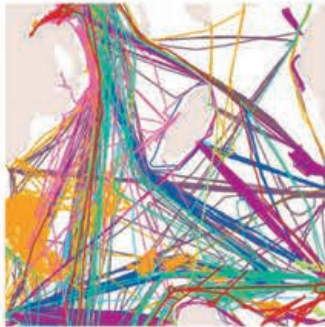


Appendices



Innovative Thinking - Sustainable Solutions

A Comments Log

Data from Excel Spreadsheet (also provided separately):

MEPE_Comments_log_Issued_to_NRW_27Jun2023.xlsx,

Appendix A. Comments Log

No.	Consultee	Topic	Comment	Response
1	DIO Estates Safequarding Officer	General	I can confirm that the MOD has no objection regarding this activity	Noted.
2	Cadw's Senior Historic Environment Planning Officer	Archaeology	The above designated historic assets are located inside 3km of the proposed development, but intervening topography, buildings and vegetation block all views between them. Consequently, the proposed development will have no impact on the settings of these designated historic assets.	Noted.
3	Cadw's Senior Historic Environment Planning Officer	Archaeology	There is a recorded shipwreck in the application area and we support the proposal to establish an archaeological exclusion zone around it and to implement a protocol for archaeological discoveries and an associated written scheme of investigation for other elements of the scheme.	Noted.
4	Cadw's Senior Historic Environment Planning Officer	Archaeology	However, the geoarchaeological assessment of existing geotechnical material has not been completed, which means that the environmental impact assessment for this application is incomplete. As such the determination of this application should not be considered until this assessment has been completed. The applicant should therefore be requested to provide a completed geoarchaeological assessment of existing geotechnical material. Once this assessment has been produced Cadw and the RCAHMW should be reconsulted on this application so that they can determine if additional mitigation will need to be introduced to the scheme in order to protect sensitive archaeological assets.	A geoarchaeological assessment of the existing geotechnical material has been undertaken. This has been issued to Cadw and RCAHMW for their consideration. Both Cadw and RCAHMW concur with the findings and have advised that no further work or additional mitigation is required.
5	Cefas scientific and technical advisor	Sediment quality	In summary I am content that the proposed 500,000 m3 of capital dredge material from the construction of the MEP extension project is suitable for disposal at sea to Mostyn Deep disposal site (IS102). I recommend that material from the proposed dredge area is re-analysed at least every 3 years throughout the continued maintenance dredge licence period.	Noted.
6	Strategic Marine Services Ltd Dee Conservancy Harbour Master	Navigation	Section 10.6.1 (figure 10.1) reference to ownership of the Freehold area, implies Mostyn have full control of the area, It is suggested that the Freehold ownership area needs better definition as it is my understanding that the freehold relates to the seabed only. There is potential for confusion over authority responsibility without clarification that NRW have SHA responsibility for the whole area outside of the Mostyn SHA	Noted.
7	Strategic Marine Services Ltd Dee Conservancy Harbour Master	Navigation	Page 13 (2nd last paragraph) outlines the maintenance dredge requirement of 600 000 m ³ which is at the limit of the existing dredge license, is this acceptable to the authority? This goes on to suggest 450 transits per year to achieve which equates to 225 dredge campaigns per annum which is a major annual commitment from the port, it is recommended that this commitment is confirmed and agreed as sustainable by the applicant.	The Port of Mostyn has discussed this issue directly with the Dee Conservancy Harbour Master. The Port has confirmed that the proposed maintenance dredge requirement will remain within the commitments in the existing maintenance dredge licence and the figures quoted in the ES are considered to be a worst case scenario for the purposes of the assessment. The Dee Conservancy Harbour Master has confirmed that he is assured that the Port of Mostyn can meet the existing dredge commitment.
8	Strategic Marine Services Ltd Dee Conservancy Harbour Master	Navigation	10.7.7 suggests wash effects are considered low to medium, however reports have been received by Dee Conservancy Harbour Master relating to cockle fishing on the Mostyn bank, close to main channel where CTV wakes are a significant hazard to beach working.	The Port of Mostyn has discussed this issue directly with the Dee Conservancy Harbour Master. The wash effects are addressed within the pilotage regulations and will be reinforced with the customer base. The Dee Conservancy Harbour Master has confirmed that he is content that this has been appropriately addressed.
9	Strategic Marine Services Ltd Dee Conservancy Harbour Master	Navigation	10.7.10 last paragraph refers to harbour master liaison meetings with local fisheries as a mitigating measure, it does not address how feedback from these liaison meetings is managed.	The Port of Mostyn has discussed this issue directly with the Dee Conservancy Harbour Master. The Dee Conservancy Harbour Master has confirmed that he is content that the points raised have been addressed.
10	Strategic Marine Services Ltd Dee Conservancy Harbour Master	Navigation	Table 10.5 needs to review issues of wash effect, which in my opinion would be uprated to a 'likely' risk unless mitigation measures are put in place.	See response to comment 8.
11	Strategic Marine Services Ltd Dee Conservancy Harbour Master	Fisheries	Chapter 9 Fisheries Section 9.8 needs to include wash effect on the Mostyn Bank where vessels are beached on edge of main channel.	See response to comment 8.
12	Strategic Marine Services Ltd Dee Conservancy Harbour Master	Cumulative	Chapter 13 Cumulative and In-combination effects; needs to be reviewed in light of the concerns over wash effects detailed above.	See response to comment 8.
13	DIO Estates Safequarding Officer	General	I can confirm that the MOD has no objection regarding this activity	Noted.

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No.	Consultee	Topic	Comment	Response
14	NE Storm Isles Cheshire to Lancashire Area Team	HRA	<p>Shadow Appropriate Assessment</p> <p>Natural England agrees that the shadow Habitat Regulation Assessment (HRA) undertaken by the applicant requires updates in accordance with the advice given by NRW. In addition, we understand that there are outstanding queries in the Environmental Statement (ES) where further assessments and/or information are required by the applicant, these may have implications for the HRA assessment.</p> <p>Natural England is of the view that we are unable to agree with the conclusions of the shadow HRA until the recommendations set out in NRW's advice have been addressed.</p> <p>Under regulation 63 of the Conservation of Habitats and Species Regulations 2017 (as amended), Natural England advises that NRW should undertake an Appropriate Assessment of the implications of this proposal against the site's conservation objectives once the applicant has updated the shadow HRA and ES. Natural England welcomes further consultation once</p>	Individual responses to each of the consultation comments that have been received from NRW are provided in this comments log. Additional supporting evidence is provided in a Further Information Report as necessary. In addition, a meeting with the coastal processes and benthic ecology specialists in NRW Advisory was held on 12 June to discuss and help resolve the issues and concerns raised.
15	NE Storm Isles Cheshire to Lancashire Area Team	MCZ Assessment	<p>Marine and Coastal Access Act 2009</p> <p>The works, as set out in the information supplied by the applicant, are not sited within or near to a Marine Conservation Zone. Natural England have not identified a pathway by which impacts from the development would affect the interest features of the site(s). We are therefore confident that the works will not hinder the conservation objectives of such a site.</p>	Noted.
16	NE Storm Isles Cheshire to Lancashire Area Team	Nature conservation	<p>Wildlife and Countryside Act 1981 (as amended)</p> <p>We can confirm that the proposed works are located within Dee Estuary/Aber Afon Dyfrdwy SSSI within English jurisdiction. Natural England is in agreement with NRW that further information is required to be able to assess the impacts on SSSI sites.</p> <p>Should the application change, or if the applicant submits further information relating to the predicted impacts of this proposal on the SSSI aimed at reducing the damage likely to be caused, we will provide further advice as appropriate.</p>	<p>See response to comment 81.</p> <p>Further information relating to the predicted impacts of the proposed development on SSSI features (in particular benthic habitats and species, and waterbirds) are included in the Further Information Report that has been prepared in support of the marine licence application CML2283.</p>
17	Env Agency Sustainable Places Technical Specialist	HRA	<p>The development is located entirely within Wales, and therefore your authority remains the competent authority, and best placed, to make a judgement on the ecological assessments.</p> <p>We would, however, suggest there are likely to be some effects on the Dee Estuary SAC, SPA, Ramsar and SSSI interest features in England. We assume Natural England will be consulted by your organisation on the Habitats Regulations Appropriate Assessment.</p> <p>We do note the Habitats Regulations Assessment does identify potential disruption to the migration of Atlantic Salmon through the estuary due to noise from percussive piling. We expect this would be covered within your assessment of the proposed works, however our suggested mitigation would be a 'soft start up' and a default to 'vibratory piling method'. Whilst these methods will help mitigate impacts, it is anticipated that louder percussive piling will be needed when piles meet bedrock. As such a timing restriction could be considered by NRW, to avoid periods of sensitive migration of salmon as they pass upstream as adults and downstream as smolts.</p> <p>In terms of the Environmental Statement, we have no comments to make at this time.</p>	<p>Natural England has been consulted on the HRA - see comments 14 to 16.</p> <p>Restrictions have been considered to avoid and/or minimise effects on migratory fish and are discussed in Section 4.5 of the Further Information Report.</p>
18	Trinity House Navigation Requirements Advisor	Navigation	<p>I can confirm that Trinity House has no objections to this application.</p> <p>Any navigational marking of the works and final structures, as required by the Statutory Harbour Authorities of the Port of Mostyn, are to be consented by Trinity House.</p>	Noted.
19	MCA Maritime Licence Advisor	Navigation	<p>We note that the all the works associated with the Marine Licence applications fall within the jurisdiction of a Statutory Harbour Authority (SHA), either The Port of Mostyn or The Dee Conservancy. Therefore, they are responsible for the safety of navigation within their waters during the construction and during the operational lifespan of the project.</p> <p>The MCA confirms we have no objections to the licences being granted on this occasion. This is on the understanding that all maritime safety legislation is adhered to, and that the following risk mitigation measures take place:</p> <p>Conditions: None</p>	Noted.
20	MCA Maritime Licence Advisor	Navigation	<p>Advisories:</p> <ol style="list-style-type: none"> 1. The site is within port limits and we note the applicant is The Port of Mostyn. They may wish to issue local warnings to alert those navigating in the vicinity to the presence of the works, as deemed necessary. 	The Port of Mostyn will consider the issue of local warnings as required.
21	MCA Maritime Licence Advisor	Navigation	<p>Advisories:</p> <ol style="list-style-type: none"> 2. Bunding and/or storage facilities must be installed to contain and prevent the release of fuel, oils, and chemicals associated with plant, refuelling and construction equipment, into the marine environment. 	Best practice environmental management techniques will be implemented by contractors during construction. Techniques and measures will follow appropriate industry guidelines for the activity. Adherence to environmental management best practice will be controlled through a Construction Environmental Management Plan (CEMP).

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No.	Consultee	Topic	Comment	Response
22	MCA Maritime Licence Advisor	Navigation	Advisories: 3. We would like to point the applicant in the direction of the Port Marine Safety Code (PMSC), and its Guide to Good Practice, which sets out a national standard for every aspect of port marine safety. We would expect the project to be carried out in accordance with the PMSC and the relevant Safety Management Systems updated to encompass the project.	As set out in the Commercial and Recreational Navigation Chapter of the ES (Chapter 10), the MEPE Project will be carried out in accordance with the PMSC and the existing Safety Management System (SMS) will be updated as necessary to take account of the project.
23	MCA Maritime Licence Advisor	Navigation	Advisories: 4. Given the time lapse since The Port of Mostyn and the Dee Conservancy confirmed their compliance with the Port Marine Safety Code, it would be useful to receive confirmation that this still remains the case.	The MCA requires a letter of confirmation under the PMSC from the Duty Holder every three years. The most recent letter to them Mostyn Docks Ltd as the SHA was dated 26.03.2021, the next letter therefore being due in March 2024. Should the MCA require an interim letter, the Port of Mostyn will be happy to provide them with one.
24	MCA Maritime Licence Advisor	Navigation	The MCA has considered the relevant Marine Plan as part of its assessment of this application.	Noted.
25	RCAHMW/CBHC Senior Investigator (Maritime)	Archaeology	RCAHMW is happy overall with the treatment of marine archaeology within the ES for CML2283. We support the proposal to establish an archaeological exclusion zone around one historic asset (a shipwreck), and to implement a protocol for archaeological discoveries and associated WSI for other elements of the scheme.	Noted.
26	RCAHMW/CBHC Senior Investigator (Maritime)	Archaeology	However, we feel that the proposed geoarchaeological assessment of existing geotechnical material (Chapter 12, Page 19) should have been done as part of the EIA process (as is the norm), rather than being part of the mitigation for the scheme. As such, the geoarchaeological assessment needs to be done prior to granting of the marine license, rather than as a condition, post determination. So we would request that this is undertaken and the resulting report submitted to ourselves by way of supplementary/further information to the ES, that can then be approved as if it had been part of the original EIA and subsequent ES.	A geoarchaeological assessment of the existing geotechnical material has been undertaken. This has been issued to Cadw and RCAHMW for their consideration. Both Cadw and RCAHMW concur with the findings and have advised that no further work or additional mitigation is required.
27	RCAHMW/CBHC Senior Investigator (Maritime)	Archaeology	Any requirements for additional mitigation can then be included in the subsequent scheme WSI as normal. We feel this would be a better process than approving a WSI initially (including geoarchaeological assessment), and then having to revisit/revise the WSI depending on the results of the geoarchaeological assessment.	Noted.
28	RYA Planning and Sustainability Administrator	General	RYA. Having reviewed the details, we have no comment to make on this.	Noted.
29	NRW Senior Advisor Dee Conservancy	Seabed ownership	I am responding to this ML application from the point of view of NRW as the Statutory Harbour (SHA) and Local Lighthouse Authority for the Dee Conservancy. I have focused on the following aspects of the proposed MEPE application, and corresponding Environment Statement Chapters: Chapter 4.2 – Seabed Owner Consent AND Chapter 10.6.1 – Regulations and Operational Procedures The footprint of the outer part of the maintenance dredge area includes riverbed owned by NRW as the Dee Conservancy SHA. The operational agreement for the management of the Mostyn Operational Area does not include any estate/land owner permission for works associated with this project. The Mostyn Operation Area exists within the legal jurisdiction of the NRW as the Dee Conservancy SHA. We advise that the Port of Mostyn provides clarification of the overlaps between the MEPE maintenance dredge regime and the Dee Conservancy owned river bed. Pete – engagement would be with Rex Humphrey Jones in Robert Williams Land Management Team, and possibly Sian Reynolds.	The Port of Mostyn can confirm that the proposed maintenance dredge requirement will remain within the commitments in the existing maintenance dredge licence and that there would not be any changes to the maintenance dredge regime within the Dee Conservancy Area (see response to comment 7). The Mostyn Operational Area (MOA) agreement provides Mostyn Docks Ltd with authorisation to carry out various marine operations in the area of the riverbed owned by NRW as the Dee Conservancy SHA (e.g. hydrographic surveys, tidal predictions, dredging and the provision of Aids to Navigation). In the absence of the Dee conservancy doing so, Mostyn Docks Ltd has provided these services at its own expense in order to keep the estuary open for commercial shipping. Following a telephone conversation and email correspondence from the NRW Senior Advisor, the Dee Conservancy has confirmed that the MOA agreement is still in effect.
30	NRW Senior Advisor Dee Conservancy	Physical processes	Chapter 6.7 – Physical Processes, Changes to seabed bathymetry as a result of dredge disposal We second Jo Ibrahim’s comments regarding gaps in the sediment dispersal assessments, which should go further to show where dredged material moves to and settles in receiving receptors (e.g. cockle beds and navigable channel). In addition to Jo Ibrahim’s comments we recommend that supplementary sediment dispersal assessments includes potential indirect impacts on the navigable channel upstream of the development to Connah’s Quay, Flintshire.	Predicted changes to SSC and sedimentation are provided in the ES. Further information with regards to the fate of the plume (including identified receptors - cockle beds, navigation channel) is provided in the Further Information Report.
31	NRW Senior Advisor Dee Conservancy	Navigation	Further down the line we will also need The Port of Mostyn to communicate its plans to provide navigational safety marks, and safety messages to maritime users of the Dee Estuary during the construction and operational phases of this proposed development.	As noted in the Commercial and Recreational Navigation Chapter of the ES (Chapter 10), the Port of Mostyn will continue to engage closely with the Dee Conservancy Harbour Master and ensure that plans are effectively communicated to maritime users of the Dee Estuary.
32	Clwyd-Powys Archaeological Trust Senior Planning Archaeologist	Archaeology	As there are no significant terrestrial or intertidal impacts to recorded or potential sites within the development area and the terrestrial assessment was scoped out of the EIA we have no additional comments to make.	Noted.
33	Clwyd-Powys Archaeological Trust Senior Planning Archaeologist	Archaeology	We have read through Chapter 12 of the ES and the appended Desk Based Assessment, and we are in agreement with the proposed mitigation and requirements for a WSI and Archaeological Protocol to offset potential impacts in the marine environment.	Noted.

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No.	Consultee	Topic	Comment	Response
34	NWIFCA Inshore Fisheries and Conservation Advisor	Benthic ecology	From reviewing the associated documents for Mostyn Energy Park Extension the NWIFCA has no concerns regarding the extension provided the following considerations are observed. <ul style="list-style-type: none"> Contractors are briefed on marine INNS and protocols for the appropriate reporting and disposal of non-native organisms. The NWIFCA are aware that the highly invasive non-native Chinese Mitten Crab (<i>Eriocheir sinensis</i>) is a species of national significance and has been documented as present in the locality of the Dee Estuary, appropriate steps will be required to minimise its distribution. The NWIFCA recommends that workers on site are familiar with identifying the crab and if one is found it is removed, isolated, and reported to either NRW, EA or NWIFCA with photographs. Care must be taken to dispose of them properly and not reintroduce specimens back into the estuary. If the specimen is 'berried', i.e., carrying eggs, special care must be taken in handling of the crab so that eggs are not washed into the estuary. 	As noted in the Nature Conservation and Marine Ecology Chapter of the ES (Chapter 8), biosecurity control measures will be included within the Construction Environment Management Plan (CEMP) in accordance with guidance. It is anticipated that this will be a condition of the marine licence.
35	NWIFCA Inshore Fisheries and Conservation Advisor	Fisheries	<ul style="list-style-type: none"> Ensure construction work will not affect nearby mussel fisheries. NWIFCA would like to highlight the presence of the commercial mussel beds in the Dee estuary at Thurstaston and West Kirby, which are in the vicinity of the construction area. NWIFCA has concerns over aspects of the construction process in relation to impacts on these fisheries. These mussel beds are important as both commercial fisheries and as a food resource to SPA overwintering bird species. 	Section 9.6 of the Fisheries ES Chapter (Chapter 9) acknowledges that there are mussel fisheries within the Dee Estuary. These are mostly on the English side (Thurstaston and West Kirby), with no mussel fisheries currently open on the Welsh side. Figure 6.8 of the Physical Processes ES Chapter (Chapter 6) shows the maximum spatial extent of the combined dredge/ disposal suspended sediment concentration (SSC) plume over peak flood and peak ebb tidal flows (on a spring tide). This demonstrates that the effects associated with the construction of the proposed development will not overlap with any of the mussel beds. Further details on the approach and outputs of the physical processes assessment are provided in the Further Information Report.
36	NWIFCA Inshore Fisheries and Conservation Advisor	General	Providing the above actions are taken into consideration the NWIFCA has no objections to a licence being granted for this project.	Noted.
37	NATS Safeguarding	Aviation	The proposed development has been examined from a technical safeguarding aspect and does not conflict with our safeguarding criteria. Accordingly, NATS (En Route) Public Limited Company ("NERL") has no safeguarding objection to the proposal.	Noted.
38	NATS Safeguarding	Aviation	However, please be aware that this response applies specifically to the above consultation and only reflects the position of NATS (that is responsible for the management of en route air traffic) based on the information supplied at the time of this application. This letter does not provide any indication of the position of any other party, whether they be an airport, airspace user or otherwise. It remains your responsibility to ensure that all the appropriate consultees are properly consulted.	Noted.
39	NATS Safeguarding	Aviation	If any changes are proposed to the information supplied to NATS in regard to this application which become the basis of a revised, amended or further application for approval, then as a statutory consultee NERL requires that it be further consulted on any such changes prior to any planning permission or any consent being granted.	Noted.
40	NRW Dee Cackle Fishery Senior Cackle Fishery Management Officer	Fisheries	Having looked through the application there is inadequate information to make an assessment on the impact of the Dee Cackle Fishery which is a major employer and economic generator in the area contributing many £M's into the local economy each year.	The ES includes an assessment of the environmental impacts on commercial fisheries (including the cockle fishery), as set out in the Scoping Report and the Scoping Opinion. The importance of a receptor/feature has been taken account of in the approach that has been applied to the fisheries assessment (Chapter 9, Section 9.3.2). The cockle fishery is recognised as a key fishery in the region and therefore its socioeconomic importance was considered to be 'moderate' (Sections 9.7.1, 9.7.3, 9.7.4 and 9.7.5).
41	NRW Dee Cackle Fishery Senior Cackle Fishery Management Officer	Fisheries	The documentation suggest there was no harvesting or classified area in the immediate vicinity of the docks but this is not correct there is a "New Bed" identified in 2021 in close proximity to the north west of the docks (an extension of the Salisbury Bed) which was extensively worked in the 2022 season and produced the majority of the catch returns for the fishery.	The latest available cockle survey report (NRW, 2022) was taken account of in the ES. This included consideration of the "New Bed" located between the Mostyn and Salisbury Channels (Chapter 8, Image 8.1; and Chapter 9, Image 9.3). NRW was consulted during the assessment stage of the EIA which confirmed that the New Bed is the main bed that permit holders have been harvesting from in 2022. This baseline information is set out in the relevant chapters (Chapter 8, Section 8.6.3; and Chapter 9, Section 9.6.3) and taken account of in the assessments (Chapter 8, Section 8.7; and Chapter 9, Section 9.7).
42	NRW Dee Cackle Fishery Senior Cackle Fishery Management Officer	Benthic ecology	There is inadequate information on hydrodynamic changes, effects of dredging on harvesting beds and any hydro geomorphological changes to sediments as a results of the works and the impact on the harvesting areas and cockle spat settlement and growth. Cockles are extremely sensitive to changes in sediment type, deposition and a wide range of other physical factors which could affect the population in different ways.	Further information on the indirect effects on benthic habitats and species (including cockles) in response to this comment is provided in Section 4.3 of the Further Information Report.
43	NRW Dee Cackle Fishery Senior Cackle Fishery Management Officer	Fisheries	It is not possible to comment in further detail at this stage until further more detailed information is provided.	Noted.

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No.	Consultee	Topic	Comment	Response
44	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	General	<p>There are a lot of concerns and questions from all the specialists. The key concerns are listed after each specialism followed by the detailed comments.</p> <p>The following are the general key concerns that I have identified from the responses, full details in the attached – (following comments</p> <p>Key issues</p> <ul style="list-style-type: none"> • Capacity of Mostyn Deep disposal site to accept dredged material • Discrepancy in agreed conversion rate between m3 to tonnes • Disagreement with assessment of permanent direct loss of Annex 1 habitats • HRA not carried out against conservation objectives of SAC and SPA • Lack of justification why potential impacts have been scoped out • Disagree with conclusion of HRA • Effects on priority species included in Section 7 of the Environment (Wales) Act 2016 should also be assessed • WFD concerns • Pile driving timina restrictions need to be considered 	<p>Responses to each of these key concerns are provided for each of the individual detailed comments below.</p>
45	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Physical processes	<p>Physical Processes comments</p> <p>Key issue 1</p> <p>ES Chapter 3 Project Methodology</p> <p>It is noted that the main navigation channel (currently Salisbury Channel) will need to be deepened to a depth of – 4 m CD and the works will be conducted under the current dredge and disposal licence (DML1542v2). The total volume of capital dredge material that needs to be removed from the main navigation channel is estimated to be up to 3 million m³ and it is proposed that the material will be disposed of in Mostyn Deep. Please note the following:</p> <p>DML1542v2 states in paragraph 1.3. The Licence Holder or any Agent or Contractor acting on their behalf under this Licence is permitted to deposit a quantity not exceeding 5,400,000 Tonnes of the substances or articles specified at sub-paragraph 1.2 of this Schedule, at the Deposit Area(s) detailed at paragraph 1.4 and up to the maximum quantity specified for each Deposit Area specified at paragraph 1.6.</p> <p>Paragraph 1.6 states “Within the overall quantities authorised for deposit set out in paragraph 1.3, and the authorised Deposit Area set out in paragraph 1.4 the following limits also apply:</p> <p>1.6.1 Up to 900,000 tonnes may be deposited annually at the following authorised Deposit Areas: IS102, Mostyn Deep (maintenance) maximum quantity tonnes 900,000 Main Site.</p> <p>We are concerned that the capital dredge operation proposed, is scheduled to be completed over a 15-month period (chapter 3, Table 3.1) and the amount of capital dredge to be deposited exceeds the maximum allowable limit at Mostyn Deep. Has the Mostyn Deep site been environmentally assessed to confirm that the site is able to disperse such a large quantity of sediment (3 million m³ or 6,000,000 tonnes) over the much shorter time period than is currently consented for under DML1542v2? We are concerned that deposition of 3 million m³ at Mostyn Deep over a much shorter time period could alter the morphological and ecological features of the Mostyn Deep site and surrounding sand banks of the Dee Estuary through sediment transport and deposition.</p>	<p>Capital dredge initially covers the port development (to be completed within the existing licence period). Further capital dredging of approach channel can be accommodated over a longer period, whilst still working within the existing disposal/landing tonnage limits in the DML1542 licence.</p> <p>Additional information related to the dispersive nature of the IS102 (Mostyn Deep) disposal site, the capacity of the site and the analysis of recent bathymetric monitoring data (compared against the 2009 baseline survey) has been included in the Further Information Report.</p>

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No.	Consultee	Topic	Comment	Response
46	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Dredge volume/tonnage	<p>Key issue 2</p> <p>Specific Gravity number for dredge material</p> <p>There is a discrepancy in the agreed conversion between m3 to tonnes. The current dredge and disposal licences DML1542v2 and DML2001 use a specific gravity of 2 to convert m3 to tonnes. The new licence CML2283-MEPE-Dredge and Disposal Application Form Redacted No 13. Details of Material to be Dredged and/or Disposed, also uses a specific gravity of 2.</p> <p>Please provide clarity as to why in the relevant chapters of the EIA (chapter 3, 6, 8) and also in the new licence application, the quoted amounts to be dredge and disposed of in m3 are converted to tonnes using a specific gravity conversion of 1.5. We are concerned that the amount of sediment that will be disposed of under the current licence (DML1542v2) at Mostyn Deep are being underestimated in tonnage.</p> <p>For example, using an agreed factor of 2 (see condition 9.20 DML1542v2) to convert 3 million m3 of capital dredged sediment to tonnes equates to 6,000,000 tonnes of sediment which is in excess of the maximum agreeable amount to be deposited at Mostyn Deep which is 5,400,000 tonnes of sediment under licence DML1542v2.</p> <p>It is also stated in ES chapter 3 section 3.2 Operational phase 3.2.1 Maintenance dredging and reuse/disposal of maintenance dredge material</p> <p>"The total volume of maintenance dredge material that is permitted to be dredged is up to 900,000 tonnes (approximately 600,000 m³) per annum under the existing dredge marine licence (DML1542v2) and an additional 99,990 tonnes (approximately 66,660 m³) per annum under the existing dredge marine licence (DML2001). The total volume of maintenance dredge material that needs to be removed from the new berth, harbour and navigation channel is estimated to be up to 600,000 m³per annum which remains within the cap set in the existing marine licences".</p> <p>We are concerned that the agreed specific gravity of 2 has not been used in this assessment to determine the maintenance dredge/disposal allowable limit which, when converting correctly from 600,000m3 to tonnage is 1,200,000 tonnes and exceeds the annual allowable limit for Mostyn Deep which is currently set to 900,000 tonnes.</p> <p>Please ensure that the amount of sediment to be disposed of or reused is considered in tonnage using a specific gravity conversion of 2 and not 1.5.</p>	<p>Additional information related to the conversion between cubic metra and metric tonnes has been provided in the Further Information Report.</p> <p>To maintain consistency with the existing licence, a conversion factor of 2 tonnes / m3 has been applied and relevant volume and tonnage values for the MEPE scheme have been included for completeness.</p>
47	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Physical processes	<p>Detailed comments</p> <p>Clarification required</p> <p>ES Chapter 6, Section 6.7.1 Changes to SSC and sedimentation as a result of construction activities: Maximum predicted increase in SSC and Sedimentation from berth dredge and disposal operations.</p> <p>Figure 6.8 shows the maximum spatial extent of the combined dredge/ disposal SSC plume over peak flood and peak ebb tidal flows (on a spring tide)</p> <p>In order for NRW to fully understand the outputs presented in Figure 6.8 we require clarification on the following:</p> <p>What does the maximum predicted increase in SSC and sedimentation in Figure 6.8 equate to in terms of amount of sediment in m3 being disposed of at the Mostyn Deep site?</p> <p>Was the model run in continuous mode until all 3million m3 of sediment had been released at the disposal site?</p> <p>How many dredge/disposal cycles does the model output represent and what is the total model run time?</p> <p>Has the model been run under neap tide conditions, given that the dredging and disposal operations will not necessarily be conducted over springs? The lower current velocities experienced during neaps would not disperse the sediment as quickly as springs and potentially could cause higher concentrations in suspension and higher sedimentation on the seabed, which could in indirectly cause a greater impact to sensitive receptors.</p> <p>It would be helpful if all the dredge/disposal scenario outputs were presented as listed.</p>	<p>Clarifications in response to this comment are provided in Section 2.1 of the Further Information Report.</p>
48	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Physical processes	<p>Detailed comments</p> <p>Clarification required</p> <p>ES Chapter 6 Section 6.7.1 Spatial dispersion of dredge plume and sedimentation</p> <p>Paragraph 7 states "Due to the timing of successive disposal events (and the subsequent tidal dispersal of the resultant plume), there is no evidence of cumulative increases in SSC (i.e. the impact from each disposal is dispersed sufficiently before the next disposal, such that there is no predicted positive trend in excess SSC with sequential disposal events)".</p> <p>Please clarify what was the timing of successive disposal events? Is there a critical time at which there would be cumulative increase in SSC, given that we don't know at this stage the exact timing of the dredge/disposal activities?</p> <p>Timing of disposal will be critical to minimise cumulative increases in SSC and sedimentation on the seabed.</p>	<p>Clarifications in response to this comment are provided in Section 2.1 of the Further Information Report.</p>

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49	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Physical processes	<p>Detailed comments</p> <p>Clarification required</p> <p>ES Chapter 6 Section 6.7.2 Changes to seabed bathymetry as a result of dredge disposal</p> <p>States "At the Mostyn Deep (IS102) disposal site, the effect of the deposition of capital dredge arisings on the seabed bathymetry will be similar to that which already occurs as a result of ongoing maintenance dredging and disposal".</p> <p>We require clarification as to what the dredge returns are at the Mostyn Deep site since renewal of the current licence in 2019? We have no dredge disposal records apart from 2021-22 annual monitoring report where all sediment dredged was pumped to shore and reused for beneficial use. We are concerned that Mostyn Deep has been infrequently used as a disposal site in recent years and since 2019 licence renewal "used for an annual average disposal quantity of 50,000 m³" or 100,000 tonnes (using a specific gravity of 2). We require that the disposal site is assessed to determine if it is able to disperse such a large quantity of capital dredge over a short time period (see comment 1 above). Until our concerns are addressed, we cannot yet agree that the magnitude of change to the Mostyn Deep disposal site and surrounding banks is negligible.</p>	Further information in response to this comment, including dredge returns since the current licence renewal, is provided in Section 2.1 of the Further Information Report.
50	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Physical processes	<p>Detailed comments</p> <p>Further assessment required to support conclusions</p> <p>Chapter 6: Physical Processes</p> <p>We are satisfied that the hydrodynamics/sediment transport model used to assess the predicted impacts on physical processes has been adequately calibrated and validated. We agree with the outcome of the environmental impact assessment, that the minor alterations to the current/wave and sediment transport processes within the vicinity of the proposed expansion works caused by the presence of the new quay wall, alteration to coastline caused by reclaimed land and deepening of the Salisbury approach channel and berth pockets, will not affect the wider hydrodynamics and sediment transport processes of the Dee Estuary.</p> <p>It does not appear however, that the Salisbury Approach channel has been assessed particularly for SSC plume dispersal and deposition during the capital dredging operations to -4m CD, only the Berth Pocket dredge and disposal at Mostyn Deep were presented (Figure 6.8). we advise that a SSC plume will be generated during the capital dredge of the approach channel, and an assessment should be carried out to show where this material advects to and whether the plume and subsequent settling of the sediment could have an indirect impact to receiving receptors (e.g. cockle beds) on the sand</p>	Further information on the material to be dredged from the Salisbury Channel, the driving hydrodynamic forcings and the likely fate of any material in suspension is provided in Section 2.4 of the Further Information Report.
51	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Benthic comments</p> <p>Key issue 1: A number of potential impacts have been scoped out during construction and operation. We advise these are scoped in and/or further justification is provided to scope them out</p>	See responses to comments 61, 69 and 70.
52	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Benthic comments</p> <p>Key issue 2: We disagree with the outcome of the assessment associated with the permanent direct loss of Annex I mudflat and sandflat feature from the construction of the quay wall and from the capital dredge</p>	See responses to comments 62 and 63.
53	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Benthic comments</p> <p>Key issue 3: We disagree with the outcome of the assessment associated with the permanent loss of Annex I Estuaries feature from the construction of the quay wall</p>	See response to comment 62.
54	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Benthic comments</p> <p>Key issue 4: The potential impacts to benthic habitats from the capital dredge of the navigational channel have not been assessed</p>	See responses to comments 64, 65, 67 and 71.
55	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Benthic comments</p> <p>Key issue 5: We are unable to agree with the conclusions of the assessments relating to the potential impacts from dredge disposal at Mostyn Deep until the queries raised by the NRW Physical Process Specialist are clarified.</p>	See responses to comments 66 and 67.
56	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Benthic comments</p> <p>Key Issue 6: An appropriate assessment has not been carried out against the conservation objectives of the SAC.</p>	See response to comment 72.
57	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Benthic comments</p> <p>Key Issue 7: An adverse effect on site integrity cannot be ruled out from the permanent loss of Annex I features of the Dee Estuary SAC as a result of the quay wall construction and capital dredge.</p>	See responses to comments 73 and 74.

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58	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Environmental Statement Chapter 8: Nature Conservation and Marine Ecology</p> <p>Clarification required</p> <p>Table 8.1</p> <p>In general, we agree with the sensitivities to the different impacts that have been assigned to the habitats in the dredge footprint and disposal sites with the exception of habitat change. We do not agree the habitats found in the dredge footprint have a low sensitivity to habitat change. According to MarESA the biotope Barren or amphipod-dominated mobile sand shores has a high sensitivity to Physical change (both to another seabed type and to another sediment type). A change to a hard or artificial substratum would significantly alter the character of the biotope. We advise this is</p>	<p>The seabed habitats found in the dredge footprint will not change to another seabed type or another sediment type as a result of the proposed development. The nature/type of habitat will remain the same but the emergence regime will change (from intertidal to subtidal). According to MarESA, the 'barren or amphipod-dominated mobile sand shores' biotope has a low sensitivity to emergence regime changes (including a decrease in emergence that leads to this biotope becoming fully sublittoral and reclassification) (https://www.marlin.ac.uk/habitats/detail/343) and therefore a sensitivity score of low is considered appropriate in this instance.</p>
59	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Environmental Statement Chapter 8: Nature Conservation and Marine Ecology</p> <p>Clarification required</p> <p>Table 8.2</p> <p>Habitats that are part of designated features of a Special Area of Conservation should be assigned a high importance value. We agree that in relation to Estuaries which is a broad feature type, this could be amended to consider the sub-features present and their relative importance. But we advise that for the Annex I Mudflats and sandflats feature this should be given a high importance value. Furthermore, the importance of Section 7 and OSPAR habitats is not defined.</p>	<p>We note your advice and agree that for the Annex 1 Mudflats and sandflats feature, this could be given a high importance value. We have reviewed all the Nature Conservation and Marine Ecology ES Chapter (Chapter 8) and can confirm that none of the impact assessment significance conclusions will change as a result of this modification in the importance value as the assessment had already taken account of a range in the importance value of intertidal habitats from low to high. This also applies to the further information that has been provided in relation to this habitat feature in Section 4.1 of the Further Information Report.</p>
60	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Environmental Statement Chapter 8: Nature Conservation and Marine Ecology</p> <p>Clarification required</p> <p>Table 8.19 Changes to benthic habitats and species as a result of sediment deposition scoped out for quayside works</p> <p>This impact has been scoped out noting that piling has the potential to result in the localised resuspension of sediment but that the amount that settles out of suspension and back into the seabed is negligible. No information on how far the sediment disperses is presented in the justification. We note from reviewing Chapter 6 that the increase in suspended sediment concentration is confined to within 2m of the pile location. We therefore agree this impact can be scoped out, but we advise the evidence presented in Chapter 6 needs to be incorporated into the justification here.</p>	<p>The evidence from the physical processes assessment had been used to inform this judgement but we acknowledge your advice and will include and/or clearly signpost to this evidence in future assessments.</p>
61	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Environmental Statement Chapter 8: Nature Conservation and Marine Ecology</p> <p>Further assessment required to support conclusions (Key issue 1)</p> <p>Table 8.19 "Indirect changes to seabed habitats and species as a result of changes to hydrodynamics and sedimentary processes marine works (capital dredging and quayside)" and "Indirect changes to seabed habitats and species as a result of changes to hydrodynamics and sedimentary processes (dredge disposal)"</p> <p>These impacts have been scoped out on the basis that the Physical Processes chapter has concluded that any impact would be insignificant/minor adverse to Physical Processes and thus negligible to benthic habitats. Any changes are expected to be negligible and the highly localised changes in bathymetry at the disposal site is not expected to cause significant changes to seabed morphology. However, the applicant should assess whether these changes although negligible from a Physical Process context have any impacts on benthic habitats and the nearby cockle beds e.g. from smothering. We therefore advise these impacts are scoped in and assessed and/or further justification is provided to</p>	<p>Taking all of the relevant factors into consideration, the overall potential impact of changes to hydrodynamic and sedimentary processes on benthic features due to capital dredging of the navigational channel is assessed as insignificant. A detailed response to this comment is provided in Section 4.3 the Further Information Report.</p>

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62	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Construction</p> <p>Assessment is sufficient but unable to agree with conclusion (Key issue 2 and 3)</p> <p>Direct loss of intertidal and subtidal habitats and species as a result of the new quay wall</p> <p>We understand from the information presented the following losses have been calculated as a result of the construction of the quay wall:</p> <p>0.27 hectares of intertidal hard substrate habitat – this is an artificial habitat consisting of tipped slag waste deposits which have partly fragmented into hard substrate of varying sizes. This habitat does not fall under the Annex I Estuaries sub feature “Intertidal hard substrate community” as it is not formed on natural rocky substrata. Although it could provide a similar ecological function to the Section 7 habitat “Estuarine rocky habitats”, NRW does not consider this habitat would classify under Section 7 as it is artificially formed and does not contain key species that make up this habitat.</p> <p>2.57 hectares of intertidal mud habitat which corresponds with the Annex I intertidal mudflat and sandflats feature of the Dee Estuary SAC</p> <p>0.65 hectares of subtidal channel habitat which corresponds with the Annex I Estuaries feature of the Dee Estuary SAC</p> <p>Based on the evidence presented the magnitude of the impact is considered to be small with respect to the intertidal hard substrate habitat. We disagree with the assessment of low magnitude as the duration of the impact is long-term and non-reversible. We advise this impact should be considered medium based on the above and the spatial scale (0.27 ha). The probability of occurrence is high thus giving a Medium exposure to change. The importance of this habitat has been presented as low. We agree with this assessment as the habitat does not qualify as a sub-feature of the Dee Estuary SAC or as a Section 7 habitat under the Environment Wales Act. Based on the standard assessment matrix, the impact of direct habitat loss as a result of the new quay wall would therefore be minor adverse with regards to the intertidal hard substrate habitat.</p> <p>With respect to the intertidal mudflat and sandflat habitat, the applicant has assessed this as negligible magnitude. We disagree with this assessment. The impact is long-term, non-reversible and over a large scale (2.57ha). We therefore advise this should be assessed as Large magnitude of change. The probability of occurrence is high, thus giving a High exposure to change result. The importance of this habitat has been presented as moderate due to the poor quality of the feature.</p>	<p>The impacts of the direct loss of intertidal and subtidal habitats under the footprint of the MEPE reclamation have been revisited and reassessed in Section 4.1 of the Further Information Report.</p>
63	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Construction</p> <p>Assessment is sufficient but unable to agree with conclusion (Key issue 2)</p> <p>Direct loss of intertidal habitat as a result of capital dredging</p> <p>Capital dredging will cause a direct loss of 1.34ha of intertidal habitat which will change to subtidal habitat as a result of the deepening of the berth pocket. The magnitude of potential impacts is considered to be negligible. We disagree with this assessment as the duration of the impact will be long-term, non-reversible and over a large scale. Based on the above we advise the magnitude of change should be assessed as large. The probability of occurrence is high thus resulting in a High exposure to change. The sensitivity of the feature is high, thus resulting in a High vulnerability. The importance of the feature has been assessed as moderate based on the highly impoverished faunal assemblage and the ongoing maintenance dredging of Bug bank. We agree with this assessment. Based on the standard assessment matrix the</p>	<p>Further consideration of the direct loss of intertidal habitat as a result of capital dredging is provided in Section 4.1 of the Further Information Report.</p>

