mm)
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259524

Station Number: 9

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795

Date: October 2017

Parameter	Result
Location (National Grid Reference)	333584, 392521
Date and time sample taken	26/09/17, 12:34 pm
Depth below water level (m)	7
Temperature (°C)	15.4
pH	7.78
Redox (Mv)	-41
APEM sample description	Dark SILT with thin brown surface layer (2-3mm)
Description using Particle Size Distribution (PSD)	Sandy SILT
Sample Reference	16259506

Station Number: 10

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795 **Date:** October 2017

Parameter	Result
Location (National Grid Reference)	333534, 392466
Date and time sample taken	26/09/17, 10:28 am
Depth below water level (m)	7
Temperature (°C)	16.0
pH	7.88
Redox (Mv)	-103
APEM sample description	Black fine SILT
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259495

Station Number: 1

Quay West at MediaCityUK,
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Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795

Date: October 2017

Parameter	Result
Location (National Grid Reference)	333496, 392475
Date and time sample taken	26/09/17, 10:42 am
Depth below water level (m)	7
Temperature (°C)	15.2
pH	5.14
Redox (Mv)	-161
APEM sample description	Dark SILT with dead snails
Description using Particle Size Distribution (PSD)	Slightly sandy and gravelly SILT
Sample Reference	16259513

Station Number: 2

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795

Date: October 2017

Parameter	Result
Location (National Grid Reference)	333453, 392462
Date and time sample taken	26/09/17, 10:57 am
Depth below water level (m)	7
Temperature (°C)	15.1
pH	8.14
Redox (Mv)	-132
APEM sample description	Black fine SILT with dead snails
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259520

Station Number: 3

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795

Date: October 2017

Parameter	Result
Location (National Grid Reference)	333398, 392464
Date and time sample taken	26/09/17, 11:03 am
Depth below water level (m)	7
Temperature (°C)	15.0
pH	7.96
Redox (Mv)	-136
APEM sample description	Black fine SILT with dead snails
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259526

Station Number: 4

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795

Date: October 2017

Parameter	Result
Location (National Grid Reference)	333337, 392465
Date and time sample taken	26/09/17, 11:20 am
Depth below water level (m)	8
Temperature (°C)	15.3
pH	6.19
Redox (Mv)	-133
APEM sample description	Black fine SILT with a layer of brown silt on top 2cm
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259535

Station Number: 5

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795 **Date:** October 2017

Parameter	Result
Location (National Grid Reference)	333336, 392540
Date and time sample taken	26/09/17, 11:50 am
Depth below water level (m)	8
Temperature (°C)	15.4
pH	6.11
Redox (Mv)	-133
APEM sample description	Dark SILT with thin brown surface layer (2-3mm)
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259544

Station Number: 6

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795 **Date:** October 2017

Parameter	Result
Location (National Grid Reference)	333398, 392522
Date and time sample taken	26/09/17, 11:59 am
Depth below water level (m)	7
Temperature (°C)	15.5
pH	6.77
Redox (Mv)	-86
APEM sample description	Dark SILT with thin brown surface layer (2-3mm)
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259554

Station Number: 7

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795

Date: October 2017

Parameter	Result
Location (National Grid Reference)	333487, 392519
Date and time sample taken	26/09/17, 12:06 pm
Depth below water level (m)	7
Temperature (°C)	15.4
pH	6.97
Redox (Mv)	-154
APEM sample description	Dark SILT with thin brown surface layer (2-3mm)
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259560

Station Number: 8

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795 **Date:** October 2017

Parameter	Result
Location (National Grid Reference)	333527, 392524
Date and time sample taken	26/09/17, 12:26 pm
Depth below water level (m)	7
Temperature (°C)	15.5
pH	7.05
Redox (Mv)	-99
APEM sample description	Dark SILT with thin brown surface layer (2-3mm)
Description using Particle Size Distribution (PSD)	Slightly sandy SILT
Sample Reference	16259524

Station Number: 9

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795

Date: October 2017

Parameter	Result
Location (National Grid Reference)	333584, 392521
Date and time sample taken	26/09/17, 12:34 pm
Depth below water level (m)	7
Temperature (°C)	15.4
pH	7.78
Redox (Mv)	-41
APEM sample description	Dark SILT with thin brown surface layer (2-3mm)
Description using Particle Size Distribution (PSD)	Sandy SILT
Sample Reference	16259506

Station Number: 10

Quay West at MediaCityUK,
Trafford Wharf Road,
Trafford Park,
Manchester M17 1HH

Tel: 0161 872 3223
Fax: 0161 872 3192
E-mail enquiries @wyg.com

Environmental Consultancy
Ground Technologies & Investigation

Project: Bramley Moore Dock

Client: Gardiner & Theobald LLP

Sample Descriptions

Project No.: A100795 **Date:** October 2017

Appendix B: Laboratory Test Results

Unit 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
Deeside
CH5 3US
Tel: (01244) 528700
Fax: (01244) 528701
email: hawardencustomerservices@alsglobal.com
Website: www.alsenvironmental.co.uk

WYG Geo-Environment
Quay West at Media City UK
Trafford Warf Palk
Manchester
Lancashire
M17 1HH

Attention: Sara Brennan

CERTIFICATE OF ANALYSIS

Date:	11 October 2017
Customer:	H_WYG_MAN
Sample Delivery Group (SDG):	170927-110
Your Reference:	A100795
Location:	Bramley Moore Dock
Report No:	427864

We received 10 samples on Wednesday September 27, 2017 and 10 of these samples were scheduled for analysis which was completed on Wednesday October 11, 2017. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

Chemical testing (unless subcontracted) performed at ALS Environmental Hawarden (Method codes TM) or ALS Environmental Aberdeen (Method codes S).

Approved By:

Sonia McWhan

Operations Manager

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
16259495	Station 1		7.00	26/09/2017
16259513	Station 2		7.00	26/09/2017
16259520	Station 3		7.00	26/09/2017
16259526	Station 4		7.00	26/09/2017
16259535	Station 5		8.00	26/09/2017
16259544	Station 6		8.00	26/09/2017
16259554	Station 7		7.00	26/09/2017
16259560	Station 8		7.00	26/09/2017
16259566	Station 9		7.00	26/09/2017
16259506	Station 10		7.00	26/09/2017

Maximum Sample/Coolbox Temperature (°C) : **12.6**

ISO5667-3 Water quality - Sampling - Part3 -

During Transportation samples shall be stored in a cooling device capable of maintaining a temperature of (5±3)°C.

ALS have data which show that a cool box with 4 frozen icepacks is capable of maintaining pre-chilled samples at a temperature of (5±3)°C for a period of up to 24hrs.

Only received samples which have had analysis scheduled will be shown on the following pages.

Validated

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

Results Legend

X Test

N No Determination Possible

Sample Types -

S - Soil/Solid
UNS - Unspecified Solid
GW - Ground Water
SW - Surface Water
LE - Land Leachate
PL - Prepared Leachate
PR - Process Water
SA - Saline Water
TE - Trade Effluent
TS - Treated Sewage
US - Untreated Sewage
RE - Recreational Water
DW - Drinking Water Non-regulatory
UNL - Unspecified Liquid
SL - Sludge
G - Gas
OTH - Other

Lab Sample No(s)				16259495			16259513			16259520			16259526			16259535			16259544			16259554
Customer Sample Reference				Station 1			Station 2			Station 3			Station 4			Station 5			Station 6			Station 7
AGS Reference																						
Depth (m)				7.00			7.00			7.00			7.00			8.00			8.00			7.00
Container				250g Amber Jar (ALE210)	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (ALE210)	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (ALE210)	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (ALE210)	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (ALE210)	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (ALE210)	400g Tub (ALE214)	60g VOC (ALE215)	250g Amber Jar (ALE210)
Sample Type				S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
EPH CWG (Aliphatic) GC (S)	All	NDPs: 0 Tests: 10		X			X			X			X			X			X			X
EPH CWG (Aromatic) GC (S)	All	NDPs: 0 Tests: 10		X			X			X			X			X			X			X
GRO by GC-FID (S)	All	NDPs: 0 Tests: 10				X			X			X			X			X			X	
Metals in solid samples by OES	All	NDPs: 0 Tests: 10		X			X			X			X			X			X			X
Organotins on soils*	All	NDPs: 0 Tests: 10		X			X			X			X			X			X			X
PAH by GCMS	All	NDPs: 0 Tests: 10		X			X			X			X			X			X			X
PCBs by GCMS	All	NDPs: 0 Tests: 10		X			X			X			X			X			X			X
PSD by laser diffraction*	All	NDPs: 0 Tests: 10			X			X			X			X			X			X		
Sample description	All	NDPs: 0 Tests: 9		X			X			X			X			X			X			X
TPH CWG GC (S)	All	NDPs: 0 Tests: 10		X			X			X			X			X			X			X
VOC MS (S)	All	NDPs: 0 Tests: 10				X			X			X			X			X			X	

16259506	Station 10		7.00	60g VOC (ALE215)	S			X								X
				400g Tub (ALE214)	S								X			
				250g Amber Jar (ALE210)	S	X	X		X	X	X	X		X	X	
16259566	Station 9		7.00	60g VOC (ALE215)	S			X								X
				400g Tub (ALE214)	S								X			
				250g Amber Jar (ALE210)	S	X	X		X	X	X	X		X	X	
16259560	Station 8		7.00	60g VOC (ALE215)	S			X								X
				400g Tub (ALE214)	S								X			
				250g Amber Jar (ALE210)	S	X	X		X	X	X	X		X	X	
16259554	Station 7		7.00	60g VOC (ALE215)	S			X								X
				400g Tub (ALE214)	S								X			

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

Sample Descriptions

Grain Sizes

very fine	<0.063mm	fine	0.063mm - 0.1mm	medium	0.1mm - 2mm	coarse	2mm - 10mm	very coarse	>10mm

Lab Sample No(s)	Customer Sample Ref.	Depth (m)	Colour	Description	Inclusions	Inclusions 2
16259495	Station 1	7.00	Black	Silt Loam	None	Stones
16259513	Station 2	7.00	Grey	Silt Loam	None	None
16259520	Station 3	7.00	Grey	Silt Loam	None	None
16259526	Station 4	7.00	Black	Silt Loam	None	None
16259535	Station 5	8.00	Black	Silt Loam	None	None
16259544	Station 6	8.00	Grey	Silt Loam	None	None
16259554	Station 7	7.00	Grey	Silt Loam	None	None
16259560	Station 8	7.00	Grey	Silt Loam	None	None
16259566	Station 9	7.00	Grey	Silt Loam	None	None
16259506	Station 10	7.00	Grey	Silt Loam	None	None

These descriptions are only intended to act as a cross check if sample identities are questioned, and to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions.

We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally ocurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample.