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64	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Construction</p> <p>Further assessment required to support conclusions (Key issue 4)</p> <p>Changes to subtidal habitats and species as result of the removal of seabed material during dredging</p> <p>A capital dredge will be required to create a new berth pocket alongside the new quay wall and to deepen the existing berth pocket along the existing quay wall. The dredging will result in changes to approximately 3.16ha of subtidal habitat as a direct result of the physical removal of subtidal sediment which is what is assessed in this section.</p> <p>It is expected that following the capital dredge from the berth pocket, the dredge pockets will provide a similar habitat to that occurring under pre-dredge conditions which would then be expected to be colonised by a similar assemblage. We advise the magnitude of the change to subtidal habitats should be assessed as medium. This based on the impact occurring over a large scale (3.5ha) but noting that recovery is expected over the short-term. The sensitivity of subtidal habitats, more specifically the biotopes present within the dredge area LS.LSa.MoSa: Barren amphipod-dominated mobile sand shores with patches of LS.LSa.FiSa:Polychaete/amphipod-dominated fine sand shores should be rated as medium sensitivity in line the assessment provided in MarESA. Based on the standard assessment matrix the resulting impact is minor/insignificant which is not significant in EIA terms.</p> <p>However, the main navigation channel will also need to be dredged to a maximum depth of – 4 m CD. The total volume of capital dredge material that needs to be removed from the main navigation channel is estimated to be up to 3 million m³. We are unclear if the assessment under this section has included the potential impacts to subtidal habitats from dredging the main navigational channel. The references to the habitats present in the area relate to those closest to the quay wall (Appendix 8.1), not those on the main navigation channel (See Chapter 3, Figure 3.1 for spatial reference). Survey data is probably available from the annual benthic monitoring that is undertaken to assess what the impacts to the habitats from the capital dredge are, but this data has not been presented. We advise impacts from capital dredging the navigational channel should be assessed.</p>	<p>Further consideration of the direct loss of intertidal habitat as a result of capital dredging is provided in Section 4.1 of the Further Information Report.</p>
65	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Construction</p> <p>Further assessment required to support conclusions (Key issue 4)</p> <p>Changes to habitat and species as a result of sediment deposition during dredging (capital dredging)</p> <p>We agree with the assessment that the potential impact of deposition from capital dredging of the berth pocket on benthic features is insignificant. Increased sedimentation above 10mm is predicted within around 500m, mainly across the proposed reclamation area, with sedimentation reducing to 1-2mm off the end of the breakwater. The predicted sedimentation is below the pressure benchmark for the habitats immediately adjacent to the works. However, it is unclear whether the plume will reach the cockle beds. Chapter 6, Figure 6.8 shows the maximum sedimentation plume extending north of the breakwater. How far is the New bed cockle bed from the plume? It would be useful to overlay Figure 6.8 (in Chapter 6) with the known cockle beds to understand the potential interactions. If the plume extends to the cockle beds, any potential impacts from sediment deposition should be assessed.</p> <p>Furthermore, we are concerned the potential impacts from sediment deposition to benthic habitats from the capital dredging of the main navigational channel have not been assessed. The assessment presented here seems to relate only to the capital dredging of the berth pockets discussed above. Potential impacts to benthic habitats from the capital dredging of the main navigational channel should also be assessed.</p>	<p>Taking all relevant factors into consideration, the overall potential impact of deposition on benthic features is assessed as insignificant. Further detail in support of this assessment is provided in Section 4.3 of the Further Information Report.</p>
66	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Construction</p> <p>Further assessment required to support conclusions (Key issue 5)</p> <p>Changes to habitat and species as a result of sediment deposition during dredging (dredge disposal)</p> <p>Please refer to comments provided by the NRW Physical process specialist in relation to the specific gravity number used to convert the dredge material and concerns relating to whether Mostyn Deep has been environmentally assessed to disperse such a large quantity of sediment (3 million m³ or 6,000,000 tonnes) over the much shorter time period than is currently consented for under DML1542v2. Until these issues are clarified we are unable to agree with the conclusions here.</p> <p>Furthermore, the potential impacts from sediment deposition during dredge disposal on the cockle beds has not been assessed. A map overlaying Figure 6.8 Maximum predicted increase in SSC (top) and sedimentation (bottom) from berth dredge and disposal activities, Chapter 6 with the cockle beds would be useful to understand the extent to which the plume interacts with the habitat.</p>	<p>See responses to comments 42, 45 and 46. Further detail is provided in the Further Information Report.</p>

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67	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Construction</p> <p>Further assessment required to support conclusions (Key issue 4 and 5)</p> <p>Changes in water and sediment quality during capital dredging and dredge disposal - SSC</p> <p>We agree with the conclusion the impact of changes suspended sediment deposition on benthic habitats from capital dredging of the berth pocket is insignificant. However, we are concerned the potential impacts from changes in suspended sediment concentration to benthic habitats from the capital dredging of the main navigational channel have not been assessed. The assessment presented here seems to relate only to the capital dredging of the berth pockets discussed above. Potential impacts to benthic habitats from the capital dredging of the main navigational channel should also be assessed.</p> <p>With regards to potential impacts from changes in suspended sediment concentration from the dredge disposal, we are unable to agree with the conclusions here until the queries raised by the NRW Physical Process Specialist in relation to</p>	See responses to comments 30, 43 and 50. Further detail is provided in the Further Information Report.
68	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Construction</p> <p>Clarification required</p> <p>Introduction and spread of non-native species</p> <p>We agree with the overall impact of insignificant to minor adverse. Notwithstanding this, NRW advise that a full Biosecurity Risk Assessment and invasive non-native species (INNS) Management Plan is completed in relation to all marine operation activities associated to the current proposal. The highly invasive species the Chinese mitten crab (<i>Eriocheir sinensis</i>) is present in the Dee Estuary and extra diligence is required to ensure the species is not spread further. The risk assessment and management plan should include consideration of all activities, vehicles and equipment used as well as how the risk will be minimised through appropriate mitigation and adherence to best practice guidance and management measures. The risk assessment should include a review of all the available data in relation to the presence of marine INNS where applicable to the current proposal, and the potential risks associated to each species identified.</p> <p>If any hopper dredgers are going to be used, NRW advise the following measures should also be implemented: Limiting amount carried. Before each new dredging campaign/and or when moving to a different region, once clear of harbour and outside shallow waters, conduct full exchange of hopper water so that at least 95% volume exchange is achieved. If unable to empty hopper due to weather, 95% volumetric exchange can be achieved by pumping through three times the volume of the hopper in accordance with the ballast water Management convention. Pump water out prior to arrival at</p>	Noted. Preparation of a biosecurity protocol is included as a mitigation measure in the ES and is anticipated to be a condition of the licence.
69	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Operation</p> <p>Further assessment required to support conclusions (Key issue 1)</p> <p>Table 8.22 Indirect changes to seabed habitats and species as a result of changes to hydrodynamics and sedimentary processes</p> <p>Potential impacts to benthic habitats from changes to hydrodynamics and sedimentary processes from the presence of the new quay wall during the operation of the project have not been assessed. In particular whether the presence of the quay wall during the operation of the project will have an impact on benthic habitats and species and on the nearby cockle beds. Figure 6.10, Chapter 6 shows some localised changes during the ebb tide: an increase in velocity along the quay wall and Salisbury channel and a reduction in velocity on the adjacent mudflat and sandflat. What are the implications of these changes from a benthic habitats perspective? This could lead to indirect loss and/or impact the condition status of Annex I features of the Dee Estuary SAC. We advise this is scoped in and assessed appropriately.</p>	Taking all relevant factors into consideration, the overall potential impact of changes to hydrodynamic and sedimentary processes on benthic features due to the quay wall is assessed as insignificant. Further detail is provided in Section 4.3 of the Further Information Report.

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70	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Operation</p> <p>Further assessment required to support conclusions (Key issue 1)</p> <p>Table 8.22 Indirect changes to seabed habitats and species as a result of changes to hydrodynamics and sedimentary processes (activity: maintenance dredging and disposal)</p> <p>This impact has been scoped out on the basis that the monitoring work undertaken over the last 15 years has not identified any changes attributable to the maintenance work. However, to our knowledge the maximum depth that has been dredge to date is up to -2.0m CD. We are also unsure how much material has been deposited in Mostyn Deep over the duration of the current licence. Clarification is sought as the 2022 annual monitoring report noted all sediment dredged was pumped to shore. The justification to scope this out also notes that the Physical Process chapter concluded that only changes in hydrodynamic and sedimentary processes that are of negligible magnitude are predicted. However, the applicant should still assess whether these changes although negligible from a Physical Process context have any impacts on benthic habitats. Based on the above, we advise this impact is scoped in and assessed.</p>	<p>Indirect effects during maintenance dredge and dredge disposal are predicted to be comparable or less than predicted for the capital dredge and disposal. On this basis, potential effects are considered to be insignificant. Further detail is provided in Section 4.3 of the Further Information Report.</p>
71	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Operation</p> <p>Further assessment required to support conclusions (Key issue 4)</p> <p>Changes to benthic habitats and species as result of seabed removal during dredging</p> <p>The maintenance dredge quantities and depth assessed in this section and proposed are within the cap set in the existing marine licences. However, it must be noted that a dredge to -4m CD has not taken place to our knowledge and as such, the results of the monitoring programme to date should be interpreted with caution. The assessment here has been carried out only against the habitats present directly adjacent to the new quay wall (as these are the results provided in Appendix 8.1). No consideration has been given to the habitats present and adjacent to the navigation channel (shown as a polygon in Chapter 3, Figure 3.3) that will also be subject to the impacts of maintenance dredging. Data for these habitats is probably available from the annual monitoring the port carries out. We are unable to agree with the conclusions presented here until those assessments are carried out.</p> <p>We agree with the applicant that for those habitats present directly adjacent to the new quay wall, the impacts of maintenance dredging are likely to be minor however uncertainty remains over what the impacts to these habitats will be from maintaining the dredge to -4.0m CD as this has not been carried out to date. Therefore, we advise the current monitoring requirements listed under marine licence DML1542v2 should remain in place to ascertain the assumptions made in the ES. That is that any impact on benthic habitats will be minor and that the balance of the spatial distribution of different habitats (e.g. mudflat and sandflat) within the estuary is maintained. The monitoring requirements should include the specific thresholds and actions to take place if a change is detected.</p>	<p>Following maintenance dredging, the navigation channel will provide a similar habitat to that occurring under pre-dredge conditions which would then be expected to be recolonised very rapidly allowing populations to re-establish to baseline conditions between maintenance dredging campaigns. Overall, the potential effect is assessed as insignificant to minor. Further detail is provided in Section 4.3 of the Further Information Report.</p>
72	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	HRA	<p>Detailed comments</p> <p>Appendix 8.5 Habitats Regulations Assessment</p> <p>Further assessment required to support conclusions (Key issue 6)</p> <p>Table 3. Assessment in advance of any mitigation</p> <p>An appropriate assessment has not been carried out against the conservation objectives of the Dee Estuary SAC. It is also unclear from Table 2 which potential impacts have been screened in and taken through to the appropriate assessment stage. The conservation objectives should be taken from the Regulation 33 Advice document as these are the agreed conservation objectives for cross boundary sites. It must be noted that the Annex I Estuaries feature has a specific conservation objective related to physical processes (see conservation objective vii further below) that is relevant to some of the potential impacts listed in this table. We also note a potential impact pathway from Accidental pollution has not been screened in. We advise this should be screened in and taken through to the appropriate assessment stage where the relevant mitigation can then be applied e.g. the production and adherence to a CEMP.</p> <p>We are unable to agree with the conclusions of the HRA until the appropriate assessments are carried out for all relevant features of the Dee Estuary SAC. Furthermore, please note there are outstanding queries in the ES where further assessments and/or information is required that have implications for the HRA assessment.</p>	<p>A full response and further details in support of the HRA are included in Section 4.7 of the Further Information Report.</p>

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No.	Consultee	Topic	Comment	Response
73	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	HRA	<p>Detailed comments</p> <p>Appendix 8.5 Habitats Regulations Assessment</p> <p>Unable to agree with conclusion (Key issue 7)</p> <p>Potential permanent loss of Annex I Mudflats and Sandflats not covered by seawater at low tide</p> <p>The applicant has presented an assessment (although noting this has not been carried out against all the conservation objectives for the SAC) for the potential permanent loss of Annex I Mudflats and sandflats not covered by seawater at low tide feature of the Dee Estuary SAC as a result of the construction of the new quay wall. This will result in a permanent loss of 2.57 hectares of feature. According to the information provided in the ES, the loss of intertidal mud represents approximately 0.016 % the Dee Estuary SAC and specifically 0.024 % of the ‘mudflats and sandflats not covered by seawater at low tide’ feature of the Dee Estuary SAC. This loss also represents 0.018 % of the Dee Estuary SPA/Ramsar site.</p> <p>There will also be a further loss of 1.34 hectares of Annex I Mudflats and sandflats not covered by seawater at low tide feature as a result of the capital dredging. According to the information provided in the ES, the loss represents approximately 0.008 % the Dee Estuary SAC and 0.013 % of the ‘mudflats and sandflats not covered by seawater at low tide’ feature of the Dee Estuary SAC17. This loss also represents 0.009 % of the Dee Estuary SPA/Ramsar. Thus, the combined permanent loss of Annex I Mudflats and sandflats not covered by seawater at low tide feature from the development is of 3.91 hectares. The applicant has concluded the loss of 2.57 hectares (note the 1.34 hectares lost due to dredging has not been assessed) will not undermine the conservation objectives of the SAC. This is based on the assessment that this habitat is of poorer quality, does not represent the ecological structure and function of the feature and thus is considered de minimus and insignificant. We disagree with this conclusion.</p> <p>The potential permanent loss of 3.91 hectares of Annex I Mudflats and sandflats not covered by seawater at low tide feature would undermine the conservation objectives as defined in the Regulation 33 advice package, in particular conservation objectives (i) which state:</p> <ul style="list-style-type: none"> the total extent of mudflat and sandflat communities within the site is maintained; the proportions of individual mudflat and sandflat communities within the site are maintained; the topography of the intertidal flats and the dynamic processes of channel migration and sinuosity across the flats are maintained; 	See responses to comments 62 and 63.
74	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	HRA	<p>Detailed comments</p> <p>Appendix 8.5 Habitats Regulations Assessment</p> <p>Unable to agree with conclusion (Key issue 7)</p> <p>Potential permanent loss of Annex I Estuaries feature</p> <p>The applicant has presented an assessment (although noting this has not been carried out against all the conservation objectives for the SAC) for the potential permanent loss of Annex I Estuaries feature of the Dee Estuary SAC as a result of the new quay wall. The development will result in the permanent loss of 0.65 hectares of subtidal habitat corresponding to the Annex I Estuaries feature. We are unsure what percentage of the feature and of the SAC this loss would equate to as this information has not been provided in the ES or the HRA.</p> <p>The potential permanent loss of 0.65 hectares of Annex I Estuaries feature would undermine the conservation objectives as defined in the Regulation 33 advice package:</p> <p>The “estuaries” feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:</p> <ul style="list-style-type: none"> the aggregate total extent of all estuarine communities within the site is maintained; the spatial distribution of estuarine communities within the site is maintained; the extent of individual estuarine habitat features within the site is maintained; the variety and relative proportions of sediment and rocky substrates within the estuary is maintained; the variety and extent of any notable subtidal sediment communities is maintained; the variety and extent of notable intertidal hard substrata communities is maintained; the spatial and temporal patterns of salinity, suspended sediments and nutrients concentrations are maintained within limits sufficient to satisfy the requirements of statements (i) to (vi) above. <p>We advise that the permanent loss of Estuaries feature would undermine conservation objectives (ii), (iii) and (iv) as the construction of the quay wall would not allow the area to recover and thus maintain the spatial distribution and extent of estuarine habitats and communities. Whilst we note the permanent loss of 1.34ha of intertidal mudflat and sandflat habitat as a result of the capital dredging will result in an area close to the quay wall becoming subtidal and therefore part of the Estuaries feature, we do not believe this offsets the Annex I Estuaries feature loss assessed here. This is because the</p>	Following further discussion with the benthic ecology specialist at NRW Advisory during a meeting held on 12 June 2022, the HRA has been revisited. Further information is provided in Section 4.7 of the Further Information Report.

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75	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	HRA	<p>Detailed comments</p> <p>Appendix 8.5 Habitats Regulations Assessment</p> <p>Important to note</p> <p>Please note that the assessments above relate only to the potential direct permanent loss of Annex I Mudflats and sandflats and the Annex I Estuaries features of the Dee Estuary SAC from the following construction activities: quay wall construction and capital dredge, resulting in direct permanent loss of feature. They do not consider any further potential indirect losses and/or degradation of habitat as a result:</p> <p>Capital dredge disposal at Mostyn Deep</p> <p>Removal of 600,000 m³ of sediment ashore to use in the reclamation (this has not been appropriately assessed)</p> <p>Maintenance dredge</p> <p>Indirect impacts to benthic habitats from changes in hydrodynamics from the operation/presence of the quay wall</p> <p>These activities could further undermine the conservation objectives of the Dee Estuary SAC features. However, until the information requested in the ES is presented and an appropriate assessment is carried out, we are unable to comment any further.</p>	<p>See responses to comments 45 and 61.</p> <p>Further information in terms of the assessment that has been carried out on the removal of dredge material ashore is provided in Sections 2.5 and 4.3 of the Further Information Report.</p>
76	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Benthic ecology	<p>Detailed comments</p> <p>Appendix 8.1 Benthic Survey Report</p> <p>Clarification required</p> <p>Figure 2</p> <p>This figure represents the intertidal habitats that were recorded during the survey. However, a figure with the subtidal habitats has not been presented and therefore it appears as though a large section of the area has not been surveyed. This is not the case as we can see from Figure 1 that there are sampling stations there. We advise a revised figure is presented with the biotopes that have been assigned to the subtidal stations.</p>	<p>It is not possible to create a biotope map of the subtidal stations given the limited point stations that have been collected (6 stations). However, the biotopes that can be assigned to each of these stations are as follows:</p> <p>Station 1 - SS.SBR.SMus.MytSS (<i>Mytilus edulis</i> beds on sublittoral sediment).</p> <p>Station 2 - SS.SMu.SMuVS (Sublittoral mud in variable salinity (estuaries)).</p> <p>Station 3 - SS.SMu.SMuVS.NhomTubi (<i>Nephtys hombergii</i> and <i>Tubificoides spp.</i> in variable salinity infralittoral soft mud).</p> <p>Station 4 - SS.SMu.SMuVS.NhomTubi (<i>Nephtys hombergii</i> and <i>Tubificoides spp.</i> in variable salinity infralittoral soft mud).</p> <p>Station 5 - SS.SMu.SMuVS.NhomTubi (<i>Nephtys hombergii</i> and <i>Tubificoides spp.</i> in variable salinity infralittoral soft mud).</p> <p>Station 6 - SS.SMu.SMuVS.NhomTubi (<i>Nephtys hombergii</i> and <i>Tubificoides spp.</i> in variable salinity infralittoral soft mud).</p>
77	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Cumulative and in-combination	<p>Detailed comments</p> <p>Chapter 13 Cumulative and In-combination effects</p> <p>Further assessment required to support conclusions</p> <p>Section 13.7.1 Proposed works alone, Benthic habitats and species – this section will need to be updated based on the comments provided by NRW on Chapter 8.</p>	<p>The significance of the following impact pathways relating to benthic habitats and species have been altered in response to comments provided by NRW (see comment 62):</p> <ul style="list-style-type: none"> - Direct loss of intertidal hard substrate habitat as a result of the new quay wall - from insignificant to minor adverse (in ES) to minor adverse - Direct loss of subtidal habitat as a result of the new quay wall - from insignificant (in ES) to moderate adverse <p>Following an agreement on suitable compensatory measures to be introduced for the loss of Annex 1 Estuaries feature of the Dee Estuary SAC, the residual impact in EIA terms of this direct loss of subtidal habitat is assessed as insignificant. Section 13.7.1 of the ES will, therefore, remain the same and not require any amendment.</p>
78	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	General	<p>Recommendations for future assessment</p> <p>Chapter 5, Tables 5.6</p> <p>We would recommend that the applicant removes the possibility of having two results within the same category and goes for the highest result because by using this type of method the applicant is down-grading the estimation of significance. A Moderate vs a moderate currently gives a result of a Moderate/Minor. But in this case the resultant effect should be moderate, not moderate/minor. Similarly, a Moderate/Low provides a resultant effect of Minor/Insignificant but in our opinion the resultant effect should be minor.</p>	<p>A minor to moderate adverse effect is treated the same as a moderate adverse effect in the sense that it is considered a significant effect and triggers the requirement for mitigation to be identified to avoid and/or minimise the effects to acceptable non-significant levels. Rather than leading to ambiguity over the significance of effects, the aim of the use of significance ranges is to allow a little more granularity in the assessment results (i.e. a greater number of effects levels from just insignificant, minor, moderate and major (4) to insignificant, insignificant to minor, minor, minor to moderate, moderate, moderate to major, and major (7)). In practice though, the implications of any moderate to major adverse effects (including minor to moderate adverse) is that additional mitigation measures need to be considered.</p>
79	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Ornithology	<p>Marine Ornithology comments</p> <p>Key issue 1 – The works have been assessed by the applicant as having an adverse effect on birds both through permanent loss of habitat and through disturbance. Although these effects are considered in the documents submitted by the applicant, they have not been assessed in sufficient detail to understand the full nature and extent of these impacts.</p>	<p>Responses to these concerns are provided for each of the individual detailed comments below.</p>

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80	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Ornithology	Marine Ornithology comments Key issue 2 – The HRA supplied by the applicant does not assess the development against the conservation objectives of SPAs. The HRA should consider how the construction, operation and maintenance of the proposed development, leading to loss of habitat and increased disturbance relate to the Conservation Objectives of the interest features of the Dee Estuary SPA. Without this information it is not possible to understand the effects of the proposed development on coastal	See response to comment 72.
81	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Ornithology	Marine Ornithology comments Key issue 3 – Further information is required to be able to understand how the proposed development (including construction, operation and maintenance) may impact the condition of protected sites and protected species. This should include the Dee Estuary SPA, Liverpool Bay SPA, the Dee Estuary SSSI, Gronant Dunes and Talacre Warren SSSI and Shotton Lagoons and Reedbeds SSSI. Effects on priority species included in Section 7 of the Environment (Wales) Act 2016	Section 4.2 of the Further information Report signposts to where information for protected sites and Section 7 priority species can be found in the existing documentation that has been submitted with the marine licence application and also provides further assessment where required.
82	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Ornithology	Detailed comments The proposed Mostyn Energy Park extension works have been assessed by the applicant as having an adverse effect on birds both through permanent loss of habitat and through disturbance. Although these effects are considered in the documents submitted by the applicant, they have not been assessed in sufficient detail to understand the full nature and extent of these impacts.	Responses to these concerns are provided for each of the individual detailed comments below.
83	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Ornithology	Bird surveys submitted by the applicant (Environmental Statement Appendix 8.3: Bird Summary) from within and around the proposed development. State that “waders and wildfowl populations of international and national importance were recorded during both the high water and low surveys with intertidal habitats in the area considered to be of high functional value for both feeding and roosting assemblages of waterbirds”. The surveys detected large numbers of waders, wildfowl, gulls and terns, many of which are features of the Dee Estuary SPA and other nearby designated sites. The applicant’s bird surveys suggest that habitats within the and around the proposed development support a large proportion of the overall Dee Estuary populations. This included areas used for roosting and feeding within the vicinity of	Noted.
84	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Ornithology	The proposed works include a direct loss of habitat to the Dee Estuary. This includes the quayside works (2.84ha intertidal habitat loss), and the capital dredging (direct loss of 1.34ha intertidal habitat). According to the Environmental Statement, the effects of this habitat loss on bird populations has been assessed by the applicant to be minor adverse. However, more detailed information on the steps taken to inform this assessment are required, including robust assessments of wider impacts of loss of roosting habitat, and loss of foraging resources on bird populations across the Dee Estuary. Effects of disposal of sediment from dredging and it’s potential impact on birds should also be assessed. Comprehensive modelling is necessary to understand how bird habitats will be affected by any changes in physical processes that would result from this development (e.g. changes in erosion or deposition due to disposal of dredging waste and/or loss of intertidal habitat). Please also see comments by Benthic Ecology, Marine Fish and Fisheries and Coastal Processes specialist advisors.	Section 4.1 of the Further Information Report provides further consideration of the direct loss of habitat in the Dee Estuary. The effects of this habitat loss on bird populations and the conclusions reached in Section 8.7.1 of the ES remain the same. There will be no loss or bird roosting habitat and the functional value for feeding birds of the recently accreted and ephemeral mud habitat that will be lost within the operational harbour is low. The effects of the disposal of sediment on prey resources for birds is assessed in the ES and further detail is provided in Sections 4.2, 4.3 and 4.4 of the Further Information Report. The potential implications of changes in physical processes on benthic habitats and species, including habitats and prey resources for birds, has been assessed in the ES and more detail is provided in Section 4.3 of the Further Information Report. Please see responses to comments on Benthic Ecology, Marine Fish and Coastal Processes topics.
85	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Ornithology	In addition, the proposed works may cause disturbance impacts both during construction, as well as during operation and maintenance. The Environmental Statement considers the probability of noise and visual disturbance during construction to be high, and these impacts have been assessed by the applicant to be minor to moderate adverse. The applicant has also assessed the disturbance during operational use of the port to be minor adverse. The area is already in use as a port and according to the Environmental Statement it is expected that disturbance to waterbirds in addition to the baseline conditions will be limited, whether from noise or visual stimuli. The Environmental Statement also provides general information on disturbance effects to birds from the literature. However, the information provided by the applicant for the proposed development does not adequately quantify 1) types and levels of disturbance and effects on different species and protected site(s) features of the Dee Estuary and surrounding areas, 2) effects of disturbance at locations throughout the Dee Estuary SPA and an assessment of sensitive locations, 3) seasonal impacts to birds, 4) which activity will cause which effect, or 5) assessment of the effects on birds of vessel traffic levels over the expected lifespan of the development, based on planned and proposed offshore developments to be serviced by the port, 6) where birds will go if disturbed. NRW advises that this information is required to understand the potential effects on birds. We also suggest a sensitivity assessment for the area of proposed works is undertaken, please see for example, work by Cutts et al. (2009). References: Cutts, N., Phelps, A. & Burdon D. 2009. Construction and waterfowl: Defining sensitivity, response, impacts and guidance. Report to Humber INCA.	A more detailed assessment of potential disturbance effects on waterbirds during construction and operation is provided in Section 4.6 of the Further Information Report.

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86	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Ornithology	Furthermore, there is insufficient information provided on the potential impacts of associated works, e.g. pontoon construction and the relocation of dolphins and/or piles. NRW advise that further information is required to understand any effects of these associated works on bird populations and supporting habitats.	As set out in the Project Methodology Chapter of the ES (Chapter 3), further detail on these associated works is not currently available and therefore we have assessed a reasonable worst case project risk envelope as part of the assessment to address any potential uncertainty in the scheme design and construction methodology.
87	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	HRA	The HRA supplied by the applicant does not assess the development against the conservation objectives of SPAs. Without this information it is not possible to understand the effects of the proposed development on coastal waterbirds and/or marine ornithology. As a minimum the HRA should consider how the construction, operation and maintenance of the proposed development, leading to loss of habitat and increased disturbance relate to the Conservation Objectives of the interact features of the Dee Estuary SPA and Liverpool Bay SPA	See response to comment 72.
88	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Nature conservation	Further information is required to be able to understand how the proposed development (including construction, operation and maintenance) may impact the condition of protected sites and protected species. This should include the Dee Estuary SPA, Liverpool Bay SPA, the Dee Estuary SSSI, Gronant Dunes and Talacre Warren SSSI and Shotton Lagoons and Reedbeds SSSI. Effects on priority species included in Section 7 of the Environment (Wales) Act 2016 should also be assessed	See response to comment 81.
89	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Water Quality and WFD comments Key issue 1 – The Water Framework Directive (WFD) compliance assessment (CA) has not considered the impact of the proposed development on the mitigation measures of the Dee (N. Wales) transitional water body which is a Heavily Modified Water Body (HMWB). The WFD CA must be able to show that the development will not compromise the effectiveness of the mitigation measures. The mitigation measures ('HMWB uses and mitigation measures July 2022') can be found on Water Watch Wales via the 3-bar menu at the top right of the screen.	Further information on impacts to the mitigation measures of the Dee (N. Wales) transitional water body is provided in Section 3.1 of the Further Information Report.
90	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Water Quality and WFD comments Key issue 2 – The WFD CA does not include details of the exceedances of the "biology – habitats" metrics as listed in Table 4 (pp11). These must be provided in order to make an assessment of the scale of impact to the water body and its habitats. The metrics must include all areas, summed together, within the water bodies that will be impacted by the development. The 1.5 x dredge area must also be included.	Further information on the exceedances of the "biology – habitats" metrics is provided in Section 3.1 of the Further Information Report.
91	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Detailed comments Environmental Statement Chapter 7: Marine water and sediment quality We agree there is no risk of deterioration to the Dee (N. Wales) or North Wales water bodies due to the resuspension of contaminated sediment	Noted.
92	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Detailed comments Environmental Statement Chapter 7: Marine water and sediment quality We agree there is no risk of deterioration to the shellfish waters due to bacterial releases.	Noted.
93	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Detailed comments Environmental Statement Chapter 7: Marine water and sediment quality We agree there is no risk of deterioration to nutrient concentrations as a result of the development.	Noted.
94	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Detailed comments Environmental Statement Chapter 7: Marine water and sediment quality Clarification required We cannot agree the conclusions with respect to Dissolve Oxygen as we have not been provided with sufficient evidence regarding suspended sediment. In particular, the dredge and disposal regime has not been sufficiently described and evidenced to enable us to assess that turbidity will remain at background levels for the 15 months of dredge and disposal. Furthermore, we understand that significant amounts of the current maintenance dredge are used on land and therefore not released into the water environment. Therefore, we need to understand any deviation from this approach and what its impacts will be. Any impacts to background turbidity could have further consequences for phytoplankton and dissolved	Further information on impacts to turbidity is provided in Section 3.2 of the Further Information Report.
95	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Detailed comments Environmental Statement Chapter 7: Marine water and sediment quality Clarification required 7.8.1 Tertiary mitigation Note that the PPGs (e.g. PPG1 and PPG6) have been discontinued and are no longer being updated. While this section does not mention the CEMP (which is mentioned in X), the mitigation measures typically fall under its remit. A marine	It is noted that the PPGs have been discontinued. However, the practices set out in these guidance documents, as described in Section 7.8.1 of Chapter 7 of the ES, will be adhered to during construction of the proposed development. Adherence to environmental management best practice will be controlled through a Construction Environmental Management Plan (CEMP). The CEMP will be provided to NRW prior to works commencing and will set out the mitigation measures needed to manage environmental effects. A marine pollution contingency plan will also be included within the CEMP, noting that an oil spill contingency plan is already in place for the

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96	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Detailed comments Environmental Statement Chapter 7: Marine water and sediment quality Clarification required Table 7.1 (pp4) West Kirby Bathing Water (BW) has not been assessed in the WFD CA as stated in the final row of this table. It is briefly mentioned on pp8 of the WFD CA. However, this BW falls under the jurisdiction of the Environment Agency so it will be for	Noted.
97	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	HRA	Detailed comments Environmental Statement Appendix 8.5: Habitats Regulations Assessment Clarification required Table 3 (pp25, pp27) It is unclear whether changes to water and sediment quality during capital dredging is included in the list for mudflats and sandflats and estuaries. We recommend this is clarified. Furthermore, mitigation for the risk of accidental pollution has	Changes to water and sediment quality during construction and operation has been assessed for both Mudflats and sandflats and Estuaries features in the HRA (see Table 3 in Appendix 8.5 of the ES). Potential accidental releases and marine pollution incidents have been taken account of in the assessment stage of the process (see Section 4.2). We agree that relevant mitigation should be in the form of a CEMP.
98	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Detailed comments Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment We agree there is no risk of deterioration to water quality as a result of potential contaminated sediment mobilisation.	Noted.
99	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Detailed comments Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment We agree that biosecurity measures should be included in the CEMP.	Noted.
100	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Detailed comments Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment We agree there is no risk to the designated shellfish waters from pathogens/bacteria as a result of the planned development	Noted.
101	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment Clarification required Throughout the WFD CA there is no differentiation between the assessment for capital dredging (construction phase) and maintenance dredging (operational phase). These should be clearly defined within the assessment so that any issues via each phase can be picked up and documented clearly.	The WFD Compliance Assessment (Appendix 7.1 of the ES) assesses the effects of both capital and maintenance dredging and disposal. The impact pathways and effects during maintenance dredging and dredge disposal are predicted to be comparable or less than predicted for the capital dredge and disposal. Therefore, to avoid unnecessary repetition, the capital and maintenance dredge activities were often considered together. However, frequent reference to each separate activity is made throughout where relevant. The assessment is considered to clearly assess each phase of the proposed development and the conclusions reached are considered
102	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment Further evidence required to support conclusions Table 6 (pp12) We have not been provided with sufficient evidence to consider that turbidity will not be impacted by the proposed development. In particular, the dredge and disposal regime has not been sufficiently described and evidenced to enable us to assess that turbidity will remain at background levels for the 15 months of dredge and disposal. Any impacts to background turbidity could have further consequences for phytoplankton and dissolved oxygen.	Further information on impacts to turbidity is provided in Section 3.2 of the Further Information Report. With specific reference to Table 6 of the WFD Compliance Assessment (Appendix 7.1 of the ES), based on the clarifications provided in the Further Information Report, it is considered that the activity would not affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days).
103	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment Further assessment required to support conclusions Table 6 (pp12) The risk of accidental releases of pollution, and relevant mitigation, has not been mentioned in the WFD CA. This is associated with the potential release of chemicals on the Environmental Quality Standards Directive (EQSD) list.	This is assessed in paragraph 6 of Section 4.4.2 of the WFD Compliance Assessment (Appendix 7.1 of the ES). The key point to note, as also noted above in response to comment 95, is that adherence to environmental management best practice will be controlled through a CEMP in accordance with guidance. The CEMP will be provided to NRW prior to works commencing and will set out the mitigation measures needed to manage environmental effects. A marine pollution contingency plan will also be included within the CEMP, noting that an oil spill contingency plan is already in place for the Port of Mostyn.
104	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment Further assessment required to support conclusions 4.1 Hydromorphology NRW advisory have raised issues with the physical processes assessment and those apply here also. Therefore, we cannot	Further information on issues relating to physical processes is provided in Section 2 of the Further Information Report. The conclusions reached in the WFD Compliance Assessment on hydromorphology (Section 4.1 of the WFD Compliance Assessment, Appendix 7.1 of the ES) remain the same.

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105	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment Clarification required 4.2 Biology (habitats) Higher sensitivity habitats include cockles, which have not been assessed. There are extensive cockle beds in the Dee and the impacts to these will need to be assessed here. We note there will be direct loss of blue mussel higher sensitivity habitat through reclamation, though understand the specific area in question is not protected under the Habitats	The indirect effects on habitats (including cockles) were considered in Section 4.2.3 of the WFD Compliance Assessment (Appendix 7.1 of the ES). Further information on indirect effects on benthic habitats and species (including cockles) is provided in Section 4.3 of the Further Information Report. On the basis of this information, the conclusions reached in the WFD Compliance Assessment on biology (habitats) (Section 4.2 of the WFD Compliance Assessment, Appendix 7.1 of the ES) remain the same and significant impacts to higher sensitivity cockle habitat is not anticipated.
106	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment Further assessment required to support conclusions 4.2 Biology (habitats) <i>We note that the navigation channel, which will be dredged to -4 mCD, is not included in the assessment</i>	See relevant responses relating to benthic ecology, in particular comments 50 and 71. Further information is also provided in Section 4.3 of the Further Information Report.
107	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment Further assessment required to support conclusions 4.4 Water Quality There is no assessment in the detailed assessment section of harmful algae though it is scoped in (Table 6, pp12); this will need to be assessed.	This is assessed in paragraph 7 of Section 4.4.2 of the WFD Compliance Assessment (WFD Compliance Assessment).
108	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment Further assessment required to support conclusions 4.5 Protected areas The impact of elevated suspended sediment and resultant deposition on the shellfish beds as a result of all the dredging schemes has not been assessed. With regard to para 6 of this section, we understand that much of the sediment dredged under current licences is used on land for beneficial reuse and therefore the statement made here is not applicable. NRW advisory do not agree with the findings of no Adverse Effect on Site Integrity for the SAC, SPA and Ramsar site and therefore we cannot agree with the conclusions relating to this in the WFD assessment. Impacts to Section 7 habitats and species should be assessed within the WFD assessment; these are not mentioned.	See relevant responses relating to benthic ecology and the HRA, in particular comments 42, 62, 74 and 81.
109	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Fish	Fish comments Key issue 1 – We advise further assessment of the magnitude of change upon sandeels is conducted. We advise that this further assessment considers the amount of preferred/marginal or prime/sub-prime sandeel habitat that will be affected by construction, capital dredging, maintenance dredging and disposal activities within the Dee Estuary, both directly and indirectly. The impact upon sandeels via habitat loss, habitat damage, direct uptake and smothering has not been sufficiently assessed in the Environmental Statement, because insufficient evidence has been presented to justify a negligible/small (depending on the impact pathway being assessed) magnitude of change. Sandeels are particularly vulnerable to habitat loss and dredging/disposal effects due to their benthic spawning, burrowing/hibernating, and high site fidelity behaviours. As a result, the magnitude of change may not be negligible/small for this species. We consider that the sensitivity of sandeels to the impact pathways from the project is moderate as there could be damage to individuals or populations with recoverability over short to moderate timescales, and we consider that the importance of the species is high given it is a Section 7 species, a key ecosystem species and a key prey item of many bird and mammal features in the ecosystem including of the breeding common tern feature of the Dee Estuary SPA. We advise that the amount of sandeel habitat affected is placed in the context of the available sandeel habitat within wider Dee Estuary, and also considered in-combination with other potentially impacting activities in the vicinity of the Dee Estuary, such as any other ongoing dredging activities (e.g. Area 392/393 or other capital or maintenance dredging).	An assessment of the potential effects on sandeels of the MEPE Project alone and in-combination with other activities is included in Section 4.4 of the Further Information Report.