Other coarse granular materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

Validated

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

Results Legend	
#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
			Depth (m)	7.00	7.00	7.00	7.00	8.00	8.00
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)
			Date Sampled	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017
			Sample Time	.	.	.	.	.	.
			Date Received	27/09/2017	27/09/2017	27/09/2017	27/09/2017	27/09/2017	27/09/2017
			SDG Ref	170927-110	170927-110	170927-110	170927-110	170927-110	170927-110
			Lab Sample No.(s)	16259495	16259513	16259520	16259526	16259535	16259544
			AGS Reference						
Moisture Content Ratio (% of as received sample)	%	PM024		56	54	57	58	58	57
PSD by laser diffraction*	-	SUB		See Attached	See Attached	See Attached	See Attached	See Attached	See Attached
PCB congener 28	<3 µg/kg	TM168		<3 M	7.68 M	<15 M	<3 M	103 M	<6 M
PCB congener 52	<3 µg/kg	TM168		25.1 M	5.05 M	<15 M	32.8 M	44.1 M	<6 M
PCB congener 101	<3 µg/kg	TM168		15.4 M	5.63 M	<15 M	20 M	24 M	<6 M
PCB congener 118	<3 µg/kg	TM168		10.6 M	6.04 M	<15 M	15.7 M	19.2 M	<6 M
PCB congener 138	<3 µg/kg	TM168		12.7 M	7.91 M	<15 M	17.4 M	19.2 M	<6 M
PCB congener 153	<3 µg/kg	TM168		15.4 M	7.68 M	<15 M	23.7 M	25.8 M	<6 M
PCB congener 180	<3 µg/kg	TM168		11.5 M	4.23 M	<15 M	20.4 M	22.2 M	<6 M
Sum of detected PCB 7 Congeners	<21 µg/kg	TM168		90.8	44.2	<105	130	257	<42
Arsenic	<0.6 mg/kg	TM181		35.1 M	21.5 M	23 M	35 M	40.3 M	16.2 M
Cadmium	<0.02 mg/kg	TM181		1.52 M	0.461 M	1.13 M	2.03 M	2.44 M	0.394 M
Chromium	<0.9 mg/kg	TM181		76.9 M	34.9 M	58.5 M	76.5 M	85.3 M	42.8 M
Copper	<1.4 mg/kg	TM181		162 M	91.9 M	104 M	126 M	125 M	88 M
Lead	<0.7 mg/kg	TM181		198 M	135 M	137 M	180 M	196 M	91 M
Mercury	<0.14 mg/kg	TM181		3.52 M	1.59 M	2.5 M	3.45 M	3.96 M	1.6 M
Nickel	<0.2 mg/kg	TM181		34.1 M	23 M	29.5 M	30.8 M	33.7 M	26.4 M
Zinc	<1.9 mg/kg	TM181		604 M	340 M	422 M	619 M	662 M	291 M

Validated

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

Results Legend	
#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	Station 7	Station 8	Station 9	Station 10		
			Depth (m)	7.00	7.00	7.00	7.00		
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)		
			Date Sampled	26/09/2017	26/09/2017	26/09/2017	26/09/2017		
			Sample Time	.	.	.	.		
			Date Received	27/09/2017	27/09/2017	27/09/2017	27/09/2017		
			SDG Ref	170927-110	170927-110	170927-110	170927-110		
			Lab Sample No.(s)	16259554	16259560	16259566	16259506		
			AGS Reference						
Moisture Content Ratio (% of as received sample)	%	PM024		58	56	59	53		
PSD by laser diffraction*	-	SUB		See Attached	See Attached	See Attached	See Attached		
PCB congener 28	<3 µg/kg	TM168		<15 M	7.47 M	<6 M	8.17 M		
PCB congener 52	<3 µg/kg	TM168		<15 M	4.03 M	<6 M	5 M		
PCB congener 101	<3 µg/kg	TM168		<15 M	4.24 M	<6 M	4.77 M		
PCB congener 118	<3 µg/kg	TM168		<15 M	3.24 M	<6 M	4.32 M		
PCB congener 138	<3 µg/kg	TM168		<15 M	4.44 M	<6 M	5.62 M		
PCB congener 153	<3 µg/kg	TM168		<15 M	6.62 M	<6 M	6.74 M		
PCB congener 180	<3 µg/kg	TM168		<15 M	6.15 M	<6 M	4.68 M		
Sum of detected PCB 7 Congeners	<21 µg/kg	TM168		<105	36.2	<42	39.3		
Arsenic	<0.6 mg/kg	TM181		20 M	17 M	18.6 M	18 M		
Cadmium	<0.02 mg/kg	TM181		0.576 M	0.447 M	0.442 M	0.599 M		
Chromium	<0.9 mg/kg	TM181		50.1 M	42.7 M	45.4 M	39.4 M		
Copper	<1.4 mg/kg	TM181		112 M	87 M	112 M	106 M		
Lead	<0.7 mg/kg	TM181		122 M	107 M	119 M	111 M		
Mercury	<0.14 mg/kg	TM181		1.95 M	1.57 M	1.63 M	1.38 M		
Nickel	<0.2 mg/kg	TM181		26.8 M	24.9 M	29.4 M	23.5 M		
Zinc	<1.9 mg/kg	TM181		338 M	296 M	308 M	297 M		

Validated

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

Organotins on soils*

Results Legend	
#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
			Depth (m)	7.00	7.00	7.00	7.00	8.00	8.00
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)
			Date Sampled	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017
			Sample Time	.	.	.	.	.	.
			Date Received	27/09/2017	27/09/2017	27/09/2017	27/09/2017	27/09/2017	27/09/2017
			SDG Ref	170927-110	170927-110	170927-110	170927-110	170927-110	170927-110
			Lab Sample No.(s)	16259495	16259513	16259520	16259526	16259535	16259544
			AGS Reference						
Dibutyl Tin*	mg/kg	SUB		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tributyl Tin*	mg/kg	SUB		<0.05	0.06	0.19	<0.05	<0.05	<0.05
Triphenyl Tin*	mg/kg	SUB		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tetrabutyl Tin*	mg/kg	SUB		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Monobutyl Tin*	mg/kg	SUB		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
Monophenyl Tin*	mg/kg	SUB		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Diphenyl Tin*	mg/kg	SUB		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Validated

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

Organotins on soils*

Results Legend	
#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	Station 7	Station 8	Station 9	Station 10		
			Depth (m)	7.00	7.00	7.00	7.00		
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)		
			Date Sampled	26/09/2017	26/09/2017	26/09/2017	26/09/2017		
			Sample Time	.	.	.	.		
			Date Received	27/09/2017	27/09/2017	27/09/2017	27/09/2017		
			SDG Ref	170927-110	170927-110	170927-110	170927-110		
			Lab Sample No.(s)	16259554	16259560	16259566	16259506		
			AGS Reference						
Dibutyl Tin*	mg/kg	SUB		<0.05	<0.05	<0.04	<0.05		
Tributyl Tin*	mg/kg	SUB		0.08	0.06	<0.04	0.06		
Triphenyl Tin*	mg/kg	SUB		<0.05	<0.05	<0.05	<0.05		
Tetrabutyl Tin*	mg/kg	SUB		<0.05	<0.05	<0.04	<0.05		
Monobutyl Tin*	mg/kg	SUB		<0.15	<0.15	<0.15	<0.15		
Monophenyl Tin*	mg/kg	SUB		<0.05	<0.05	<0.04	<0.05		
Diphenyl Tin*	mg/kg	SUB		<0.05	<0.05	<0.04	<0.05		

Validated

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

PAH by GCMS

Results Legend	
#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
			Depth (m)	7.00	7.00	7.00	7.00	8.00	8.00
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)
			Date Sampled	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017
			Sample Time	.	.	.	.	.	.
			Date Received	27/09/2017	27/09/2017	27/09/2017	27/09/2017	27/09/2017	27/09/2017
			SDG Ref	170927-110	170927-110	170927-110	170927-110	170927-110	170927-110
			Lab Sample No.(s)	16259495	16259513	16259520	16259526	16259535	16259544
			AGS Reference						
Naphthalene-d8 % recovery**	%	TM218		121	111	112	119	122	118
Acenaphthene-d10 % recovery**	%	TM218		118	110	111	114	117	115
Phenanthrene-d10 % recovery**	%	TM218		117	114	116	112	113	114
Chrysene-d12 % recovery**	%	TM218		121	105	112	112	110	100
Perylene-d12 % recovery**	%	TM218		126	110	115	117	112	106
Naphthalene	<9 µg/kg	TM218		488 M	170 M	214 M	397 M	439 M	221 M
Acenaphthylene	<12 µg/kg	TM218		264 M	<12 M	109 M	219 M	262 M	<12 M
Acenaphthene	<8 µg/kg	TM218		113 M	38.2 M	37.3 M	101 M	97.8 M	54.9 M
Fluorene	<10 µg/kg	TM218		234 M	<10 M	83.4 M	197 M	218 M	85.2 M
Phenanthrene	<15 µg/kg	TM218		598 M	248 M	271 M	573 M	696 M	394 M
Anthracene	<16 µg/kg	TM218		436 M	123 M	197 M	332 M	467 M	122 M
Fluoranthene	<17 µg/kg	TM218		1210 M	452 M	449 M	1010 M	2250 M	490 M
Pyrene	<15 µg/kg	TM218		1640 M	526 M	1210 M	1550 M	1810 M	533 M
Benz(a)anthracene	<14 µg/kg	TM218		804 M	307 M	348 M	643 M	1230 M	285 M
Chrysene	<10 µg/kg	TM218		663 M	181 M	177 M	499 M	1110 M	179 M
Benzo(b)fluoranthene	<15 µg/kg	TM218		2490 M	907 M	1580 M	2190 M	2660 M	913 M
Benzo(k)fluoranthene	<14 µg/kg	TM218		741 M	295 M	469 M	746 M	726 M	273 M
Benzo(a)pyrene	<15 µg/kg	TM218		1750 M	529 M	990 M	1460 M	1860 M	466 M
Indeno(1,2,3-cd)pyrene	<18 µg/kg	TM218		1040 M	342 M	629 M	896 M	1040 M	310 M
Dibenzo(a,h)anthracene	<23 µg/kg	TM218		259 M	85 M	155 M	246 M	303 M	78.3 M
Benzo(g,h,i)perylene	<24 µg/kg	TM218		1320 M	473 M	1010 M	1190 M	1340 M	427 M
PAH, Total Detected USEPA 16	<118 µg/kg	TM218		14000	4680	7920	12300	16500	4830

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

PAH by GCMS

Results Legend	
#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	Station 7	Station 8	Station 9	Station 10		
			Depth (m)	7.00	7.00	7.00	7.00		
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)		
			Date Sampled	26/09/2017	26/09/2017	26/09/2017	26/09/2017		
			Sample Time	.	.	.	.		
			Date Received	27/09/2017	27/09/2017	27/09/2017	27/09/2017		
			SDG Ref	170927-110	170927-110	170927-110	170927-110		
			Lab Sample No.(s)	16259554	16259560	16259566	16259506		
			AGS Reference						
Naphthalene-d8 % recovery**	%	TM218		110	121	109	121		
Acenaphthene-d10 % recovery**	%	TM218		109	114	103	121		
Phenanthrene-d10 % recovery**	%	TM218		111	105	102	123		
Chrysene-d12 % recovery**	%	TM218		97.2	102	97.2	110		
Perylene-d12 % recovery**	%	TM218		99.4	118	98.7	115		
Naphthalene	<9 µg/kg	TM218		192 M	174 M	165 M	234 M		
Acenaphthylene	<12 µg/kg	TM218		80.1 M	58.9 M	63.1 M	174 M		
Acenaphthene	<8 µg/kg	TM218		48.3 M	37.7 M	36.5 M	188 M		
Fluorene	<10 µg/kg	TM218		<10 M	76.9 M	70.7 M	257 M		
Phenanthrene	<15 µg/kg	TM218		285 M	271 M	297 M	1600 M		
Anthracene	<16 µg/kg	TM218		141 M	117 M	125 M	427 M		
Fluoranthene	<17 µg/kg	TM218		464 M	396 M	502 M	2370 M		
Pyrene	<15 µg/kg	TM218		617 M	455 M	555 M	2070 M		
Benz(a)anthracene	<14 µg/kg	TM218		316 M	296 M	268 M	1240 M		
Chrysene	<10 µg/kg	TM218		200 M	213 M	221 M	1000 M		
Benzo(b)fluoranthene	<15 µg/kg	TM218		1030 M	919 M	726 M	2120 M		
Benzo(k)fluoranthene	<14 µg/kg	TM218		311 M	273 M	277 M	859 M		
Benzo(a)pyrene	<15 µg/kg	TM218		576 M	530 M	422 M	1390 M		
Indeno(1,2,3-cd)pyrene	<18 µg/kg	TM218		371 M	361 M	318 M	679 M		
Dibenzo(a,h)anthracene	<23 µg/kg	TM218		98.4 M	91.7 M	95.4 M	207 M		
Benzo(g,h,i)perylene	<24 µg/kg	TM218		512 M	546 M	425 M	847 M		
PAH, Total Detected USEPA 16	<118 µg/kg	TM218		5240	4820	4570	15700		