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110	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Fish	<p>Fish comments</p> <p>Key issue 2 – We advise that timing restrictions are applied to percussive piling activities to minimise potential impacts upon diadromous migrant fish species in the Dee Estuary. This is because of the predicted noise levels from percussive piling activities required to construct the new quay wall, and the limited evidence of the effectiveness of the soft-start piling mitigation at deterring fish from the area where they will be killed, injured or subject to TTS, masking or disturbance effects. We advise that timing restrictions could involve preventing percussive piling during night-time all year and preventing percussive piling entirely during the smolt migration period from mid-April to mid-June. We note that similar conditions were applied to piling activities in Marine Licence CML1343 for the Mostyn Energy Park development. These timing restrictions would protect the majority of key migratory periods for the diadromous fish species using the Dee Estuary. Alternatively, we advise a timing restriction to limit piling to a period either side of low tide would also be effective at minimising noise impacts to all diadromous fish species using the Dee Estuary. We advise the period either side of low tide could be defined using the same water level models used in Environmental Statement Appendix 8.4: Underwater Noise Assessment.</p> <p>Detailed comments Environmental Statement Chapter 8: Nature Conservation and Marine Ecology Clarification required Section 8.3.2 Determining significance of effects The criteria for determining 'probability of occurrence' for impacts to fish species has not been presented in Chapter 5: Impact Assessment Approach or Chapter 8: Nature Conservation and Marine Ecology. Therefore, we do not have sufficient</p>	<p>Restrictions have been considered to avoid and/or minimise effects on migratory fish and are discussed in Section 4.5 of the Further Information Report.</p> <p>The 'probability of occurrence' does not have any associated defining criteria as it is simply a measure of whether the change or pressure has a high, medium, low or negligible chance of taking place e.g. there will definitely be an increase in underwater noise during impact piling that could affect fish and therefore the probability of occurrence is assessed as high.</p>
111	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Fish	<p>Detailed comments Environmental Statement Chapter 8: Nature Conservation and Marine Ecology Clarification required Table 8.2 The importance of Section 7 fish species, or other protected species that are not the listed diadromous migrant species, is</p>	<p>Given the statutory protection afforded to Section 7 fish species (and any other protected species), their importance is considered to be high. Further information in support of the assessment of potential effects on Section 7 species is provided in Section 4.2 of the Further Information Report.</p>
112	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Fish	<p>Detailed comments Environmental Statement Chapter 8: Nature Conservation and Marine Ecology Further assessment required to support conclusions Section 8.7.1 Construction phase: Underwater noise and vibration disturbance during construction Project impact assessment: Quayside works Herring have a high sensitivity to noise and vibration, and are of high importance as a Section 7 species. Therefore, we advise the significance of effect for this species is re-assessed.</p>	<p>It is recognised that herring have a greater hearing capability than some other fish (e.g. Atlantic salmon, European eels and lamprey) and therefore fall within the Popper et al. (2014) category: Fish with a swim bladder or air cavities that aid hearing. However, they are still assessed as having an overall moderate sensitivity to underwater noise from piling against the sensitivity criteria set out in the impact assessment methodology (Section 8.3.2 of the ES) whereby a moderate sensitivity is defined as "pressures in which damage to individuals or populations could occur but recoverability is expected to occur over short to moderate timescales". Given the statutory protection they are afforded as a Section 7 species and that they are considered to have an important supporting function/value as prey for birds and marine mammals, their importance is indeed considered to be high. The overall impact of underwater noise and disturbance during impact piling on herring is therefore assessed as moderate adverse in line with migratory fish species, including shad (which are also in the same hearing capability category as herring). The mitigation measures that are proposed for migratory fish will also help to avoid and/or minimise significant adverse effects on herring (i.e. soft start and vibro piling as much as possible and further restrictions which are proposed in Section 4.5 of the Further Information Report).</p>
113	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	HRA	<p>Detailed comments Environmental Statement Appendix 8.5: Habitats Regulations Assessment Further assessment required to support conclusions The following conservation objective has not been considered for the breeding common tern feature within the HRA: the abundance of common tern prey species within the estuary is maintained; Specifically in relation to the potential effect of the project upon sandeels, the conservation objectives for the Dee Estuary SPA identify that key common tern prey species include sandeel. We advise further assessment is conducted to rule out an adverse effect on site integrity for this feature.</p>	<p>The 'population size' (or abundance) conservation objective has been considered in the HRA for the Common Tern interest features (see Table 3 in Appendix 8.5 of the ES). An explanation of how the conservation objectives have been considered in the HRA is provided in Section 4.7 of the Further Information Report. An assessment of the potential effects on sandeel are included in the Further Information Report. This does not have any implications on the assessment and proposed mitigation measures that are already presented in the HRA.</p>

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114	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	<p>Detailed comments</p> <p>Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment / NRW MLT WFD Compliance Assessment</p> <p>Further assessment required to support conclusions</p> <p>We advise that the WFD assessment considers upstream river WFD water bodies. This is because of the potential for the project to impact diadromous migrant species (sea trout, Atlantic salmon, European eel, river lamprey and sea lamprey) whose river populations are used as part of the FCS2 classification of the fish quality element in river water bodies. Therefore, impacts in the Dee Estuary could affect the fish quality element classification of upstream river water bodies.</p>	<p>Further information on issues relating to the fish quality element in upstream river WFD water bodies is provided in Section 3.1 of the Further Information Report. The conclusions reached in the WFD Compliance Assessment on fish quality elements (Section 4.3 of Appendix 7.1 of the ES) remain the same.</p>
115	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	WFD/ Water Quality	<p>Detailed comments</p> <p>Environmental Statement Appendix 7.1: Water Framework Directive Compliance Assessment / NRW MLT WFD Compliance Assessment</p> <p>Further assessment required to support conclusions</p> <p>We advise that the potential effect of the project upon sandeels is considered in relation to WFD compliance. An effect on this underpinning ecosystem species could change the structure of the fish community which may be discernible by the EMFI/TFCI tools used to classify the fish quality element of transitional water bodies. We advise further assessment is</p>	<p>Further information on the potential effects on sandeels is provided in Section 4.4 of the Further Information Report. The effects are not anticipated to change the structure of the fish community and, therefore, the conclusions reached in the WFD Compliance Assessment on fish quality elements (Section 4.3 of Appendix 7.1 of the ES) remain the same.</p>
116	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Marine mammals	<p>Marine Mammal comments</p> <p>Overall comments:</p> <p>Due to the location and scale of this development we agree with the overall conclusions of the assessment for marine mammals and acknowledge the applicant's intention to follow the JNCC guidelines for reducing the potential for disturbance/injury to marine mammals from piling during construction. Overall, there is considered to be no potential for an AEOL on the marine mammal interest features of the Gogledd Môn Forol / North Anglesey Marine SAC, Gorllewin Cymru Forol / West Wales Marine SAC, Dynesfeydd Môr Hafren / Bristol Channel Approaches SAC, Pen Llŷn a'r Sarnau / Llyn Peninsula and the Sarnau SAC, Cardigan Bay / Bae Ceredigion SAC and Pembrokeshire Marine / Sir Benfro Forol SAC with the proposed mitigation measures specifically. However, we would advise that further detail and clarification is provided regarding the noise modelling methodology for piling.</p>	<p>See response to comment 118.</p>
117	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Underwater noise	<p>Key issues</p> <p>No key issues that would prevent us from agreeing with the conclusions, however we would advise that further detail and clarifications are included for the below comment</p>	<p>Noted.</p>
118	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	Underwater noise	<p>Detailed comments</p> <p>Appendix 8.4: Underwater Noise Assessment.</p> <p>8.2 Marine mammals, Section 8.2.1 Impact piling, pg 34</p> <p>"If the propagation of underwater noise from impact piling were unconstrained by any boundaries, the maximum theoretical distance at which the predicted cumulative SEL weighted levels of underwater noise during impact piling is within the limits of PTS and TTS in bottlenose dolphin is 514 m and 3.5 km respectively, and in harbour porpoise is 9.7 km and 67.0 km respectively. The maximum distance for PTS and TTS in seals is 5.0 km and 34.3 km respectively."</p> <p>NRW notes that this prediction for harbour porpoises is incorrect. From our information NRW advisory suspects that this harbour porpoise calculation has been based on the unweighted values rather than the weighted values as stated in the paragraph. This has led to a range for harbour porpoise which is much higher than for cumulative SEL, giving a range of 67km TTS for harbour porpoise. It is required that the applicant correct this.</p> <p>NRW advisory note the applicant has not assessed for behavioural disturbance in marine mammals comprehensively. The information required to do this is available to the applicant and has been shortly outlined within the report. An additional paragraph detailing the behavioural disturbance is required and would suffice.</p>	<p>We have double-checked all the assumptions, input values and equations that have been used in the freely available online NOAA calculation spreadsheet, and the cumulative SEL results are based on weighted values. It is important to reiterate though that these outputs are from a simple logarithmic spreading model that assumes that there are no physical boundaries. In the case of the MEPE Project, the breakwater, existing quay and tidal nature of the estuary (i.e. banks exposed at lower states of tide) will all limit and constrain the propagation of noise as described in the underwater noise appendix and illustrated in the supporting figures. A TTS range of 67 km will therefore not occur in reality as a result of the proposed piling for MEPE. There are no published behavioural disturbance thresholds for marine mammals and therefore it is not possible to calculate the ranges of disturbance. Instead, the underwater noise appendix (Section 6.3, page 21-22, Appendix 8.4 of the ES) and Chapter 8 of the ES (Section 8.7.1, page 95-96) include a scientific literature review of the behavioural responses of marine mammals to piling and other noise generating activities. Based on this review and the results of the PTS/TTS modelling, the extent of behavioural disturbance effects in marine mammals are anticipated to be restricted to the Dee Estuary and to vary with the tide.</p>

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119	cyfoethnaturiolcymru.gov.uk Marine Area Advice and Management Team	FCA	<p>Development and Flood Risk comments</p> <p>There are a few deficiencies in the Flood Consequence Assessment (FCA), including reference to the new TAN15 (this is not yet 'in force' and we did not advise them to refer to it in our pre-app advice) and use of the wrong tidal node for their analysis of tidal flood risk.</p> <p>They've used a node at the open coast rather than one of the estuary nodes. I've had a look at the Coastal Flood Boundary Dataset (CFBD) 2018 and the 0.5% Annual Exceedance Probability (AEP) event flood level for the closest estuary node (6.11 m AOD) is 0.2m higher than the highest level they've referred to in the FCA based on the open coast levels (5.91 m AOD), so their assessment underestimates the expected flood level for present day.</p> <p>However, they've applied 100 years of climate change in their climate change assessment section, whereas we would normally expect 75 years to be applied for this kind of development. The difference between the climate change figures for 75 and 100 years is coincidentally 0.2 m, so the calculated 'design' flood level for the 0.5% AEP event with an allowance for climate change of 7.14 m AOD is still correct (even if the method of deriving it is not quite right). They are proposing to set the infilled area at 7.5 m AOD, so this would be expected to be above the design flood level.</p> <p>Their assessment of the impact on flood risk elsewhere is based purely on assumptions rather than any evidence. Given the scale of the proposal and the location it's unlikely this would significantly impact flood risk elsewhere, so the FCA is broadly acceptable.</p>	<p>The FCA refers to both the 2021 and 2004 TAN1, but is primarily based on the guidance and policies within the 'live' 2004 edition.</p> <p>Modelled data for the open coast node would underestimate the flood level for the 0.5% AEP event, however, the proposed ground level would be over 350mm higher than the modelled flood level for the estuary node when climate change is considered.</p> <p>The assessment of flood risk to off-site areas is based in part on opinion. The estimated increased volumes of runoff, calculated as part of the FCA, would have a minimal impact within the wider estuary area. Mitigation to provide treatment to the runoff will be confirmed as part of detailed design works.</p>
120	RSPB CYMRU	General	<p>Thank you for consulting the RSPB on the above consultation. The RSPB has a number of significant concerns relating to this application, which have not been adequately addressed in the Environmental Statement (ES) and we consider, that at present it is not possible to conclude that there will be no adverse effects on the integrity of the following internationally designated sites and their features:</p> <ul style="list-style-type: none"> • Dee Estuary Special Protection Area (SPA); • Dee Estuary Special Area of Conservation (SAC); • Dee Estuary Ramsar site; 	Noted.
121	RSPB CYMRU	HRA	<p>The RSPB's key concerns are summarised below. We have set out detailed comments on the ES in an Annex attached to this letter. These relate principally to the assessment of potential impacts on the ornithological interests.</p> <p>BRIEF SUMMARY OF CONCERNS:</p> <ul style="list-style-type: none"> • Insufficient information, in particular a lack of a full assessment of impacts against the conservation objectives of the SPA; • Permanent habitat loss from within the designated sites; • Disturbance impacts. 	Responses to these concerns are provided for each of the individual detailed comments below.
122	RSPB CYMRU	Ornithology	<p>Annex 1-The RSPB's detailed comments on the Mostyn Energy Park Extension proposal.</p> <p>Survey method</p> <p>In our scoping advice we recommended additional between the tide counts for the Port of Mostyn ornithological surveys. We understand that this advice has not been followed. However, whilst we would like to have seen counts covering all stages of the tidal cycle (as birds use different areas at different stages of this cycle) we acknowledge the timing of counts presented in the ES are sufficient, being undertaken on an hourly basis two hours before and after high or low water respectively, therefore covering approximately two-thirds of the tidal cycle.</p>	Noted.
123	RSPB CYMRU	Ornithology	<p>Habitat damage/loss</p> <p>The footprint of the port extension will result in the permanent physical loss of approximately 3.49 ha of marine habitat, comprising of 2.84 ha of intertidal habitat and 0.65 ha of subtidal habitat within all of the designated sites. Therefore, it is integral to them. We note that while the footprint of the habitat lost supports relatively low numbers of waterbirds, these birds form an integral part of the SPA/Ramsar site interest and so this habitat would be permanently lost to them.</p>	See response to comment 63.
124	RSPB CYMRU	Benthic ecology	<p>The intertidal habitat is further characterised as Intertidal hard substrate habitat (0.27 ha) & Intertidal mud habitat (2.57 ha). The applicant considers the above habitats within the footprint to be of poor quality and not representative of 'Mudflats and sandflats not covered by seawater at low tide' qualifying feature of the Dee Estuary SAC and Ramsar site. However this still represents a permanent loss of 3.49 ha of designated marine habitat which cannot be mitigated, including mudflats that support SPA/Ramsar waterbirds.</p>	See response to comment 63.

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125	RSPB CYMRU	HRA	The Applicant's characterisation and the quality of these habitats needs validating. We note that Table 3 Assessment in advance of any mitigation of Appendix 8.5: Habitats Regulations Assessment states: "Overall, there is considered to be a potential for an AEOI on this habitat interest feature of the Dee Estuary/Aber Dyfrdwy SAC and Dee Estuary Ramsar site in advance of any mitigation." With the above statement in mind, it would be helpful if the Applicant could clarify what mitigation measures are intended in terms of addressing loss/damage of marine habitat. The net loss of 3.49 ha of designated marine habitat will have effects/implications on habitats throughout the estuary. As we note above, its permanent loss cannot be mitigated.	A potential AEOI is not possible to rule out in advance of mitigation because there is a risk that the structure and function, and typical species associated with the Mudflat and sandflats interest feature will not be maintained due to the potential introduction and spread of non-native species. The mitigation that is proposed to address this risk is to include biosecurity management procedures in a CEMP as set out in Table 4 in Appendix 8.5 of the ES. There is not considered to be an effect on the extent of range of this habitat feature as explained in the
126	RSPB CYMRU	Ornithology	Disturbance impacts We are concerned over the potential disturbance to nearby roosts and feeding areas, particularly during construction but also during operation. However, the ES lacks the detailed assessment of the likely effects of disturbance and sensitivity at various locations on the estuary, for example noise modelling in relation to feeding/roosting/breeding sites of SPA bird species. We welcome the proposed mitigation measures to address noise and visual disturbance although it is not clear what mitigation is needed until further information on disturbance levels is provided, both during construction and operational phases. We request further details on how such measures would be implemented, as well how they would be legally secured. This is to ensure that appropriate mitigation measures are in place to ensure the predicted disturbance will not have an adverse effect on the integrity of the SPA/Ramsar waterbird features. With the benefit of additional information on disturbance levels, further measures could be considered, for example restrictions on piling linked to certain tidal states, or a shorter period of adverse/cold weather before ceasing operations.	See response to comment 85.
127	RSPB CYMRU	HRA	Insufficient supporting information The developer has not supplied sufficient information to inform a HRA in relation to additional associated works including the potential construction of a Ro-Ro linkspan pontoon and relocation of existing dolphins. Furthermore, it is not clear where the remediation works sit/fit within the proposal. These entail the scraping back of rubble from the toe of the breakwater structure along the western section of the dock. They are entitled as "Enhancement works" in some documents and are also referred to within Table 3 Assessment in advance of any mitigation of Appendix 8.5: Habitats Regulations Assessment, as promoting natural mudflat restoration. As they do not avoid the permanent loss of designated intertidal and sub-tidal habitats referred to above, they cannot be considered as mitigation measures. Further information is required from the Applicant as to what status they propose the measures to have: site management (to restore natural mudflat functioning) or compensation (to address residual adverse effects on site integrity as a result of the permanent habitat loss described above). The applicant has not considered potential impacts on all of the conservation objectives of the SPA, for example whether the proposed dredging will affect the abundance or availability to birds of prey species, and whether the sightlines of birds from roosting sites and feeding areas are affected. To conclude it is not currently possible to fully assess the impact of the development against the conservation objectives on the Dee Estuary. There is a need for further information to assess the effects on bird populations and associated habitats of the Dee Estuary SPA/Ramsar site.	As set out in the Project Methodology Chapter of the ES (Chapter 3), we have assessed a reasonable worst case project risk envelope as part of the assessment to address any potential uncertainty in the scheme design and construction methodology. The proposed environmental enhancement measure set out in Section 3.1.7 (Chapter 3 of the ES) forms part of the proposed development and is not considered mitigation in terms of the EIA or the HRA. Further details of this measure are provided in response to comment 139. The conservation objectives of the Dee Estuary SPA have been assessed in line with the example HRA that was provided by NRW Advisory (see response to comment 72). These include population size (which take account of effects on abundance and availability of prey). Further information on the assessment of effects on ornithology and the consideration of conservation objectives in the HRA is included in Section 4.6 and 4.7 of the Further Information Report respectively.
128	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	General	Request for further information In accordance with Regulation 14 of the Regulations, NRW considers that further information is required to properly consider, or come to a conclusion on, the likely significant environmental effects of the project. NRW will not proceed with the consideration of the environmental impact or the determination of the Marine Licence until this information is provided.	Further information is provided in this comments log and also a Further Information Report.
129	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	General	General Comment The consultation responses received during determination have been shared with you and you will note a number of significant concerns which should be addressed. Based on the comments made across a range of topic areas further assessment will be required, you may wish to consider withdrawing the application in its current state and resubmit following further engagement with stakeholders. However, as detailed below, should you wish to continue with the determination we consider the following information necessary to allow us to properly consider the potential effects of the project. We would expect that you engage with all relevant stakeholder as you look to address concerns and comments made to ensure that any further information is sufficient, as we would not envisage any further opportunity to	Individual responses to each of the consultation comments are provided in this comments log. Where necessary, additional evidence in support of these responses is included in a Further Information Report.
130	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	General	It is strongly recommended that you review and look to respond accordingly to the points raised by the various consultees. We would request that a signposting matrix and relevant supporting documents should be provided to allow cross-referencing against this information request letter and the consultation responses received.	See response to comment 129. This comments log signposts to the relevant supporting evidence as appropriate.

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131	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Physical processes	Physical Processes Further assessment and evidence is required in order to provide confidence that Mostyn Deep disposal site is able to accept the volumes of material proposed, and that the potential impacts of disposal of this quantity of material over the time period proposed has been properly assessed. This concern has been raised by both Statutory Nature Conservation Bodies (SNCB): NRW Advisory (NRW A) and Natural England (NE). Further detail is provided below.	See response to comment 49.
132	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Physical processes	NRW A have raised concerns that the amount of capital dredge proposed to be deposited exceeds the volumes currently consented within existing licences. There is also concern whether the assessment has considered the ability of the disposal site to disperse the large quantity of material that would be produced during the construction period, which has the potential to alter the morphological and ecological features of the Mostyn Deep site as well as the surrounding sand banks and Dee Estuary through sediment transport and deposition.	See response to comment 45.
133	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Physical processes	There is an inconsistency in the conversion factor used between m3 and tonnes for dredge material. In email dated 23 February 2023 it was confirmed that this was due to the difference between in situ seabed material (2tns/m3) versus dredge material landed ashore (1.5tns/m3). However, this had led to inaccuracies within the Environmental Statement (ES) which must be rectified as this leads to confusion when referring to and comparing what has previously been consented under existing licences and what is being proposed. For example, as highlighted by NRW A, in their consultation response in reference to ES chapter 3 section 3.2.1, if the same conversion factor was used for the existing licences and the ES then the maintenance disposal tonnage would in fact exceed the limits of the current licence rather than be in line with it as stated in the ES. We request that the ES is reviewed, and a consistent conversion factor used, as your email dated 23 February 2023 suggests and as recommended by NRW A, we would ask that a specific gravity conversion of 2 is used, to remain consistent with the existing licences.	See response to comment 46.
134	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Physical processes	Clarification is required to the queries raised by NRW A in relation to the modelling carried out relating to Section 6.7.1 of the ES. We would advise that you discuss these with NRW A in advance of submission, as if the clarification provided raises concerns surrounding the modelling used we would expect that this is addressed at this stage prior to submission of further information. This includes providing clarification surrounding the timing of successive disposal events that has been used within the assessment.	A meeting was held with the coastal processes specialist from NRW Advisory on 12 June to discuss these issues. See responses to comments 47, 48 and 49.
135	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Physical processes	We request that you provide disposal returns for the Mostyn Deep disposal site and any other evidence, in order to support the statement made in section 6.7.2 of the ES the effect of the deposition of capital dredge arisings on the seabed bathymetry will be similar to that which already occurs as a result of ongoing maintenance dredging and disposal. Based on disposal return held by the Marine Licensing Team It is considered that the disposal volumes proposed exceed the volumes that have been deposited at the Mostyn Deep site in recent years.	See response to comment 49.
136	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Physical processes	In addition, NRW A have raised concern that the Salisbury Approach channel has not been assessed particularly for SSC plume dispersal and deposition during the capital dredge operation. An assessment should be carried out in order to show where the plume and subsequent settling of sediment could have an indirect impact to receiving receptors.	See response to comment 50.
137	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Physical processes	We would draw your attention to NRW A consultation response, which has been shared with you, and would ask that you address the points raised. We would strongly recommend that you engage with both NRW A and NE who have raised concerns surrounding the assessment within the area, to ensure that any revision to assessment is sufficient.	Individual responses to each of the consultation comments are provided in this comments log. In addition, a meeting with the coastal processes specialist in NRW Advisory was held on 12 June to discuss and help resolve the issues and concerns raised.
138	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Benthic ecology	Benthic Ecology NRW A have raised concerns that insufficient evidence has been presented to rule out impacts on benthic habitats as a result of changes to the hydrodynamic and sedimentary regimes. We request that further assessment is carried out or justification provided to support the conclusions of the ES. We would again encourage you to discuss this with NRW A prior to making your submission, ensuring that if any justification or further assessment addresses the concerns raised.	Individual responses to each of the consultation comments are provided in this comments log. Additional supporting evidence is also provided in a Further Information Report as necessary. In addition, a meeting with the benthic ecology specialist in NRW Advisory was held on 12 June to discuss and help resolve the issues and concerns raised.
139	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Benthic ecology	Further information is required surrounding the area proposed from scrape back along the western side of the dock. This should include the expected area of mudflat that this would expose.	Section 3.1.7 of the Project Methodology Chapter of the ES (Chapter 3) describes the proposed area to be scraped back along the western side of the dock estate. The location is shown on Figure 3.2 and covers a spatial area of approximately 1.5 ha. This lowering in elevation of the area will expose some intertidal mudflat habitat that is anticipated to be present beneath the layer of rubble and also allow the settling and accretion of mud in areas it has not previously been present. The maximum area of mudflat that could be created by this subsequent measure is estimated to be around 1.5 ha.
140	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Benthic ecology	NRW A and RSPB disagree with conclusion of the assessment relating to direct loss of intertidal habitat as a result of works to the quay wall and capital dredge. We request that you review the comment made by NRW A and RSPB and provide a response to comments made.	See response to comment 62.

Appendix A. Comments Log

No.	Consultee	Topic	Comment	Response
141	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Benthic ecology	Further information is required in order to understand the potential impact of the works on the cockle beds, this should include both the dredge and disposal activity. Maps denoting known cockle beds overlaid with the predicted sediment plume should be provided. If the plume extends over the cockle beds any potential impacts from sediment deposition must be assessed	See responses to comments 61, 65, 66 and 69.
142	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Benthic ecology	Concerns have been raised by NRW A that an assessment of potential impact to benthic habitats from the capital dredge of the main navigation channel has not been provided, including as a result of sediment deposition and changes in water and sediment quality. An assessment of impact of capital dredging of the main navigation channel on benthic features must be carried out	See responses to comments 64 and 71.
143	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Benthic ecology	NRW A disagree that no assessment is required in relation to indirect changes to the seabed habitat and species as a result of changes to hydrodynamics. We would direct you to comment provided by NRW A in their representation and consider that further assessment or evidence is required to support the conclusion presented.	See responses to comments 61, 69 and 70.
144	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Benthic ecology	In line with NRW A comment in relation to Appendix 8.1 Benthic Survey Report we ask that you provide a revised figure which includes subtidal habitats.	See response to comment 76.
145	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	HRA	We would also draw your attention to comments raised below in relation to the Habitat Regulations Assessment (HRA), surrounding assessing impacts against the conservation objectives of the site, which is relevant to benthic features and needs to be addressed.	See response to comment 72.
146	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Ornithology	Marine Ornithology We would direct you to comments raised by NRW A and RSPB. Although impact on birds through permanent loss of habitat and through disturbance has been identified, further information is required to understand the full nature and extent of these impact. At this stage there are significant concerns from NRW A and the RSPB that the assessment within the ES on Marine Ornithology is insufficient	See responses to comments 84 and 85.
147	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Ornithology	We would advise that you review representation made by NRW A and the RSPB and look to address the concerns raised. We would strongly recommend that you engage with both stakeholders to ensure that future information provided is sufficient.	Individual responses to each of the consultation comments are provided in this comments log. Additional supporting evidence is provided in a Further Information Report as necessary.
148	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Ornithology	The key concerns raised which must be addressed include; • Further assessment of the wider impacts of loss of roosting habitat, and loss of foraging resource	See response to comment 84.
149	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Ornithology	More information to understand how conclusion of the ES in relation to effect of habitat loss and disturbance have been reached	See responses to comments 84 and 85.
150	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Ornithology	Further assessment is required to understand how impacts on bird habitats will be affected by changes in physical processes	See response to comment 84.
151	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	HRA	Impact of the works against the specific conservation objectives of the relevant designated sites must be carried out	See response to comment 72.
152	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Proposed development	There is a lack of information presented for the associated works, including pontoon construction, and the location of dolphins and/or piles. Further information regarding these works should be provided and fed into the assessment.	As set out in the Project Methodology Chapter of the ES (Chapter 3), we have assessed a reasonable worst case project risk envelope as part of the assessment to address any potential uncertainty in the scheme design and construction methodology. As much detail as is currently available has been provided.
153	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	WFD/ Water Quality	Water Quality and WFD NRW A have raised concerns surrounding the WFD assessment provided in addition to the assessment of water quality within the ES. We would ask that you review the detailed comment made and provide the clarification requested.	Individual responses to each of the consultation comments are provided in this comments log. Additional supporting evidence is provided in Further Information Report as necessary.
154	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	WFD/ Water Quality	These include; Assessment of impact of the proposed works on the mitigation measures of the Dee Transitional water body	See response to comment 89.

Appendix A. Comments Log

No.	Consultee	Topic	Comment	Response
155	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	WFD/ Water Quality	Further evidence of impact of the works on suspended sediment, which has potential impact including on Dissolved Oxygen, and phytoplankton.	See response to comment 94.
156	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	WFD/ Water Quality	The WFD should make clear if any impacts identified are in relation to the construction phase, maintenance phase or both.	See response to comment 101.
157	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	WFD/ Water Quality	Calculation demonstrating the total area of the water bodies that will be impacted by the development	See response to comment 90.
158	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	WFD/ Water Quality	Consideration should be given in the WFD to accidental spills	See response to comment 103.
159	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	WFD/ Water Quality	Assessment of higher sensitivity habitats including cockles	See response to comment 105.
160	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	WFD/ Water Quality	Clarity on whether the navigation channel has been considered within the assessment of impact on habitat.	See response to comment 106.
161	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	WFD/ Water Quality	Section 7 habitat – effects on priority species included in Section 7 of the Environment (Wales) Act 2016 must be assessed.	See response to comment 108.
162	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Fish	Fish Concerns have been raised by NRW A surrounding the assessment on sandeels. Further evidence is required to support the conclusion presented. The assessment should consider the potential impact upon sandeel habitat as a result of the proposed development. NRW A currently advise that the assessment of impact on sandeel as a result of habitat loss, habitat damage, direct uptake and smothering is insufficient. We would advise that you review all comment made as you look to address this concern.	See response to comment 109.
163	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Fish	NRW A propose additional mitigation including timing restriction surrounding percussive piling activity in order to minimise impact to fish species. Please provide any comment you have on the proposed mitigation.	See response to comment 110.
164	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Fish	NRW A note that a number of fish species that are considered under Section 7 of the Environment (Wales) Act 2016 have not been appropriately assessed. Please see detailed comment within NRW A representation and look to address these.	See responses to comments 111 and 112.
165	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	WFD/ Water Quality	NRW A advise that Fish have not been considered sufficiently within Appendix 7.1 WFD compliance assessment. Further consideration is required of potential impact on fish species upstream of the works, and impact to sandeel should be considered.	See response to comments 114 and 115.
166	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Fisheries	Fisheries NRW Cockle Fisheries Management Officer has significant concern surrounding the assessment carried out for impact of the works on cockle fisheries. These comments must be reviewed and addressed.	See response to comment 42.
167	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Fisheries	These include; Correct identification and assessment of harvesting areas which are in the vicinity of the docks.	See response to comment 41.
168	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Fisheries	Following further consideration of physical process (see comments above), a further assessment to consider potential impact of the works on the harvesting beds must be presented.	See responses to comments 30, 50 and 61.

Appendix A. Comments Log

No.	Consultee	Topic	Comment	Response
169	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Fisheries	North Western Inshore Fisheries and Conservation Advisor (NWIFCA) have highlighted the presence of nearby Mussel Fisheries in the vicinity of the development. Following addressing comments made around the assessment of physical processes, including impact of sedimentation and water quality, further consideration must be given to impact of the works on commercial mussel fisheries.	See response to comment 35.
170	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Marine Mammals	Clarification has been sought by NRW A surrounding the noise modelling methodology used for piling. This should be provided.	See response to comment 118.
171	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	HRA	In relation to Appendix 8.5 Habitat Regulation Assessment this will need to be revisited based on the results of comments above.	Individual responses to each of the consultation comments are provided in this comments log. Additional supporting evidence is provided in a Further Information Report as necessary.
172	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	HRA	RSBP and NRW A have raised that the HRA produced does not assess the works appropriately against the conservation objectives for the site. The assessment must be revisited ensuring that impacts of the works on the conservation objectives of the sites are fully considered.	See response to comment 72.
173	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	General	A number of comments have been raised in relation to the assessment of physical processes. Any revision of this assessment should be drawn through to the relevant topics of the ES as well as the HRA. This may lead to further consideration of potential indirect losses and or degradation of habitats as a result of; <ul style="list-style-type: none"> • Capital dredge disposal at Mostyn Deep • Removal of 600,000 m³ of sediment ashore to use in the reclamation • Maintenance dredge • Indirect impacts to benthic habitats from changes in hydrodynamics from the operation/presence of the quay wall 	The implications of the responses to the consultation comments provided in this comments log and further supporting evidence included in the Further Information Report on other topics/HRA have been considered.
174	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Navigation	Navigation A number of comments requiring clarification have been made by the Dee Conservancy. Please review the comments made and provide a response.	Individual responses to each of the consultation comments are provided in this comments log.
175	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Navigation	We would also draw your attention to comment made by the Dee Conservancy in relation to location of the operational area; clarification is required in order to understand overlap between the maintenance dredge regime and the riverbed owned by the Dee Conservancy.	See response to comment 7.
176	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Physical processes	Please confirm whether consideration has been given on potential impact of sediment dispersal on other developments including Connah's Quay.	See response to comment 30.
177	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Archaeology	Both Cadw and RCAHMW agree with the proposal to establish an archaeological exclusion zone around the recorded shipwreck and to implement a protocol for archaeological discoveries and an associated Written Scheme of Investigation.	Noted.
178	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	Archaeology	However, both Cadw and RCAHMW consider that geoarchaeological assessment of the existing geotechnical material has not been completed and therefore the assessment carried out in support of the application is incomplete. Please address concerns raised. We would advise that you liaise with both Cadw and RCAHMW to ensure that the geoarchaeological assessment is provided and is sufficient.	See responses to comments 4 and 26.
179	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	General	Please provide the information requested above by 23 June 2023. We have allowed 3 Months due to the substantive further information request above, and to ensure opportunity for you to engage with relevant stakeholder as you seek to address concerns raised. If NRW has not received this information by this date, in accordance with regulation 14 application CML2283 will be treated as having been withdrawn. Please contact me as soon as possible if additional time will be required to collate this information. If the information is available before this date NRW will be able to accept it prior to the deadline date .	Noted.
180	cyfoethnaturiolcymru Natural Resources Wales Marine Licensing Team	General	Please note that further information must be publicised in accordance with the requirements stipulated in Regulation 16 of the Regulations. Therefore, once this information is received by NRW, you will be provided with a public notice to publish in the same newspaper as the project was previously publicised at your own expense.	Noted.

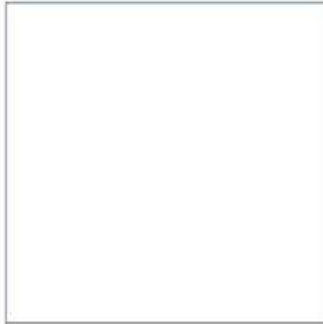
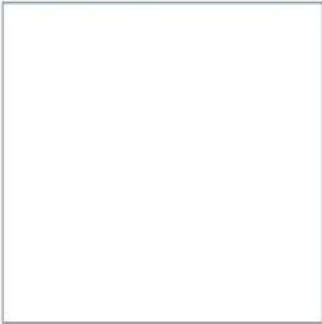
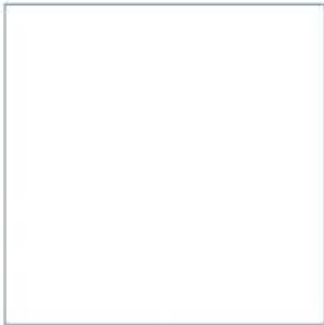
B Review of Bathymetric Survey and Modelling Work (ABPmer, 2021)

Port of Mostyn Ltd

Mostyn Channel Dredge and Disposal – Hydraulic Modelling Studies 2021

Review of annual bathymetric survey and numerical modelling work for Marine Licence DML 1542v2

November 2021



Innovative Thinking - Sustainable Solutions



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Mostyn Channel Dredge and Disposal – Hydraulic Modelling Studies 2021


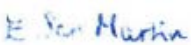
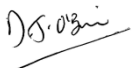
Review of annual bathymetric survey and numerical modelling work for Marine Licence DML 1542v2

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Executive Summary

Report background

At the Port of Mostyn, dredging is carried out to maintain a safe navigable approach channel with the dredged sediment then being deposited subtidally within the 'Mostyn Deep' area in the outer Dee Estuary. To accompany these dredging and disposal activities, the Port has carried out a detailed monitoring programme over several years. This monitoring programme has been undertaken by the Port of Mostyn in fulfilment of conditions within marine licences provided by Natural Resources Wales (NRW).

The core aims of this programme are to understand the physical and ecological consequences of this dredging and disposal work and to determine whether the resulting changes could affect the nature conservation interests of the Dee Estuary. The latest phase of this ongoing programme of monitoring work is being conducted under Marine Licence Ref DML1542v2 (NRW, 2019).

In contribution to this monitoring programme, this report presents results from a sequence of surveys and modelling studies that were undertaken to describe the geomorphological and hydrodynamic conditions within the Dee Estuary. The results presented will inform the production of the 2021 annual report under this monitoring programme. The main aims of the analyses within this report are to:

- Summarise historic and recent physical changes within the estuary based on bathymetric and topographic data (including the latest estuary-wide Light Detection and Ranging (LiDAR) survey) that has been collected by the Port;
- Revisit the modelling analyses that were carried out to evaluate the effects of the channel deepening work to determine whether the previous findings still apply as the estuary continues to evolve;
- Provide complementary information which underpins the other surveys and ecological investigations which are carried out under the monitoring programme.

The Port commissioned ABPmer to carry out this latest annual data and modelling review. For this study, particular care has been taken to ensure that the methods applied, and data presentation techniques employed, are consistent with those adopted during the previous impact assessment studies, monitoring and modelling reviews that have been carried out by the Port.

Marine Licence background and recent channel changes

The past and present marine licences for the approach channel dredging work have provided consent for regular maintenance dredging of the approach channel to no deeper than -2 mCD, as well as for a larger capital deepening, and regular maintenance dredging, to a maximum depth of -4 mCD, should that be required. So far however, only comparatively small maintenance dredging activities have been undertaken because there has not, as yet, been a commercial need to carry out the capital deepening.

The maintenance dredging has been undertaken on an 'as required' basis and this has meant that the channels have been allowed to morphologically adjust over time. As a consequence, the Mostyn Channel has naturally migrated westward at around 20 m/year since 2005 (and has also reduced in depth and meandered significantly, to such an extent that it is no longer viable for some vessels to manoeuvre into the Port through this channel).

As a possible linking effect of the Mostyn Channel migration, an additional channel has continued to form and mature since 2017, which lies approximately 1 km to the east of the Mostyn Channel. This has been recognised as a new navigation channel (now known as the ‘Salisbury Channel’) and is used as the approach to the Port of Mostyn for small vessels.

Project summary and conclusions

For this study, recent bathymetric and topographic data (from 2020 and 2021) have been analysed, to extend and build on an equivalent assessment of previous annual monitoring surveys, since 2003. The observed morphological changes have been considered and a modelling study carried out to assess the effects of a potential future -4 mCD capital dredging project within the Salisbury Channel. The observed morphological changes and modelling results are summarised below.

Morphological change: banks and channels

A review of LiDAR and bathymetric data that has been collected between 2006 and 2021 describes the inter-annual changes that have taken place to the orientation and alignment of the banks and channels of the Dee Estuary. As noted above, the original navigation channel to the Port of Mostyn, as it meanders between the Mostyn Bank and the Salisbury Bank, has shown a general westerly migration over the monitoring period. The original alignment of this channel has filled in between 2006 and 2021 as it has realigned further to the west.

Over this period (2006 and 2021), the centre-line of the Mostyn Channel has migrated up to approximately 580 m in places, from its original alignment. In addition, its orientation has also shifted from a straighter channel in 2006 to a significantly more curved one in 2021 while the Salisbury Channel has migrated east, deepened and widened, between 2006 and 2021.

There is also a notable lateral movement of the main channels in the central estuary, along with alterations to the banks and channels around Mostyn Deep. Similar to that described above for the Mostyn Channel and the Salisbury Channel, the main channels of the central estuary have exhibited a number of shifts in alignment between 2006 and 2021. The upper reaches of the Hilbre Channel have straightened, to a degree, over the monitoring period, with the original alignment showing evidence of infilling. Also, to the east and west of the original meander (to the northeast of Salisbury Bank), deepening is evident. In contrast, the upper reaches of the Welsh Channel exhibit a reversal of this pattern with the alignment of the channel in 2006 being straighter than the more meandering orientation shown in the more recent survey data. Over the period between 2017 and 2021, there has been a relatively small change in bed elevation across the central estuary which is similar to the changes reported in previous studies. Therefore, previously observed trends (e.g. in channel migration) have generally continued during this latest year of the monitoring programme.

Towards the entrance to the Dee Estuary, notable changes are also observed, particularly in relation to the development of the Welshman’s Gut and the Mid Hoyle Channel. In around 2006 Welshman’s Gut closed (infilled) and has remained in this state through to (and including) 2021. Meanwhile, over the same time period, the Mid Hoyle Channel has further developed with the entrance to the Welsh Channel initially moving eastwards, albeit with the rate slowing, particularly on the east side, hence narrowing the channel. In 2021 the west side of the channel was seen to be continuing a westwards migration, particularly on the north side of the bank. In addition, since 2006, new channels have developed through the West Hoyle Spit, particularly to the west of the Mid Hoyle entrance channel, connecting to the Mid Hoyle channel to the north. This has effectively split the flow in this area.

As noted above, from 2017 onwards the monitoring data and modelling review has extended past the mouth of the Dee Estuary. It now encompasses the West Hoyle Bank, the West Hoyle Spit and parts of

the East Hoyle Bank, along with the approaches to the Welsh and Hilbre channels. As more data is collected over this extended area in subsequent years, the analysis of bed elevation change will also be extended further to include analysis of the changes occurring on these outer banks.

Morphological change: Statistical analysis of estuary bathymetry

Statistical analyses of the recent bathymetric and topographic data show that changes in estuary volume have occurred between 2017 and 2021 that are comparable with those reported in the previous monitoring studies. In general, average annual changes between subsequent years remain relatively small.

Modelled assessment of potential -4 mCD Salisbury Channel dredging

The numerical modelling study examined the potential effects of maintenance dredging, to -4 mCD, within the Salisbury Channel. It was found that the predicted effects of dredging on the hydrodynamic and sediment transport generally remain localised to the Port of Mostyn region. As described above, there are broader changes occurring in the rest of the estuary as the outer channels change and then influence, in turn, the central estuary and the upstream channels. The Salisbury Channel to the Port of Mostyn dredged to -4 mCD, still appears to have a negligible influence on the distribution of the main tidal flows and the movements of channels in the main estuary.

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1 Introduction

1.1 Project background

At the Port of Mostyn (Dee Estuary, North Wales (see Figure 1)), occasional dredging is carried out to maintain safe navigable access to the Port through the 'Salisbury Channel'. The dredged sediment is then deposited subtidally within the 'Mostyn Deep' area, in the outer Dee Estuary. To accompany these dredging and disposal activities, the Port has carried out a detailed monitoring programme over several years. This programme has been undertaken in fulfilment of conditions within marine licences provided by Natural Resources Wales (NRW). The latest phase of this ongoing programme of monitoring work is being conducted under Marine Licence Ref DML1542v2 (NRW, 2019).



Figure 1. Location of the Port of Mostyn with aerial view of the Port from the south west

The core aims of the Port's monitoring programme are to understand the physical and ecological consequences of the dredging and disposal work and to determine whether the resulting changes could affect the nature conservation interests of the Dee Estuary. The Dee Estuary is subject to a high level of national and international nature conservation protection through its designation as: A Site of Special Scientific Interest (SSSI); a Special Protection Area (SPA); a Wetland of International Importance (Ramsar site) and a Special Area of Conservation (SAC).

The monitoring programme is therefore carried out, primarily, to understand whether the dredging activities may have any effect on the conservation status and conservation objectives of the Dee Estuary's designated sites. In circumstances where adverse effects could arise, the monitoring would also be used to understand what mitigation measures needed to be adopted to address these in advance. These objectives are presented in the Mostyn Channel Monitoring Protocols (SMP, 2008; 2015).

1.2 Report background and scope of work

This report presents the results from a sequence of surveys and modelling studies that have been undertaken to describe contemporary geomorphological conditions within the Dee Estuary. These analyses were carried out to inform the production of the 2021 annual report under this monitoring programme.

The extant marine licence provides permission for the Port of Mostyn to dredge and maintain a navigable approach channel in the outer Dee Estuary. It also permits the Port to deposit defined volumes of dredged sediment in the Mostyn Deep area in the outer estuary (see Figure 2 for locations). The core aims of the Port's monitoring programme are to understand the physical and ecological consequences of this dredging and disposal work and to determine whether the resulting changes could affect the nature conservation interests of the Dee Estuary. In this context, the main aims of the analyses within this report are to:

- Summarise historic and recent physical changes within the estuary based on bathymetric and topographic data (including the latest estuary-wide Light Detection and Ranging (LiDAR) survey) that has been collected by the Port;
- Revisit the modelling analyses that were carried out to evaluate the effects of the channel deepening work to determine whether the previous findings still apply as the estuary continues to evolve;
- To provide complementary information to underpin other surveys and ecological investigations that are carried out under the monitoring programme.

This report follows on from a series of previous impact assessment studies and annual monitoring and modelling reviews that have been produced regularly since 2005. It also follows on from a recent review of all the monitoring undertaken between 2005 and 2016 that was carried out for the Port (again as a condition of the existing marine licence) by ABPmer (2017). A number of recommendations from this review emerged, which were discussed and agreed with NRW. These included reducing the scope and frequency of a number of monitoring components but also involved extending the boundary of the survey area to cover the outer banks in front of the estuary. It also included having a longer-term view for survey planning, over 2 to 5-year periods, rather than having all work repeated work on an annual cycle.

The Port has now commissioned ABPmer to carry out this latest annual data and modelling review. For this latest annual review work, particular care has been taken to ensure that the methods applied are consistent and comparable with those adopted over previous reporting years.

1.3 Report outline

This report includes the following sections:

- Section 2:** Description of the datasets used, methods applied, and results obtained from the continuing annual bathymetric analysis of the Dee Estuary;
- Section 3:** Summarises the setup, calibration and application of the numerical modelling tools to investigate the hydrodynamic and sediment transport across the study area;
- Section 4:** Details the results of the numerical modelling, assessing the effects of dredging the Salisbury Channel to maintain a minimum depth of -4 m CD; and
- Section 5:** Provides a discussion of the results from the various study tasks, in the context of the wider morphology of the Dee Estuary and the Outer Banks system.

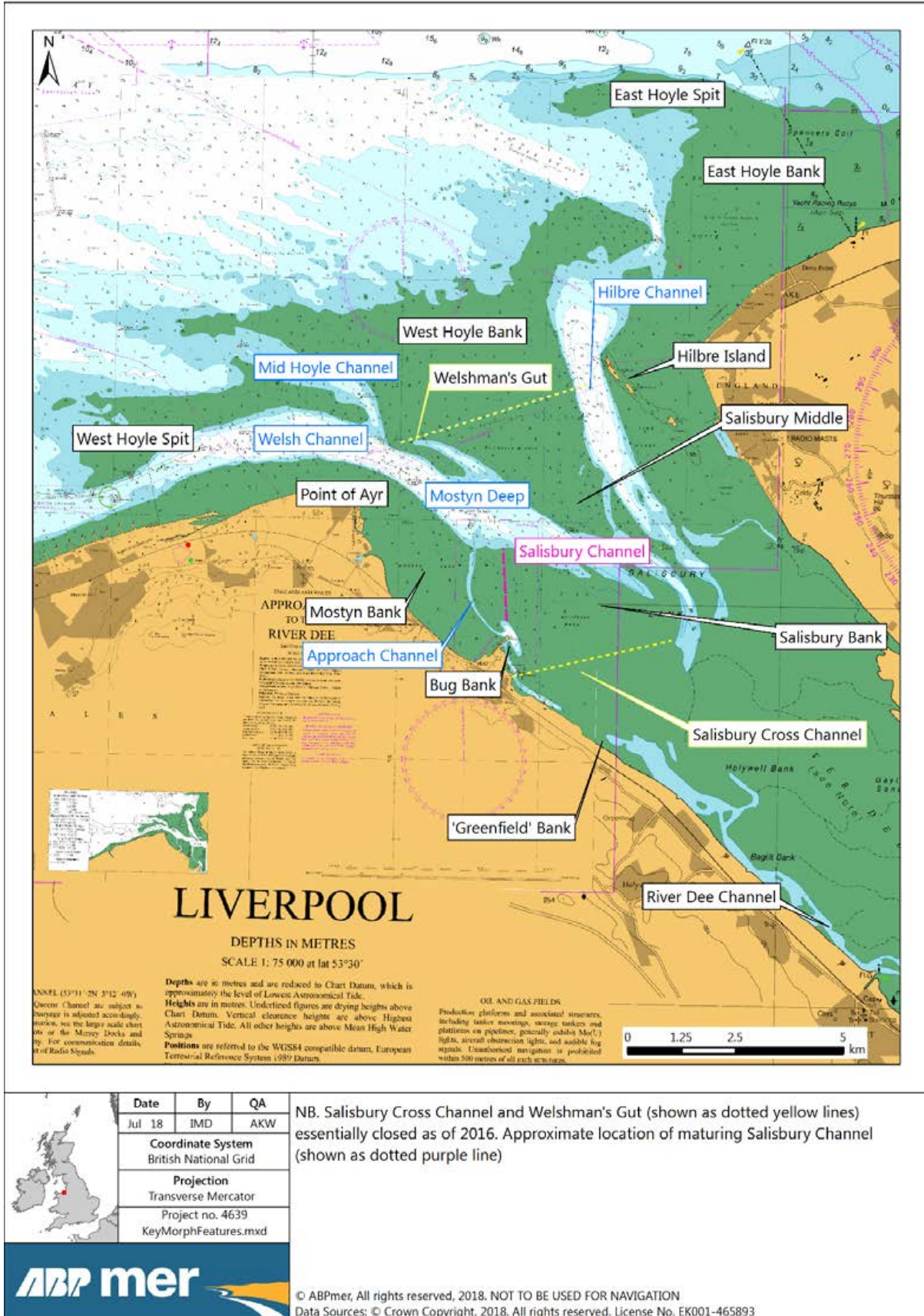


Figure 2. Arrangement of banks and channels within the Dee Estuary and Approaches

2 Bathymetric Analysis

The present study builds on the ongoing annual monitoring, including analysis of the most recent (2021) bathymetric and topographic datasets. The following sections detail the datasets used in the analysis, along with the methodology applied within the assessment.

2.1 Previous datasets (2006 to 2017)

Bathymetric and topographic data, in the form of combined DTM (Digital Terrain Model) grid nodes, were provided from the annual monitoring studies between 2006 and 2015 (e.g. HR Wallingford, 2016). These DTM grid nodes were then used to re-create the elevation surfaces for their respective years, in order that comparative analysis could continue, with the latest data. The spatial resolution of the DTM nodes varied throughout the estuary with coarser resolution in the intertidal areas (requiring more interpolation), and finer resolution across the subtidal areas, and in the vicinity of the Port of Mostyn. As described below, the most recent 2016 to 2021 DTMs are represented at higher resolution, with a consistent grid spacing of 1 m used across the analysis extent. The potential implications of varying the DTM resolution are discussed further in Section 2.2.3.

For the purposes of the bathymetric analyses, the DTM datasets were referenced to British National Grid, in the horizontal and Chart Datum (CD), in the vertical.

2.2 Set-up and analysis of 2021 DTM

The following sections describe the data that has been used to create the DTM elevation surfaces for the 2021 period, and the methods used to carry out the analysis of areas and volumes across the estuary. A description of the checks carried out to ensure consistency with previous annual monitoring studies, is also provided.

2.2.1 Bathymetry set-up

The 2021 DTM was created using data from multiple sources that were combined into a single dataset (applying a priority to more recent/higher resolution datasets in each case); any gaps were subsequently filled with earlier data sources, taking care to merge the datasets smoothly, with the more recent data. Where LiDAR data has been used, any water surface present in the raw data has been manually removed. The most recent, comprehensive and consistent set of bathymetric and topographic data for the 2021 DTM was provided by using the following:

- LiDAR data collected in February 2021; and
- Bathymetry information collected by the Port of Mostyn between January and July 2021.

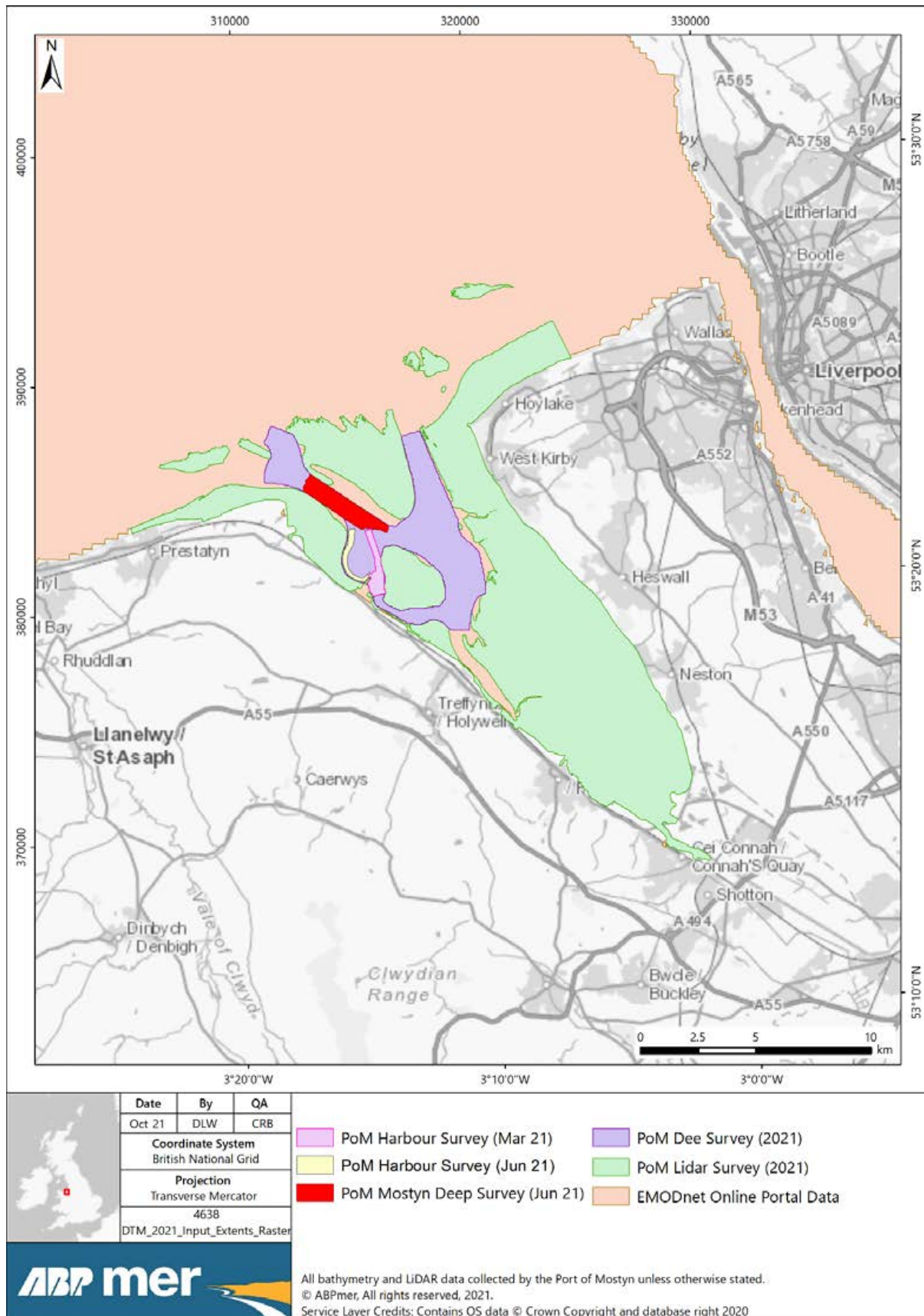


Figure 3. Bathymetric and topographic datasets used in the interpolation of the 2021 DTM

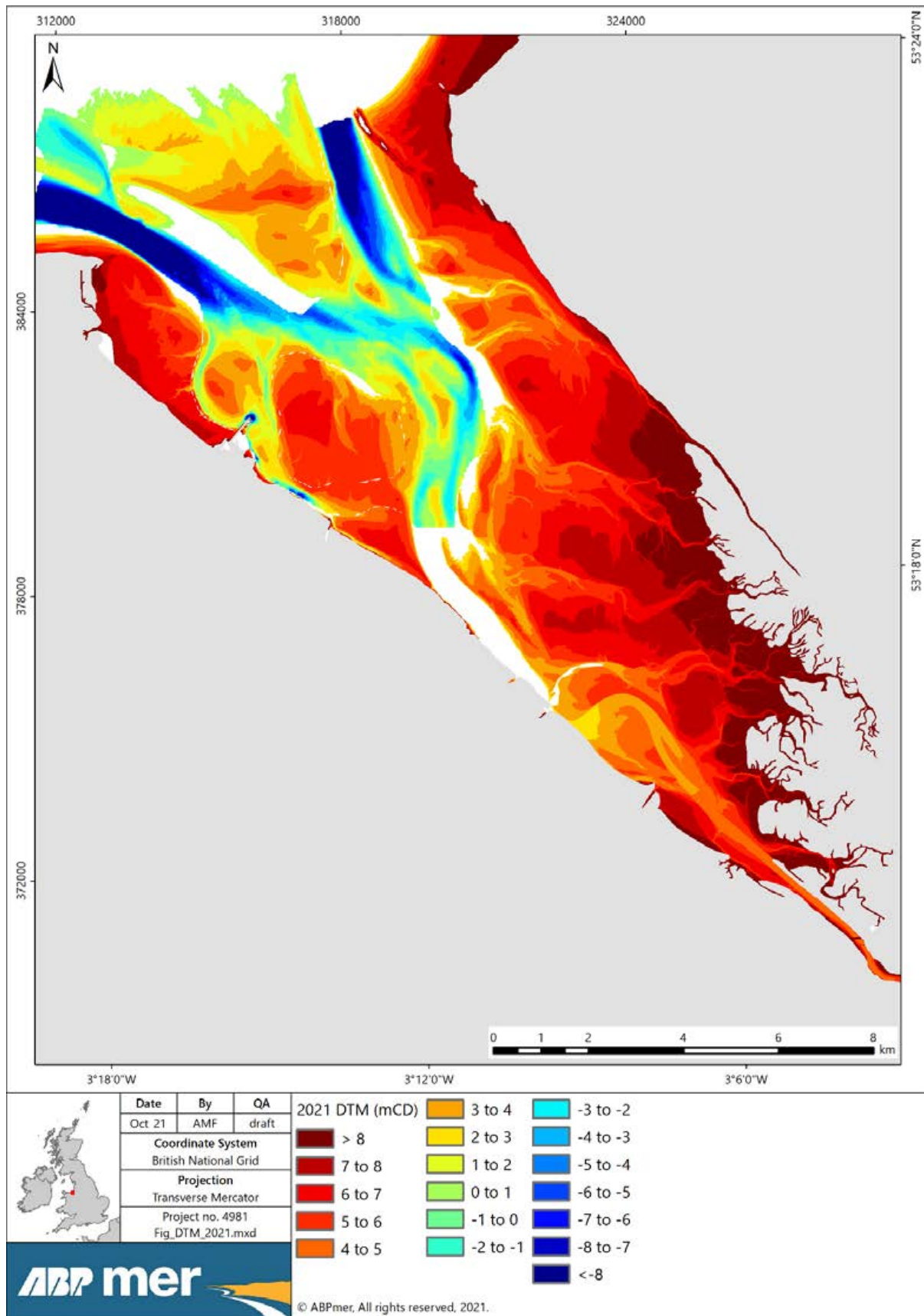


Figure 4. DTM for 2021

The interpolated DTM elevation surface for 2021 is shown in Figure 4. The white areas in the figure show gaps in coverage where contemporary data is not available; in these areas, the DTM has been filled with data from the previous (2017) DTM surface. Checks on the DTM interpolation have shown that the elevation surfaces created for 2021 is smooth, with no indication of ‘stepping’ at the join of different data sources. Once the new DTM surface was created, the changes in bed elevation, between annual survey periods from 2006 to 2021, were calculated (as described below).

2.2.2 Analysis of bed level changes between 2006, 2017 and 2021

Using the interpolated DTMs from the earliest study (2006) and the most recent study (2017), along with those created for 2021, the difference in bed elevation has been calculated. As far as possible, the units, reference frames and colour scales provided in the present study have been matched to those used previously, in order to assist in comparison between datasets.

In addition to the map plots of bed level change, cross-estuary profiles have also been extracted along two sections across the estuary: one across the mouth of Dee between Point of Ayr and Hilbre Point; the second just down-estuary of the Port of Mostyn, extending through the Mostyn and Salisbury Channels (see Figure 2 for locations of the banks and channels discussed below). The bed elevation profiles for these two sections, between 2006 and 2021, are shown in Figure 5 and Figure 6, which also contain annotations of the main observable changes.

Analysis of the map plots of elevation change, and the temporal variation in bed elevation shown in the cross-section profiles, indicates that the primary changes observed across the period of data coverage (2021 to 2006) are as summarised below:

- The Mostyn Channel to the Port of Mostyn, as it meanders between the Mostyn Bank and the Salisbury Bank, has shown a general westerly migration over the monitoring period. This movement, between 2006, 2017 and 2021, is shown Figure 8 and Figure 9 and reveals how the original alignment of the Mostyn Channel has filled in over the 15-year period (shown by the red/orange colours) and realigned further to the west (shown by the blue/green colours). Between 2006 and 2021, the centre-line of the Mostyn Channel has migrated up to approximately 580 m in places, from its original alignment. In addition, its orientation has also shifted from a straighter channel in 2006 to a more curved one (Figure 9).
- In addition to the evolution of the Mostyn Channel, the Salisbury Channel is also shown to be developing over the analysis period. In contrast to the Mostyn Channel, the Salisbury Channel exhibits an easterly migration since 2006 (by a slightly smaller distance of around 350 m).
- There is also a notable lateral movement of the main channels in the central estuary, along with alterations to the banks and channels around Mostyn Deep. Similar to that described above for the Mostyn Channel, the main channels of the central estuary have exhibited a number of shifts in alignment between 2006 and 2021 (Figure 9).
- The upper reaches of the Hilbre Channel have straightened over the monitoring period, with the original alignment showing evidence of infilling. Also, to the east and west of the original meander (to the northeast of Salisbury Bank), deepening is evident. In contrast, the upper reaches of the Welsh Channel exhibit a reversal of this pattern with the alignment of the channel in 2006 being straighter than the more meandering orientation shown in the 2021 survey data. Over the period between 2017 and 2021, there was an eastward shift of the main channel in the central estuary (Figure 8).
- Towards the entrance to the Dee Estuary, notable changes are also observed, particularly in relation to the development of the Welshman’s Gut and the Mid Hoyle Channel. In around 2006 Welshman’s Gut closed (infilled) and has remained in this state through to 2021, as shown

by the orange/yellow colours on Figure 9. Meanwhile, over the same time period, the Mid Hoyle Channel has further developed with the entrance to the Welsh Channel moving eastwards.

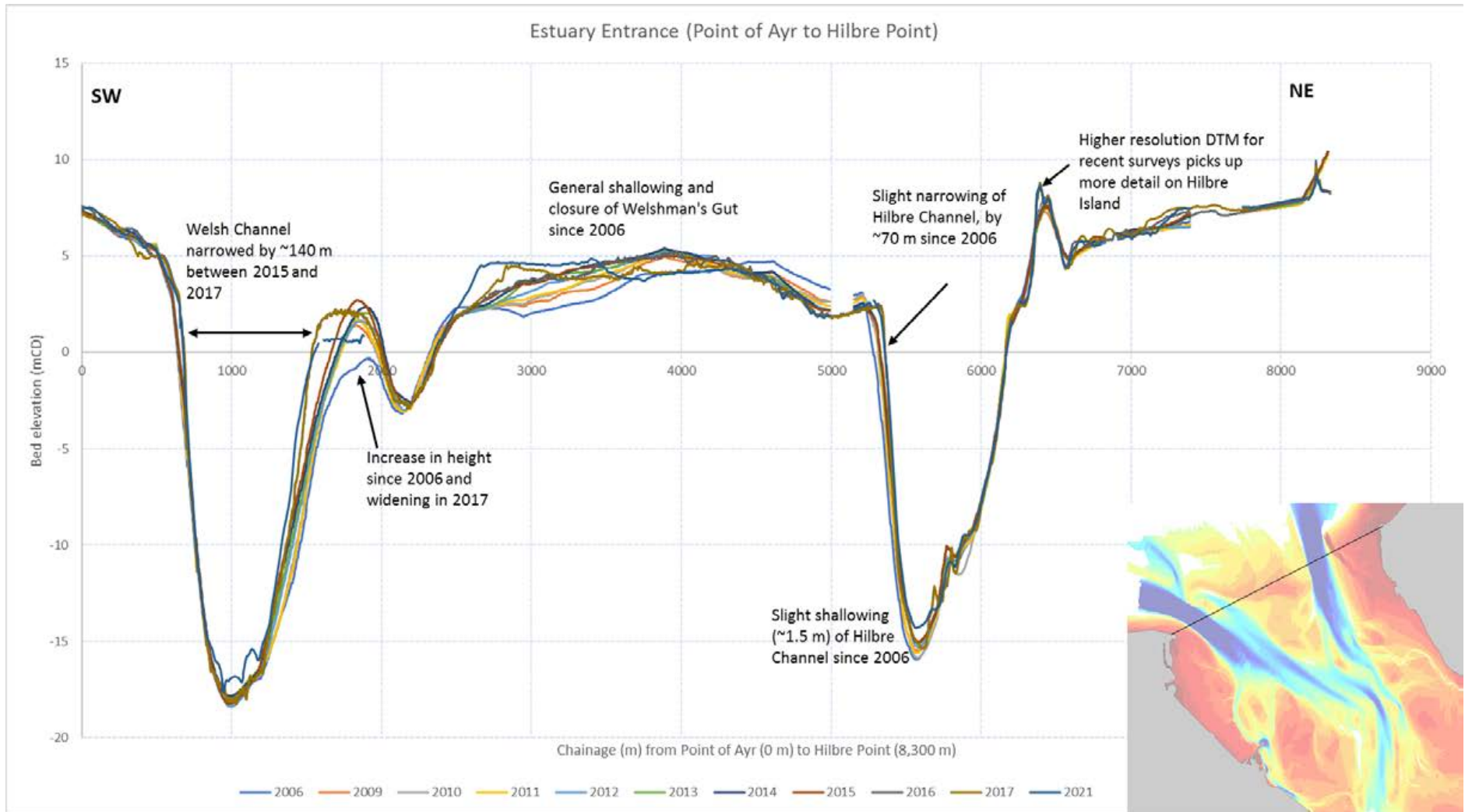


Figure 5. Temporal variation in bed elevation across profile at the mouth of the Dee Estuary

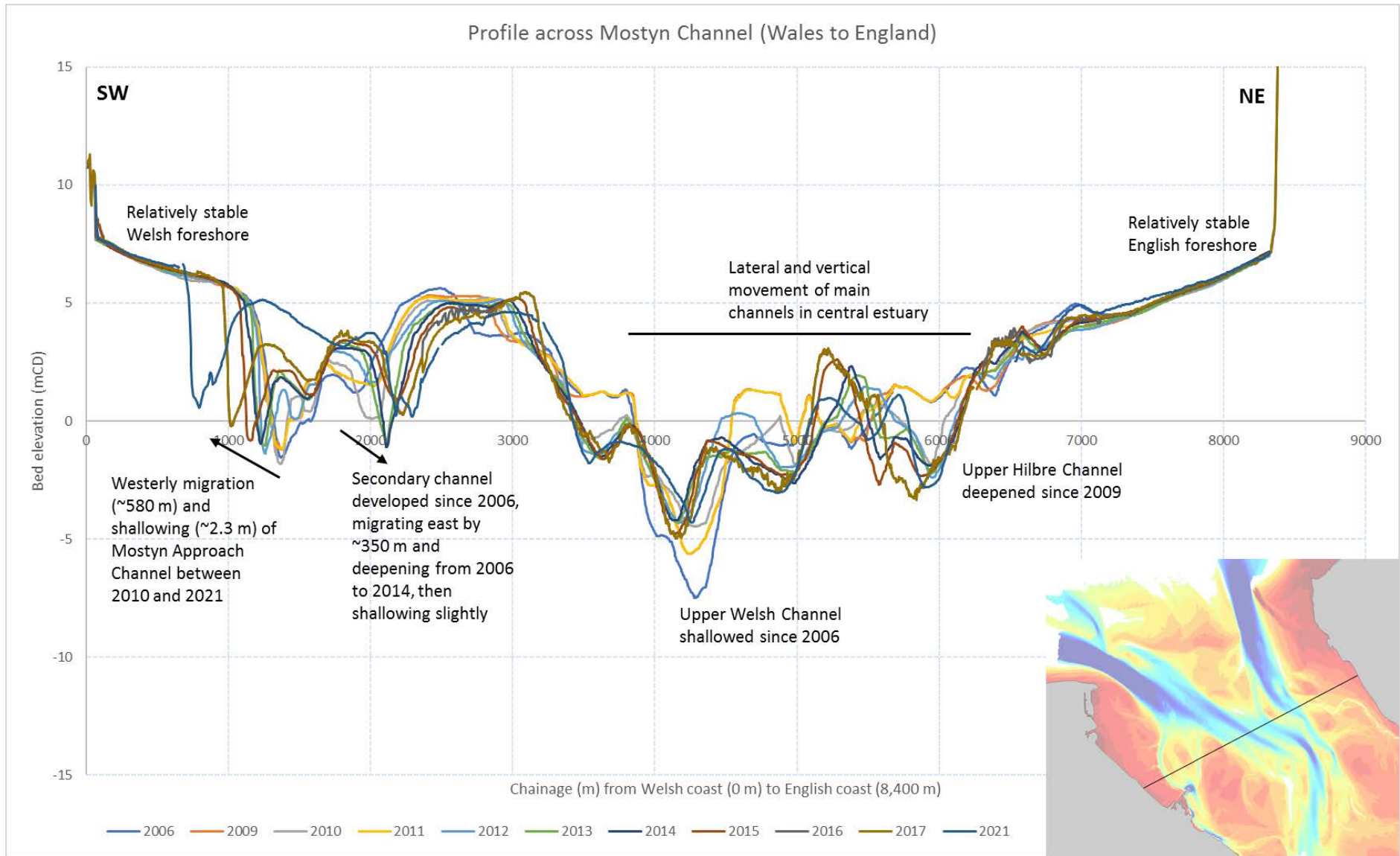


Figure 6. Temporal variation in bed elevation across profile down-estuary of the Port of Mostyn

2.2.3 Statistical analysis of bed level changes between 2003 and 2021

In addition to the assessment of bed elevation change between annual survey periods, the DTM surfaces were analysed to further provide the sediment volume above a given set of elevation thresholds (as defined in previous monitoring reports). In following the approach used in HR Wallingford (2016), the volume statistics were calculated for the whole Dee Estuary (defined as up-estuary of a line between Point of Ayr and Hilbre Point), and also broken down into the northern and southern halves (as defined in Figure 7). In this way, detailed information on annual changes in volume are provided. In future years, this analysis can be extended to cover the area of the outer sand banks and channels, within the approximate area shown in Figure 7.

The results of the volume analysis, for all years between 2003 and 2021, are provided in Table 1 to Table 3. Within these outputs and the text of this report, the interpretation of levels relative to CD is defined by positive elevations above CD, and negative elevations below CD. In each of these tables, data up to and including 2015 are taken from the previous monitoring report (HR Wallingford, 2016); values for 2016 onwards are as calculated in the subsequent studies (including ABPmer, 2018b).

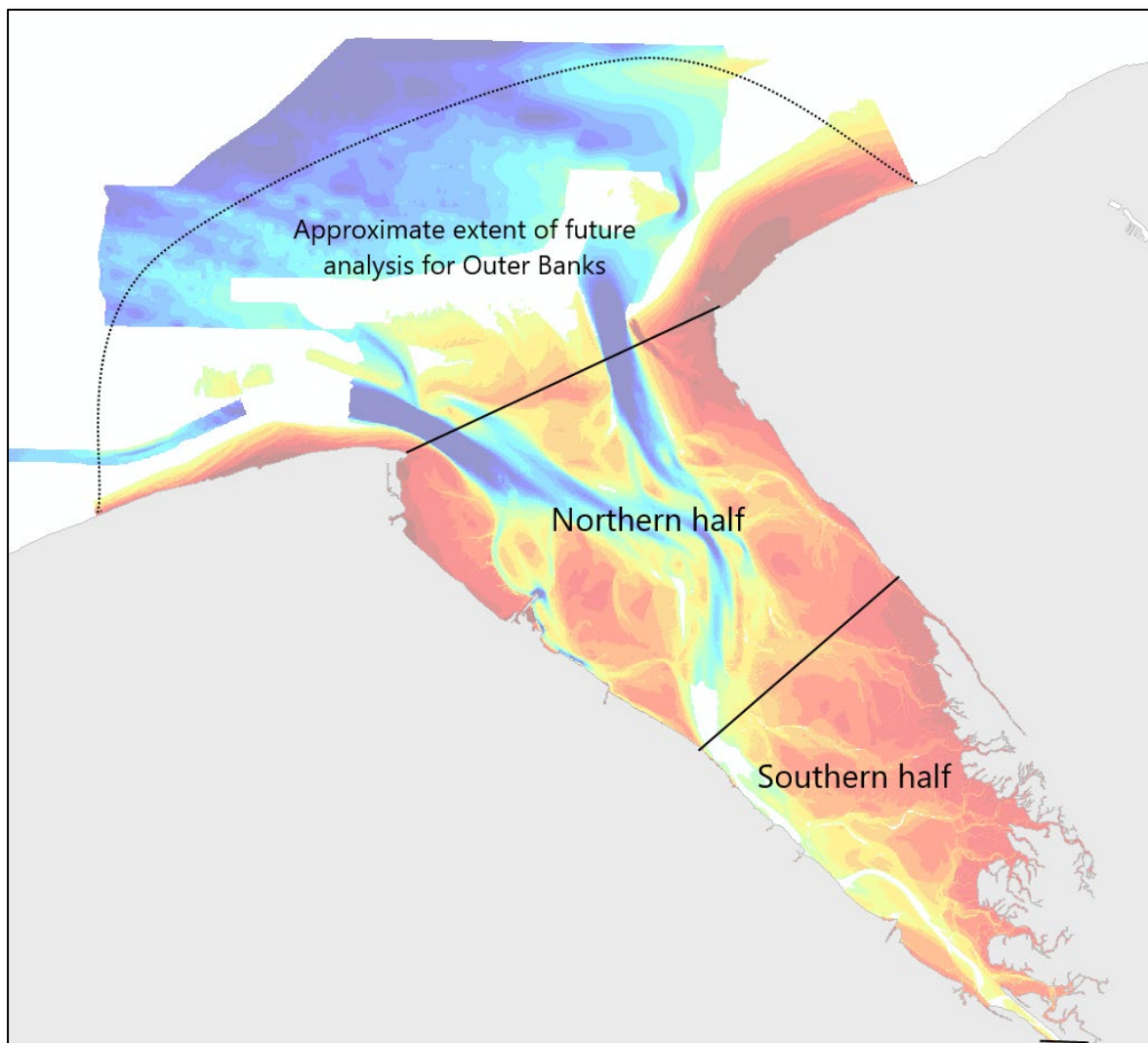


Figure 7. Definition of northern and southern estuary sections for area and volume analysis

The results of the volume analysis are also presented graphically in Figure 10 to Figure 12, showing total volume, along with changes between annual survey periods. In addition, the sediment volumes normalised to the earliest (2003) dataset, are presented graphically in Figure 12

The results of the comparison between 2015, 2016, 2017 and 2021 reveal similar scales of change to the general changes observed between earlier surveys, particularly when considering the average annual change between the 2017 to 2021 period. Throughout the duration of the surveys (since 2003), the changes calculated between 2013 and 2014 stand out as particularly large annual increases in volume (when compared against inter-annual comparison of earlier and later datasets). This is presumably related to the effect of the large winter storms of 2013-14, which appear to have pushed sediment higher up in the tidal plane, resulting in the relatively large increases above the -5 mCD threshold (Figure 11).

The comparison between 2017, 2016 and 2015 data reveals a slight increase in sediment volume over the whole estuary (noting the differences in DTM grid resolution and the resultant influence on area and volume calculations, as described in Section 2.2.3). The statistical analysis shows a small increase in volume above -1 mCD, over both the northern and southern regions, whilst volumes below this threshold reduce slightly over the southern half.

Extending the analysis to compare the 2021 dataset, indicates that there was an overall increase in volume over the whole estuary, at thresholds above -5 mCD, and a small increase in volume below this threshold, over the four years covered by the analysis. The observed changes are generally comprised of small average annual increases in volume for the northern half, at each threshold elevation; along with generally little change in volumes over the southern half.

Figure 12 shows the calculated changes in volume, normalised to 2003 values. As noted previously (HR Wallingford, 2016), due to the small values from the 2003 base data, in some cases the normalised parameters show large relative changes, where (in fact) the absolute changes are relatively small. As with the values described above, the normalised plots show a slight increase in volume for 2016, followed by a slight reduction (back to approximately 2015 values) in 2017. Subsequent increases over the four years to 2021 are also evident in the normalised plots (Figure 12).

Over the duration of the monitoring, the normalised volume plot (Figure 12) confirms an established view that the estuary is generally infilling with time. The greatest changes occur higher up on the banks, with the smallest change below -3 mCD. The largest year-on-year change tends to be observed around the ± 1 mCD thresholds.

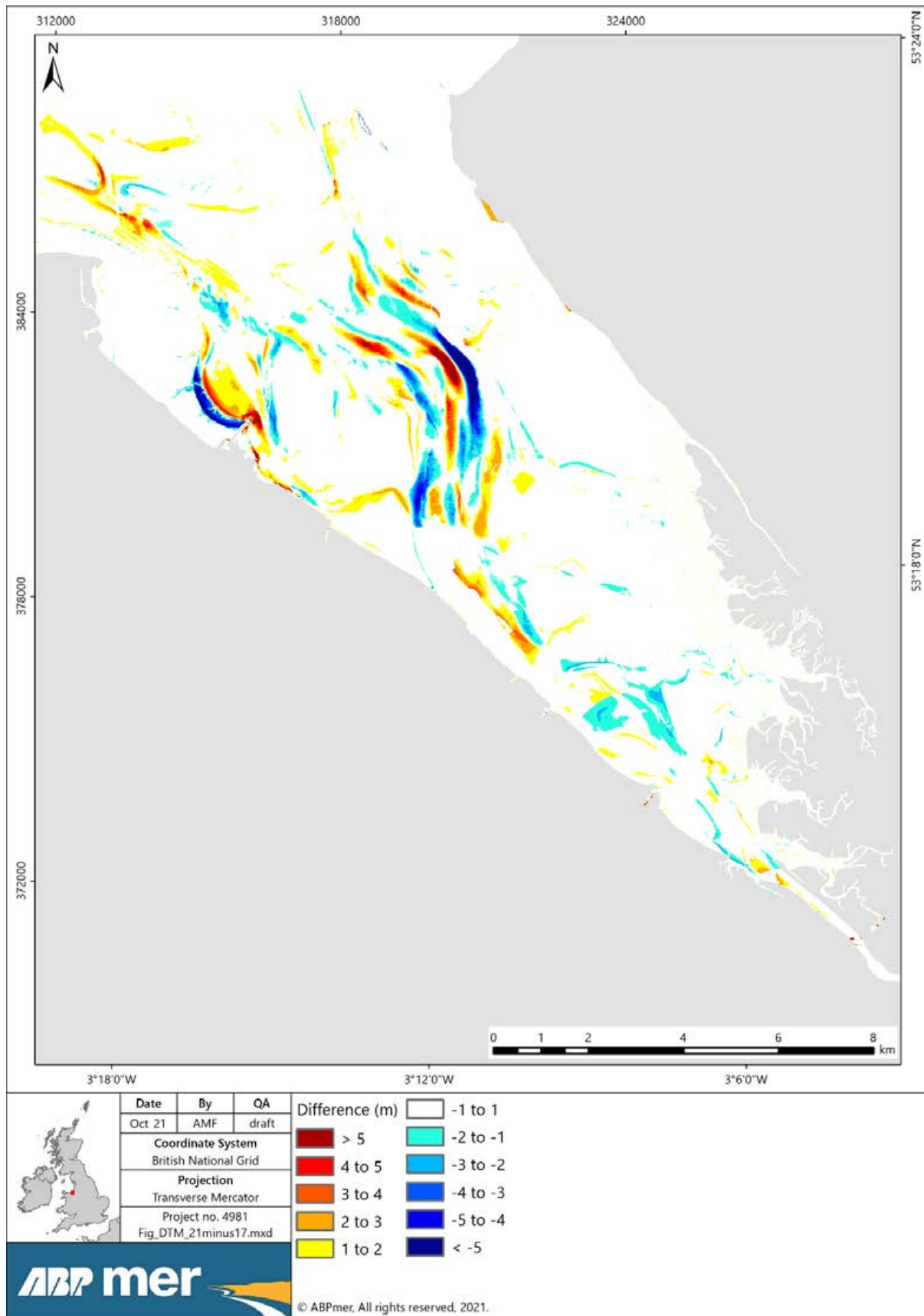


Figure 8. DTM difference between 2021 and 2017

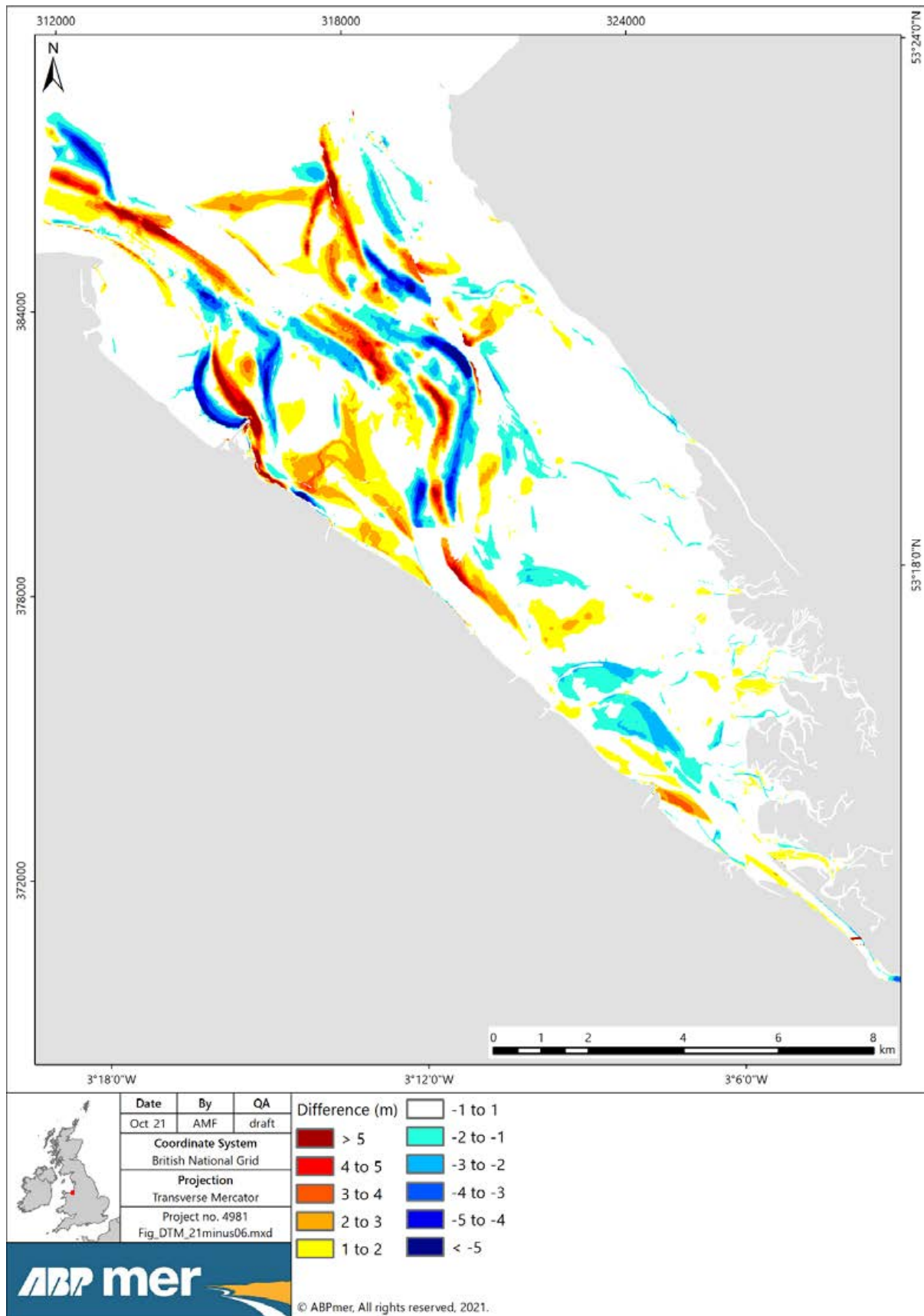


Figure 9. DTM difference between 2021 and 2006

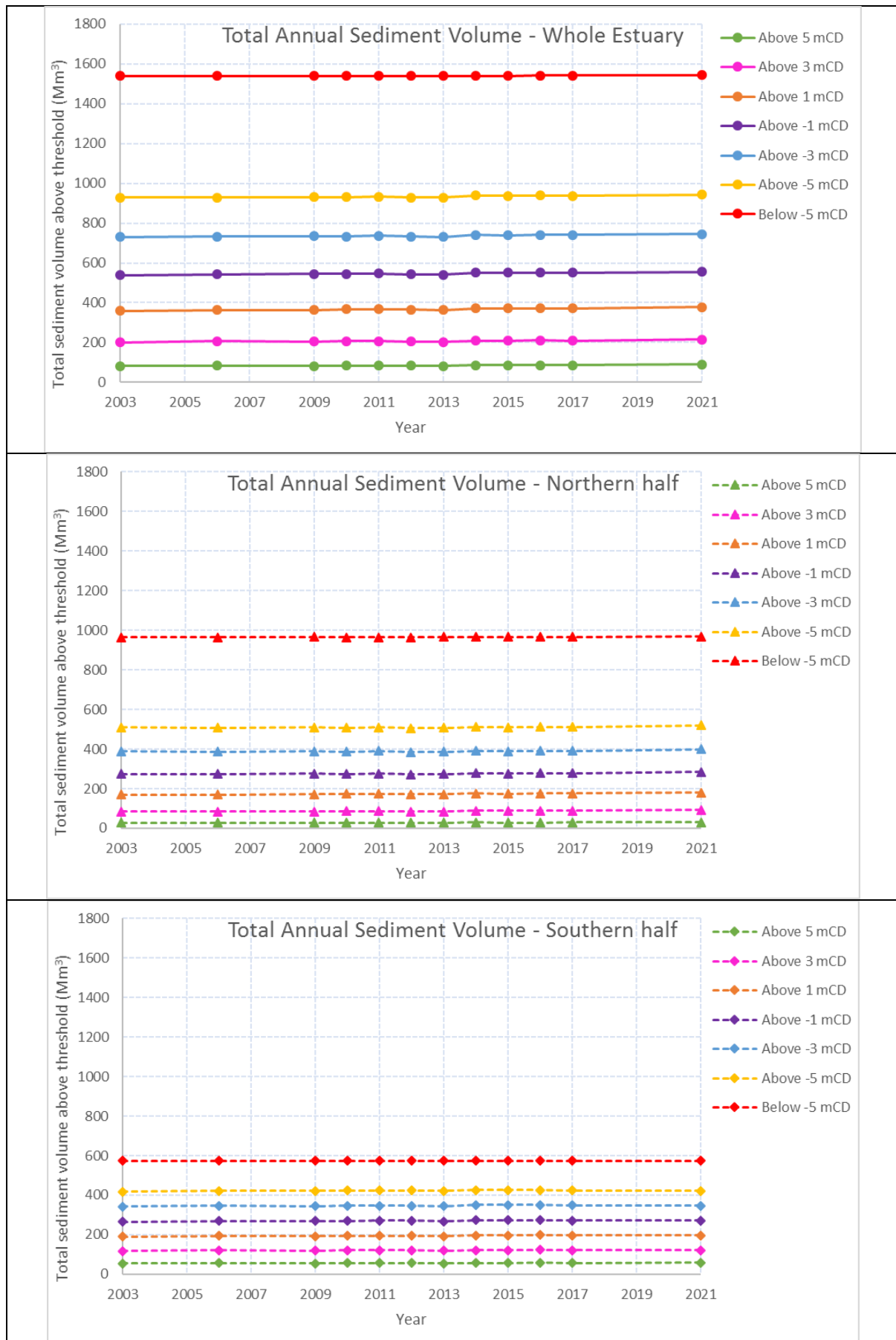


Figure 10. Total annual sediment volume above given thresholds for estuary sections