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

TPH CWG (S)

Results Legend	
#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
			Depth (m)	7.00	7.00	7.00	7.00	8.00	8.00
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)
			Date Sampled	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017
			Sample Time	.	.	.	.	.	.
			Date Received	27/09/2017	27/09/2017	27/09/2017	27/09/2017	27/09/2017	27/09/2017
			SDG Ref	170927-110	170927-110	170927-110	170927-110	170927-110	170927-110
			Lab Sample No.(s)	16259495	16259513	16259520	16259526	16259535	16259544
			AGS Reference						
GRO Surrogate % recovery**	%	TM089		68	68	71	62	53	53
GRO TOT (Moisture Corrected)	<44 µg/kg	TM089		1200 M	114 M	619 M	775 M	3010 M	<44 M
Methyl tertiary butyl ether (MTBE)	<5 µg/kg	TM089		<5 #	<5 #	<5 #	<5 #	<5 #	<5 #
Benzene	<10 µg/kg	TM089		<10 M	<10 M	<10 M	<10 M	<10 M	<10 M
Toluene	<2 µg/kg	TM089		<2 M	<2 M	<2 M	<2 M	9.6 M	<2 M
Ethylbenzene	<3 µg/kg	TM089		<3 M	<3 M	<3 M	<3 M	9.6 M	<3 M
m,p-Xylene	<6 µg/kg	TM089		<6 M	<6 M	<6 M	<6 M	<6 M	<6 M
o-Xylene	<3 µg/kg	TM089		<3 M	<3 M	<3 M	<3 M	<3 M	<3 M
sum of detected mpo xylene by GC	<9 µg/kg	TM089		<9	<9	<9	<9	<9	<9
sum of detected BTEX by GC	<24 µg/kg	TM089		<24	<24	<24	<24	<24	<24
Aliphatics >C5-C6	<10 µg/kg	TM089		18.4	11	16.1	16.8	33.6	<10
Aliphatics >C6-C8	<10 µg/kg	TM089		39.1	26.4	50.6	38.4	106	<10
Aliphatics >C8-C10	<10 µg/kg	TM089		122	22	80.5	98.4	326	<10
Aliphatics >C10-C12	<10 µg/kg	TM089		557	22	251	329	1380	<10
Aliphatics >C12-C16	<100 µg/kg	TM173		69000	19400	8030	42200	119000	4290
Aliphatics >C16-C21	<100 µg/kg	TM173		228000	92600	40500	138000	295000	20800
Aliphatics >C21-C35	<100 µg/kg	TM173		689000	361000	121000	400000	809000	73900
Aliphatics >C35-C44	<100 µg/kg	TM173		158000	99300	32800	88500	184000	22100
Total Aliphatics >C12-C44	<100 µg/kg	TM173		1140000	573000	202000	668000	1410000	121000
Aromatics >EC5-EC7	<10 µg/kg	TM089		<10	<10	<10	<10	<10	<10
Aromatics >EC7-EC8	<10 µg/kg	TM089		<10	<10	<10	<10	<10	<10
Aromatics >EC8-EC10	<10 µg/kg	TM089		85.1	17.6	55.2	69.6	233	<10
Aromatics >EC10-EC12	<10 µg/kg	TM089		370	13.2	166	221	922	<10
Aromatics >EC12-EC16	<100 µg/kg	TM173		8210	3150	<100	8120	15400	2190
Aromatics >EC16-EC21	<100 µg/kg	TM173		83800	35100	12800	72100	121000	13100
Aromatics >EC21-EC35	<100 µg/kg	TM173		380000	184000	46500	297000	472000	69100
Aromatics >EC35-EC44	<100 µg/kg	TM173		101000	65900	11500	79700	141000	25500
Aromatics >EC40-EC44	<100 µg/kg	TM173		39000	20800	3590	25200	47900	6540
Total Aromatics >EC12-EC44	<100 µg/kg	TM173		573000	288000	70700	457000	749000	110000
Total Aliphatics & Aromatics >C5-C44	<100 µg/kg	TM173		1720000	861000	273000	1130000	2160000	231000

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

TPH CWG (S)

Results Legend	
#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	Station 7	Station 8	Station 9	Station 10		
			Depth (m)	7.00	7.00	7.00	7.00		
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)		
			Date Sampled	26/09/2017	26/09/2017	26/09/2017	26/09/2017		
			Sample Time	.	.	.	.		
			Date Received	27/09/2017	27/09/2017	27/09/2017	27/09/2017		
			SDG Ref	170927-110	170927-110	170927-110	170927-110		
			Lab Sample No.(s)	16259554	16259560	16259566	16259506		
			AGS Reference						
GRO Surrogate % recovery**	%	TM089		66	68	70	67		
GRO TOT (Moisture Corrected)	<44 µg/kg	TM089		120 M	143 M	110 M	145 M		
Methyl tertiary butyl ether (MTBE)	<5 µg/kg	TM089		<5 #	<5 #	<5 #	<5 #		
Benzene	<10 µg/kg	TM089		<10 M	<10 M	<10 M	<10 M		
Toluene	<2 µg/kg	TM089		<2 M	<2 M	<2 M	<2 M		
Ethylbenzene	<3 µg/kg	TM089		<3 M	<3 M	<3 M	<3 M		
m,p-Xylene	<6 µg/kg	TM089		<6 M	<6 M	<6 M	<6 M		
o-Xylene	<3 µg/kg	TM089		<3 M	<3 M	<3 M	<3 M		
sum of detected mpo xylene by GC	<9 µg/kg	TM089		<9	<9	<9	<9		
sum of detected BTEX by GC	<24 µg/kg	TM089		<24	<24	<24	<24		
Aliphatics >C5-C6	<10 µg/kg	TM089		12	13.8	14.4	12.6		
Aliphatics >C6-C8	<10 µg/kg	TM089		31.2	32.2	31.2	25.2		
Aliphatics >C8-C10	<10 µg/kg	TM089		24	29.9	21.6	23.1		
Aliphatics >C10-C12	<10 µg/kg	TM089		19.2	25.3	16.8	37.8		
Aliphatics >C12-C16	<100 µg/kg	TM173		3310	1610	2700	16600		
Aliphatics >C16-C21	<100 µg/kg	TM173		20300	11900	13600	80200		
Aliphatics >C21-C35	<100 µg/kg	TM173		71600	45300	51800	306000		
Aliphatics >C35-C44	<100 µg/kg	TM173		16100	9110	9640	88100		
Total Aliphatics >C12-C44	<100 µg/kg	TM173		111000	67900	77700	491000		
Aromatics >EC5-EC7	<10 µg/kg	TM089		<10	<10	<10	<10		
Aromatics >EC7-EC8	<10 µg/kg	TM089		<10	<10	<10	<10		
Aromatics >EC8-EC10	<10 µg/kg	TM089		19.2	23	16.8	18.9		
Aromatics >EC10-EC12	<10 µg/kg	TM089		12	18.4	12	25.2		
Aromatics >EC12-EC16	<100 µg/kg	TM173		<100	<100	<100	2120		
Aromatics >EC16-EC21	<100 µg/kg	TM173		10000	6350	6750	24400		
Aromatics >EC21-EC35	<100 µg/kg	TM173		52200	33300	37000	149000		
Aromatics >EC35-EC44	<100 µg/kg	TM173		11300	5920	<100	55900		
Aromatics >EC40-EC44	<100 µg/kg	TM173		3380	1670	<100	23300		
Total Aromatics >EC12-EC44	<100 µg/kg	TM173		73500	45600	43700	232000		
Total Aliphatics & Aromatics >C5-C44	<100 µg/kg	TM173		185000	114000	122000	723000		

Validated

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

VOC MS (S)

Results Legend	
#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
			Depth (m)	7.00	7.00	7.00	7.00	8.00	8.00
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)
			Date Sampled	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017
			Sample Time	.	.	.	.	.	.
			Date Received	27/09/2017	27/09/2017	27/09/2017	27/09/2017	27/09/2017	27/09/2017
			SDG Ref	170927-110	170927-110	170927-110	170927-110	170927-110	170927-110
			Lab Sample No.(s)	16259495	16259513	16259520	16259526	16259535	16259544
			AGS Reference						
Toluene-d8**	%	TM116		85.1	91.4	89.8	85.7	82.5	89.9
Benzene	<9 µg/kg	TM116		<9 M	<9 M	<9 M	<9 M	<9 M	<9 M
Toluene	<7 µg/kg	TM116		<7 M	<7 M	<7 M	<7 M	<7 M	<7 M
Ethylbenzene	<4 µg/kg	TM116		<4 M	<4 M	<4 M	<4 M	<4 M	<4 M
p/m-Xylene	<10 µg/kg	TM116		<10 #	<10 #	<10 #	<10 #	<10 #	<10 #
o-Xylene	<10 µg/kg	TM116		<10 M	<10 M	<10 M	<10 M	<10 M	<10 M

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

VOC MS (S)

Results Legend	
#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	Station 7	Station 8	Station 9	Station 10		
			Depth (m)	7.00	7.00	7.00	7.00		
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)		
			Date Sampled	26/09/2017	26/09/2017	26/09/2017	26/09/2017		
			Sample Time	.	.	.	.		
			Date Received	27/09/2017	27/09/2017	27/09/2017	27/09/2017		
			SDG Ref	170927-110	170927-110	170927-110	170927-110		
			Lab Sample No.(s)	16259554	16259560	16259566	16259506		
			AGS Reference						
Toluene-d8**	%	TM116		88.8	90.4	90.7	90.1		
Benzene	<9 µg/kg	TM116		<9 M	<9 M	<9 M	<9 M		
Toluene	<7 µg/kg	TM116		<7 M	<7 M	<7 M	<7 M		
Ethylbenzene	<4 µg/kg	TM116		<4 M	<4 M	<4 M	<4 M		
p/m-Xylene	<10 µg/kg	TM116		<10 #	<10 #	<10 #	<10 #		
o-Xylene	<10 µg/kg	TM116		<10 M	<10 M	<10 M	<10 M		

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

Table of Results - Appendix

Method No	Reference	Description	Wet/Dry Sample [1]	Surrogate Corrected
PM001		Preparation of Samples for Metals Analysis		
PM024	Modified BS 1377	Soil preparation including homogenisation, moisture screens of soils for Asbestos Containing Material		
SUB		Subcontracted Test		
TM089	Modified: US EPA Methods 8020 & 602	Determination of Gasoline Range Hydrocarbons (GRO) and BTEX (MTBE) compounds by Headspace GC-FID (C4-C12)		
TM116	Modified: US EPA Method 8260, 8120, 8020, 624, 610 & 602	Determination of Volatile Organic Compounds by Headspace / GC-MS		
TM168	EPA Method 8082, Polychlorinated Biphenyls by Gas Chromatography	Determination of WHO12 and EC7 Polychlorinated Biphenyl Congeners by GC-MS in Soils		
TM173	Analysis of Petroleum Hydrocarbons in Environmental Media – Total Petroleum Hydrocarbon Criteria	Determination of Speciated Extractable Petroleum Hydrocarbons in Soils by GC-FID		
TM181	US EPA Method 6010B	Determination of Routine Metals in Soil by iCap 6500 Duo ICP-OES		
TM218	Determination of PAH by GCMS Microwave extraction	The determination of PAH in soil samples by microwave extraction and GC-MS		

[1] Applies to Solid samples only. DRY indicates samples have been dried at 35°C. NA = not applicable.

Chemical testing (unless subcontracted) performed at ALS Environmental Hawarden (Method codes TM) or ALS Environmental Aberdeen (Method codes S).

Validated

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

Test Completion Dates

Lab Sample No(s)	16259495	16259513	16259520	16259526	16259535	16259544	16259554	16259560	16259566	16259506
Customer Sample Ref.	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10
AGS Ref.										
Depth	7.00	7.00	7.00	7.00	8.00	8.00	7.00	7.00	7.00	7.00
Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)
EPH CWG (Aliphatic) GC (S)	02-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	02-Oct-2017
EPH CWG (Aromatic) GC (S)	02-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	02-Oct-2017
GRO by GC-FID (S)	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017
Metals in solid samples by OES	04-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017
Organotins on soils*	11-Oct-2017	11-Oct-2017	11-Oct-2017	11-Oct-2017	11-Oct-2017	11-Oct-2017	11-Oct-2017	11-Oct-2017	11-Oct-2017	11-Oct-2017
PAH by GCMS	02-Oct-2017	02-Oct-2017	02-Oct-2017	03-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	03-Oct-2017	02-Oct-2017
PCBs by GCMS	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017
PSD by laser diffraction*	06-Oct-2017	06-Oct-2017	06-Oct-2017	06-Oct-2017	06-Oct-2017	06-Oct-2017	06-Oct-2017	06-Oct-2017	06-Oct-2017	06-Oct-2017
Sample description	28-Sep-2017	28-Sep-2017	28-Sep-2017	28-Sep-2017	28-Sep-2017	28-Sep-2017	28-Sep-2017	28-Sep-2017	28-Sep-2017	28-Sep-2017
TPH CWG GC (S)	02-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	03-Oct-2017	02-Oct-2017
VOC MS (S)	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017	02-Oct-2017

ASSOCIATED AQC DATA

EPH CWG (Aliphatic) GC (S)

Component	Method Code	QC 1653	QC 1655	QC 1657
Total Aliphatics >C12-C35	TM173	**88.75** 66.17 : 105.28	**88.13** 70.76 : 104.69	**86.88** 66.17 : 105.28

EPH CWG (Aromatic) GC (S)

Component	Method Code	QC 1653	QC 1655	QC 1657
Total Aromatics >EC12-EC35	TM173	**84.0** 65.78 : 102.90	**85.33** 68.16 : 102.29	**85.33** 65.78 : 102.90

GRO by GC-FID (S)

Component	Method Code	QC 1665	QC 1666
Benzene by GC (Moisture Corrected)	TM089	**100.5** 76.23 : 120.71	**105.5** 76.33 : 121.87
Ethylbenzene by GC (Moisture Corrected)	TM089	**96.5** 73.32 : 122.02	**102.5** 75.73 : 123.83
m & p Xylene by GC (Moisture Corrected)	TM089	**96.5** 72.90 : 122.64	**103.75** 75.52 : 120.32
MTBE GC-FID (Moisture Corrected)	TM089	**104.5** 72.17 : 124.81	**114.5** 77.89 : 119.70
o Xylene by GC (Moisture Corrected)	TM089	**96.0** 71.65 : 124.40	**104.5** 74.15 : 124.59
QC	TM089	**89.79** 68.17 : 113.61	**79.52** 62.31 : 122.61
Toluene by GC (Moisture Corrected)	TM089	**100.0** 74.60 : 120.38	**105.5** 77.91 : 122.33

Metals in solid samples by OES

Component	Method Code	QC 1661	QC 1625	QC 1650	QC 1653
Aluminium	TM181	**92.59** 80.01 : 119.99	**89.63** 80.01 : 119.99	**86.67** 80.01 : 119.99	**88.89** 80.01 : 119.99
Antimony	TM181	**95.37** 88.00 : 113.03	**93.82** 88.00 : 113.03	**95.75** 88.00 : 113.03	**98.07** 88.00 : 113.03
Arsenic	TM181	**95.63** 82.63 : 117.37	**93.83** 82.63 : 117.37	**93.06** 82.63 : 117.37	**93.83** 82.63 : 117.37
Barium	TM181	**91.41** 79.45 : 120.55	**89.06** 79.45 : 120.55	**91.41** 79.45 : 120.55	**92.19** 79.45 : 120.55
Beryllium	TM181	**94.52** 82.93 : 117.07	**93.49** 82.93 : 117.07	**94.52** 82.93 : 117.07	**95.89** 82.93 : 117.07
Boron	TM181	**90.68** 69.98 : 130.02	**88.7** 69.98 : 130.02	**86.16** 69.98 : 130.02	**88.7** 69.98 : 130.02
Cadmium	TM181	**99.47** 81.95 : 118.05	**98.4** 81.95 : 118.05	**98.4** 81.95 : 118.05	**98.94** 81.95 : 118.05
Chromium	TM181	**95.57** 81.29 : 118.71	**93.46** 81.29 : 118.71	**94.94** 81.29 : 118.71	**98.1** 81.29 : 118.71

Metals in solid samples by OES

		QC 1661	QC 1625	QC 1650	QC 1653
Cobalt	TM181	**94.98** 83.86 : 116.14	**94.98** 83.86 : 116.14	**96.55** 83.86 : 116.14	**98.75** 83.86 : 116.14
Copper	TM181	**88.36** 78.57 : 121.43	**87.19** 78.57 : 121.43	**89.67** 78.57 : 121.43	**92.43** 78.57 : 121.43
Iron	TM181	**97.22** 83.21 : 116.79	**94.44** 83.21 : 116.79	**94.44** 83.21 : 116.79	**95.14** 83.21 : 116.79
Lead	TM181	**90.43** 85.12 : 107.33	**91.91** 85.12 : 107.33	**93.19** 85.12 : 107.33	**94.47** 85.12 : 107.33
Manganese	TM181	**89.29** 82.91 : 117.09	**89.49** 82.91 : 117.09	**89.49** 82.91 : 117.09	**91.52** 82.91 : 117.09
Mercury	TM181	**96.08** 81.99 : 118.01	**94.9** 81.99 : 118.01	**94.51** 81.99 : 118.01	**95.69** 81.99 : 118.01
Molybdenum	TM181	**94.98** 81.45 : 118.55	**93.82** 81.45 : 118.55	**94.21** 81.45 : 118.55	**95.37** 81.45 : 118.55
Nickel	TM181	**94.87** 79.64 : 120.36	**93.47** 79.64 : 120.36	**93.24** 79.64 : 120.36	**94.41** 79.64 : 120.36
Phosphorus	TM181	**95.96** 81.03 : 118.97	**94.01** 81.03 : 118.97	**94.31** 81.03 : 118.97	**95.06** 81.03 : 118.97
Selenium	TM181	**92.58** 83.31 : 116.69	**92.28** 83.31 : 116.69	**92.88** 83.31 : 116.69	**94.96** 83.31 : 116.69
Strontium	TM181	**91.75** 83.64 : 116.36	**89.64** 83.64 : 116.36	**91.12** 83.64 : 116.36	**94.08** 83.64 : 116.36
Thallium	TM181	**89.84** 81.18 : 118.82	**89.45** 81.18 : 118.82	**91.02** 81.18 : 118.82	**93.75** 81.18 : 118.82
Tin	TM181	**96.45** 81.44 : 118.56	**95.04** 81.44 : 118.56	**95.04** 81.44 : 118.56	**96.1** 81.44 : 118.56
Titanium	TM181	**86.15** 71.02 : 128.98	**83.85** 71.02 : 128.98	**83.08** 71.02 : 128.98	**86.15** 71.02 : 128.98
Vanadium	TM181	**90.18** 84.93 : 104.46	**88.96** 84.93 : 104.46	**89.88** 84.93 : 104.46	**91.72** 84.93 : 104.46
Zinc	TM181	**95.29** 88.64 : 107.38	**94.07** 88.64 : 107.38	**93.89** 88.64 : 107.38	**96.51** 88.64 : 107.38

PAH by GCMS

Component	Method Code	QC 1614	QC 1622	QC 1650	QC 1654
Acenaphthene	TM218	**99.5** 70.00 : 130.00	**99.5** 84.23 : 117.80	**99.5** 84.23 : 117.80	**99.5** 86.71 : 113.69
Acenaphthylene	TM218	**89.0** 70.00 : 130.00	**95.0** 81.31 : 114.54	**92.5** 81.31 : 114.54	**91.5** 82.45 : 109.59
Anthracene	TM218	**95.0** 70.00 : 130.00	**94.5** 82.92 : 112.10	**94.5** 82.92 : 112.10	**92.5** 81.57 : 109.85
Benz(a)anthracene	TM218	**110.5** 70.00 : 130.00	**113.0** 82.35 : 116.46	**102.5** 82.35 : 116.46	**106.0** 80.40 : 121.27
Benzo(a)pyrene	TM218	**111.0** 70.00 : 130.00	**102.5** 83.39 : 123.49	**104.5** 83.39 : 123.49	**107.5** 82.28 : 120.13
Benzo(b)fluoranthene	TM218	**121.5** 70.00 : 130.00	**108.5** 83.86 : 122.20	**113.0** 83.86 : 122.20	**114.0** 82.24 : 121.86
Benzo(ghi)perylene	TM218	**110.0** 70.00 : 130.00	**107.0** 83.13 : 118.94	**108.5** 83.13 : 118.94	**112.5** 83.49 : 115.72
Benzo(k)fluoranthene	TM218	**103.0** 70.00 : 130.00	**99.0** 86.04 : 114.17	**103.0** 86.04 : 114.17	**99.0** 84.32 : 113.31
Chrysene	TM218	**100.5** 70.00 : 130.00	**100.0** 84.27 : 111.96	**97.0** 84.27 : 111.96	**98.0** 86.11 : 112.00

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

PAH by GCMS

		QC 1614	QC 1622	QC 1650	QC 1654
Dibenzo(ah)anthracene	TM218	**107.0** 70.00 : 130.00	**101.5** 82.98 : 121.47	**102.5** 82.98 : 121.47	**103.5** 83.84 : 116.37
Fluoranthene	TM218	**99.5** 70.00 : 130.00	**99.0** 83.23 : 111.58	**98.5** 83.23 : 111.58	**96.5** 81.40 : 111.81
Fluorene	TM218	**96.5** 70.00 : 130.00	**99.0** 86.64 : 120.17	**97.5** 86.64 : 120.17	**95.0** 85.09 : 113.02
Indeno(123cd)pyrene	TM218	**107.0** 70.00 : 130.00	**103.0** 84.02 : 120.55	**104.0** 84.02 : 120.55	**103.5** 83.72 : 116.90
Naphthalene	TM218	**97.5** 70.00 : 130.00	**104.5** 85.90 : 115.32	**100.0** 85.90 : 115.32	**98.0** 84.24 : 113.39
Phenanthrene	TM218	**101.0** 70.00 : 130.00	**97.0** 84.23 : 117.60	**97.5** 84.23 : 117.60	**95.5** 83.88 : 111.41
Pyrene	TM218	**99.0** 70.00 : 130.00	**98.5** 79.66 : 106.32	**98.0** 79.66 : 106.32	**96.0** 79.67 : 111.26