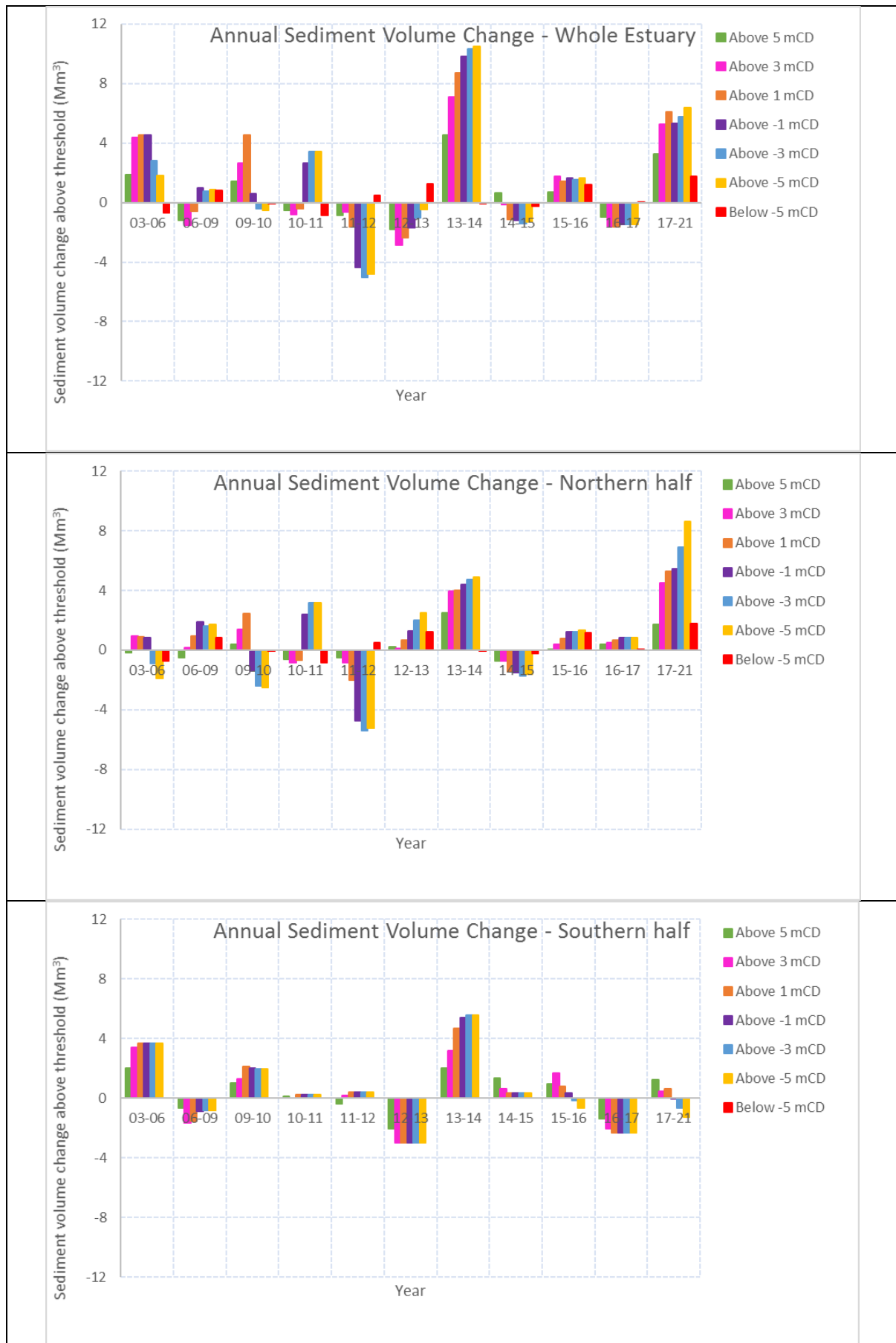


Figure 11. Total annual sediment volume change above given thresholds for estuary sections

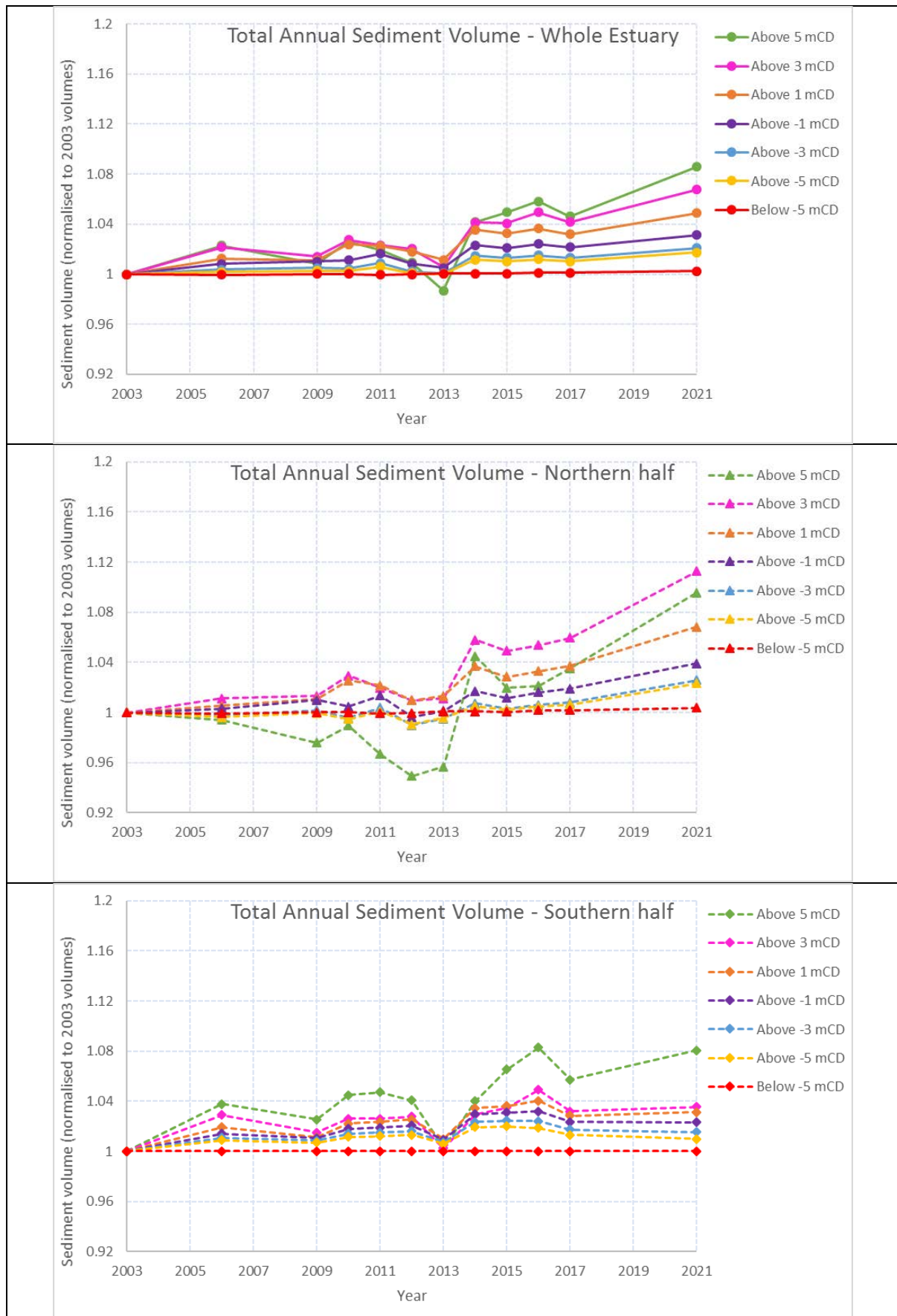


Figure 12. Total annual sediment volume above given thresholds, normalised to 2003 volumes, for estuary sections

Table 1. Summary of sediment volume – Dee Estuary

Bed Level Threshold (mCD)	Total Sediment Volume Above Threshold (Mm ³)												Change in Sediment Volume Above Threshold (Mm ³)										
	2003	2006	2009	2010	2011	2012	2013	2014	2015	2016	2017	2021	03-06	06-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16*	16-17*	17-21
5	82.33	84.21	83.03	84.45	83.94	83.08	81.25	85.75	86.41	87.12	86.13	89.39	1.88	-1.18	1.42	-0.51	-0.86	-1.83	4.51	0.66	0.71	-0.99	3.26
3	201.70	206.07	204.57	207.23	206.41	205.76	202.92	210.03	209.91	211.68	210.11	215.35	4.37	-1.50	2.66	-0.82	-0.65	-2.84	7.11	-0.12	1.77	-1.57	5.24
1	359.69	364.24	363.67	368.23	367.81	366.17	363.81	372.52	371.38	372.78	371.16	377.23	4.55	-0.57	4.56	-0.42	-1.64	-2.36	8.72	-1.14	1.4	-1.62	6.07
-1	538.87	543.40	544.39	544.98	547.63	543.29	541.58	551.38	550.21	551.88	550.41	555.72	4.53	0.99	0.59	2.65	-4.34	-1.70	9.79	-1.17	1.67	-1.47	5.31
-3	730.22	733.02	733.80	733.38	736.81	731.81	730.80	741.10	739.71	741.24	739.78	745.56	2.80	0.78	-0.42	3.44	-5.01	-1.01	10.29	-1.39	1.53	-1.46	5.78
-5	927.53	929.32	930.20	929.66	933.07	928.25	927.76	938.22	936.94	938.60	937.15	943.54	1.79	0.88	-0.54	3.41	-4.82	-0.49	10.46	-1.28	1.66	-1.45	6.39
Below -5	1,538.98	1,538.28	1,539.11	1,539.04	1,538.19	1,538.66	1,539.90	1,539.89	1,539.65	1,540.83	1540.84	1542.60	-0.70	0.82	-0.07	-0.85	0.47	1.24	-0.01	-0.24	1.18	0.01	1.76
Area of estuary:	114.94		Mm ²																				

* 2016, 2017 and 2021 analysis carried out using 30 m resolution DTM

Table 2. Summary of sediment volume – northern half of Dee Estuary

Bed Level Threshold (mCD)	Total Sediment Volume Above Threshold (Mm ³)												Change in Sediment Volume Above Threshold (Mm ³)										
	2003	2006	2009	2010	2011	2012	2013	2014	2015	2016	2017	2021	03-06	06-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16*	16-17*	17-21
5	28.33	28.16	27.65	28.03	27.39	26.89	27.10	29.60	28.89	28.94	29.33	31.04	-0.16	-0.52	0.38	-0.63	-0.51	0.21	2.50	-0.70	0.05	0.39	1.71
3	83.86	84.81	84.96	86.33	85.51	84.66	84.80	88.72	87.98	88.38	88.85	93.32	0.95	0.15	1.37	-0.82	-0.84	0.13	3.93	-0.75	0.40	0.47	4.47
1	169.39	170.28	171.24	173.70	173.03	171.00	171.64	175.65	174.19	174.98	175.67	180.95	0.89	0.96	2.46	-0.67	-2.03	0.64	4.01	-1.46	0.79	0.69	5.28
-1	273.40	274.23	276.12	274.72	277.12	272.38	273.68	278.06	276.56	277.80	278.63	284.07	0.83	1.89	-1.40	2.40	-4.74	1.30	4.38	-1.50	1.24	0.83	5.44
-3	388.45	387.54	389.14	386.75	389.94	384.54	386.54	391.28	389.56	390.76	391.60	398.51	-0.91	1.61	-2.39	3.19	-5.40	2.00	4.74	-1.72	1.20	0.84	6.91
-5	509.26	507.34	509.05	506.53	509.70	504.48	507.00	511.90	510.29	511.64	512.49	521.11	-1.92	1.71	-2.51	3.16	-5.21	2.52	4.90	-1.61	1.35	0.85	8.62
Below -5	965.21	964.51	965.33	965.26	964.41	964.88	966.13	966.11	965.87	967.06	967.07	968.83	-0.70	0.82	-0.07	-0.85	0.47	1.24	-0.01	-0.24	1.19	0.01	1.76
Area of estuary:	114.94		Mm ²																				

* 2016, 2017 and 2021 analysis carried out using 30 m resolution DTM

Table 3. Summary of sediment volume – southern half of Dee Estuary

Bed Level Threshold (mCD)	Total Sediment Volume Above Threshold (Mm ³)												Change in Sediment Volume Above Threshold (Mm ³)										
	2003	2006	2009	2010	2011	2012	2013	2014	2015	2016	2017	2021	03-06	06-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16*	16-17*	17-21
5	54.00	56.04	55.38	56.42	56.55	56.19	54.15	56.16	57.52	58.47	57.09	58.35	2.04	-0.66	1.04	0.12	-0.36	-2.04	2.01	1.36	0.95	-1.38	1.26
3	117.84	121.26	119.61	120.90	120.90	121.10	118.12	121.31	121.94	123.63	121.59	122.03	3.42	-1.65	1.29	0.00	0.20	-2.97	3.18	0.63	1.69	-2.04	0.44
1	190.30	193.96	192.43	194.53	194.77	195.17	192.17	196.87	197.19	197.99	195.68	196.28	3.66	-1.53	2.10	0.25	0.40	-3.01	4.70	0.32	0.80	-2.31	0.60
-1	265.47	269.17	268.27	270.26	270.51	270.90	267.90	273.32	273.65	273.98	271.68	271.65	3.70	-0.90	1.99	0.25	0.40	-3.01	5.42	0.33	0.33	-2.3	-0.03
-3	341.77	345.48	344.65	346.62	346.87	347.27	344.26	349.81	350.15	350.00	347.70	347.05	3.71	-0.83	1.97	0.25	0.40	-3.01	5.55	0.33	-0.15	-2.3	-0.65
-5	418.27	421.98	421.15	423.13	423.37	423.77	420.77	426.32	426.65	426.01	423.71	422.43	3.71	-0.83	1.98	0.25	0.40	-3.01	5.55	0.33	-0.64	-2.3	-1.28
Below -5	573.77	573.77	573.77	573.77	573.77	573.77	573.77	573.77	573.77	573.77	573.77	573.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area of estuary:	114.94		Mm ²																				

* 2016, 2017 and 2021 analysis carried out using 30 m resolution DTM

3 Model Setup

3.1 Estuary summary description and mesh design

The Dee Estuary is a semi-enclosed coastal water body open to the Irish Sea through an entrance about 8.2 km wide. The estuary is tidal for about 35 km up-estuary of the entrance on the River Dee (to the weir at Chester). The entrance to the Dee Estuary is characterised by a series of banks and channels, notably Mostyn Bank, Salisbury Middle, West Hoyle Spit, East Hoyle Bank, Welsh Channel, Hilbre Channel and Mid Hoyle Channel. The Welsh, Hilbre and Mid Hoyle channel (as well as relatively fixed points such as Hilbre Island or the Holocene clay bank of the Salisbury Middle) play a key role in influencing tidal exchange between the estuary and coastal waters. The relative contribution that these features make to tidal dynamics in the estuary alters over long-term timescales as their alignments and orientations adjust. In order to encompass the outer banks and Liverpool Bay (which influence the flow dynamics in this region), a large area of the southern Irish Sea was included in the model, extending west to east from Llandudno to Formby and into the Mersey Estuary. The model extends offshore approximately 25 km.

Two open offshore boundaries have been defined, allowing for orientation to the natural flows, either parallel, or perpendicular, to the general offshore flow directions. This modelling approach provides a more accurate simulation of the flow and water level dynamics along the boundaries. In addition to the offshore boundaries, an upstream river boundary has also been included to represent the inflow from the River Dee at Chester Weir.

Within the MIKE21 software, the HD module can be constructed using either a rectilinear mesh (RM) or flexible mesh (FM) covering the area of interest. For this project, the mesh has been designed by combining the two types; FM is used across most of the model extent whilst RM is used in the river sections approximately upstream of Connah's Quay (Figure 13).

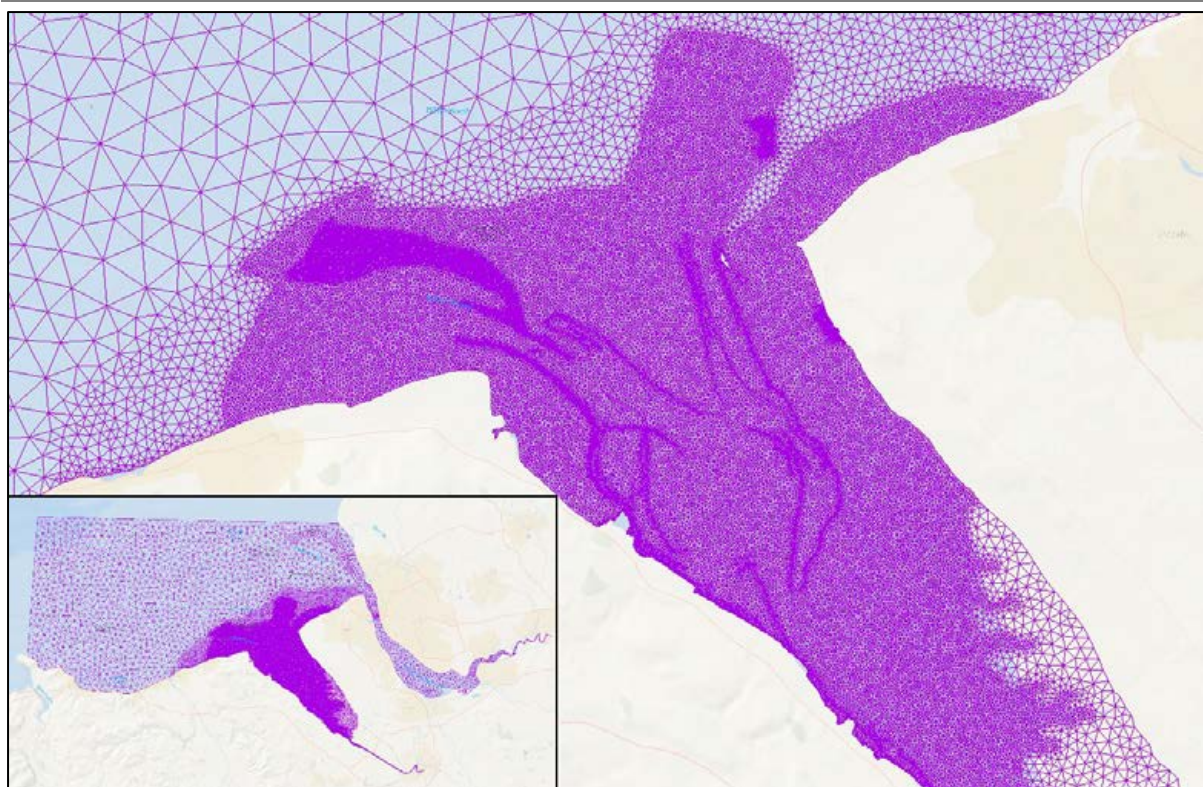


Figure 13. Model mesh with high resolution in Dee Estuary (and wider extent as inset)

This approach enables the complexities of the project to be sufficiently resolved within the model, while maintaining a coarser resolution away from the site of interest to maximise computational efficiency. FM resolutions range from 1 km in offshore areas to around 30 m in the main area of interest around the Port of Mostyn.

The same higher resolution is also applied to the main entrance channels in order that the steeply-sided slopes are adequately represented in the model. This level of resolution is necessary to adequately represent the large vertical gradients over relatively shorter horizontal length scales (with slopes of up to around 1 in 3 in places). The resolution of the RM is 5 cells across the width of the river section (providing a transverse resolution of around 30 m).

3.2 Hydrodynamic model

3.2.1 Boundaries

The model contains one open river boundary and two open offshore boundaries. The river boundary is defined by a mean discharge of $10 \text{ m}^3/\text{s}$ (NRFA, 2017), whilst the offshore boundaries are driven by a combination of time-varying water levels and flows. Since the Mersey is implemented primarily to ensure volume exchange from the Irish Sea, no river discharge is included from this estuary.

Extractions from ABPmer's SEASTATES¹ Tide and Surge model (ABPmer, 2017) were used to drive the two offshore boundaries. The ABPmer SEASTATES model has been extensively calibrated and validated against available measured datasets around the UK coastline, with NTSLF gauge sites at Llandudno and Liverpool within the present study area (further detail on calibration of the SEASTATES Tide and Surge model is provided in ABPmer, 2017b).

¹ ABPmer SEASTATES: <http://www.seastates.net/>

3.2.2 Bed resistance

Manning's roughness was selected as the bed resistance type and was defined as variable throughout the domain. Deeper areas, including deep channels, were given a higher Manning's number (representing lower bed resistance) than shallower areas, such as intertidal banks. Intermediate depth roughness values were allocated based on a scaling factor between the deep and shallow values. In addition, the main channel connecting the outer estuary to the upstream sections of the Dee was also given a lower bed roughness, to encourage tidal propagation to the tidal limit at Chester.

Having a variable bed roughness in this way encourages peak flows through the deeper channels within the estuary (where the roughness is lower); a flow characteristic observed in the survey data collected prior to model creation. The bed resistance map, as applied to the baseline model, is shown in Figure 14.

Through the model calibration stage, the response of the model, particularly the upstream sections, was found to be sensitive to the definition of the bed resistance applied. The magnitudes of the bed resistance were also important in ensuring that sufficient tidal volume was able to pass through the estuary (and the Mersey) and into the upstream river sections, thus helping the model to provide representative flow conditions across the primary area of interest.

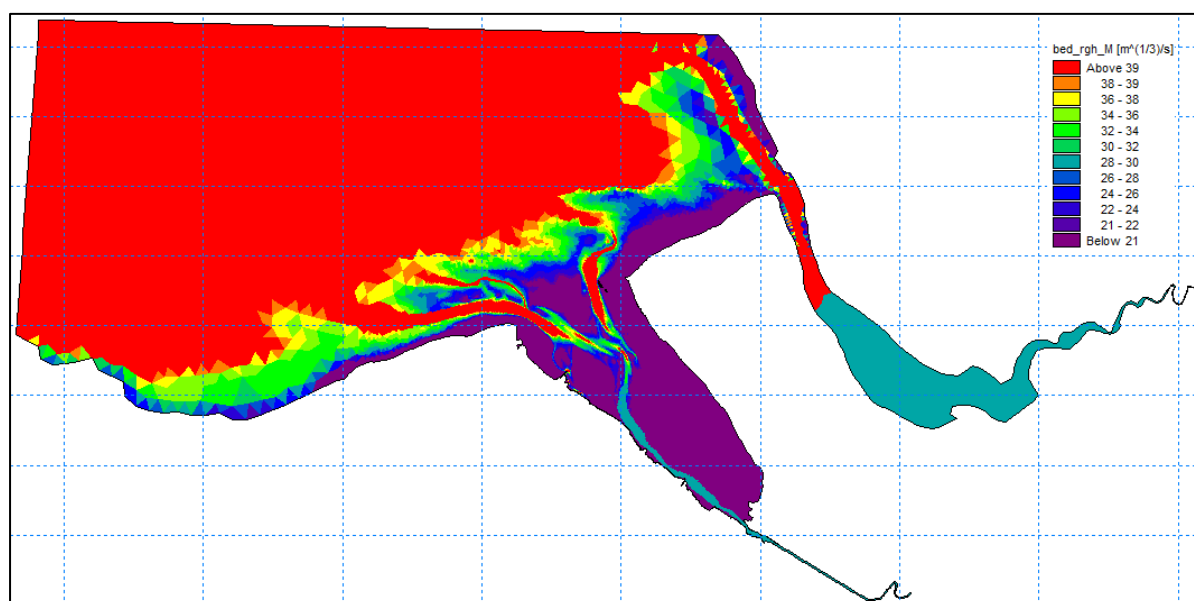


Figure 14. Spatially varying bed resistance map

3.2.3 Model calibration

Full details of the model setup, calibration and validation have been provided in ABPmer (2018a). This report was prepared for Port of Mostyn, using survey data collected at a number of locations within the Dee Estuary and its Approaches. To provide the data and extra understanding needed to underpin the development of this model, a series of physical processes surveys were carried out by ABPmer and the Port of Mostyn between September and December 2017.

The model validation was assessed for water levels, flow speed and direction, with very good agreement between the model and measured datasets. Subsequently, it is considered that the model performs well at replicating the hydrodynamics that are occurring within the wider Dee Estuary, and in the vicinity of the Port of Mostyn.

4 Simulations of -4 mCD Channel Dredge

4.1 Introduction

The aim of this study was to assess the impact of dredging the Salisbury Channel to a minimum depth of -4 mCD (equivalent to -8.5 mODN), by comparing the hydrodynamic and sediment transport patterns simulated with the channel in place, against the latest 2021 bathymetry. A 'baseline' hydrodynamic model that uses 2021 data, has been setup and calibrated in order to provide the 'as surveyed' flow characteristics over the wider study area.

From the baseline model, an additional scenario run has been carried out to include the implementation of a 4 m below CD dredged approach channel into the port. The channel dredge has been implemented along the present Salisbury Channel alignment, using the same extent and dimensions as in previous studies. Figure 15 shows the existing bathymetry from the 2021 survey data, with the simulated dredge shown in Figure 16. The difference in bed elevation, as a result of the dredge, is shown in Figure 17. The results of the dredged scenario have then been compared to those of the baseline model run, in order to describe the potential hydrodynamic effects arising from the proposed channel maintenance.

In addition to modelling the hydrodynamics of the system, the MIKE21 Sand Transport (ST) module has also been used in order to consider the potential effects of the proposed dredge on the sediment flux within the estuary (as compared to the baseline 'as surveyed' scenario). The results have been analysed for both a mean (morphological) tide and a large spring tide, both of which are provided in the following sections.

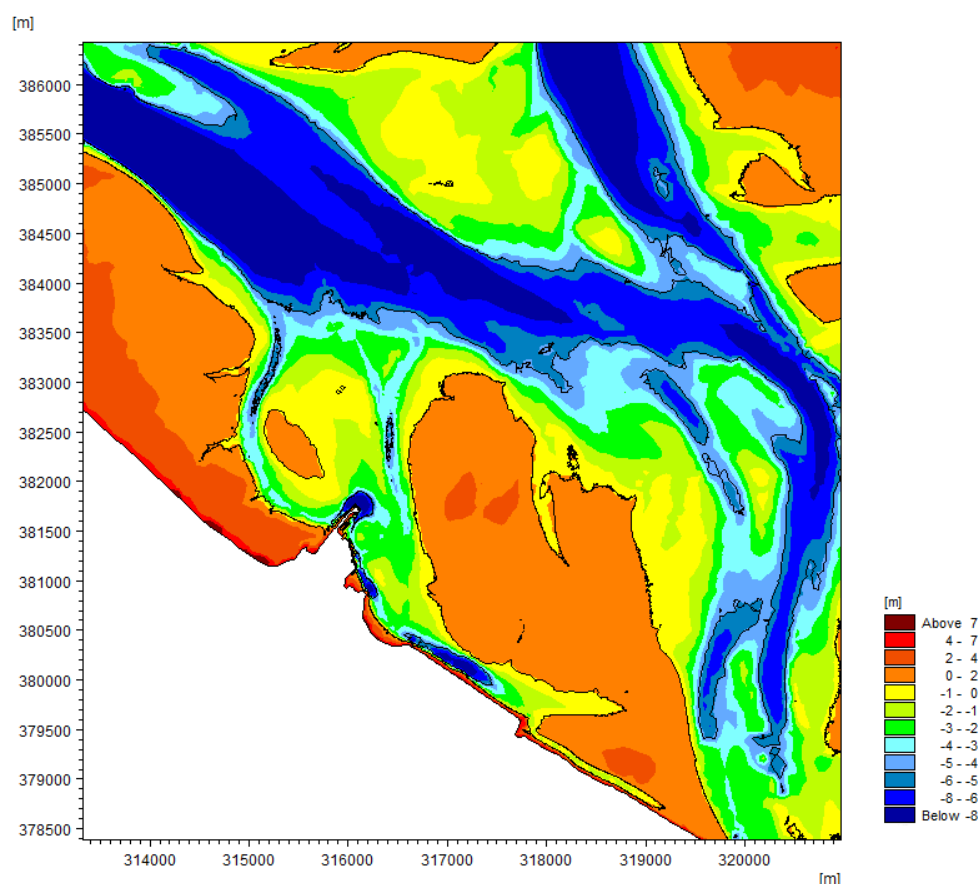


Figure 15. Model bathymetry showing the baseline channel for 2021

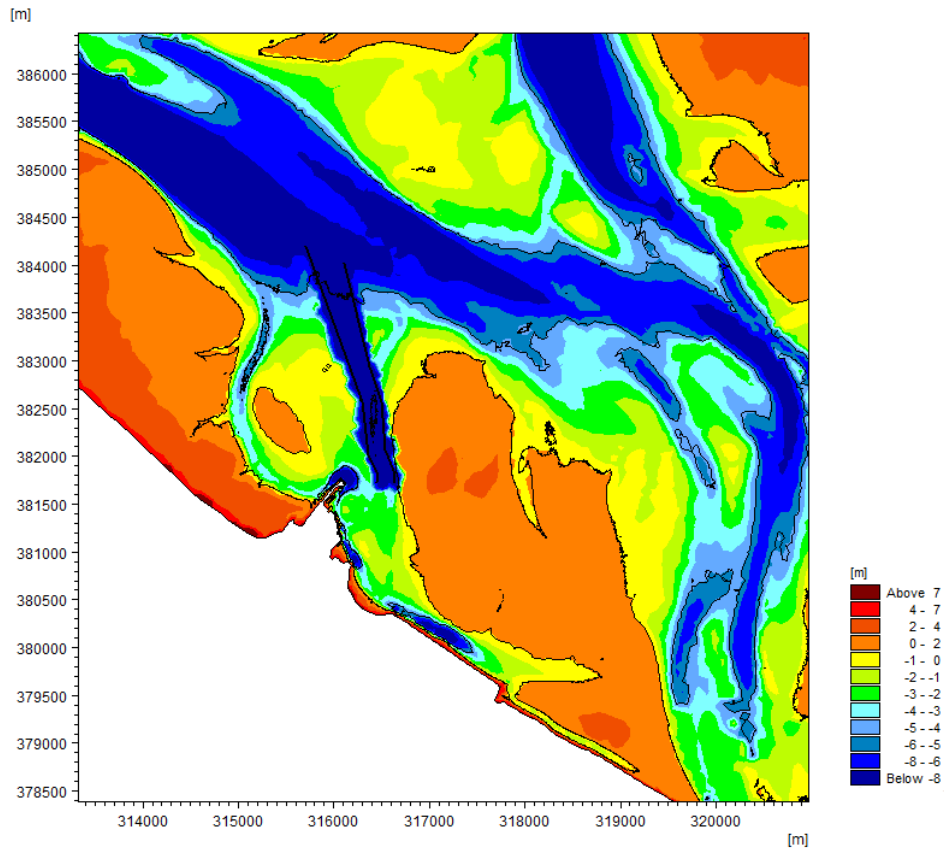


Figure 16. Model bathymetry showing the -4 mCD channel

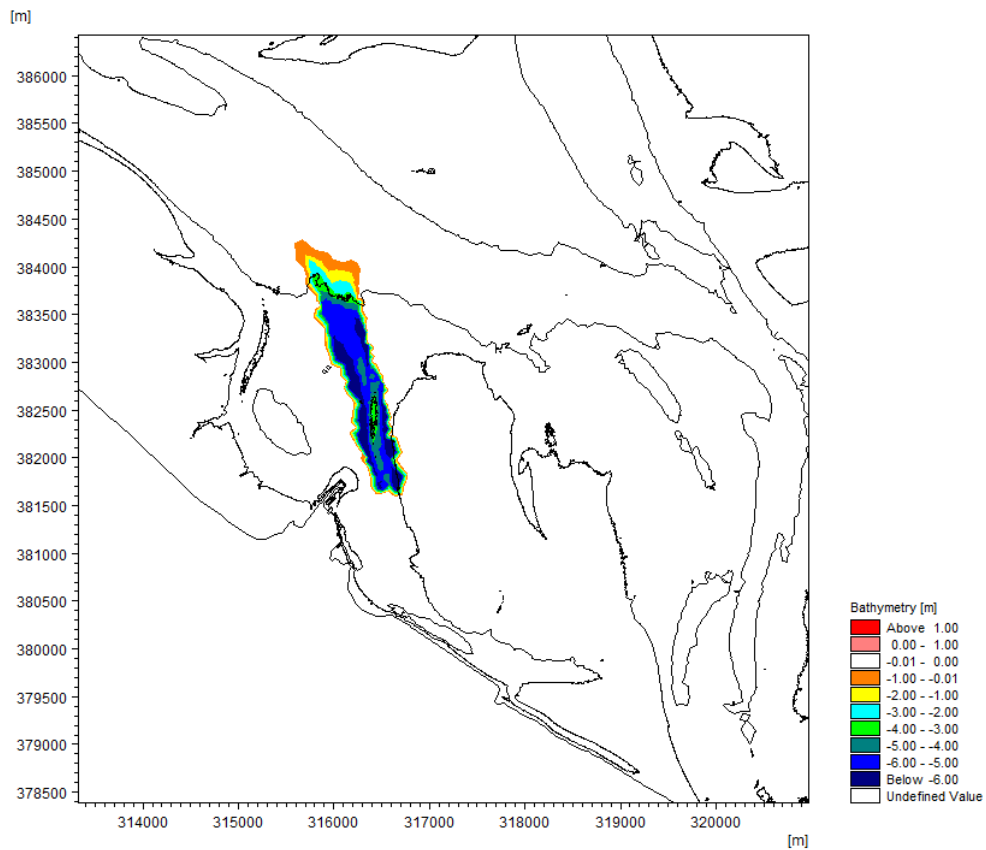


Figure 17. Difference in bathymetry between the -4 mCD channel and baseline

4.2 Mean tide hydrodynamics

4.2.1 Tidal current patterns

Figure 18 Figure 19 show a comparison of the current vectors at the time of peak flood and peak ebb respectively, for the mean tide. The figures show the baseline model results in blue, with the -4 mCD channel scenario overlaid in red. Figure 20 and Figure 21 show the differences in current magnitude, at the equivalent tidal states, following the dredge of the -4mCD channel.

Changes in velocity are most apparent in the Salisbury Channel and the Mostyn Channel, particularly at the time of peak flood, with reductions in current magnitude of 0.5 m/s in the Salisbury Channel and 0.4 m/s in the Mostyn Channel. Differences in current magnitude at the time of peak ebb are much less evident, with reductions only occurring in the Mostyn Channel of 0.15 m/s. For context, peak baseline flow speeds within the Salisbury Channel are around 1.0 m/s and 0.7m/s in the Mostyn Channel.

4.2.2 Tidal water levels

The effect of dredging the Salisbury Channel to a minimum depth of -4 mCD on water levels is shown in Figure 22, for three locations in the vicinity of the Port. In general, the effect of the dredge on water levels is negligible. Absolute elevations of HW and LW are unchanged at the entrance of the Salisbury Channel (Point 1) and up-estuary of the Port (Point 3). The most prominent effect is seen near to the Port of Mostyn (Point 2), where the dredge enables the ebb tide to flow out of the area quicker, resulting in LW predicted to occur around 30-40 minutes earlier, than under existing (baseline) conditions. This shows that changes to the tidal propagation are restricted to the vicinity of the dredged channel.

4.2.3 Tidal discharges

The changes in tidal discharge at the time of peak flood and peak ebb as a result of the -4 mCD channel are shown in Figure 23 and Figure 24, respectively. As with the changes in velocity, differences in discharge at the time of peak flood and peak ebb are apparent around the Salisbury Channel and the Mostyn Channel. Reduced discharge is predicted in the Mostyn Channel of up to 1.9 m³/s/m, whilst in the Salisbury Channel discharge increases by up to 2.2 m³/s/m. For context, baseline peak discharges through the Salisbury Channel are around 7 m³/s/m for a mean tide.

By way of comparison to the previously assessed channel dredge (ABPmer, 2018b), Source: Comparison of modelled flux from dredging Mostyn Channel obtained from ABPmer, 2018b

Figure 25 shows the modelled change in peak flood tidal discharge for a -4 mCD dredge in the original Mostyn Channel (from ABPmer, 2018b) and a -4 mCD dredge in the Salisbury Channel (from the present study). The linkages between the two channels are evident within this comparison. Dredging the original Mostyn Channel results in an increase in tidal discharge, which is mirrored by an associated reduction in discharge through the Salisbury Channel. In contrast, a dredge of the Salisbury channel results in an associated reduction in tidal discharge through the Mostyn Channel. Outside of the immediate study area, both dredge schemes result in a similarly low magnitude extent of effect within the main channel up- and down-estuary of Mostyn (Figure 25).

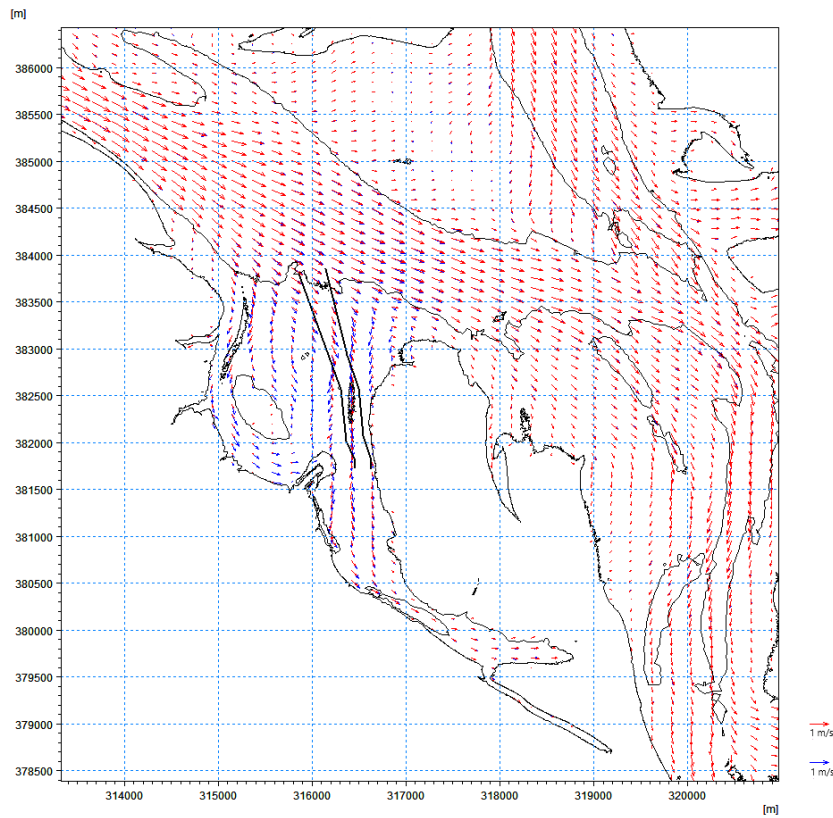


Figure 18. Peak flood velocity vectors for a mean tide. Blue vectors baseline, red vectors -4 mCD channel

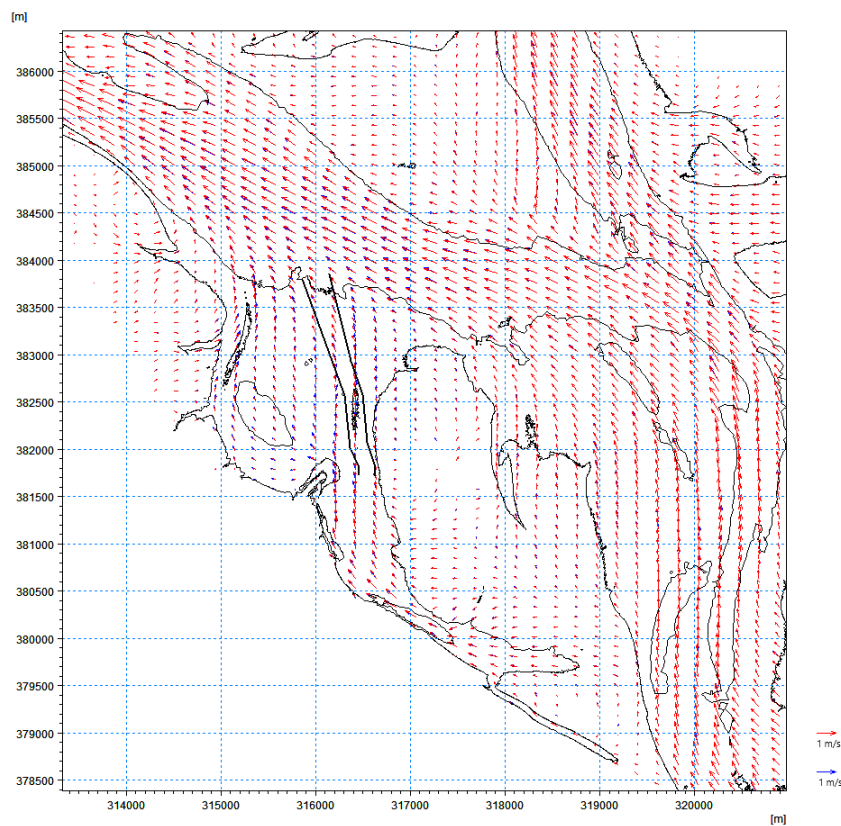


Figure 19. Peak ebb velocity vectors for a mean tide. Blue vectors baseline, red vectors -4 mCD channel