PCBs by GCMS

Component	Method Code	QC 1687	QC 1637
PCB congener 101	TM168	**86.7** 76.50 : 116.94	**109.0** 80.77 : 111.39
PCB congener 105	TM168	**84.6** 75.93 : 120.03	**105.0** 79.28 : 115.39
PCB congener 114	TM168	**85.2** 76.64 : 119.06	**107.0** 81.30 : 114.31
PCB congener 118	TM168	**85.3** 75.18 : 118.08	**109.0** 80.32 : 112.22
PCB congener 123	TM168	**86.2** 75.72 : 117.84	**109.0** 80.25 : 114.57
PCB congener 126	TM168	**82.6** 76.10 : 125.90	**103.0** 75.17 : 124.58
PCB congener 138	TM168	**83.7** 78.04 : 121.72	**105.0** 82.92 : 114.57
PCB congener 153	TM168	**85.3** 77.67 : 119.31	**107.0** 83.90 : 111.70
PCB congener 156	TM168	**85.0** 73.48 : 118.60	**110.0** 75.33 : 115.33
PCB congener 157	TM168	**81.3** 77.47 : 123.91	**105.0** 80.94 : 117.86
PCB congener 167	TM168	**84.5** 75.77 : 121.97	**106.0** 78.02 : 117.22
PCB congener 169	TM168	**82.9** 74.49 : 130.71	**108.0** 73.31 : 125.29
PCB congener 180	TM168	**85.0** 77.34 : 121.26	**108.0** 79.60 : 113.91
PCB congener 189	TM168	**81.0** 75.60 : 127.20	**110.0** 71.41 : 124.18
PCB congener 28	TM168	**86.8** 79.43 : 121.67	**104.0** 83.25 : 112.46
PCB congener 52	TM168	**89.9** 78.72 : 119.28	**108.0** 85.30 : 110.14
PCB congener 77	TM168	**84.3** 74.04 : 120.60	**105.0** 73.92 : 120.16
PCB congener 81	TM168	**80.7** 78.47 : 124.85	**102.0** 81.05 : 122.39

CERTIFICATE OF ANALYSIS

SDG:	170927-110	**Client Reference:**	A100795	**Report Number:**	427864
Location:	Bramley Moore Dock	**Order Number:**	MAN17/8116/4488	**Superseded Report:**	

VOC MS (S)

Component	Method Code	QC 1674	QC 1653
1,1,1,2-tetrachloroethane	TM116	**107.8** 79.10 : 119.66	**100.6** 79.10 : 119.66
1,1,1-Trichloroethane	TM116	**105.2** 82.02 : 111.83	**98.2** 82.02 : 111.83
1,1,2-Trichloroethane	TM116	**99.0** 75.16 : 112.70	**99.6** 75.16 : 112.70
1,1-Dichloroethane	TM116	**110.2** 77.84 : 124.12	**101.4** 77.84 : 124.12
1,2-Dichloroethane	TM116	**113.6** 86.58 : 129.62	**111.4** 86.58 : 129.62
1,4-Dichlorobenzene	TM116	**89.6** 71.61 : 124.63	**95.4** 71.61 : 124.63
2-Chlorotoluene	TM116	**81.0** 66.81 : 118.43	**86.0** 66.81 : 118.43
4-Chlorotoluene	TM116	**78.8** 65.88 : 114.76	**84.2** 65.88 : 114.76
Benzene	TM116	**103.8** 84.42 : 119.78	**101.0** 84.42 : 119.78
Carbon Disulphide	TM116	**84.8** 75.11 : 124.81	**94.4** 75.11 : 124.81
Carbontetrachloride	TM116	**101.2** 82.35 : 126.46	**105.0** 82.35 : 126.46
Chlorobenzene	TM116	**101.8** 75.96 : 121.69	**100.0** 75.96 : 121.69
Chloroform	TM116	**113.2** 82.52 : 123.25	**102.8** 82.52 : 123.25
Chloromethane	TM116	**62.2** 57.48 : 132.44	**102.2** 57.48 : 132.44
Cis-1,2-Dichloroethene	TM116	**107.4** 74.86 : 118.23	**104.2** 74.86 : 118.23
Dibromomethane	TM116	**101.2** 71.69 : 119.43	**99.0** 71.69 : 119.43
Dichloromethane	TM116	**120.8** 81.68 : 125.21	**111.0** 81.68 : 125.21
Ethylbenzene	TM116	**92.2** 80.09 : 119.91	**96.2** 80.09 : 119.91
Hexachlorobutadiene	TM116	**62.0** 27.70 : 164.24	**73.6** 27.70 : 164.24
Isopropylbenzene	TM116	**63.6** 52.15 : 132.52	**75.8** 52.15 : 132.52
Naphthalene	TM116	**88.6** 76.79 : 127.18	**96.8** 76.79 : 127.18
o-Xylene	TM116	**77.4** 71.75 : 103.66	**82.8** 71.75 : 103.66
p/m-Xylene	TM116	**88.4** 77.41 : 112.71	**93.3** 77.41 : 112.71
Sec-Butylbenzene	TM116	**52.6** 44.71 : 117.87	**74.4** 44.71 : 117.87
Tetrachloroethene	TM116	**102.0** 79.68 : 120.25	**99.8** 79.68 : 120.25
Toluene	TM116	**99.2** 82.00 : 116.10	**98.8** 82.00 : 116.10
Trichloroethene	TM116	**93.2** 79.80 : 112.33	**94.4** 79.80 : 112.33

VOC MS (S)

		QC 1674	QC 1653
Trichlorofluoromethane	TM116	**106.0** 72.76 : 118.80	**101.0** 72.76 : 118.80
Vinyl Chloride	TM116	**105.8** 64.90 : 133.10	**103.4** 64.90 : 133.10

The above information details the reference name of the analytical quality control sample (AQC) that has been run with the samples contained in this report for the different methods of analysis.
The figure detailed is the percentage recovery result for the AQC.
The subscript numbers below are the percentage recovery lower control limit (LCL) and the upper control limit (UCL). The percentage recovery result for the AQC should be between these limits to be statistically in control.

CERTIFICATE OF ANALYSIS

Work Order	: **PR1762754**	Issue Date	: 06-Oct-2017
Client	: **ALS Life Sciences Ltd**	Laboratory	: ALS Czech Republic, s.r.o.
Contact	: Hawarden Subcontracting	Contact	: Client Service
Address	: Unit 7-8 Hawarden Business Park Manor Road, Hawarden CH5 3US Deeside United Kingdom	Address	: Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	: hawsub@alcontrol.com	E-mail	: customer.support@alsglobal.com
Telephone	: ----	Telephone	: +420 226 226 228
Facsimile	: ----	Facsimile	: +420 284 081 635
Project	: 170927-110	Page	: 1 of 3
Order number	: 38969	Date Samples Received	: 03-Oct-2017
C-O-C number	: ----	Quote number	: PR2017ALSAL-GB0002 (CZ-251-17-0022)
Site	: ----	Date of test	: 03-Oct-2017 - 06-Oct-2017
Sampled by	: client	QC Level	: ALS CR Standard Quality Control Schedule

General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.
The laboratory declares that the test results relate only to the listed samples.

Responsible for accuracy

Testing Laboratory No. 1163
Accredited by CAI according to
CSN EN ISO/IEC 17025:2005

Signatories		*Position*
Zdeněk Jirák		Environmental Business Unit Manager

Analytical Results

Sub-Matrix: SOIL	Client sample ID	Station 1 16259495		Station 2 16259513		Station 3 16259520	
	Laboratory sample ID	PR1762754-001		PR1762754-002		PR1762754-003	
	Client sampling date / time	26-Sep-2017 00:00		26-Sep-2017 00:00		26-Sep-2017 00:00	

Parameter	Method	LOR	Unit	Result	MU	Result	MU	Result	MU
Physical Parameters									
Fraction 31.5-63 mm	S-GRAINSIZ	0.010	%	<0.010	----	<0.010	----	<0.010	----
Fraction 16-31.5 mm	S-GRAINSIZ	0.010	%	<0.010	----	14.8	± 10.0%	1.63	± 10.0%
Fraction 8-16 mm	S-GRAINSIZ	0.010	%	<0.010	----	0.723	± 10.0%	<0.010	----
Fraction 4-8 mm	S-GRAINSIZ	0.010	%	0.438	± 10.0%	2.68	± 10.0%	0.624	± 10.0%
Fraction 2-4 mm	S-GRAINSIZ	0.010	%	1.27	± 10.0%	2.48	± 10.0%	1.25	± 10.0%
Fraction 1-2 mm	S-GRAINSIZ	0.010	%	1.36	± 10.0%	1.82	± 10.0%	0.763	± 10.0%
Fraction 0.5-1 mm	S-GRAINSIZ	0.010	%	2.14	± 10.0%	1.89	± 10.0%	0.936	± 10.0%
Fraction 0.25-0.5 mm	S-GRAINSIZ	0.010	%	4.64	± 10.0%	7.12	± 10.0%	2.22	± 10.0%
Fraction 0.125-0.25 mm	S-GRAINSIZ	0.010	%	2.14	± 10.0%	7.95	± 10.0%	1.84	± 10.0%
Fraction 0.063-0.125 mm	S-GRAINSIZ	0.010	%	1.44	± 10.0%	3.72	± 10.0%	3.36	± 10.0%
Fraction 0.032-0.063 mm	S-GRAINSIZ	0.010	%	1.21	± 10.0%	1.92	± 10.0%	3.91	± 10.0%
Fraction 0.016-0.032 mm	S-GRAINSIZ	0.010	%	14.6	± 10.0%	7.57	± 10.0%	14.4	± 10.0%
Fraction 0.008-0.016 mm	S-GRAINSIZ	0.010	%	28.8	± 10.0%	16.6	± 10.0%	26.5	± 10.0%
Fraction 0.004-0.008 mm	S-GRAINSIZ	0.010	%	22.8	± 10.0%	15.1	± 10.0%	21.0	± 10.0%
Fraction 0.002-0.004 mm	S-GRAINSIZ	0.010	%	13.0	± 10.0%	10.2	± 10.0%	13.8	± 10.0%
Fraction > 63 mm	S-GRAINSIZ	0.010	%	<0.010	----	<0.010	----	<0.010	----
Fraction < 0.002 mm	S-GRAINSIZ	0.010	%	6.09	± 10.0%	5.38	± 10.0%	7.70	± 10.0%

Sub-Matrix: SOIL	Client sample ID	Station 4 16259526		Station 5 16259535		Station 6 16259544	
	Laboratory sample ID	PR1762754-004		PR1762754-005		PR1762754-006	
	Client sampling date / time	26-Sep-2017 00:00		26-Sep-2017 00:00		26-Sep-2017 00:00	