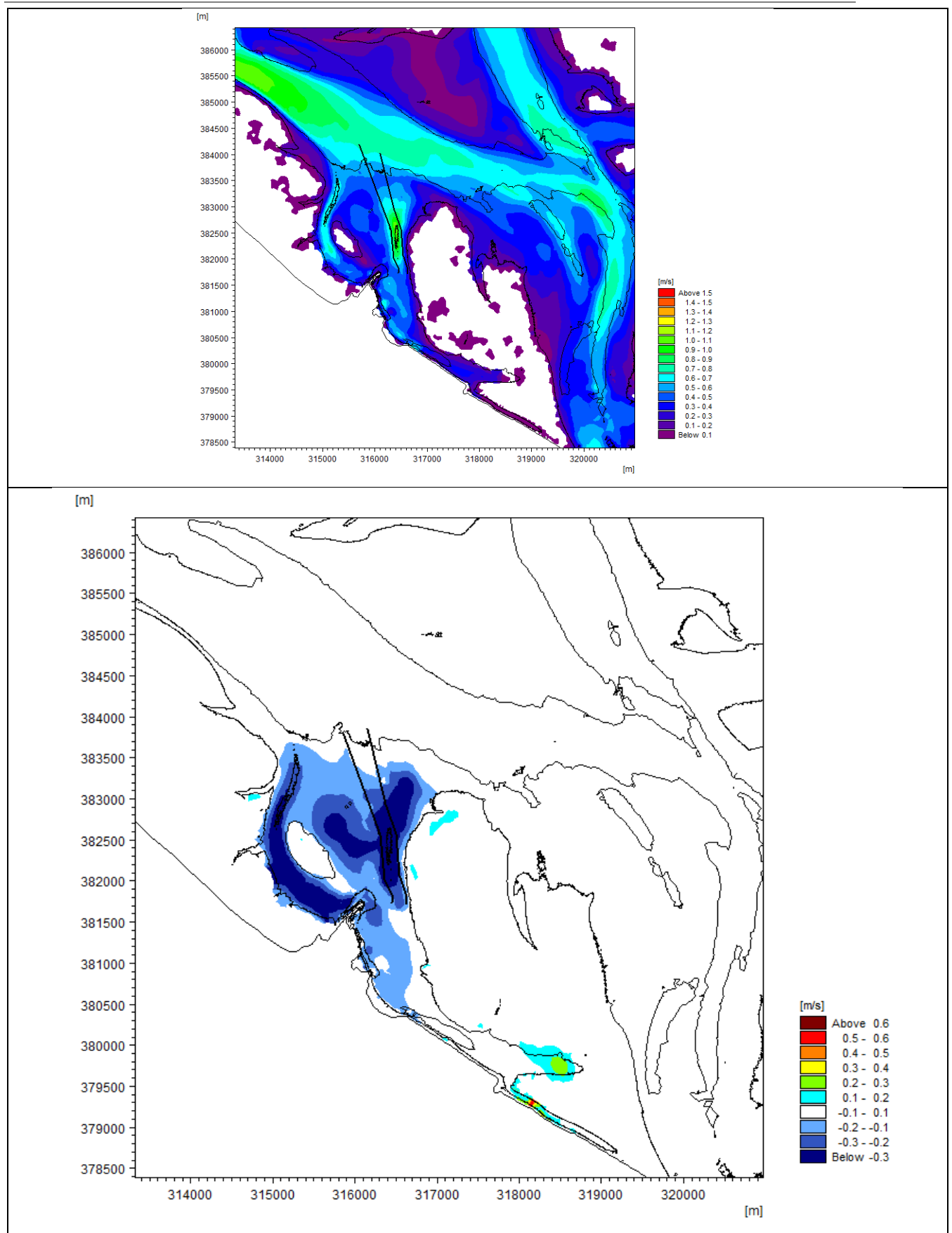


Figure 20. Baseline current speed (top) and difference in current magnitude (bottom) at time of peak flood (mean tide), following the addition of the -4 mCD channel

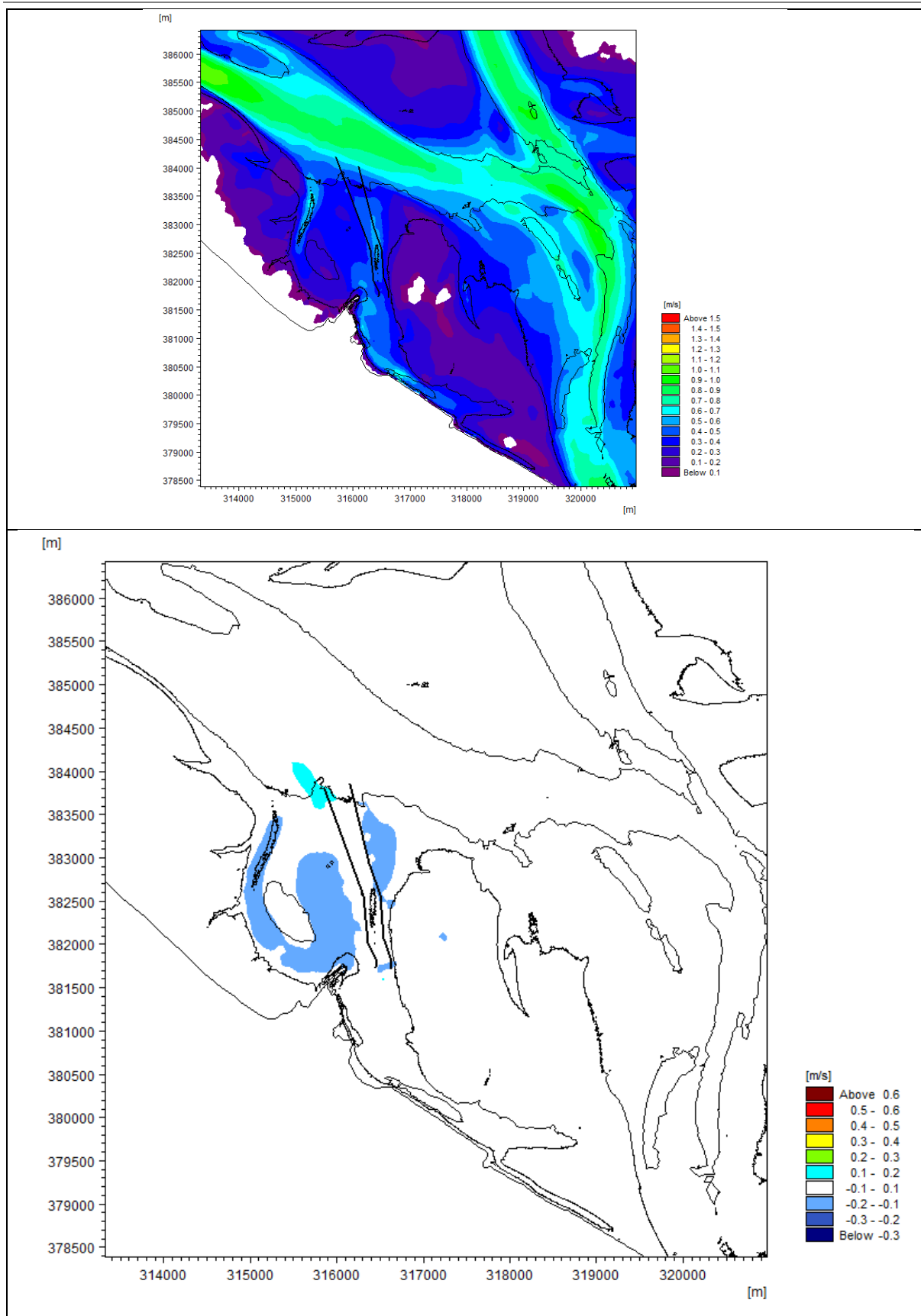


Figure 21. Baseline current speed (top and difference in current magnitude (bottom) at time of peak ebb (mean tide), following the addition of the -4 mCD channel

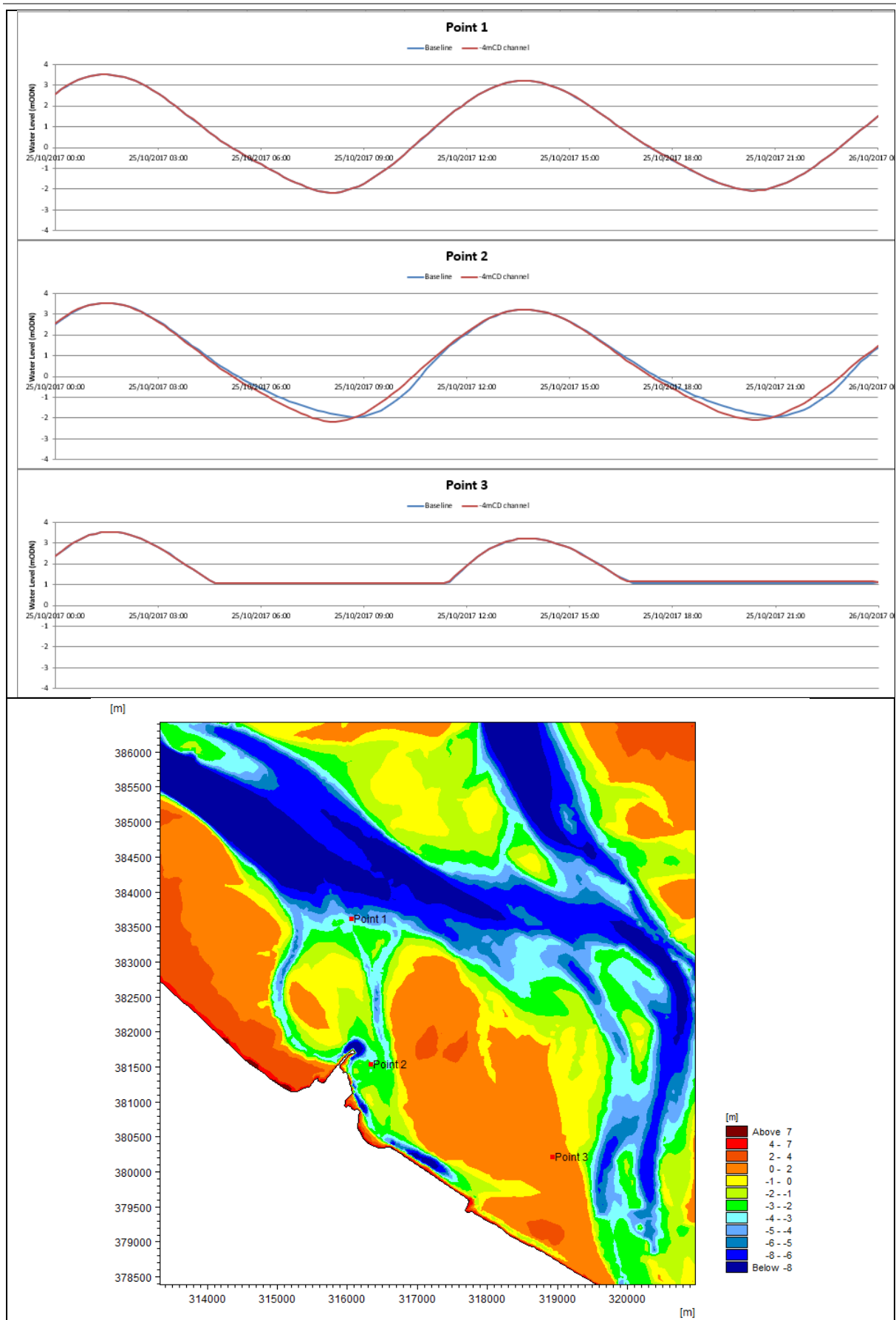


Figure 22. Timeseries comparison of water levels with existing and dredged channel

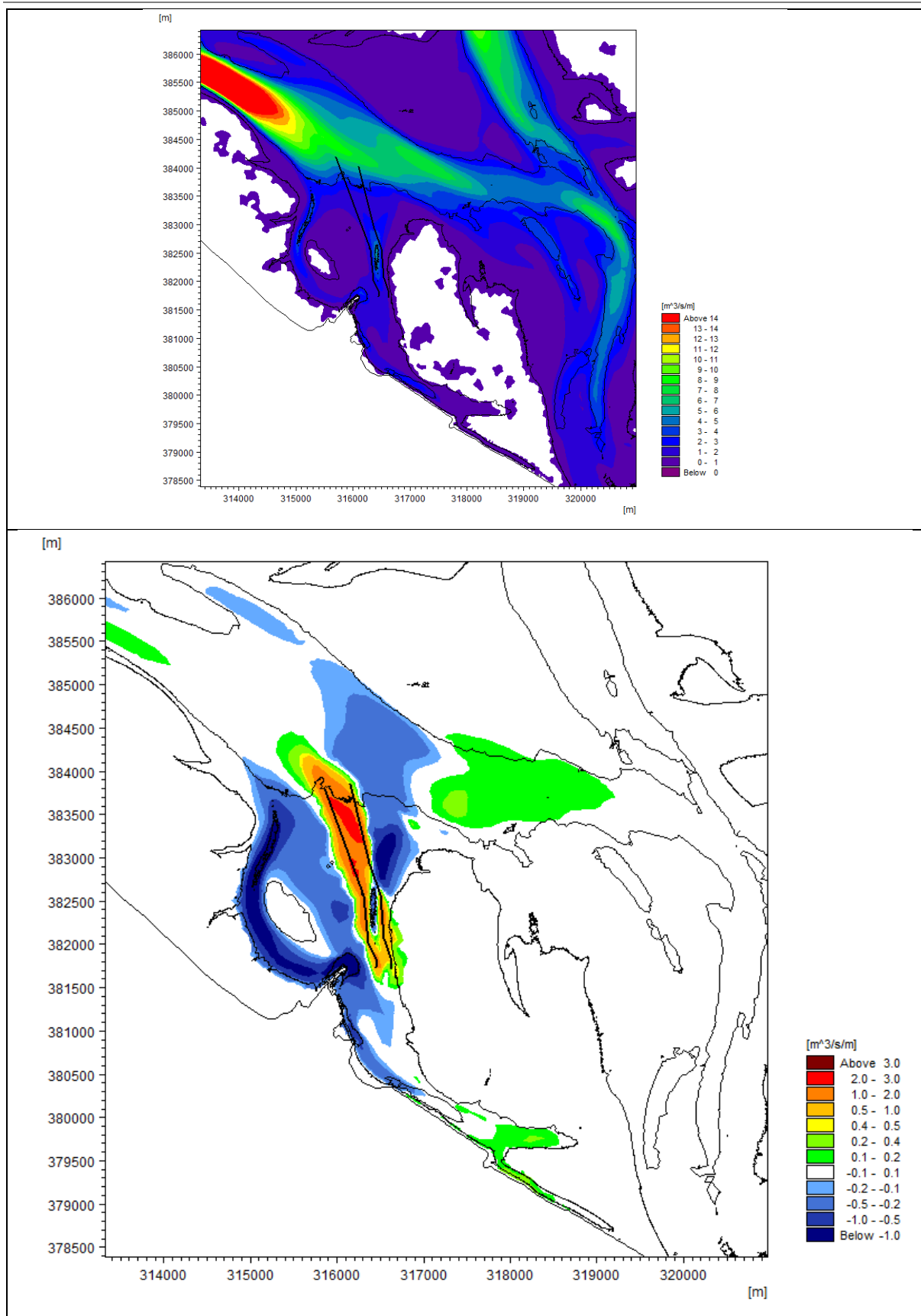


Figure 23. Baseline magnitude (top) and difference (bottom) in peak flood discharge (mean tide), as a result of the -4 mCD channel

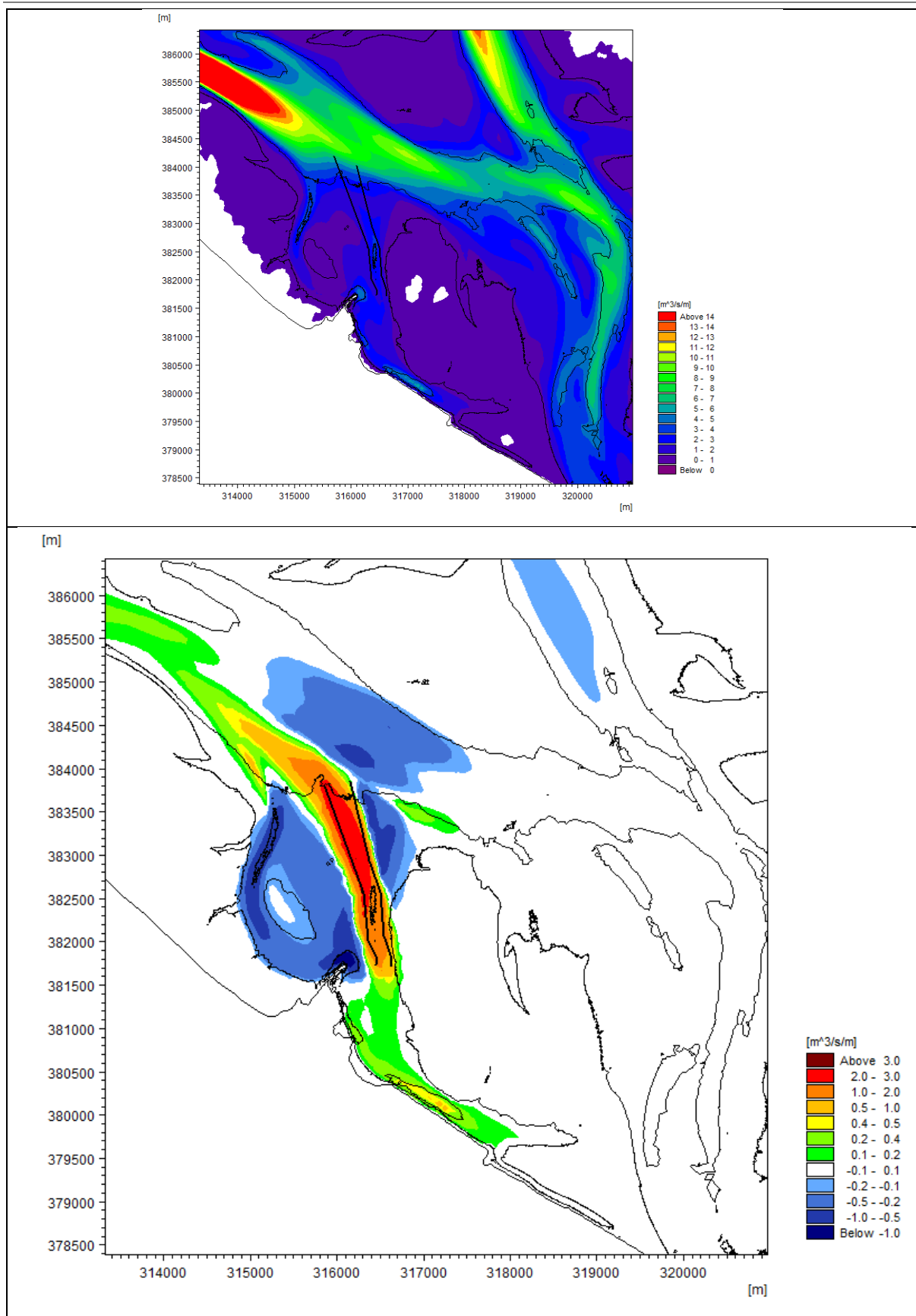
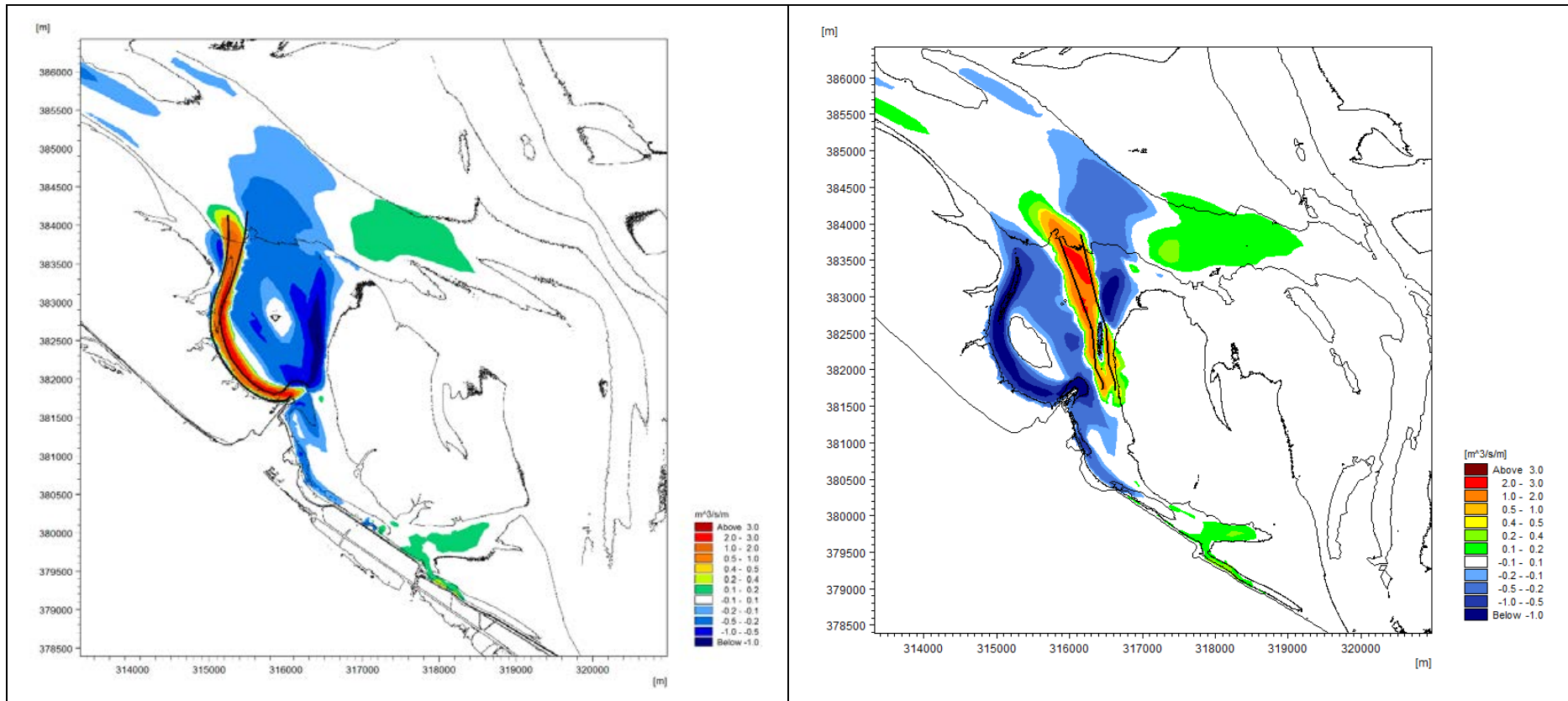


Figure 24. Baseline magnitude (top), and difference (bottom) in peak ebb discharge (mean tide), as a result of the -4 mCD channel



Source: Comparison of modelled flux from dredging Mostyn Channel obtained from ABPmer, 2018b

Figure 25. Comparison of changes to peak flood tidal discharge resulting from a -4 mCD dredge within the Mostyn Channel (left) and the Salisbury Channel (right)

4.3 Sediment transport and morphological change

Following the assessment of the estuary hydrodynamics, as a result of the Salisbury Channel dredge, the MIKE21FM Sand Transport (ST) module was applied to investigate the effect of the dredge on the sediment flux, both local to the port and across the wider Dee Estuary.

4.3.1 Sediment flux patterns

The predicted change in sediment flux vectors, as a result of the -4 mCD channel dredge, is shown in Figure 26. The effect of the dredge is shown to be small, and hard to discern from this figure. Within the main tidal channels, the dredge has no observable effect. Local to the Port of Mostyn, and within the dredged channel, small changes can be seen.

The effect is easier to see when comparing the change in sediment flux as shown in Figure 27. This reveals a slight reduction in sediment flux through the Mostyn Channel, and a slightly larger reduction through the Salisbury Channel. These results are similar to those obtained from previous studies (ABPmer, 2018b).

The reduction in sediment flux through the channels are a result of the increased depth arising from the assessed dredge.

4.3.2 Patterns of erosion and deposition

The changing patterns of sediment erosion and deposition, resulting from the -4 mCD channel dredge, are shown in Figure 28. These show the predicted changes in sediment thickness (resulting from erosion and deposition of the existing bed), over a single mean tide. In these figures, increases (red/yellow colours) reveal areas where the dredge scenario results in an increased bed thickness (compared to baseline conditions); this could be due to less erosion or more deposition. Conversely, reductions (blue/green colours) reveal areas where the dredge scenario results in a decreased bed thickness (compared to baseline); this could be due to more erosion or less deposition.

These results indicate that there exists potential for slight movement of sediment on the bed under both baseline and dredged conditions. These changes are predicted primarily in the main channels, towards the middle of the estuary and are evident mostly up-estuary of the Port.

Comparing the predicted changes to sediment thickness between the baseline and dredged scenarios (Figure 29), some small changes (less than 0.01 m) are predicted up-estuary, but the main effects are shown in the dredged Salisbury Channel and the associated Mostyn Channel. Predicted changes to sediment thickness, within the dredged channel, are within ± 0.02 m.

4.3.3 Sediment fluxes in and out of the estuary

The tidal sediment fluxes across the estuary mouth are shown in Figure 30, which also provides the flood and ebb values from the previous (ABPmer, 2018b) study, for comparison. In this figure, the top plot provides the sediment flux magnitude over the flood, ebb and full-tide, whilst the bottom plot reveals the differences between the baseline and dredged scenarios.

With regards to the general sediment flux through the Welsh Channel, the upper plot (left hand side) shows the majority of flux on the flood tide is concentrated along the western edge of the Welsh Channel. By contrast, under ebb flow, the flux out of the Welsh Channel is shown to be more evenly distributed across the full channel width. The same flux pattern is seen under both baseline and dredged

conditions. When considering the flux through the Hilbre Channel, the upper plot (right hand side) shows the flux over the flood more evenly distributed across the full channel width. Under ebb conditions, there is still a relatively even distribution, although the flux tends to concentrate slightly more within the middle of the Hilbre Channel. As with the Welsh Channel, the same pattern of flux is shown under both baseline and dredged conditions.

In general, the changes observed across the mouth of the estuary (as a result of the dredge) are small, with a general increase in flux within the Welsh Channel, for each tidal state. In relative terms, the changes as a result of the assessed dredge amount to approximately $\pm 2.5\%$ of baseline fluxes. In the Hilbre Channel, the model results indicate a small increase in flux on the flood tide, but a small decrease in flux over the ebb tide. Similar to the Welsh Channel, in relative terms the predicted changes amount to approximately $\pm 3\%$ of baseline fluxes. Between the main channels (across the West Hoyle Bank and Salisbury Middle), the dredge is not predicted to have any effect on sediment flux, which is shown to be negligible when compared against the flux through the main channels. These relative effects are similar to those predicted in the 2017 study (ABPmer, 2018b).

4.3.4 Sediment fluxes across the centre of the estuary

The tidal sediment fluxes across the centre of the estuary (aligned just to the northwest of the Port), are shown in Figure 31, which also provides the flood and ebb values from the previous (ABPmer, 2018b) study, for comparison. As with the section across the entrance of the estuary, these results are broken down by tidal state showing the effects over flood, ebb and full-tide conditions for a mean tide.

These results show the greatest predicted effect is, as might be expected, within the dredged Salisbury Channel. Here, the effect of the assessed -4 mCD dredge is a relatively large increase in the flood flux, through the dredged channel, along with increased flood flux over the bank between the Mostyn and Salisbury channels. With regards to the ebb flux, each of the channels (and the bank between) show a smaller increase in ebb flux. There are no notable effects predicted within the upper reaches of the Hilbre Channel (to the northern side of the estuary). As also shown in Figure 25, the relationship between the Mostyn and Salisbury channels is again highlighted in Figure 31, where increased flux through one channel is associated with reduced flux through the other (and *vice versa*).

In relative terms, the predicted changes to sediment flux through the approach channels to the Port of Mostyn are much greater than those predicted across the upper reaches of the Hilbre Channel; although it should also be noted that overall magnitude of sediment flux is significantly greater through the Hilbre Channel, as compared to the combined Mostyn and Salisbury channels. These results are similar to those reported in the 2017 study (ABPmer, 2018).

4.4 Large spring tide model results

As previously reported (ABPmer, 2018b), model results over a larger spring tide predicted patterns of change similar to those described for the mean tide but with a generally slightly larger magnitude of change indicating a degree of natural variability in the tidal forcing conditions. These trends have continued with this study.

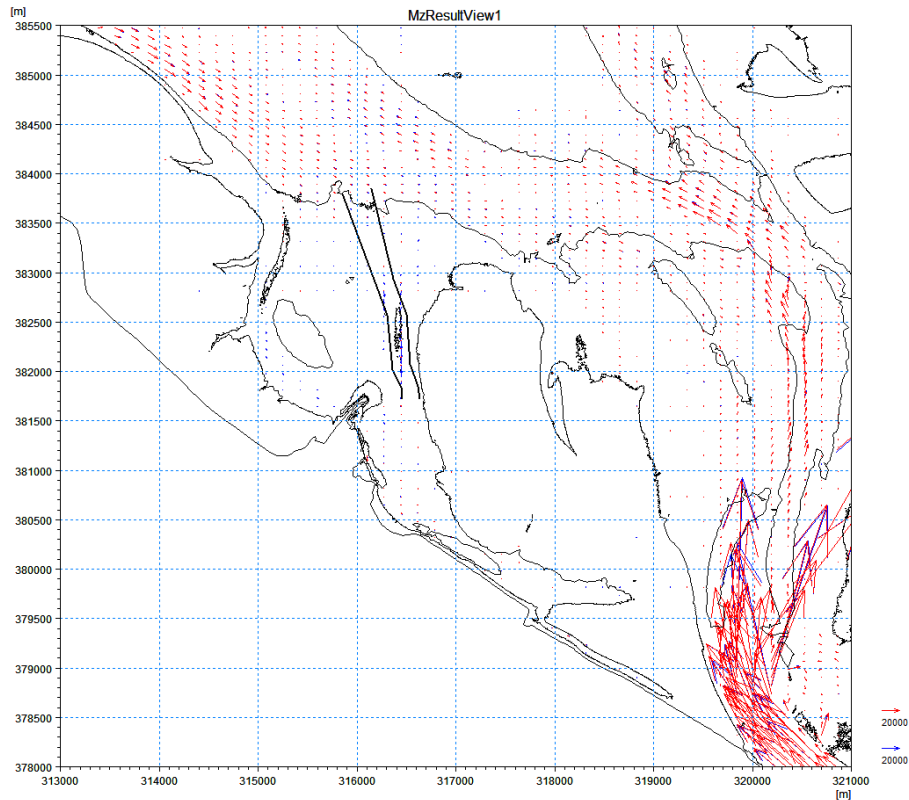


Figure 26. Net tidal sediment fluxes (kg/m/mean tide) with -4 mCD channel. Blue vectors - baseline; red vectors - -4 mCD channel

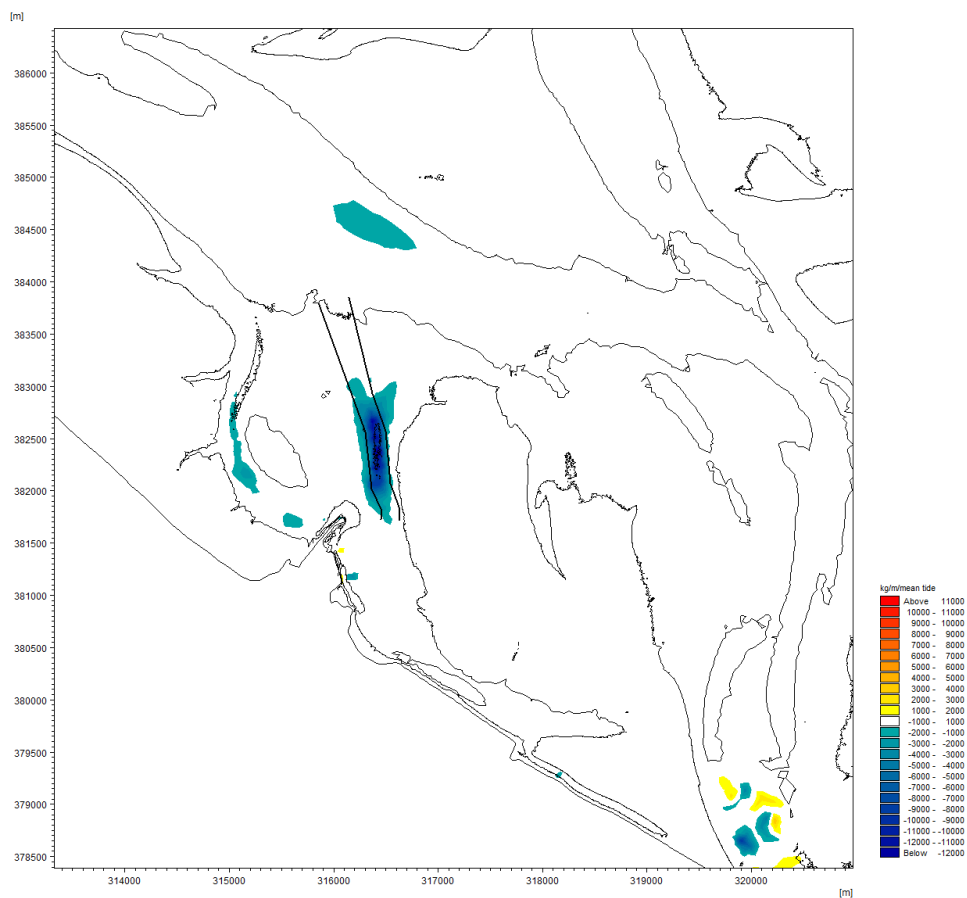


Figure 27. Change in net tidal sediment flux (mean tide) with -4 mCD channel

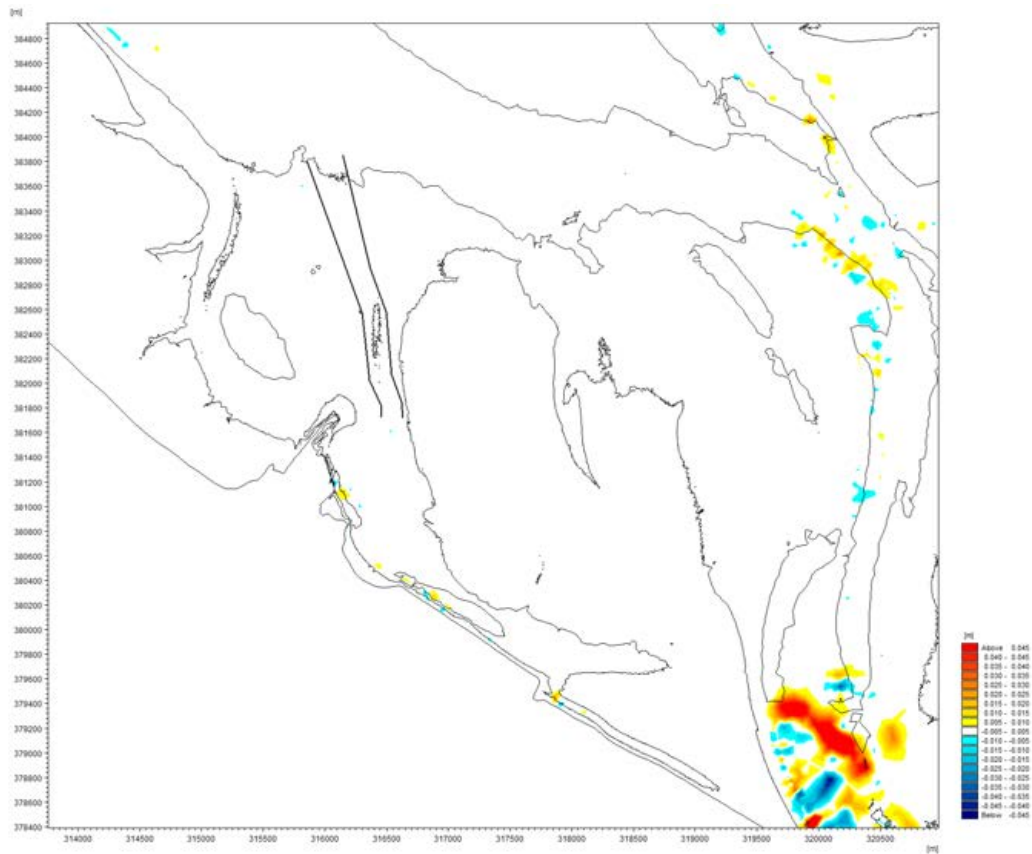


Figure 28. Patterns of erosion and deposition with a -4 mCD channel (mean tide)

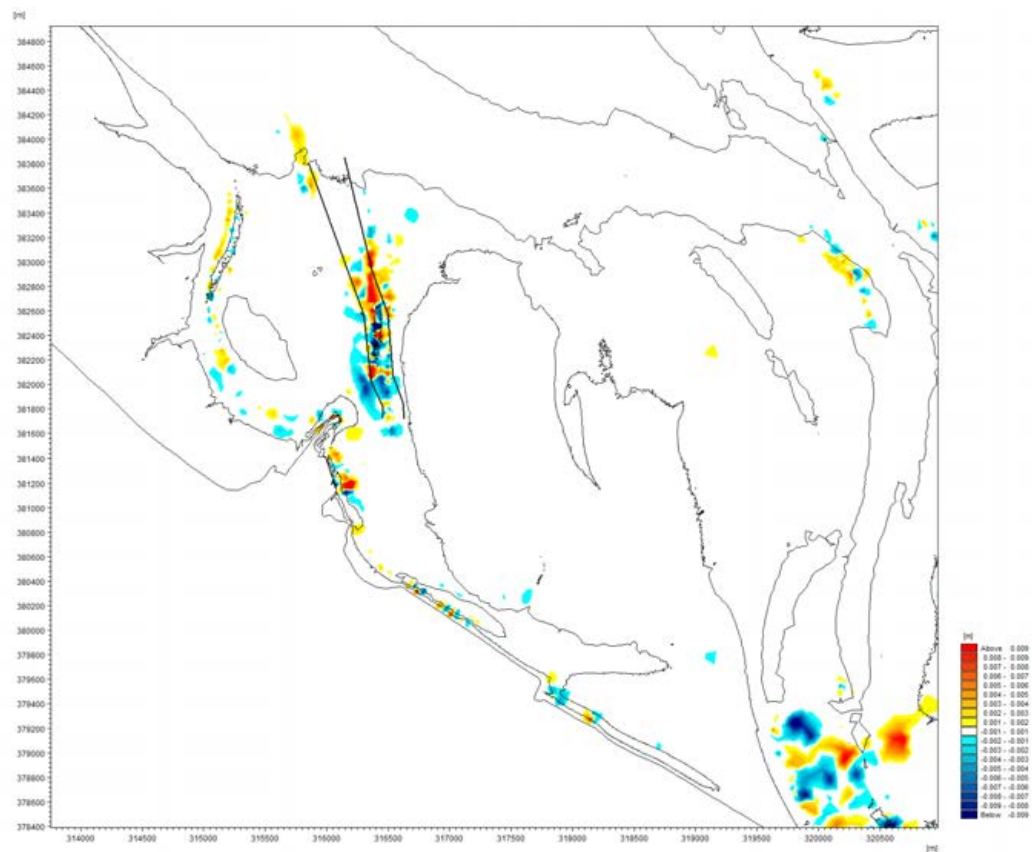
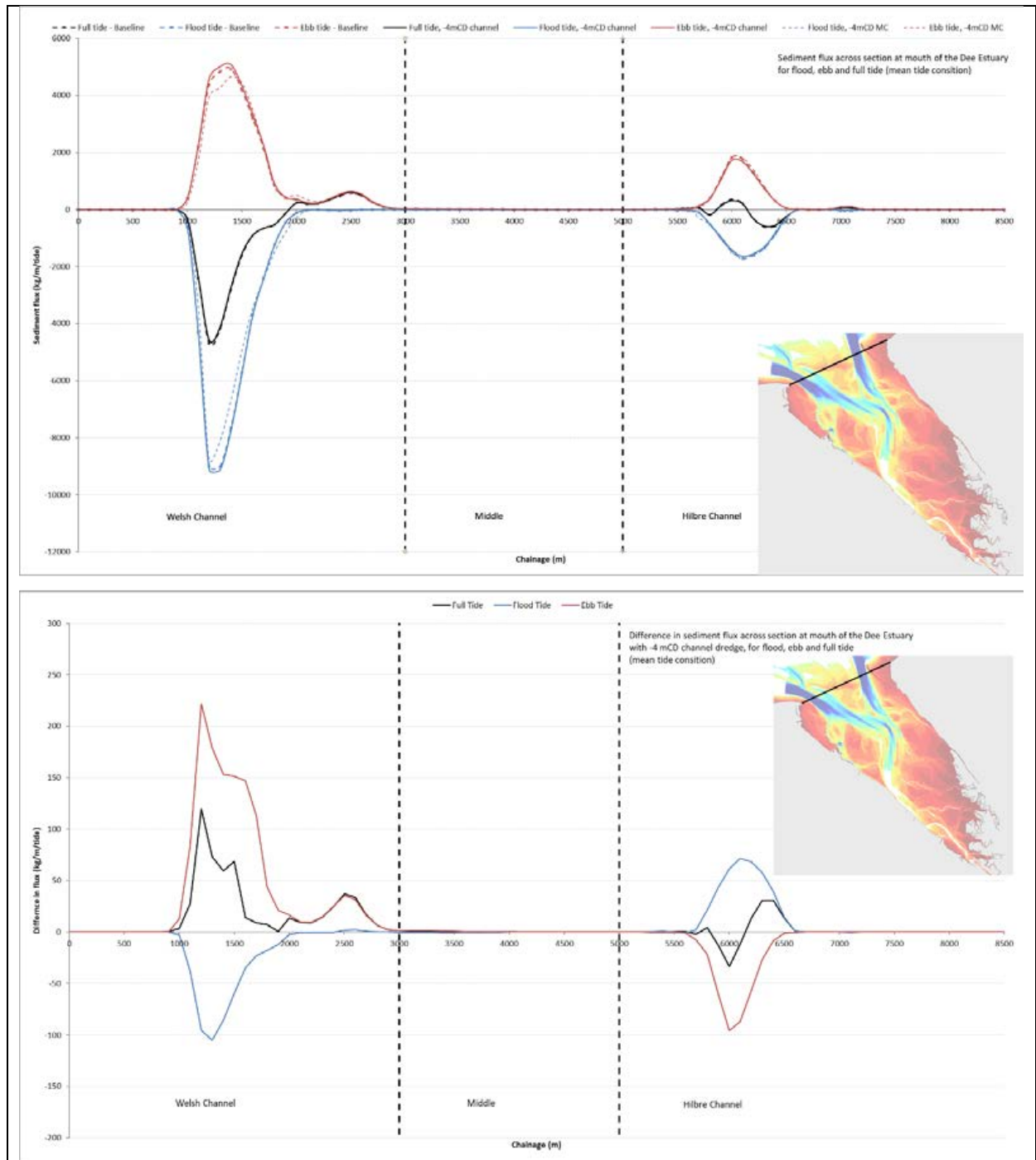
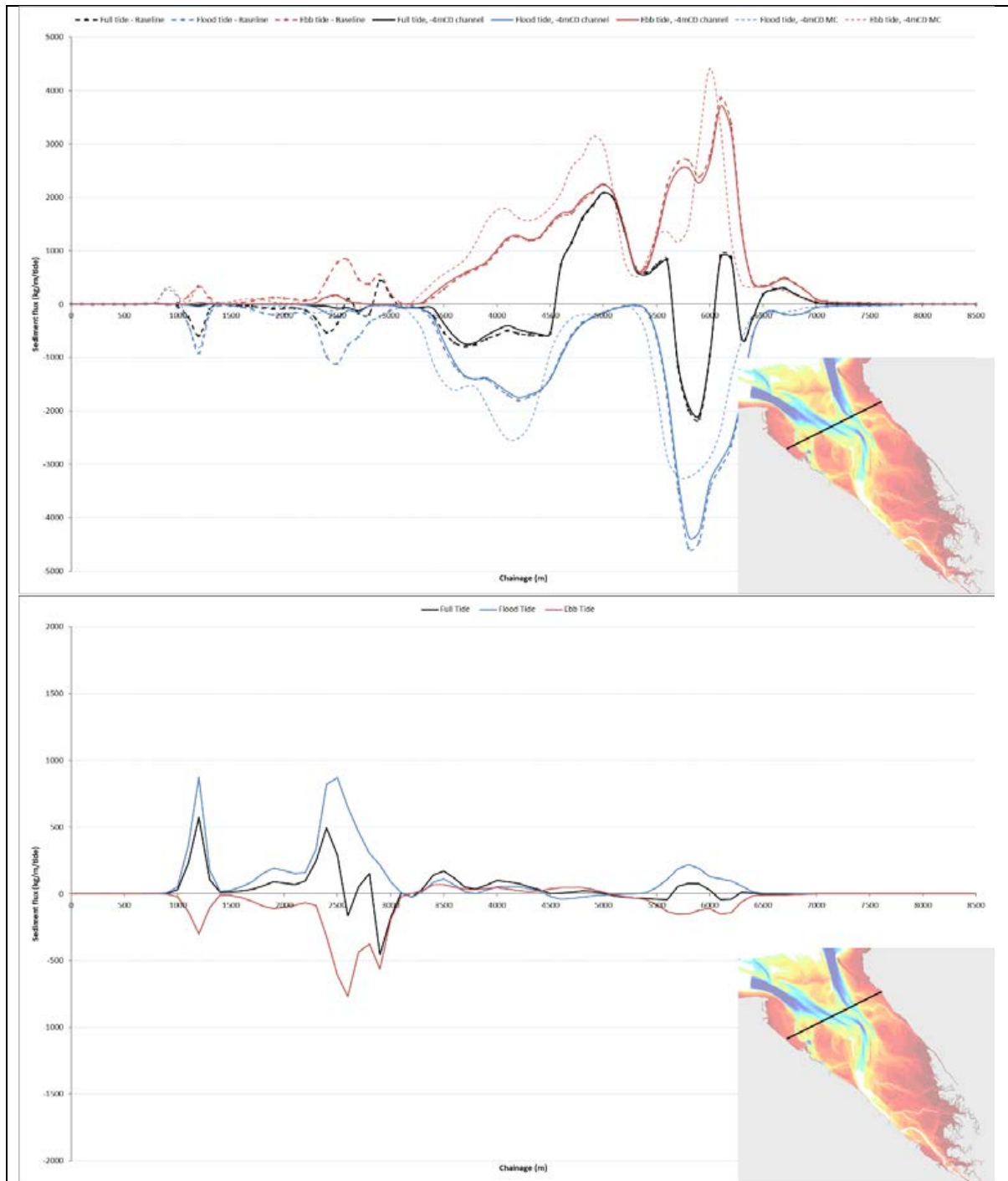


Figure 29. Difference in patterns of erosion and deposition with the baseline (mean tide)



Source: Sediment flux from dredging Mostyn Channel (MC) obtained from ABPmer, 2018b

Figure 30. Sediment flux lines across the mouth of the Dee Estuary (mean tide)



Source: Sediment flux from dredging Mostyn Channel (MC) obtained from ABPmer, 2018b

Figure 31. Sediment flux lines across the Dee Estuary in the vicinity of Mostyn (mean tide)

5 Conclusions

Recent bathymetric and topographic data have been analysed, to extend and build on an equivalent assessment of previous annual monitoring surveys since 2003. The observed morphological changes are summarised below, along with a summary of the modelling work that has been carried out to assess the effects of a potential future -4 mCD capital dredging project.

5.1 Morphological change: banks and channels

Changes to the orientation and alignment of the banks and channels of the Dee Estuary are evident in the inter-annual analysis. Whilst differences are observed over the full analysis period, the elevation change between years remains relatively small across much of the study area.

Between 2006 and 2021, three main areas of change are evident from the analysis. These are summarised below:

- The Mostyn Channel has shown a continued westerly migration over the monitoring period. The original alignment of the Mostyn Channel has filled in between 2006 and 2021 as it has realigned further to the west. Over this period, the centre-line of the Mostyn Channel has migrated up to approximately 580 m in places, from its original alignment. In addition, its orientation has also shifted from a straighter channel in 2006 to a significantly more curved one in 2021. The Salisbury Channel has also deepened and widened allowing this to become the main navigation channel for the Port of Mostyn.
- There is also a notable lateral movement of the main channels in the central estuary, along with alterations to the banks and channels around Mostyn Deep. Similar to that described above for the Mostyn Channel, the main channels of the central estuary have exhibited a number of shifts in alignment between 2006 and 2021. The upper reaches of the Hilbre Channel have straightened, to a degree, over the monitoring period, with the original alignment showing evidence of infilling. Also, to the east and west of the original meander (to the northeast of Salisbury Bank), deepening is evident. In contrast, the upper reaches of the Welsh Channel exhibit a reversal of this pattern with the alignment of the channel in 2006 being straighter than the more meandering orientation shown in the 2021 survey data.
- It is possible that these changes to the central estuary channels have led to an improved efficiency of tidal transmission to the upstream sections of the estuary. Within the upper estuary, the main channel from the recent (2021) survey data is aligned slightly closer to the Welsh coastline at Greenfield than in earlier (2006) surveys.

Towards the entrance to the Dee Estuary, notable changes are also observed, particularly in relation to the development of the Welshman's Gut and the Mid Hoyle Channel. In approximately 2006, Welshman's Gut closed (infilled) and has remained in this state through to 2021. Meanwhile, over the same time period, the Mid Hoyle Channel has further developed with the entrance to the Welsh Channel initially moving eastwards, albeit with the rate slowing, particularly on the east side, hence narrowing the channel. In 2021 the west side of the channel was seen to continue eroding westwards particularly on the north side of the bank. In addition, during the period 2006 to 2021 new channels have developed through the West Hoyle Spit, particularly to the west of the Mid Hoyle entrance channel, connecting to the Mid Hoyle channel to the north. This has effectively split the flow in this area.

5.2 Morphological change: statistical analysis of estuary bathymetry

Statistical analysis of the recent bathymetric and topographic data shows comparable changes in estuary area and volume, as those reported in the previous monitoring studies. In summary the following has been observed:

- Between 2017 and 2015 data analyses reveal a slight increase in sediment volume over the whole estuary. The statistical analysis shows a small increase in volume above -1 mCD, over both the northern and southern regions, whilst volumes below this threshold reduce slightly over the southern half.
- Comparison between the 2021 and 2017 datasets, indicates that there was an overall increase in volume over the whole estuary, at thresholds above -5 mCD, and a small increase in volume below this threshold, over the four years covered by the analysis. The observed changes are generally comprised of small average annual increases in volume for the northern half, at each threshold elevation; along with generally little change in volumes over the southern half.
- Throughout the period of surveys (since 2003), the changes calculated between 2013 and 2014 stand out as particularly large increases in volume (when compared against inter-annual comparison of earlier and later datasets). This is likely to be related to the effect of the large winter storms of 2013-14, which appear to have pushed sediment higher up in the tidal plane, resulting in the relatively large increases above the -5 mCD threshold.

5.3 Modelled assessment of potential -4 mCD Salisbury Channel dredging

A numerical modelling approach has been used to assess potential effects of maintenance dredging of the Salisbury Channel to -4 mCD. Similar to earlier studies, the predicted effects of dredging on the hydrodynamic and sediment transport generally remain localised to the Port of Mostyn region.

- The effect of the dredge on water levels is negligible. Absolute elevations of HW and LW are unchanged at the entrance of the Mostyn Channel, the Salisbury Channel and up-estuary of the Port. The most prominent effect is seen in close proximity to the PoM, where the dredge enables the ebb tide to flow out of the area quicker, resulting in LW predicted to occur around 30 to 40 minutes earlier, than under existing (baseline) conditions. Changes to the tidal propagation are restricted to the vicinity of the dredged channel. These results are similar to the effects of the -4 mCD dredge of the Mostyn Channel results from earlier studies.
- Changes in velocity are most apparent in the Salisbury Channel, the Mostyn Channel and surrounding area, particularly at the time of peak flood, with reductions in current magnitude of up to 0.5 m/s in the Salisbury Channel itself, and 0.4 m/s in the Mostyn Channel. Differences in current magnitude at the time of peak ebb are much less evident, with differences of ± 0.5 m/s in isolated areas around the channel.
- As with the changes in velocity, differences in discharge at the time of peak flood and peak ebb are apparent around the local study area. Reduced discharge is predicted in the Mostyn Channel of up to 1.9 m³/s/m, whilst in the Salisbury Channel itself, increases in discharge of up to 2.2 m³/s/m are observed.
- Predicted changes to sediment thickness are greatest in the dredged approach channel and the original Mostyn Channel to the west of the port. In these area changes to sediment thickness, within the dredged channel, tend to be within ± 0.02 m, over a mean tide.

-
- The dredged channel has a negligible effect on the distribution of the main tidal flows into and out of the estuary, through the Welsh and Hilbre channels. Within the estuary, the dredge affects the discharges through the Mostyn and Salisbury channels (in proximity to the Port of Mostyn), but again has a negligible effect on the main tidal flows through the upper Hilbre channel (to the north of the estuary).
 - In general, the changes observed across the mouth of the estuary (as a result of the dredge) are small, with a general increase in sediment flux within the Welsh Channel, for each tidal state. In the Hilbre Channel, the model results indicate a small increase in sand flux on the flood tide, but a small decrease over the ebb tide. Between the main channels (across the West Hoyle Bank and Salisbury Middle), the dredge is not predicted to have any effect on sediment flux.

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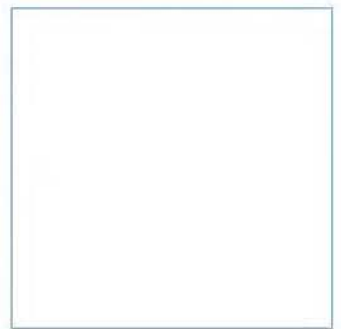
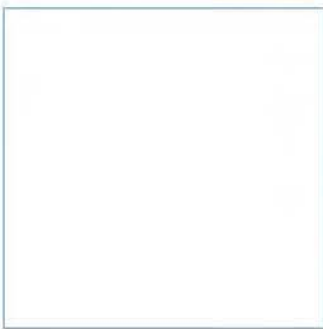
C Review of Monitoring Survey Work (ABPmer, 2017)

Port of Mostyn

Review of Dredge and Disposal Monitoring

Overview of survey work carried out by the Port in the Dee Estuary from 2005 to 2016

March 2017



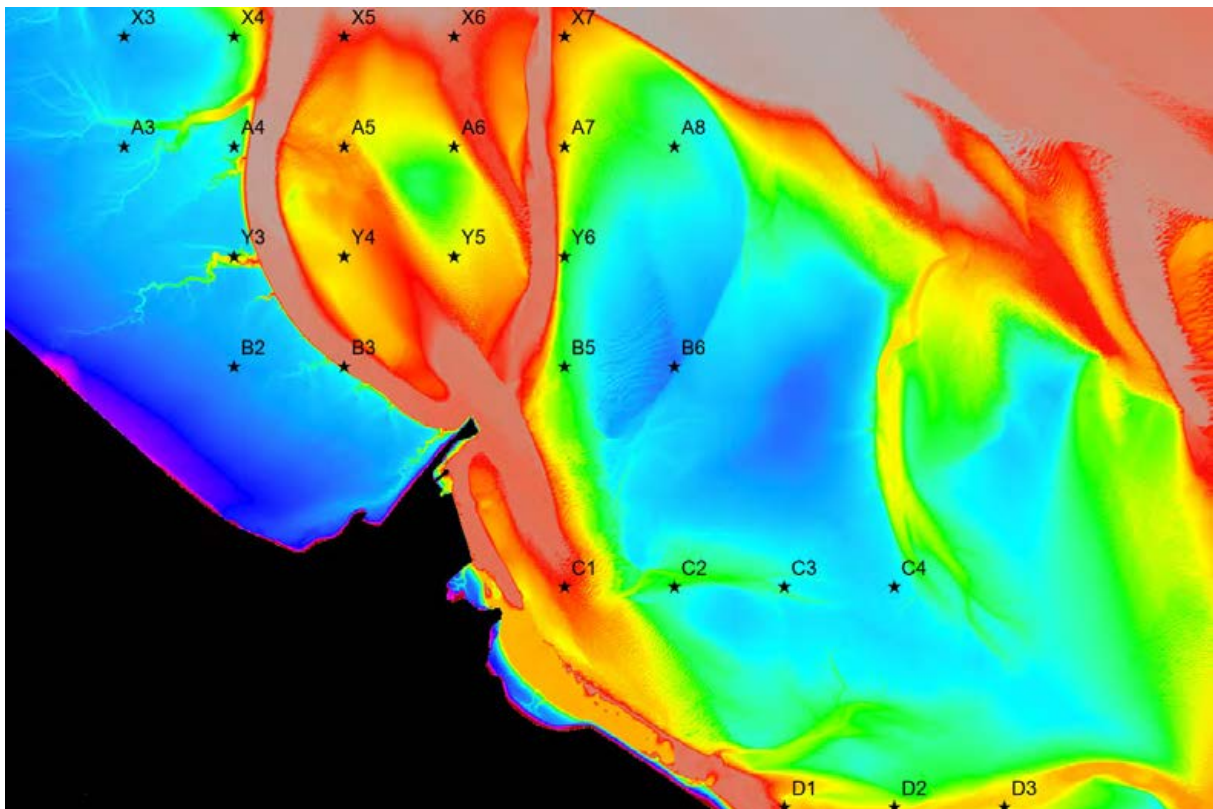
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Review of Dredge and Disposal Monitoring




Overview of survey work carried out by the Port in the Dee Estuary from 2005 to 2016

March 2017



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Contributing Authors

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Executive Summary

Report Background

This report presents a high-level review of monitoring work that the Port of Mostyn has undertaken in the Dee Estuary over the last 11 years (2005 to 2016). This monitoring has been carried out in fulfilment of relevant marine licence conditions and in order to understand the impacts of the Port's dredging and disposal activities (as undertaken to maintain safe navigable approaches to the Port).

This monitoring programme has been relatively detailed and has now been carried out over a long period of time. It includes a wide range of regular topographic, bathymetric and ecological surveys as well as data collation work, numerical modelling exercises and reporting commitments. The programme is designed to describe the local effects of the dredging works and, to place these results in context, examine any broader changes across the estuary as a whole.

Over the course of the 11 year programme, the monitoring commitments have been reviewed and, where necessary reduced, in response to the results obtained. The most recent NRW licence (dated 10 May 2016 Ref DML1542) includes a further reduced scope of monitoring which will apply under circumstances where the Port continues its existing practice of dredging the Approach Channel to a depth of 2 m below CD. There would be a reversion to a more detailed scope of monitoring (with more regular surveys and reporting) if the Port takes up its option (under the licence) to dredge the Approach Channel to deeper depths up to 4 m below CD.

This review has been undertaken to fulfil a condition within the latest Natural Resources Wales (NRW) marine licence. It has been requested to provide a review of the monitoring commitments and an evaluation of whether they are appropriate. For this overview, a large amount of the survey data has been collated and some broad-scale analysis and re-presentation of this data has been undertaken to examine the monitoring findings against their original objectives. This study does not, however, try to repeat the more detailed analysis and reporting work that have already been undertaken over this long-term monitoring programme. Based on the findings from this review, recommendations are presented for future monitoring. These recommendations will be subject to further review with NRW.

General Conclusions

The general conclusion is that the overall monitoring approach is appropriate and the key tasks within it do not need to be substantially altered. This is because the surveys provide a comprehensive description of the key areas. It is also because the data obtained in the future should be consistent with that collected in the past in order to ensure a standardised evidence-base is built up over time.

It is recommended however that a number of individual tasks are reduced in frequency. In large part this should be done by following the approach set out by NRW in the latest marine licence. However, measures are recommended to reduce other analyses. These reductions are merited because the very extensive survey work that has already been done provides confidence about the effects of the dredging and its role within an estuary context. The survey work also helps to describe the general rates of change in the estuary which indicates that reduced survey frequencies are appropriate.

In particular it is recommended that the estuary-wide monitoring survey and analysis work (Light Detection and Ranging (LiDAR) surveys and modelling especially) are reduced substantially in frequency. In the past these analyses of the full estuary system have helped understand the extent to which the area around the dredge channel (the Local Area sub-system) could be influenced by wider-

scale morphological changes. They have also been of value in terms of providing reassurance that there are no wider effects on the Dee Estuary European Marine Site from the Port dredging works. To date, the channel deepening work does not appear to have had effects beyond the local area. Therefore, the reasons for collecting estuary-wide data are more about understanding how the estuary morphology affects the dredge area than the other way around.

Also, the estuary has been relatively stable in recent years and is evidently exhibiting morphological evolution over long (multi-year) timelines. For these reasons a reduction in the frequency of this work is appropriate. It is proposed that any estuary-wide work is done over 2, 3 and 5-yearly cycles rather than annually. It should also be a general principle of the monitoring programme that priority is given to the analysis of conditions around the Approach Channel itself (i.e. the Local Area sub-system). This is because it is this local area where most changes occur, and where the greatest risks of change exist, from the Port's dredging and disposal work¹. To continue examining conditions in this area, emphasis should be placed on using the bathymetry surveys to describe the scale and trends of morphological change.

Some further adjustments to the scope of other survey and reporting tasks are also proposed to either fill some gaps in understanding or to address redundancies where certain commitments are not necessary. This includes a proposed increase in the coverage of the LiDAR data (taken at a reduced frequency) to enhance the value of the contextual estuary-wide information provided by this survey. This increased coverage could ideally be achieved through collaboration with established NRW monitoring work.

The most important recommendation for the future relates to analysis and interpretation. While no major change to established practices are proposed at this time, it is recommended that the presentation and interpretation of future survey work includes more interpretations of long-term temporal and spatial changes. In other words future analyses should consider the full monitoring data sets each time (as far as is reasonable). Such analysis will build directly upon the work done for this review and allow interpretations, and the visual presentation of this information, to build year on year. This will help to describe and understand temporal and spatial change over time in the survey areas. A summary of the key recommendations for each task is presented below.

Recommendations for Each Monitoring Task

The monitoring programme is separated out into tasks which cover the 'Local Area' (labelled LA1 to LA6) around the Approach Channel and those which cover the wider 'Estuary Basis' (labelled EB1 to EB5). Set against each of these key tasks the key recommendations for the future are as follows²:

- **LA1 Dredged Channel Survey.** For these bathymetric surveys of the Approach Channel area it is recommended that the reduced survey frequency of three times per year as per the NRW licence (compared to bi-monthly formerly) is adopted. However, following practices that are already being adopted by the Port, the western boundary/extent of the survey area should be seen as flexible/moveable to ensure the work captures the Mostyn Bank channel edge. Over time, and with regular analysis of this full dataset, this work could be reduced to biannual or annual (given the rate of change that has been observed historically) but further clear evidence for the appropriateness of this should be obtained given that this is the most important element of the programme.

¹ The existing data provides a comprehensive description of these local area changes. To date the Approach Channel has been maintained at 2 m below CD with dredging occurring where needed to maintain the navigable approaches. This approach has essentially 'managed' the influences of nature and allowed the channel to adjust and move westwards.

² As the local area surveys, and especially the bathymetric surveys of the Approach Channel (LA1), are viewed as the most important element of the programme, these are therefore presented first throughout this review.

- **LA2 Mostyn Deep Site 'A' Deposition Area.** A continuation of the existing approach is recommended in which these bathymetric surveys of the Mostyn Deep (carried out before and after the deposition) are only required if the option of dredging greater than 2 m below CD is taken up. While this deeper dredge has not happened (and, therefore, these surveys have not been formally undertaken) relevant data describing the deposit areas has been provided separately from extra surveys that the Port has carried out under Task EB4 and relevant data has been presented in the annual reports under LA2 and EB4 topic headings. The results from Task EB4 provide confidence that no further work under Task LA2 is needed while the channel is being dredged at no more than 2 m below CD.
- **LA3 Mostyn Deep Site 'A' Deposition Area Seabed.** This sediment sampling of Mostyn Deep for Particle Size Analysis (PSA) should continue, initially, on an annual basis with Task EB4. However, it should be subject to ongoing review because information from this work along with the EB4 survey data shows there is a rapid export of deposited sediment in this area. Future annual reporting should include a review of the spatial and temporal PSA changes in this area and on the basis of such an analysis, further discussions should be had about whether this work is: a) stopped, b) continued with a reduced number of samples or, c) continued but made contingent on findings from other surveys (especially the results from EB4 which describe morphological change in this area).
- **LA4 Cockle Survey Salisbury/Mostyn Bank (NRW data).** It is recommended that NRW data on cockle beds continues to be reviewed on an annual basis alongside consideration of the changes occurring around the main Approach Channel.
- **LA5 Benthic Survey Salisbury/Mostyn Bank.** It is recommended that this work continues on an existing basis with surveys of habitats and sediments being carried out in the Spring months and any follow up Autumn ecology surveys then being determined on the basis of the findings. Past reviews, have not indicated any ecological effects from the dredging work but annual checks in the Spring should be maintained given the importance of understanding the ecological conditions. However, from all that has been learned over several years, there is an expectation that Autumn surveys are unlikely to be needed (or will be an exception rather than a rule). Suggestions for the relocation of a few sampling sites are included to enhance the work and cover areas upstream of the Port including locations near to the South Salisbury Cockle bed (that could be linked to the LA4 work). In response to past discussions with NRA and Cefas there are no single-value parameters that could be derived from the Spring surveys which could objectively signal significant changes that trigger Autumn sampling (further analysis on this subject is presented within this report). It will therefore continue to be important to rely on surveyor observations for these surveys. However, there should also be further and continuing dialogue with Cefas on these aspects of evidence and interpretation.
- **LA6 Port Area Survey and Local Cockle Survey.** A continuation of the existing approach is recommended in which cockle surveys are only required if the option of dredging greater than 2 m below CD is taken up. The local port area surveys should continue on an appropriate basis.
- **EB1 LiDAR/Swathe Survey of Seabed Levels.** The LiDAR survey work and associated modelling analyses provide broad-scale contextual information about estuarine morphology. However, for reasons described above, sampling and re-modelling on an annual basis is considered unnecessary and should be reduced in frequency. It is recommended therefore that this work is viewed at 5-yearly cycles with the LiDAR being undertaken on a repeating 2-year and then 3-year cycles. The modelling work could then be carried out, if required, every

5 years to tie in with such a cycle. As per suggestions in the latest annual report, it is recommended that there should be an increase in the LiDAR and modelling survey area so that it includes the outer banks and channels (especially the Welsh and Hilbre Channels). One off small-scale bathymetric surveys of the channels may also be needed in this area. This expanded coverage is proposed because the conceptual understanding of the estuary hinges on the behaviour of these outer banks and channels. However, it is also recognised that the Port is not responsible for these changes it just needs to be able to understand them to underpin the survey interpretations. Therefore it is hoped that this work can be carried out as a collaboration between the Port's surveys and those carried out by NRW. After the first such updated modelling exercise it is also recommended that future modelling work is not undertaken on an automatic basis but only under circumstances where there is a need to explain changes within the estuarine system that have been observed from other survey work.

- **EB2 Estuary Transects.** For these bathymetric surveys of the Approach Channel area it is recommended that the reduced survey frequency of three times per year as per the NRW licence (as compared to bimonthly formerly) is adopted. Some adjustments to the timing of this survey are proposed however. As with all other tasks, this regime should be kept under review and appraised against the emerging evidence. It is very likely for this work that with regular analyses of the full dataset the survey could be reduced to biannual and even annual but further clear evidence for the appropriateness of this should be obtained over time.
- **EB3 Mid-Hoyle/Welsh Channel Confluence.** For these bathymetric surveys it is recommended that the reduced survey frequency of annual surveys (as opposed to biannual) is adopted. When it is carried out the coverage should be slightly expanded to cover the banks either side and get a full description of the channel. If the channel continues to show slow change this survey element could be removed in years when LiDAR data is collected but again this will need to be subject to further review.
- **EB4 Mostyn Deep.** These bathymetric surveys should continue on an annual basis to verify the transient nature of dredge sediment deposits and to understand how this area is morphologically changing.
- **EB5 Holocene Clay Bank.** It is recommended that the scope of the work on the Holocene Bank is reduced from biannual visits to annual observations (as proposed by NRW). However the scope of the work can also be reduced. It is no longer important to understand how it develops ecologically but it is important in terms of understanding the physical conditions in the outer estuary. This can be done through quick annual visits which describe the physical conditions (and amount of exposed clay) on site and can also be done by using LiDAR data.
- **Progress Reporting.** NRW has proposed that progress reporting is reduced to three times a year (one of which would be at a similar time to the annual report). It is recommended however that there is just the one progress report each year in June after the Spring surveys. The annual report (see next bullet) then fulfils the role of a further progress update at the end of the year.
- **Annual Reporting.** Annual reporting (at the end of each calendar year) should be continued. As noted above, it is recommended that these reports include analyses that build year on year so that long-term temporal and spatial trends can be described (outputs presented within this review may be helpful for this continuing analysis).

Future Reviews

In the future the scope of the surveys should be kept under review as it has been in the past. In particular, there is value in reconsidering the reporting approaches or survey frequencies when the licence is due for renewal (in March 2019). By that time a further two years of updated survey and interpretation will have been undertaken.

If there is any commercial need to deepen to greater depths (and a maximum depth of 4 m below CD is currently consented) then this is likely to have a greater effect. The channel position is likely to become more fixed and will require greater dredging to maintain navigable depth. It is agreed that this scenario should be accompanied by more detailed local surveys. However, the level of detail currently proposed for the monitoring is comprehensive and could be reduced without any loss in effectiveness. Should such an approach be adopted it is recommended that there is rapid revision/reduction in monitoring scope over time in response to evidence obtained. It is also recommended that emphasis remains on the local area analysis and especially the local area bathymetry surveys.

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1 Introduction

1.1 Project Background

At the Port of Mostyn (Dee Estuary, North Wales (see Image 1), regular dredging is carried out to maintain a safe navigable Approach Channel and the dredged sediment is then deposited subtidally within the 'Mostyn Deep' area in outer Dee Estuary. To accompany these dredging and disposal activities, the Port has carried out a detailed monitoring programme over several years. This programme has been undertaken to fulfil relevant consent conditions of past marine licences (including References 12/38/ML/1 dated 26 March 2015 which superseded 12/38/ML).



Image 1. Location of the Port of Mostyn with aerial view of the Port from the south west

This report presents a review of the monitoring work that has been undertaken over the last 11 years from 2005 to 2016. It has been prepared as a condition of the latest marine licence for these activities (as issued by NRW and dated 10 May 2016 (Reference DML1542)) and it provides a high-level overview of the methods and findings from this past monitoring. As one key outcome of this review, recommendations are made for future monitoring work based on the results that have been obtained and set against the original objectives. This future programme will be informed by this review and subsequent discussions on the findings with NRW.

1.2 Aims and Approach of the Existing Monitoring

The core aims of the Port's monitoring programme are to understand the physical and ecological consequences of the dredging and disposal work and to determine, particularly, whether the resulting changes could affect the nature conservation interests of the Dee Estuary. The Dee Estuary is subject to a high level of national and international nature conservation protection through its designation as: a Site of Special Scientific Interest (SSSI); a Special Protection Area (SPA); a Wetland of International

Importance (Ramsar site) and a Special Area of Conservation (SAC). The location and extent of these designated sites within the estuary is shown in Figure 1.

The monitoring programme is therefore carried out, primarily, to understand whether the dredging activities may have any effect on the conservation status and conservation objectives of these Dee Estuary's designated sites. In circumstances where adverse effects could arise, the monitoring would also be used to understand what mitigation measures needed to be adopted to address these in advance. These objectives are presented in the Mostyn Channel Monitoring Protocols (SMP, 2008, 2015). In summary they are as follows (bold **text/emphasis** has been added for this report):

- To **monitor the evolution of the estuary and** local and ambient effects of the model studies of dredging and deposition on the integrity of the estuary and on **the conservation objectives for the SAC** (especially those for the 'Estuary' feature which has objectives for spatial distribution of estuarine communities and the extent of notable hard substrata communities and for the 'Mudflats and Sandflats' feature which have objectives for proportions of mud and sandflat communities and the abundance of typical species);
- To compare monitoring results with the estuary basis (i.e. the seabed level survey) used for model studies and the **forecast effects** from those studies of the dredging and deposition and quantify any differences; to assess the significance of such differences and, if necessary, review the forecast **of dredge and deposition effects on the integrity of the estuary**;
- To **inform the development of additional mitigation measures that may be required** to avoid or reduce adverse impacts on the estuary; and
- To **inform future applications for maintenance of navigation to the port.**

To achieve these goals, the monitoring programme examines the estuary at two spatial levels as follows:

- **Local Sub-system (Local Area (LA) Surveys):** A series of studies are undertaken to describe local changes within and around the dredging and disposal locations. It is in this local sub-system where change is most likely to occur that is attributable to the dredging; and
- **Estuary-Wide System (Estuary Basis (EB) Surveys):** A further series of studies are carried out to describe the broader changes occurring across the estuary. This work provides information on how the dominant forces acting throughout the estuary are, or might be, changing in order to provide a context for understanding any changes that are observed within the local sub-system. This wider context about the estuary as a whole is needed to inform and understand what is happening locally. It also helps to understand whether local effects from the dredging and disposal activities are having any more widespread effects across the Dee Estuary SAC.

To cover these two zones, the monitoring programme includes a wide range of different survey and analysis tasks which are regularly undertaken. These tasks include: boat-based bathymetric surveys; airborne Light Detection and Ranging (LiDAR) survey work; hydrodynamic modelling; sediment analyses; ecological sampling; and the collation of cockle data from commercial beds. These discrete monitoring tasks are separated out into those which cover the 'Local Area' (labelled LA1 to LA6) and those which cover the 'Estuary Basis' (labelled EB1 to EB5). In outline, the surveys are as follows:

- LA1 Dredged Channel Survey;
- LA2 Mostyn Deep Site 'A' Deposition Area;
- LA3 Mostyn Deep Site 'A' Deposition Area Seabed;
- LA4 Cockle Survey Salisbury/ Mostyn Bank (NRW data);
- LA5 Benthic Survey Salisbury/Mostyn Bank;
- LA6 Port area survey and local cockle survey;
- EB1 LiDAR/Swathe Survey of seabed levels;
- EB2 Estuary Transects;
- EB3 Mid-Hoyle/Welsh channel confluence;
- EB4 Mostyn Deep; and
- EB5 Holocene Clay Bank.

The main geomorphological features within the estuary that these surveys are investigating (e.g. Approach Channel, Mid-Hoyle Channel, Mostyn Deep etc.) are illustrated in Figure 2. Figure 3 shows the main monitoring sites and survey boundaries and, because these boundaries can be adjusted in response to need Figure 4 shows the different boundaries for the surveys of Mid-Hoyle (EB3), Mostyn Deep (EB4), and the Approach Channel (LA1).

Throughout the monitoring programme, the results of the surveys and other analyses are reviewed and circulated to NRW and other stakeholders within regularly-produced reports (as required under the licences). These reports were produced monthly from 2005 to 2008 and then from May 2009 have been produced bimonthly (every two months). An annual report is also produced at the end of each year. The reports include an analysis of the results from each monitoring task and a comparison of the findings against 'task thresholds' using a 'traffic light system' to rapidly describe conditions and findings. This system was designed at the start of the monitoring programme based on the available knowledge at the time. The most recent annual report produced under this programme was issued in December 2015 (SMP, 2015). The most recent three bi-monthly reports (Nos 42, 43 and 44) cover the periods January/February 2016, March/April 2016 and May/June/July 2016 respectively (SMP 2016a-c).

1.3 Background and Scope of this Review

This review of the monitoring results has been undertaken as a specific requirement of conditions set out within a newly-issued marine licence (Ref: DML1542) for the Port's dredging and sediment disposal work. This new licence, a copy of which is included as Appendix A, has been issued by the NRW Marine Licencing Team (NRW MLT) and runs from June 2016 to March 2019. This licence includes the following two consent requirements:

- **Condition 9.5:** This identifies a requirement to submit 'a methodology and scope of review of the previous 11 years of monitoring data; and
- **Condition 9.6:** This identifies a requirement to implement and 'submit the Review' over a timescale to be agreed with NRW.

The requirements of Condition 9.5 (i.e. scoping this review process) were fulfilled through the preparation of a proposed scheme of work (ABPmer 2016) and through discussions with NRW MLT and NRW Technical Advisers (TA). These discussions include the feedback received by consultees following the circulation of previously-issued monitoring reports and the key written responses are included within Appendix A of this report.

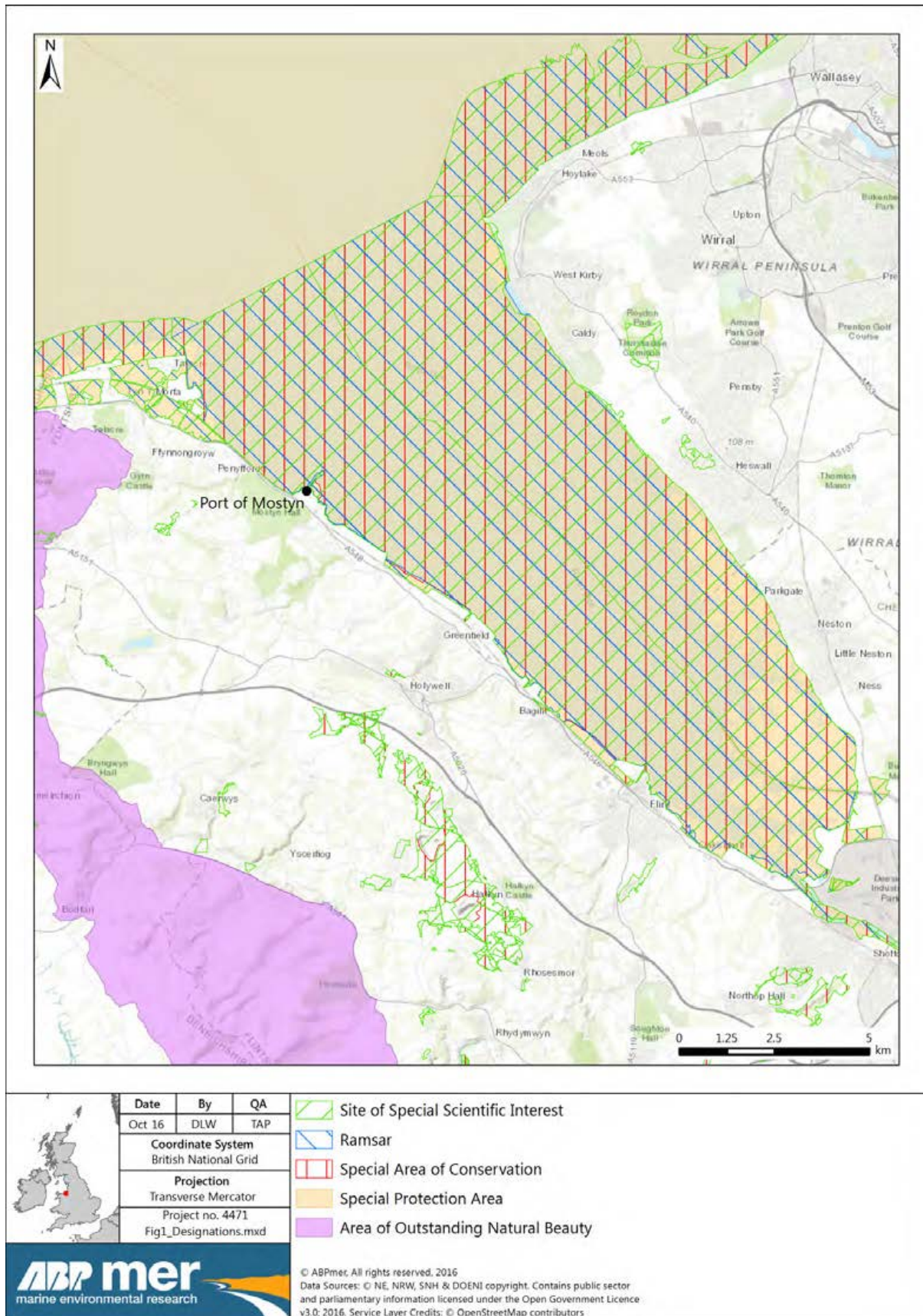


Figure 1. Map of designated sites within the Dee Estuary

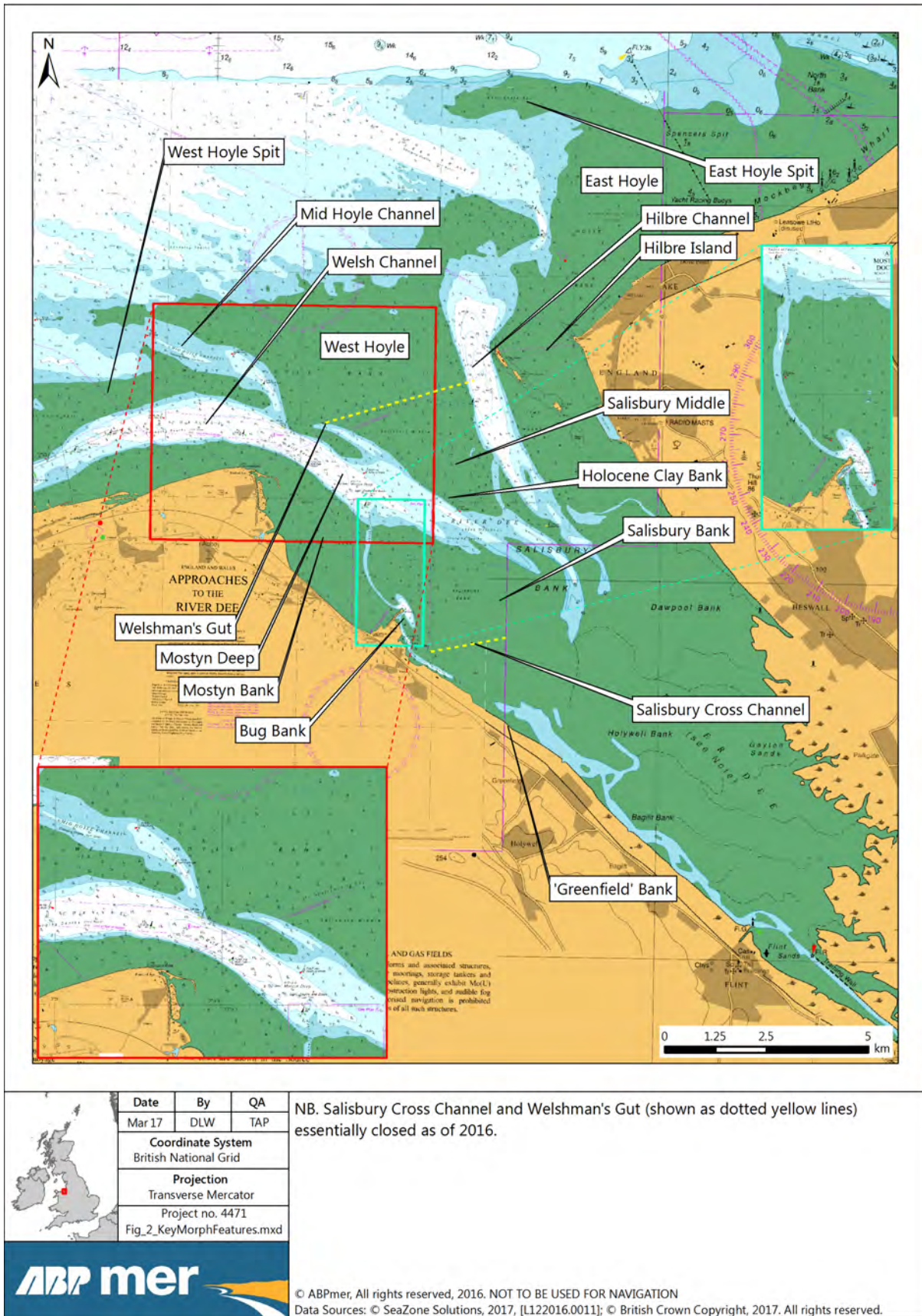


Figure 2. Dee Estuary morphological features of relevance to the monitoring programme

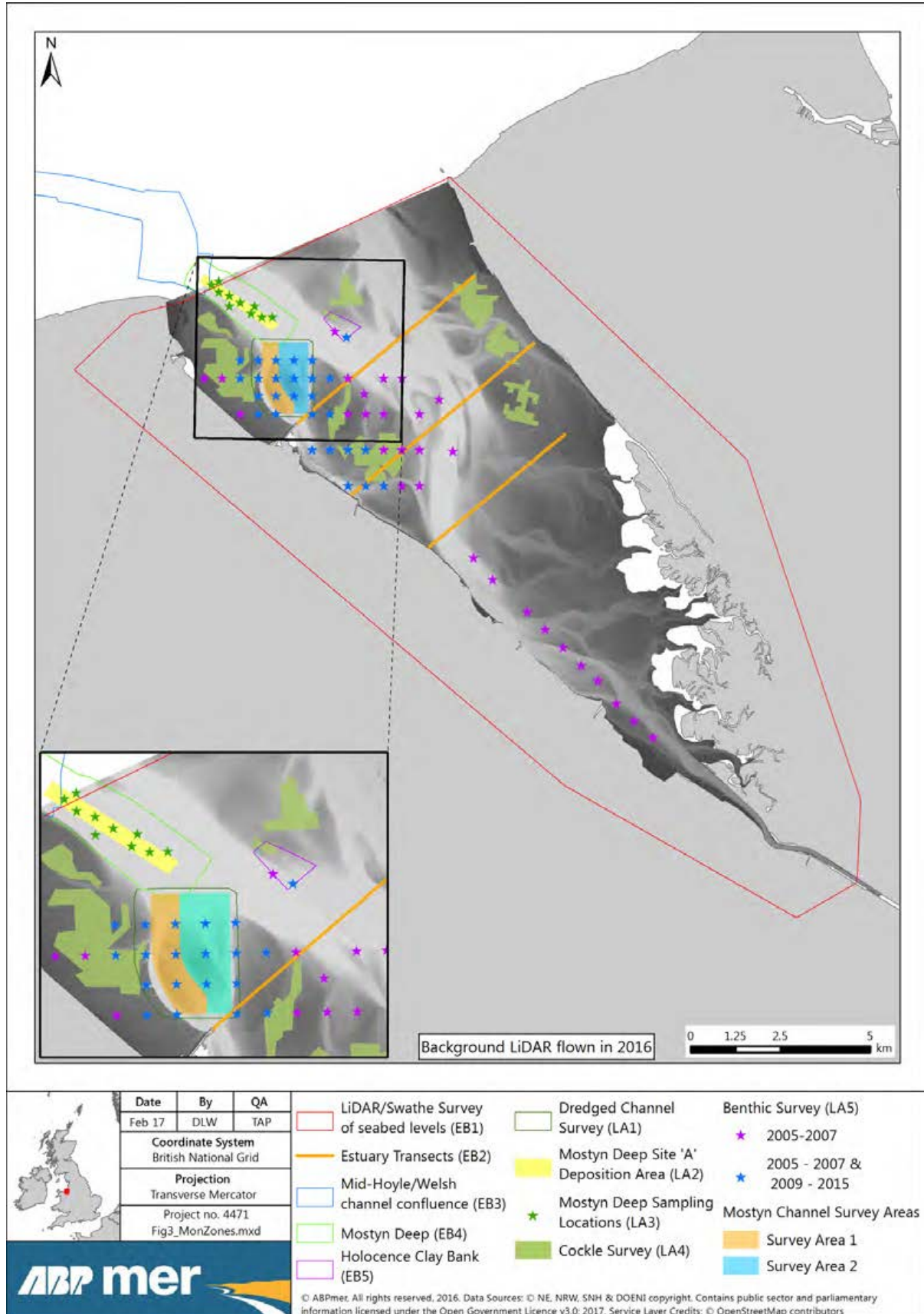


Figure 3. Survey zones and site locations for the Port of Mostyn monitoring programme

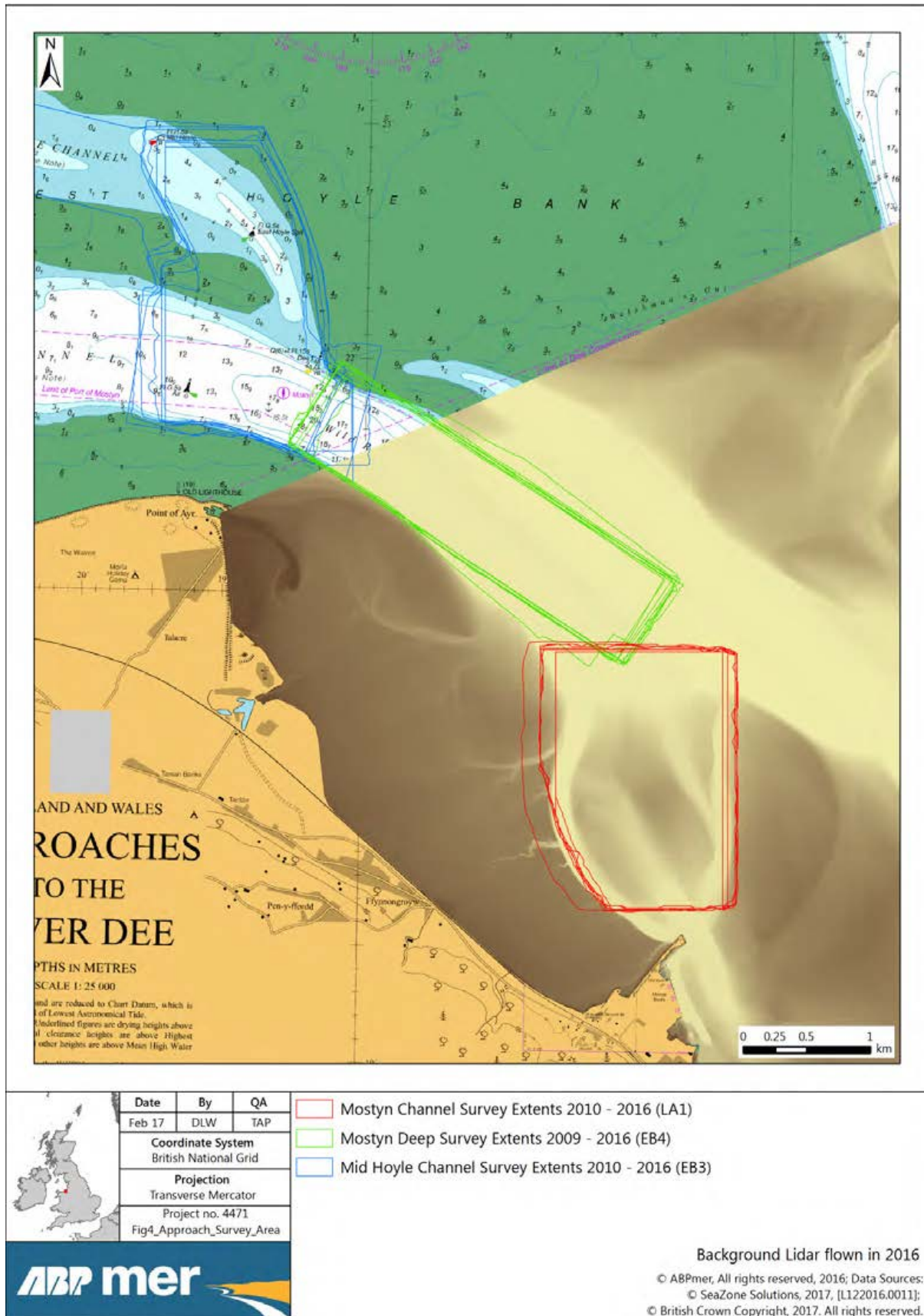


Figure 4. Boundary detail for individual Mid-Hoyle (EB3), Mostyn Deep (EB4), and Approach Channel (LA1) surveys

In summary the key reports, correspondence and communications which have informed the preceding dialogue process, and hence this review, were as follows:

- **Reports, Licence and Proposals in 2016**
 - **Latest Port of Mostyn annual monitoring** (dated December 2015) as prepared by SMP (2015);
 - **Monitoring review proposal as issued by the Port to NRW** (dated 7 July 2016) as prepared by ABPmer (2016) in fulfilment of Condition 9.5 of the licence;
 - **Latest Port of Mostyn bi-monthly reports** Nos 42, 43 and 44 as prepared by SMP (2016a-c); and
 - **NRW Marine Licence Ref: DML1542** (dated 10 May 2016) issued with conditions for monitoring review.