Parameter	Method	LOR	Unit	Result	MU	Result	MU	Result	MU
Physical Parameters									
Fraction 31.5-63 mm	S-GRAINSIZ	0.010	%	<0.010	----	<0.010	----	<0.010	----
Fraction 16-31.5 mm	S-GRAINSIZ	0.010	%	<0.010	----	<0.010	----	0.998	± 10.0%
Fraction 8-16 mm	S-GRAINSIZ	0.010	%	<0.010	----	<0.010	----	0.354	± 10.0%
Fraction 4-8 mm	S-GRAINSIZ	0.010	%	<0.010	----	<0.010	----	0.547	± 10.0%
Fraction 2-4 mm	S-GRAINSIZ	0.010	%	0.140	± 10.0%	0.122	± 10.0%	0.580	± 10.0%
Fraction 1-2 mm	S-GRAINSIZ	0.010	%	0.326	± 10.0%	0.325	± 10.0%	0.515	± 10.0%
Fraction 0.5-1 mm	S-GRAINSIZ	0.010	%	0.186	± 10.0%	0.285	± 10.0%	0.354	± 10.0%
Fraction 0.25-0.5 mm	S-GRAINSIZ	0.010	%	0.326	± 10.0%	0.447	± 10.0%	1.90	± 10.0%
Fraction 0.125-0.25 mm	S-GRAINSIZ	0.010	%	0.605	± 10.0%	1.10	± 10.0%	4.93	± 10.0%
Fraction 0.063-0.125 mm	S-GRAINSIZ	0.010	%	3.72	± 10.0%	5.61	± 10.0%	4.76	± 10.0%
Fraction 0.032-0.063 mm	S-GRAINSIZ	0.010	%	4.18	± 10.0%	4.50	± 10.0%	0.893	± 10.0%
Fraction 0.016-0.032 mm	S-GRAINSIZ	0.010	%	15.8	± 10.0%	15.9	± 10.0%	9.09	± 10.0%
Fraction 0.008-0.016 mm	S-GRAINSIZ	0.010	%	29.8	± 10.0%	29.5	± 10.0%	23.6	± 10.0%
Fraction 0.004-0.008 mm	S-GRAINSIZ	0.010	%	23.6	± 10.0%	22.7	± 10.0%	24.3	± 10.0%
Fraction 0.002-0.004 mm	S-GRAINSIZ	0.010	%	14.1	± 10.0%	13.1	± 10.0%	17.6	± 10.0%
Fraction > 63 mm	S-GRAINSIZ	0.010	%	<0.010	----	<0.010	----	<0.010	----
Fraction < 0.002 mm	S-GRAINSIZ	0.010	%	7.15	± 10.0%	6.45	± 10.0%	9.59	± 10.0%

Sub-Matrix: SOIL	Client sample ID	Station 7 16259554		Station 8 16259560		Station 916259566	
	Laboratory sample ID	PR1762754-007		PR1762754-008		PR1762754-009	
	Client sampling date / time	26-Sep-2017 00:00		26-Sep-2017 00:00		26-Sep-2017 00:00	

Parameter	Method	LOR	Unit	Result	MU	Result	MU	Result	MU
Physical Parameters									
Fraction 31.5-63 mm	S-GRAINSIZ	0.010	%	<0.010	----	<0.010	----	<0.010	----
Fraction 16-31.5 mm	S-GRAINSIZ	0.010	%	<0.010	----	<0.010	----	<0.010	----
Fraction 8-16 mm	S-GRAINSIZ	0.010	%	<0.010	----	<0.010	----	<0.010	----
Fraction 4-8 mm	S-GRAINSIZ	0.010	%	<0.010	----	1.08	± 10.0%	0.317	± 10.0%
Fraction 2-4 mm	S-GRAINSIZ	0.010	%	0.198	± 10.0%	0.455	± 10.0%	0.095	± 10.0%
Fraction 1-2 mm	S-GRAINSIZ	0.010	%	0.265	± 10.0%	0.594	± 10.0%	0.317	± 10.0%
Fraction 0.5-1 mm	S-GRAINSIZ	0.010	%	1.12	± 10.0%	1.15	± 10.0%	0.730	± 10.0%

Sub-Matrix: SOIL				Client sample ID	Station 7 16259554		Station 8 16259560		Station 916259566	
				Laboratory sample ID	PR1762754-007		PR1762754-008		PR1762754-009	
				Client sampling date / time	26-Sep-2017 00:00		26-Sep-2017 00:00		26-Sep-2017 00:00	
Parameter	*Method*	*LOR*	*Unit*	**Result**	**MU**	**Result**	**MU**	**Result**	**MU**
Physical Parameters - Continued									
Fraction 0.25-0.5 mm	S-GRAINSIZ	0.010	%	**3.61**	± 10.0%	**9.09**	± 10.0%	**6.28**	± 10.0%
Fraction 0.125-0.25 mm	S-GRAINSIZ	0.010	%	**8.34**	± 10.0%	**12.4**	± 10.0%	**14.2**	± 10.0%
Fraction 0.063-0.125 mm	S-GRAINSIZ	0.010	%	**6.16**	± 10.0%	**4.65**	± 10.0%	**5.78**	± 10.0%
Fraction 0.032-0.063 mm	S-GRAINSIZ	0.010	%	**0.201**	± 10.0%	**1.02**	± 10.0%	**1.12**	± 10.0%
Fraction 0.016-0.032 mm	S-GRAINSIZ	0.010	%	**8.12**	± 10.0%	**7.55**	± 10.0%	**8.76**	± 10.0%
Fraction 0.008-0.016 mm	S-GRAINSIZ	0.010	%	**24.9**	± 10.0%	**20.4**	± 10.0%	**20.1**	± 10.0%
Fraction 0.004-0.008 mm	S-GRAINSIZ	0.010	%	**23.8**	± 10.0%	**19.9**	± 10.0%	**20.2**	± 10.0%
Fraction 0.002-0.004 mm	S-GRAINSIZ	0.010	%	**15.4**	± 10.0%	**14.0**	± 10.0%	**14.3**	± 10.0%
Fraction > 63 mm	S-GRAINSIZ	0.010	%	<0.010	----	<0.010	----	<0.010	----
Fraction < 0.002 mm	S-GRAINSIZ	0.010	%	**7.87**	± 10.0%	**7.60**	± 10.0%	**7.72**	± 10.0%

Sub-Matrix: SOIL				Client sample ID	Station 10 16259506		----		----	
				Laboratory sample ID	PR1762754-010		----		----	
				Client sampling date / time	26-Sep-2017 00:00		----		----	
Parameter	*Method*	*LOR*	*Unit*	**Result**	**MU**	**Result**	**MU**	**Result**	**MU**
Physical Parameters									
Fraction 31.5-63 mm	S-GRAINSIZ	0.010	%	<0.010	----	----	----	----	----
Fraction 16-31.5 mm	S-GRAINSIZ	0.010	%	<0.010	----	----	----	----	----
Fraction 8-16 mm	S-GRAINSIZ	0.010	%	**0.304**	± 10.0%	----	----	----	----
Fraction 4-8 mm	S-GRAINSIZ	0.010	%	**0.304**	± 10.0%	----	----	----	----
Fraction 2-4 mm	S-GRAINSIZ	0.010	%	**0.525**	± 10.0%	----	----	----	----
Fraction 1-2 mm	S-GRAINSIZ	0.010	%	**0.746**	± 10.0%	----	----	----	----
Fraction 0.5-1 mm	S-GRAINSIZ	0.010	%	**1.38**	± 10.0%	----	----	----	----
Fraction 0.25-0.5 mm	S-GRAINSIZ	0.010	%	**9.43**	± 10.0%	----	----	----	----
Fraction 0.125-0.25 mm	S-GRAINSIZ	0.010	%	**18.3**	± 10.0%	----	----	----	----
Fraction 0.063-0.125 mm	S-GRAINSIZ	0.010	%	**5.34**	± 10.0%	----	----	----	----
Fraction 0.032-0.063 mm	S-GRAINSIZ	0.010	%	**1.88**	± 10.0%	----	----	----	----
Fraction 0.016-0.032 mm	S-GRAINSIZ	0.010	%	**7.77**	± 10.0%	----	----	----	----
Fraction 0.008-0.016 mm	S-GRAINSIZ	0.010	%	**17.6**	± 10.0%	----	----	----	----
Fraction 0.004-0.008 mm	S-GRAINSIZ	0.010	%	**17.7**	± 10.0%	----	----	----	----
Fraction 0.002-0.004 mm	S-GRAINSIZ	0.010	%	**12.2**	± 10.0%	----	----	----	----
Fraction > 63 mm	S-GRAINSIZ	0.010	%	<0.010	----	----	----	----	----
Fraction < 0.002 mm	S-GRAINSIZ	0.010	%	**6.46**	± 10.0%	----	----	----	----

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.
Key: LOR = Limit of reporting; MU = Measurement Uncertainty

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Descriptions*
Location of test performance: Bendlova 1687/7 Ceska Lipa Czech Republic 470 01	
S-GRAINSIZ	CZ_SOP_D06_07_120 (BS ISO 11277:2009) Grain size analysis of solid samples using sieve analysis and laser diffraction

A `*` symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.
The calculation methods of summation parameters are available on request in the client service.

RESULTS OF GRAIN SIZE ANALYSIS

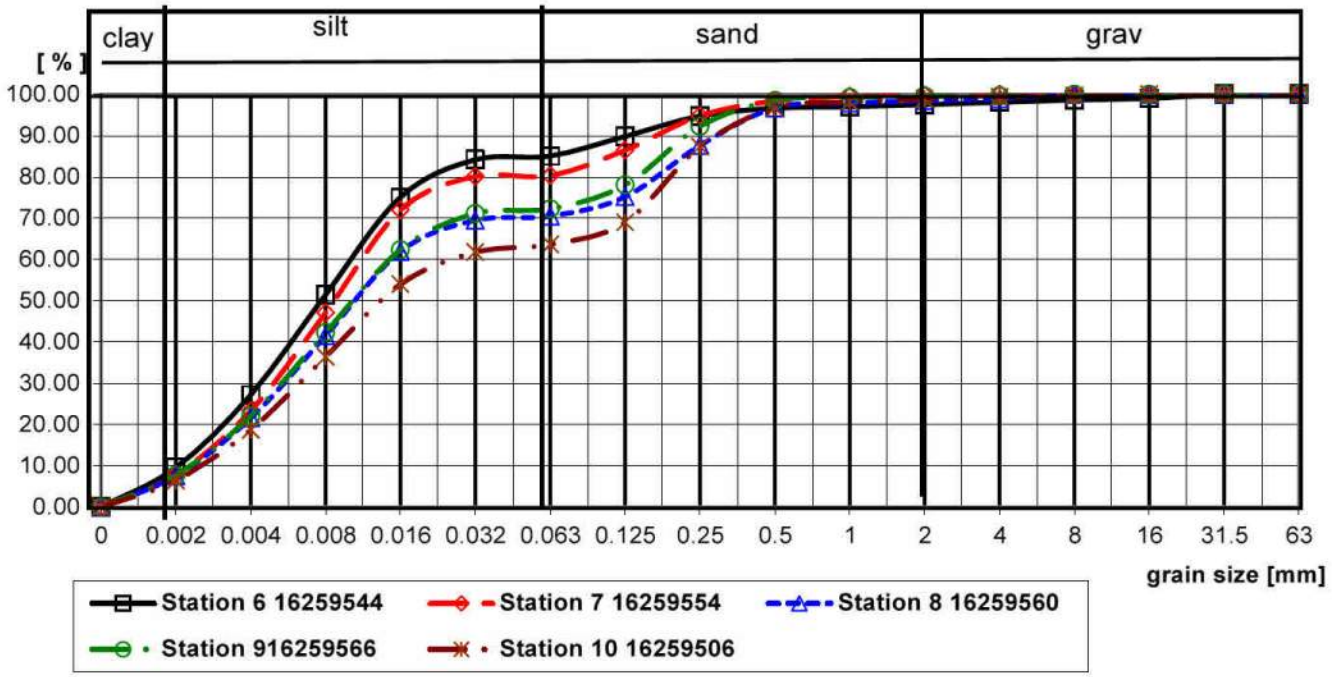
Sample label:				Station 6 16259544	Station 7 16259554	Station 8 16259560	Station 916259566	Station 10 16259506
Lab. ID:				006	007	008	009	010
Total weight of sample:			[g]	31.05	30.21	28.59	31.50	36.18
q	< 0.002	mm	[%]	9.59	7.87	7.60	7.72	6.46
q	0.002–0.004	mm	[%]	17.60	15.44	13.99	14.34	12.25
q	0.004–0.008	mm	[%]	24.27	23.76	19.95	20.22	17.70
q	0.008–0.016	mm	[%]	23.62	24.91	20.40	20.10	17.59
q	0.016–0.032	mm	[%]	9.09	8.12	7.55	8.76	7.77
q	0.032–0.063	mm	[%]	0.89	0.20	1.02	1.12	1.88
q	< 0.063	mm	[%]	85.06	80.31	70.52	72.26	63.65
q	0.063–0.125	mm	[%]	4.77	6.16	4.65	5.78	5.34
q	0.125–0.250	mm	[%]	4.93	8.34	12.45	14.22	18.33
q	0.250–0.500	mm	[%]	1.90	3.61	9.09	6.29	9.43
q	0.500–1.000	mm	[%]	0.35	1.13	1.15	0.73	1.38
q	1.000–2.000	mm	[%]	0.52	0.26	0.59	0.32	0.75
q	2.000–4.000	mm	[%]	0.58	0.20	0.45	0.10	0.53
q	4.000–8.000	mm	[%]	0.55	0.00	1.08	0.32	0.30
q	8.000–16.000	mm	[%]	0.35	0.00	0.00	0.00	0.30
q	16.00–31.50	mm	[%]	1.00	0.00	0.00	0.00	0.00
q	31.50–63.00	mm	[%]	0.00	0.00	0.00	0.00	0.00
q	> 63.00	mm	[%]	0.00	0.00	0.00	0.00	0.00
Q	< 0,002	mm	[%]	9.59	7.87	7.60	7.72	6.46
Q	< 0.004	mm	[%]	27.18	23.31	21.59	22.06	18.71
Q	< 0.008	mm	[%]	51.45	47.08	41.54	42.28	36.41
Q	< 0.016	mm	[%]	75.08	71.98	61.95	62.38	53.99
Q	< 0.032	mm	[%]	84.17	80.11	69.50	71.14	61.77
Q	< 0.063	mm	[%]	85.06	80.31	70.52	72.26	63.65
Q	< 0.125	mm	[%]	89.82	86.46	75.17	78.03	68.98
Q	< 0.250	mm	[%]	94.75	94.80	87.62	92.25	87.31
Q	< 0.500	mm	[%]	96.65	98.41	96.71	98.54	96.74
Q	< 1.000	mm	[%]	97.01	99.54	97.87	99.27	98.12
Q	< 2.000	mm	[%]	97.52	99.80	98.46	99.59	98.87
Q	< 4.000	mm	[%]	98.10	100.00	98.92	99.68	99.39
Q	< 8.000	mm	[%]	98.65	100.00	100.00	100.00	99.70
Q	< 16.00	mm	[%]	99.00	100.00	100.00	100.00	100.00
Q	< 31.50	mm	[%]	100.00	100.00	100.00	100.00	100.00
Q	< 63.000	mm	[%]	100.00	100.00	100.00	100.00	100.00

q –fraction percentage part, **Q** – fraction cumulative part.

Test method specification: CZ_SOP_D06_07_120 Grain size analysis using the wet sieve analysis using laser diffraction (fraction from 2 µm to 63 mm). Fractions > 63 mm, 31.5–63 mm, 16–31.5 mm, 8–16 mm, 4–8 mm, 2–4 mm, 1–2 mm, 0.5–1 mm, 0.25–0.50 mm, 0.125–0.25 mm and 0.063–0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification:

RESULTS OF GRAIN SIZE ANALYSIS



Attachment no. 1 to the certificate of analysis for work order PR1762754

RESULTS OF GRAIN SIZE ANALYSIS

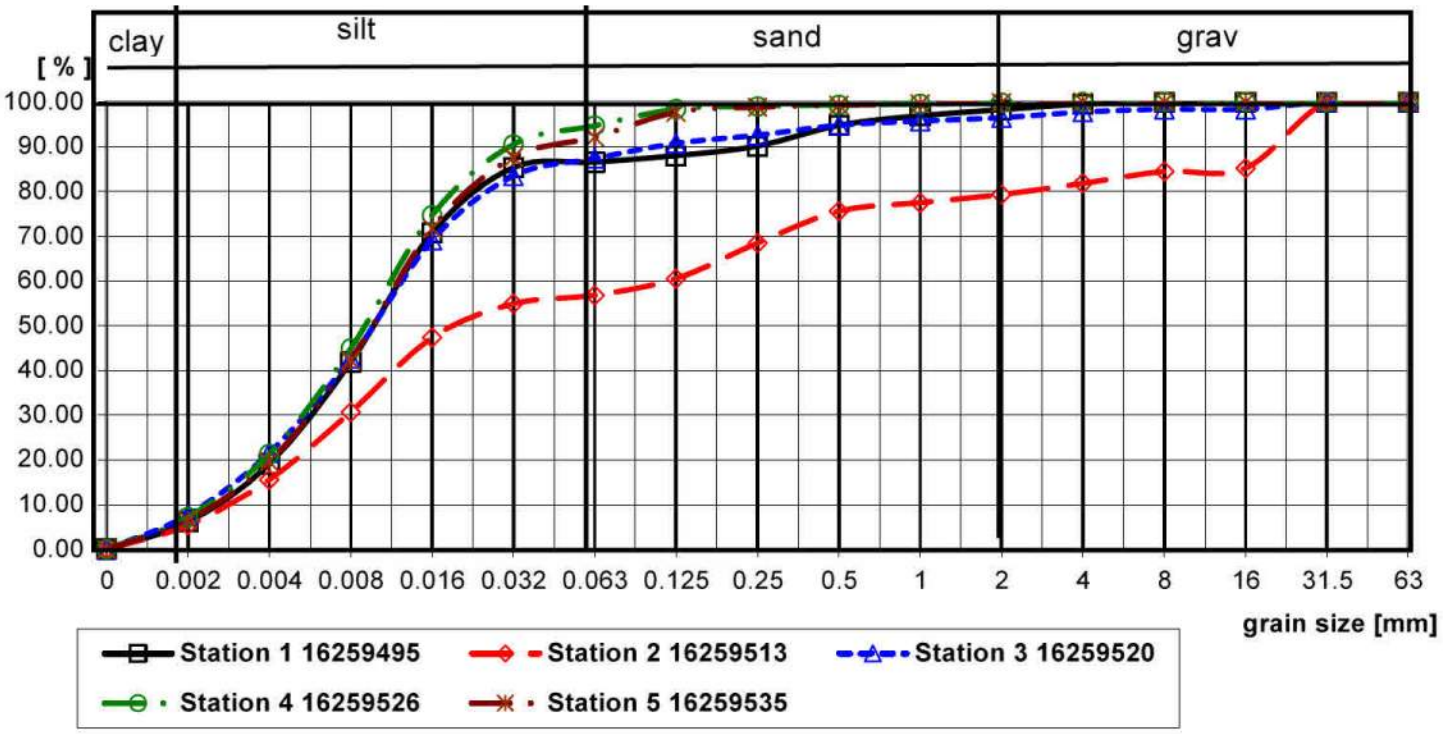
Sample label:				Station 1 16259495	Station 2 16259513	Station 3 16259520	Station 4 16259526	Station 5 16259535
Lab. ID:				001	002	003	004	005
Total weight of sample:			[g]	22.84	29.05	28.84	21.47	24.60
q	< 0.002	mm	[%]	6.09	5.38	7.70	7.15	6.45
q	0.002–0.004	mm	[%]	13.01	10.17	13.86	14.14	13.11
q	0.004–0.008	mm	[%]	22.76	15.13	21.05	23.60	22.72
q	0.008–0.016	mm	[%]	28.85	16.63	26.48	29.80	29.46
q	0.016–0.032	mm	[%]	14.63	7.57	14.37	15.83	15.87
q	0.032–0.063	mm	[%]	1.21	1.92	3.91	4.18	4.50
q	< 0.063	mm	[%]	86.56	56.80	87.38	94.69	92.11
q	0.063–0.125	mm	[%]	1.44	3.72	3.36	3.73	5.61
q	0.125–0.250	mm	[%]	2.15	7.95	1.84	0.61	1.10
q	0.250–0.500	mm	[%]	4.64	7.13	2.22	0.33	0.45
q	0.500–1.000	mm	[%]	2.15	1.89	0.94	0.19	0.28
q	1.000–2.000	mm	[%]	1.36	1.82	0.76	0.33	0.33
q	2.000–4.000	mm	[%]	1.27	2.48	1.25	0.14	0.12
q	4.000–8.000	mm	[%]	0.44	2.68	0.62	0.00	0.00
q	8.000–16.000	mm	[%]	0.00	0.72	0.00	0.00	0.00
q	16.00–31.50	mm	[%]	0.00	14.80	1.63	0.00	0.00
q	31.50–63.00	mm	[%]	0.00	0.00	0.00	0.00	0.00
q	> 63.00	mm	[%]	0.00	0.00	0.00	0.00	0.00
Q	< 0,002	mm	[%]	6.09	5.38	7.70	7.15	6.45
Q	< 0.004	mm	[%]	19.10	15.55	21.56	21.29	19.56
Q	< 0.008	mm	[%]	41.87	30.68	42.61	44.88	42.28
Q	< 0.016	mm	[%]	70.71	47.31	69.09	74.68	71.74
Q	< 0.032	mm	[%]	85.35	54.88	83.46	90.52	87.62
Q	< 0.063	mm	[%]	86.56	56.80	87.38	94.69	92.11
Q	< 0.125	mm	[%]	88.00	60.52	90.74	98.42	97.72
Q	< 0.250	mm	[%]	90.15	68.47	92.58	99.02	98.82
Q	< 0.500	mm	[%]	94.79	75.59	94.80	99.35	99.27
Q	< 1.000	mm	[%]	96.94	77.49	95.73	99.53	99.55
Q	< 2.000	mm	[%]	98.29	79.31	96.50	99.86	99.88
Q	< 4.000	mm	[%]	99.56	81.79	97.75	100.00	100.00
Q	< 8.000	mm	[%]	100.00	84.48	98.37	100.00	100.00
Q	< 16.00	mm	[%]	100.00	85.20	98.37	100.00	100.00
Q	< 31.50	mm	[%]	100.00	100.00	100.00	100.00	100.00
Q	< 63.000	mm	[%]	100.00	100.00	100.00	100.00	100.00

q –fraction percentage part, **Q** – fraction cumulative part.

Test method specification: CZ_SOP_D06_07_120 Grain size analysis using the wet sieve analysis using laser diffraction (fraction from 2 µm to 63 mm). Fractions > 63 mm, 31.5–63 mm, 16–31.5 mm, 8–16 mm, 4–8 mm, 2–4 mm, 1–2 mm, 0.5–1 mm, 0.25–0.50 mm, 0.125–0.25 mm and 0.063–0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification:

RESULTS OF GRAIN SIZE ANALYSIS



2 Shaftesbury Industrial Centre, Icknield Way, Letchworth Garden City, Hertfordshire, SG6 1HE
T +44 (0)1462 480 400, **F** +44 (0)1462 480 403, **E** rpsmh@rpsgroup.com, **W** rpsgroup.com

Certificate of Analysis

Report No.: 17-65642-1

Issue No.: 1
Date of Issue 11/10/2017

Customer Details:	ALS Life Sciences Limited, Unit7-8, Hawarden Business Park, Manor Road, Hawarden, Deeside, Flintshire, CH5 3US
Customer Contact:	Carrie Foster (2)
Customer Order No.:	38903
Customer Reference:	170927-110
Quotation Reference:	170712/04
Description:	10 soil samples
Date Received:	29/09/2017
Date Started:	03/10/2017
Date Completed:	06/10/2017
Test Methods:	Details available on request (refer to SOP code against relevant result/s)
Notes:	None

Approved By: **Matthew Hickson, Laboratory Manager**

This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service.
Observations and interpretations are outside of the scope of UKAS accreditation.
Results reported herein relate only to the items supplied to the laboratory for testing.

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T +44 (0)1462 480 400, **F** +44 (0)1462 480 403, **E** rpsmh@rpsgroup.com, **W** rpsgroup.com

Results Summary

Report No.: 17-65642-1

Customer Reference: 170927-110

Customer Order No: 38903

				Customer Sample No		**16265521**	**16265090**	**16265303**	**16265333**	**16265414**	**16265469**	**16265063**	**16265171**	**16266198**	**16265404**
				Customer Sample ID		STATION 1	STATION 10	STATION 2	STATION 3	STATION 4	STATION 5	STATION 6	STATION 7	STATION 8	STATION 9
				RPS Sample No		341604	341605	341606	341607	341608	341609	341610	341611	341612	341613
				Sample Type		**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**
				Sampling Date		26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017	26/09/2017
Determinand	**CAS No**	**Codes**	**SOP**	**Units**	**RL**										
dry solids (at 105øC)		N	208	% w/w		40.3	44.4	44.2	43.7	39.2	38.7	41.0	40.2	41.6	44.8
dibutyltin (DBT)	1002-53-5	N	in house	mg/kg as cation DW	0.02	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.04
diphenyltin (DPT)		N	in house	mg/kg as cation DW	0.02	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.04
monobutyltin (MBT)	78763-54-9	N	in house	mg/kg as cation DW	0.1	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15
monophenyltin (MPT)		N	in house	mg/kg as cation DW	0.02	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.04
tributyltin (TBT)	56573-85-4	N	in house	mg/kg as cation DW	0.02	< 0.05	0.06	0.06	0.19	< 0.05	< 0.05	< 0.05	0.08	0.06	< 0.04
triphenyltin (TPT)	668-34-8	N	in house	mg/kg as cation DW	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
tetrabutyltin	1461-25-2	N	in house	mg/kg as cation DW	0.02	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.04

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Deviating Samples

Report No.: 17-65642-1

Customer Reference: 170927-110

Customer Order No: 38903

Our policy on Deviating Samples and reference list of Holding Times applied can be supplied on request. These have been implemented in accordance with UKAS Policy on Deviating Samples (TPS63).
RPS is not responsible for the integrity of samples as received, unless RPS personnel performed the sampling, and it is possible that samples submitted may be declared to be deviating.
Where applicable the analysis method remains UKAS accredited, however results reported for a deviating sample may be invalid. The reason for a sample being declared to be deviating is indicated below.
Where no sampling date was supplied, samples have been declared to be deviating. However, if a date of sampling can be supplied, the results may be reissued with the deviating sample status removed.
Where the sample container used was unsuitable, the appropriate Holding Time was exceeded, or the sample is flagged as deviating for some other reason, re-sampling/re-submisson may be required.

RPS No.	Customer No.	Customer ID	Date Sampled	Containers Received	Deviating Sample	Reason for Sample Deviation
341604	16265521		26/09/2017	60ml amber glass jar	No	
341605	16265090		26/09/2017	60ml amber glass jar	No	
341606	16265303		26/09/2017	60ml amber glass jar	No	
341607	16265333		26/09/2017	60ml amber glass jar	No	
341608	16265414		26/09/2017	60ml amber glass jar	No	
341609	16265469		26/09/2017	60ml amber glass jar	No	
341610	16265063		26/09/2017	60ml amber glass jar	No	
341611	16265171		26/09/2017	60ml amber glass jar	No	
341612	16266198		26/09/2017	60ml amber glass jar	No	
341613	16265404		26/09/2017	60ml amber glass jar	No	

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Report Information

Key to Report Codes

U	UKAS Accredited
M	MCERTS Accredited
N	Not accredited
S	Subcontracted to approved laboratory
US	Subcontracted to approved laboratory UKAS Accredited for the test
MS	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
SI	Subcontracted to internal RPS Group laboratory
USI	Subcontracted to internal RPS Group laboratory UKAS Accredited for the test
MSI	Subcontracted to internal RPS Group laboratory MCERTS/UKAS Accredited for the test
I/S (in results)	Insufficient Sample
U/S (in results)	Unsuitable Sample
S/C (in results)	See Comments
ND (in results)	Not Detected
DW (in units)	Results are expressed on a dry weight basis

Where the dry solids value of a sample is low (<50%), reporting limits are automatically raised for all determinants analysed on an as-received basis.

Soil Typing

Type 1	Clay - Brown
Type 2	Clay - Grey/Black
Type 3	Sand
Type 4	Top Soil (Standard)
Type 5	Top Soil (High Peat)
Type 6	Made Ground (>50% Clay)
Type 7	Made Ground (>50% Sand)
Type 8	Made Ground (>50% Top Soil)
Type X	Other

Sample Retention and Disposal

Samples will generally* be retained for the following times prior to disposal:

Perishables, e.g. foodstuffs	1 month (if frozen) from the issue date of this report
Waters	2 weeks from the issue date of this report
Other Liquids	1 month from the issue date of this report
Solids (including Soils)	1 month from the issue date of this report

*Sample retention may be subject to agreement with the customer for particular projects

Appendix General

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH4 by the BRE method, VOC TICs and SVOC TICs.

2. Samples will be run in duplicate upon request, but an additional charge may be incurred.

3. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALS reserve the right to charge for samples received and stored but not analysed.

4. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

5. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

6. When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as “Not detected”. If no asbestos fibre types are found all will be reported as “Not detected” and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible (NDP). The quantity of asbestos present is not determined unless specifically requested.

7. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

8. If appropriate preserved bottles are not received preservation will take place on receipt. However, the integrity of the data may be compromised.

9. NDP - No determination possible due to insufficient/unsuitable sample.

10. Metals in water are performed on a filtered sample, and therefore represent dissolved metals - total metals must be requested separately.

11. Results relate only to the items tested.

12. LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.

13. **Surrogate recoveries** - Surrogates are added to your sample to monitor recovery of the test requested. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-130%, they are generally wider for volatiles analysis, 50-150%. Recoveries in soils are affected by organic rich or clay rich matrices. Waters can be affected by remediation fluids or high amounts of sediment. Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix affect.

14. **Product analyses** - Organic analyses on products can only be semi-quantitative due to the matrix effects and high dilution factors employed.

15. Phenols monohydric by HPLC include phenol, cresols (2-Methylphenol, 3-Methylphenol and 4-Methylphenol) and Xylenols (2,3 Dimethylphenol, 2,4 Dimethylphenol, 2,5 Dimethylphenol, 2,6 Dimethylphenol, 3,4 Dimethyphenol, 3,5 Dimethylphenol).

16. Total of 5 speciated phenols by HPLC includes Phenol, 2,3,5-Trimethyl Phenol, 2-Isopropylphenol, Cresols and Xylenols (as detailed in 15).

17. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

18. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

19. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

20. For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

21. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

22. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

23. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

24. **Tentatively Identified Compounds (TICs)** are non-target peaks in VOC and SVOC analysis. All non-target peaks detected with a concentration above the LoD are subjected to a mass spectral library search. Non-target peaks with a library search confidence of >75% are reported based on the best mass spectral library match. When a non-target peak with a library search confidence of <75% is detected it is reported as “mixed hydrocarbons”. Non-target compounds identified from the scan data are semi-quantified relative to one of the deuterated internal standards, under the same chromatographic conditions as the target compounds. This result is reported as a semi-quantitative value and reported as Tentatively Identified Compounds (TICs). TICs are outside the scope of UKAS accreditation and are not moisture corrected.

Sample Deviations

If a sample is classed as deviated then the associated results may be compromised.

1	**Container with Headspace provided for volatiles analysis**
2	**Incorrect container received**
3	**Deviation from method**
4	**Holding time exceeded before sample received**
5	**Samples exceeded holding time before presevation was performed**
§	**Sampled on date not provided**
♦	**Sample holding time exceeded in laboratory**
@	**Sample holding time exceeded due to sampled on date**
&	**Sample Holding Time exceeded - Late arrival of instructions.**

Asbestos

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: - Trace - Where only one or two asbestos fibres were identified.

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

About Carcinus Ltd

Carcinus Ltd is a leading provider of aquatic environmental consultancy and survey services in the UK.

Carcinus was established in 2016 by its directors after over 30 years combined experience of working within the marine and freshwater environment sector. From our base in Southampton, we provide environmental consultancy advice and support as well as ecological, topographic and hydrographic survey services to clients throughout the UK and overseas.

Our clients operate in a range of industry sectors including civil engineering and construction, ports and harbours, new and existing nuclear power, renewable energy (including offshore wind, tidal energy and wave energy), public sector, government, NGOs, transport and water.

Our aim is to offer professional, high quality and robust solutions to our clients, using the latest techniques, innovation and recognised best practice.

Contact Us

Carcinus Ltd

Wessex House

Upper Market Street

Eastleigh

Hampshire

SO50 9FD

Tel. 023 8129 0095

Email. enquiries@carcinus.co.uk

Web. https://www.carcinus.co.uk

Environmental Consultancy

Carcinus provides environmental consultancy services for both freshwater and marine environments. Our freshwater and marine environmental consultants provide services that include scoping studies, Environmental Impact Assessment (EIA) for ecological and human receptors, Habitats Regulations Appraisal (HRA), Water Framework Directive (WFD) assessments, project management, licensing and consent support, pre-dredge sediment assessments and options appraisal, stakeholder and regulator engagement, survey design and management and site selection and feasibility studies.

Ecological and Geophysical Surveys

Carcinus delivers ecology surveys in both marine and freshwater environments. Our staff are experienced in the design and implementation of ecological surveys, including marine subtidal and intertidal fish ecology and benthic ecology, freshwater fisheries, macro invertebrate sampling, macrophytes, marine mammals, birds, habitat mapping, River Habitat Surveys (RHS), phase 1 habitat surveys, catchment studies, water quality and sediment sampling and analysis, ichthyoplankton, zooplankton and phytoplankton.

In addition, we provide aerial, topographic, bathymetric and laser scan surveys for nearshore, coastal and riverine environments.

Our Vision

"*To be a dependable partner to our clients, providing robust and reliable environmental advice, services and support, enabling them to achieve project aims whilst taking due care of the sensitivity of the environment*"