- **Key Correspondence in 2016**
 - **Letter from** Centre for Environment, Fisheries and Aquaculture Science (Cefas) (dated 16 June 2016) in response to the 2015 annual monitoring report;
 - **Email from NRW MLT** (dated 22 June 2016) in response to the 2015 annual monitoring report and including summaries of NRW-TA and Cefas comments;
 - **Teleconference and email discussions with NRW** (dated 2 August and the 27/28 September 2016) to consider the monitoring review proposal and identify other relevant issues; and
 - **Emails from NRW MLT** (dated 14 July and 5 October 2016) reviewing bi-monthly reports 42-44 and the identifying any additional relevant issues.

Through this dialogue process a series of key issues were highlighted by the NRA-TA and Cefas (see Appendix A) which can be summarised as follows (with details about where, within this report, the resulting information can be found):

- **Produce a map illustrating the key locations** including the key geomorphological features and survey areas. This information has been presented in Figures 3 and 4.

- **Review the history of dredging and disposal activities** and identify locations and timings of these activities as undertaken over the last 11 years. This is presented in Section 1.4 below.

- **Review the outcomes of the monitoring survey work** with further specific consideration of the following main issues:
 - The recent geomorphological changes in the estuary;
 - The survey specifications including the levels of accuracy and the location of the sampling and the need to move channel survey areas to the west to cover the Mostyn Bank Erosion;
 - The value of using multibeam echo-sounder rather than a single-beam approach for bathymetric survey work;
 - The influence of the 2013/14 Winter storms and the extent to which these played a part in the changes observed during the 2014 surveys;
 - The role of modelling and the value of updating it using latest bathymetric data from the outer Dee and Irish sea; and
 - The benthic ecology sampling strategy and methods of analysis and interpretation

This review is presented in Section 3 which considers each of the monitoring tasks in turn.

These issues are addressed within Section 2 of this report which presents the aims, methods and outcomes of the review process for each of the monitoring tasks (i.e. LA1 to LA6 and EB1 to EB5). Overall conclusions and recommendations are then presented in Section 3. Following completion of this review the conclusions will be discussed with NRW and the two next stages of the process will involve:

- **A follow up consultation meeting/discussions with NRW** to agree the findings of the review and any proposed adjustments to the monitoring regime that arise from it; and
- **Implementation of ongoing monitoring** in which the survey work, activity recording and reporting programmes will be pursued according to agreed methods and timescales over the remaining licence period (which runs from 1 June 2016 to 31 March 2019).

In advance of this review (which is mainly within Section 2 and 3) further details about the approach taken for this review along with contextual information about the dredging and disposal programmes are presented in Sections 1.4 to 1.6.

In addition to these key issues, NRW also raised some subsidiary presentational comments (in email dated 5 October 2016) following the issuing of the latest bi-monthly reports (Report Number 44 covering the monitoring up to July 2016). These presentational comments were as follows:

- Annex III provides information on the dredge campaign, however, there are no units associated with the data presented. Can this be amended in future reports for clarity? These values are m³ and the unit will be added to future reports;
- Please could clarification be provided as to the meaning of 'single', 'double' and 'triple' on page 2 of Annex III; These refer to the frequency of the sediment placement in each of the cells of the disposal ground. There is a colour code for the number of loads deposited in a particular cell. In most campaigns only a single layer is deposited but in a major campaign several layers may be made. The licence calls for the material to be spread evenly over the disposal area, one layer to be completed before the next one commences.
- Could a simple map be provided to demonstrate where the 'channel' and 'harbour' are? This is shown in Section 1.6.

1.4 Review Approach and Report Structure

This review has been prepared on behalf the Port of Mostyn by ABPmer with support and advice from Dr Barber of Shoreline Management Partnership (SMP). Dr Barber is the Port's long-term specialist advisor on estuarine processes and monitoring. ABPmer is the lead marine ecology consultant for the Port and has carried out the ecological surveys and a number of impact assessment studies under the previous consent arrangements.

To begin this review, a large amount of the monitoring data that has been collected over the last 11 years was brought together. The Port of Mostyn Harbour Master (Roy Hyde-Linaker) assisted ABPmer with the retrieval and collation of this information. As ABPmer has been responsible for the ecological survey and reporting work, the information for the Benthic Survey (LA5); and the Holocene Clay Bank work (EB5) was already held in-house. It was necessary, however, to bring together data from the other bathymetric and LiDAR surveys. The Port provided these datasets to ABPmer along with other advice and information where needed. In some instances the available data covers the entirety of the 11-year monitoring period in other instances they cover a lesser duration. Once collated, these

datasets were subject to selected quality check (especially on the LiDAR data) before a series of selected additional high-level analyses were undertaken to inform this review and respond to key issues raised by NRW and other consultees.

In advance of conducting this review, it was recognised that substantial analysis of this data has already been undertaken in fulfilment of past consents and that this past work has provided an existing and detailed understanding about physical changes and ecological characteristics of the Dee Estuary. Therefore, it was not considered possible or necessary to undertake any substantial data re-analysis for this review. Instead the focus of this study has been on producing a stand-alone interpretive report that includes selected extra high-level analyses where these are helpful for addressing a particular need or considering specific topics.

This monitoring review has been conducted with a view to understanding, firstly, what has been achieved through the established monitoring programme and secondly to identify what survey work is required in the future. Every effort has been made to pursue the work in an objective and scientifically-robust manner with the report being structured to provide relevant information and answers key questions in sequence. The key proposed questions/objectives of this review work and the overall report structure are as follows:

- **Introduction (Section 1):** This section outlines the background to the project and the scope of this review. It clarifies the questions that the established monitoring programme has been seeking to answer and reviews the historical dredging and disposal work that has been carried out on site;
- **Monitoring Review (Section 2):** The main section of the report considers the findings from the survey work and the extent to which the established monitoring has answered the questions as originally posed and/or whether new questions have emerged. Sections 2.2 to 2.12 review each of the key components of the monitoring schedule in turn and reviews the following:
 - The survey work that has been undertaken;
 - The findings from past surveys work and any extra analysis conducted for this review,
 - The gaps in current understanding and/or areas of redundancy or uncertainty; and
 - The recommendations for the future in the light of these findings.

As part of these analyses the review considers the justification for the range of monitoring tasks and their execution frequencies;

- **Conclusions and Recommendations (Section 3):** To fulfil Condition 9.6 of the marine licence, this review collates the proposed recommendation and summarises where changes to the monitoring programme are proposed.

1.5 Channel Depth and Forecast Period

In considering the results of the monitoring and making recommendations for the future there are two particular considerations which should be highlighted. Firstly, the monitoring programme was originally set up based on an expectation that the Port would need to deepen the Approach Channel to 4 m below Chart Datum (CD). In the end, this has not yet been needed and the channel has only been deepened to at most 2 m below CD (often only maintained to 1 m below CD). This means that all observations made so far relate to the effects arising from maintaining the channel at these shallower depths.

Different and larger changes are to be expected from deepening to 4 m below CD and under such a scenario the channel is likely to be more stable and ‘fixed’ in its form and location by the maintenance dredging requirement more than is the case with the present 2 m below CD scenario. Under the existing regime, dredging is undertaken on an ‘as required’ basis in areas where there is Approach Channel shoaling to maintain the required depth for the existing channel usage. As a consequence, the Approach Channel has been allowed to migrate (as described further in Section 2.2).

As a consequence of the reduced level of intervention (i.e. maintenance of the channel at no more than 2 m below CD) and in response to the results of completed surveys, the frequency of some future survey and reporting tasks have been reduced over time. The most recent NRW licence (dated 10 May 2016 Ref DML1542) sets out the latest reduced scope of monitoring. Under the current situation, and pending discussions following this review, the Port will implement this reduced monitoring programme. However, the Port will revert to a more detailed monitoring regime in the event that there is a requirement to deepen to the channel further to depths between 2 m and 4 m below CD as currently licenced. The two monitoring scenarios that are set out in the latest marine licence (DML1542) are illustrated in Image 2.

2m	Month												4m	Month														
Task	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Task	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
EB1				■	■								EB1				■	■										
EB2	▲			▲					▲				EB2	▲		▲	▲			▲		▲		▲				
EB3				■	■								EB3				■	■						■	■			
EB4										■	■		EB4										■	■				
EB5			■	■									EB5			■	■							■	■			
LA1	□												LA1	□							□				□			
LA2			(As Appropriate)													(As Appropriate)												
LA3													LA3															
LA4			(NRW to provide)													(NRW to provide)												
LA5													LA5															
LA6			(As Appropriate)													(As Appropriate)												
Progress Reports	○												Progress Reports	○	○						○	○			○			
Annual Report													Annual Report												●			

Source NRW Marine Licence Ref: DML1542

Image 2. Monitoring timetables for a typical year (left schedule relates to dredge not >2 m below CD and right relates to lower depths up to 4 m below CD as consented)

The deeper dredging scenario is expressed as a range (i.e. from 2 m and 4 m below CD) to reflect the fact that, even in a situation where the Port’s customer needs change and deeper channel dredging is required, deepening to 4 m below CD might not occur. Instead, it may well be that deepening to 3 m below CD will suffice. It is also a relevant consideration that dredging to a deeper and more ‘fixed’ channel will result in greater rates of infill by depositing sediment. Therefore this will inherently lead to higher dredging commitments and costs. There is therefore always a commercial requirement to minimise the depth of any dredging if possible. These considerations reflect the inherent complexities associated with port management, dredging and maintaining safe navigation (especially in complex estuary systems). They also highlight how the monitoring requirements need to continue to consider and reflect these complexities.

The current expectation is that the Port will continue to maintain the Approach Channel at depths of no greater than 2 m below CD. This situation is unlikely to change in the near future or within the lifetime of the current marine consent which expires on 31 March 2019.

1.6 Dredging and Disposal History

To provide a brief context for this review, this section outlines the dredging and disposal work that has been undertaken at the Port over the course of the monitoring programmes. The inner estuary Approach Channel to the Port of Mostyn was first dredged in 2001 (following consent granted in 1995). This increased the 'navigation window' for vessels accessing the Port and allowed the expanded facility to meet the commercial needs of the emerging offshore windfarm sector for example. In the past the channels in this area were dynamic and disconnected and they were navigated at higher tidal states over much smaller tidal windows (to reach the Port which itself had constrained high-tide access only).

Since 2001, the single and distinct inner estuary Approach Channel has been maintained at around 2 m below CD (see also Section 1.5). The key details of the dredging campaigns over the last including the campaign dates; the volumes of sediment dredged; the broad locations of the work and the maintained navigation depths are all detailed and tabulated within the annual reports (see Section 2 of SMP, 2015). This information is also provided here within Appendix B. The dredge campaigns are carried out in the 'channel' and the 'harbour' and these areas are shown in Image 3.

The harbour area includes locations in front of the main berth and including the Bug Bank which, like the Approach Channel dredging, is undertaken with a trailer suction hopper dredge. Here anywhere between 0 and 70,000 m³ is dredged in any given year (average over the seven years from 2007 to 2014 is 37,000 m³). Also additional WID³ or plough dredging takes place alongside the Ro-Ro berth as shown in Image 3. Within the 'harbour' zone, dredging has also been undertaken less frequently in a 'horseshoe' shaped area in an upstream section of Bug Bank in order to enable vessels to turn and berth at the quayside.

The Approach Channel alignment that is shown in Image 3 has since moved (as noted below and in Section 2.2) but the requirement within the licence is that the channel connects the M1 Buoy and the South Salisbury Buoy the positions of which are shown on Image 1. Within this 'Approach Channel' dredging is mainly undertaken between buoys M3 and M6 in areas where there is shoaling and where there is a need to achieve navigable depths. From these areas anywhere between 20,000 and 300,000 m³ of sediment can be dredged during each year (average over the seven years from 2007 to 2014 is 120,000 m³).

As described in the preceding section, the Approach Channel dredging has been undertaken in areas where there is a clear need (i.e. where there is distinct shallowing/shoaling in the approaches). This is in contrast to an alternative approach which would involve dredging great volumes to try to preserve the channel in place along a more fixed and unchanging alignment. The adopted technique has minimised the degree of on-site intervention and the volumes and extent of the dredging commitments. A consequence of this approach is that the channel has been allowed to adjust 'naturally' to some degree and that natural evolution has resulted in an westerly drift of the channel alignment. This will be discussed further in Section 2.2.

The material from the areas are disposed at the licensed Mostyn Deep Site 'A' Deposition Area (Figure 3). Under the licence there is a limit on the volume of sediment of 900,000 tonnes/year.

³ Water Injection Dredging

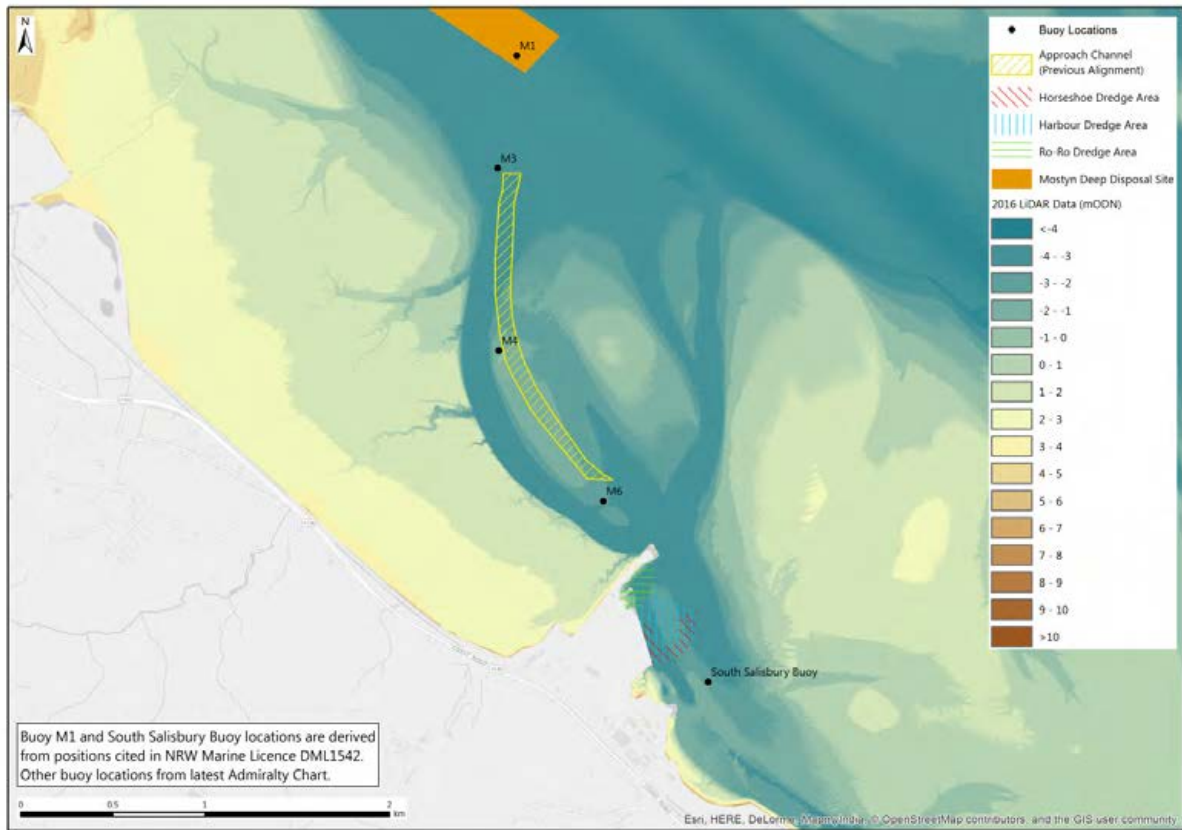


Image 3. Indicative locations of Approach Channel, harbour and horseshoe dredge areas (note change to Approach Channel alignment as described in Section 2.2)

2 Monitoring Review

2.1 Introduction

The following sections present the background, outcome and conclusions of the review process. Each section considers a separate monitoring task (as listed in Section 1.2) and in each case consideration is given to the survey work undertaken, the results of the review process, the identified gaps and redundancies before the final recommendations are derived.

For this section, the Local Area surveys are listed and considered first. This is because it is the local area that is most important with respect to evaluating the Port navigation channel. It is within the local area that changes are most likely to occur as a result of the channel maintenance and therefore it is here that the main consideration should be directed. In other words, if the local changes are confined in their extent (i.e. in the local area sub-system) and are assessed as 'small' or 'minor' then observed changes to the wider estuary area are less likely to occur as a consequence of the dredging and disposal operations for the navigation Approach Channel.

2.2 LA1 Dredged Channel Survey

2.2.1 Survey work undertaken 2005 to 2016

The aim of the LA1 'Dredged Channel Surveys' is to monitor the position and morphology of the Port's navigable Approach Channel and understand aspects such as the changes in the channel flank elevation shape and channel corridor width. For these surveys regular bathymetric surveys are conducted by the Port. These involve taking single-beam echo-sounder readings along established lateral and longitudinal transects that are set about 50 m apart. The extent of the survey area can be seen in Figures 3 and 4.

In the early years of the existing monitoring programme (between 2005 and March 2009) these surveys were undertaken on a monthly basis. In response to recommendations within the Mostyn Channel Monitoring Protocols (SMP, 2008) the frequency of these surveys were later reduced (from May 2009 as part of Licence Consent 12/38/ML) to bi-monthly (two monthly) intervals⁴.

The 2015 Annual Monitoring Report recommended that the frequency of monitoring surveys for LA1 is reduced from bi-monthly (six surveys per annum) to four surveys per annum by omitting the April and October surveys. This reduction was recommended on the basis that the omitted surveys were adding nothing distinctive to the overall record of changes not already provided by the surveys recommended to remain following a review of the data back to 2004. However, there were issues with this frequency change causing uneven intervals between surveys.

The newly-issued marine licence (Ref: DML1542) confirmed that there should be a reduction in surveys to every four months (three surveys per year in January, June and October) for dredging up to but not exceeding 2 m below CD Dredge. The bi-monthly approach would be restored for channel deepening to greater than 2 m below CD) should this be required (see Image 2).

⁴ This frequency was derived from a consideration of monthly surveys for each of these tasks. The data sets were analysed for monthly intervals; then for simulated two monthly intervals and a difference plot produced. This work demonstrated that the physical changes over the period were adequately captured by the two-month interval (SMP, 2008).

2.2.2 Monitoring review

For this review the Port has provided data (in 'xyz' format) for the period from 2009 to 2016 (21 surveys in total). The results of this work have been described in the monitoring reports and it is known from this work that there has generally been a progressive westerly shift in the alignment of the Approach Channel. For this review the bathymetric survey data were subject to GIS analysis to further describe and examine this change.

For the GIS analysis, the data points were used to generate a 'raster' surface layer covering the same extent as the survey. These surface layers were then used to directly compare the results obtained between each of eight separate (and approximately annual⁵) surveys (as opposed to solely presenting the xyz point data in each year). Specifically, these surface layers were used to produce the following outputs:

- **Contour plot and transects:** Individual contours were selected and derived from the surface raster plots. This enables the migration of individual contours to be examined over multiple years to highlight patterns in movement. Contours were derived from a single survey for each year at the Mean Low Water Spring (MLWS) alignment. Cross-sectional depth profiles were also created along selected transect alignments in four key areas of interest. These analyses are plotted in Figures 5 and 6.
- **Difference plot:** In addition, a plot was created which shows the net difference in seabed depth recorded between 2009 and 2016. This is shown in Image 4 with warm colours (orange and red) showing a net lowering/erosion of seabed levels and cold colours (green and blue) showing net raising/accretion over the seven year period (Image 4). Image 4 also includes the alignment of the original 2001 dredge channel.

In summary⁶ these plots describe how there has been a clear and gradual westerly drift (and also a 'shallowing') of the Approach Channel over the course of the surveys. As the channel has moved it has been necessary to adjust the position of the navigation buoys which mark the main channel.

This westerly change has occurred at around 20 m/year although the rate is variable along the length of the Approach Channel (lower to the north and higher to the south). This change has occurred because (as described in Section 1.5) the dredging strategy has been relatively small-scale and undertaken where necessary to maintain navigation depths (at and higher than 2 m below CD) within the migrating channel. This approach has allowed a degree of natural change to take place (albeit one that is 'managed' in depth terms) by the dredging work. There has been no Port operational requirement yet to dredge to the maximum consented depth of 4 m below CD. Such a scenario would represent a much bigger intervention in the morphology and one that is more likely to create a fixed Approach Channel alignment.

Image 4 and Figures 5 and 6 also show how the westerly migration of the Approach Channel has resulted in erosion along the edge of the Mostyn Bank. They also indicate how new channels have evolved and shifted to the east of the Approach Channel. However, the overall width of the channels has remained relatively static and the net amount of erosion generally equates to the net amount of accretion. This indicates that there has been no net loss of intertidal in the area.

⁵ For this high-level review (and in order to describe the key temporal trends) it was considered appropriate to examine annual surveys rather than all of the survey data. Future monitoring reports will continue to examine all between survey data not just annual results.

⁶ As it is important to understand the changes taking place the Approach Channel (given that this is where the greatest risks of change from the dredging and disposal work exist), a more detailed description of this analysis is also provided in Appendix C.

Before the 2001 dredging took place the conditions in this area were relatively dynamic and there were separate, disconnected and mobile channels. Under the present regime of ongoing maintenance (following on from the original 2001 dredging) this dynamism is still in evidence but the continuing maintenance dredging can be viewed as influencing and moderating the rate and pattern of this natural change. In particular it is likely to have had the net effect of marginally reducing the rate of on-going channel migration.

The effects, however, appear to be small and not obvious within the monitoring data. Without dredging, the environment within and around the channel would probably be more dynamic with a less uniform navigation channel. It is likely that the hydrodynamics and morphologies would return to a more complex and disconnected channel system that existed prior to 2001.

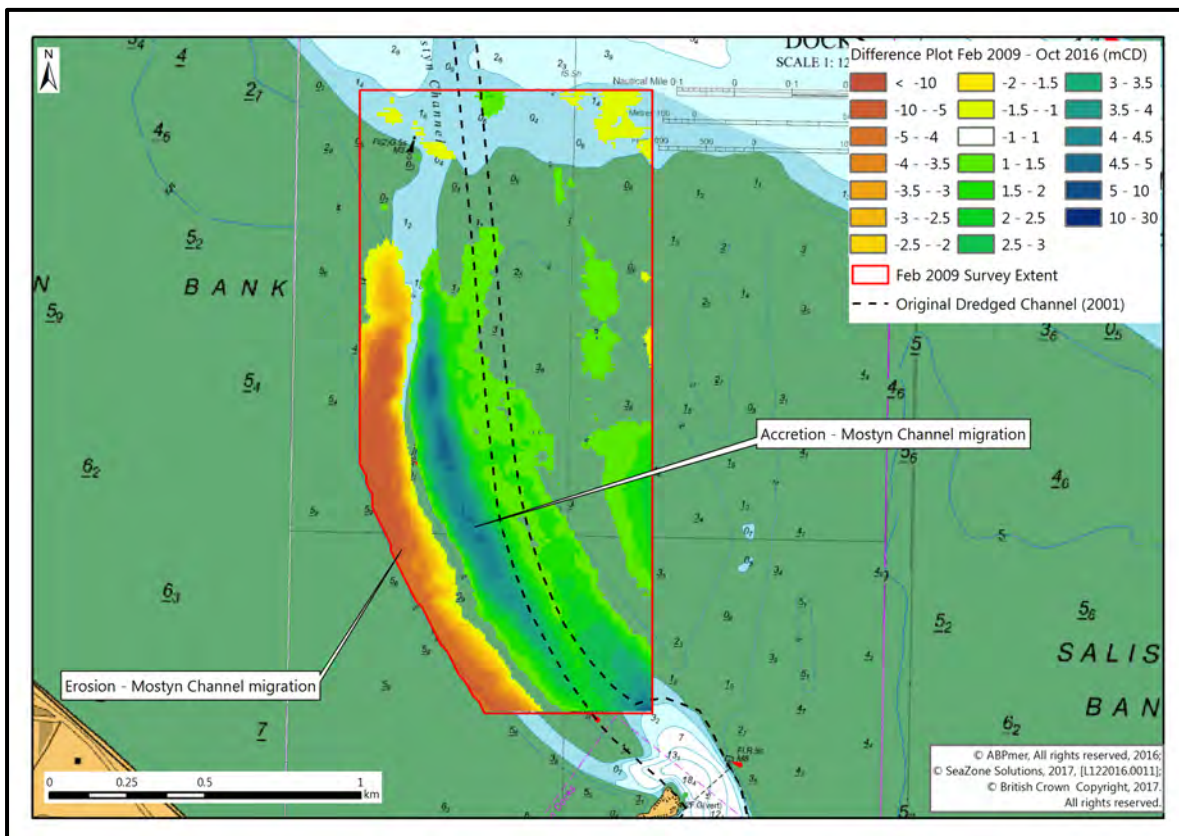


Image 4. Bathymetry difference plot indicating net change (m ODN) from February 2009 and October 2016

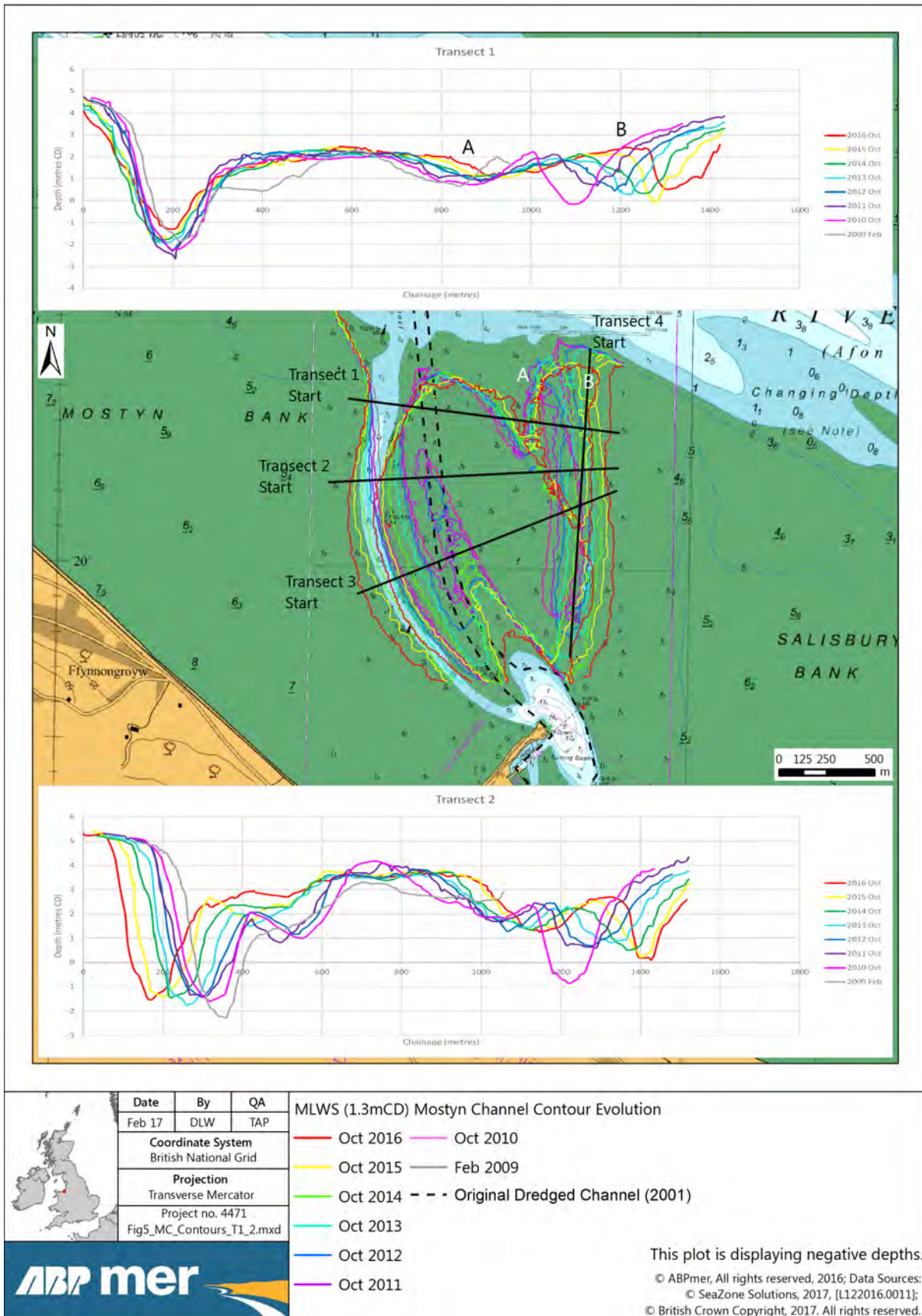


Figure 5. Comparison of Approach Channel bathymetric data from 2009 to 2016 showing the MLWS contour and profile details from Transects 1 and 2

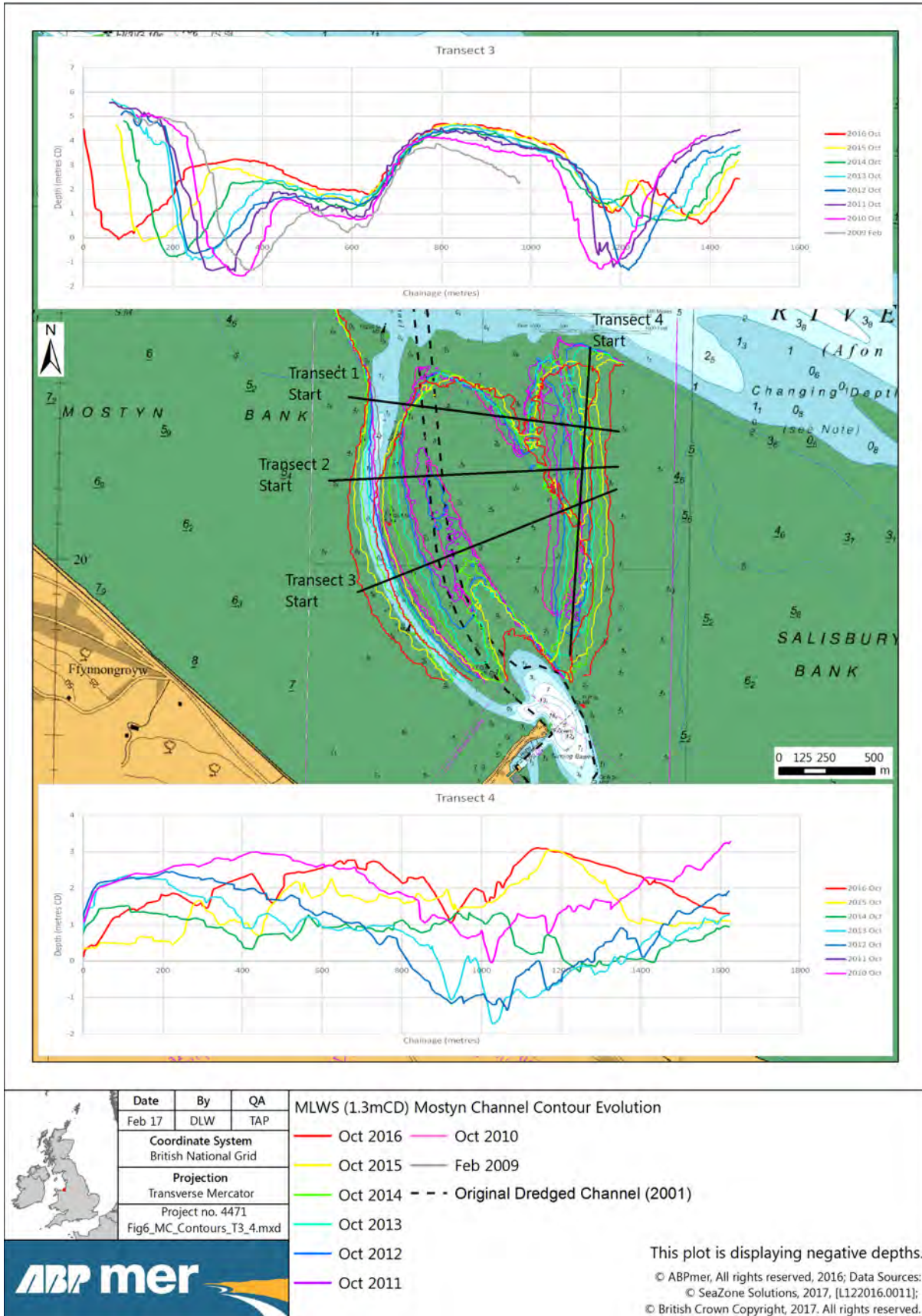


Figure 6. Comparison of Approach Channel bathymetric data from 2009 to 2016 showing the MLWS contour and profile details from Transects 3 and 4

2.2.3 Gaps and redundancies in existing monitoring

These bathymetric surveys of the Approach Channel area are the most effective and important element of the monitoring programme. This is because they efficiently describe the morphological conditions in the area of greatest concern (i.e. with respect to determining whether there are any consequences from the dredging work). The available data is comprehensive and the quality of the bathymetric data is appropriate for making interpretations about the changes that have occurred. No major redundancies have been identified although survey frequency can be reduced (as proposed by NRW) and some minor enhancements are recommended in Section 2.2.4.

2.2.4 Recommendations for future monitoring

On the basis of this high-level review no substantial change to the existing survey methods are proposed. The requirement to undertake three surveys per year for the Approach Channel monitoring (as proposed by NRW) is considered appropriate given the scale of the change that has been observed for the years analysed as part of the review. Channel migration movements of the order of 9-40 m/year have been observed which means that changes of no more than a few metres are to be expected between surveys. In other words it is unlikely that having more frequent surveys will provide any greater confidence in the findings, or to provide earlier alerts to issues, than is the case for the proposed '3-surveys per year' approach.

Also, the value of having fixed intervals for the surveys (i.e. every 4 months) ensures a consistency of approach and should not be changed. Over time with continued regular analysis of the full dataset this work could be reduced to biannual and even annual (given the rate of change that has been observed historically) but further clear evidence for the appropriateness of this should be obtained given that this is the most important element of the programme.

It is noted however that there will also be occasions where bathymetric surveys are conducted before and after dredging to evaluate the implementation of individual campaigns (whether as part of the standard '3-surveys per year' approach or through the inclusion of extra surveys undertaken by the Port)⁷. Where these are carried out either side of a dredging campaign it will be useful to use them to gain a more detailed comparative analysis between the volumes and locations of the dredging activities before and after dredging has taken place. This information can be used to determine the local effects of specific dredge campaigns in the short-term to understand whether these can be seen within the monitoring records.

In the future it will be important to ensure that the western limit of the survey area is flexible/moveable. It should be extended to a point where a datum of 5 m above CD has been achieved. This will ensure that the edge of Mostyn Bank is always well defined and this will help to understanding how this channel edge is moving. The LA1 survey area is divided into two zones (Survey Areas 1 and 2 in Figure 3) to understand conditions within the Approach Channel and across areas to the east respectively. These sub areas should remain although their boundaries are likely to shift over time. In the annual reports however the full area should be subject to holistic analyses to understand the broad changes in channel shape, channel alignment and the intertidal resource.

It is recommend that at least one of the surveys each year (e.g. October) is extended to include a 'sweep' of the channel system upstream of the Port. This upstream area appears to have a relatively dynamic channel system and this dynamism may be influenced in the future by a throughput of tidal water following channel dredging (especially if a deeper channel dredge option is taken up). This area

⁷ It is noted for example that the Port carries out more bathymetric surveys under Task EB4 than is officially required under the monitoring programmes (see Section 2.3)

is not currently examined in any detail and it will be valuable to include this in future so that there is a baseline for future analysis should that be required.

In the event that the Port needs to deepen more than 2 m below CD then a restoration of the survey frequency to bimonthly is fully expected to be more than appropriate for describing changes over time. Under such a programme the frequency of these surveys can then be reviewed and where needed reduced over time in the light of the survey findings (in the same way that existing survey frequency has been rationalised over the last decade).

2.3 LA2 Mostyn Deep Site 'A' Deposition Area

2.3.1 Survey work undertaken 2005 to 2016

The aim of LA2 'Mostyn Deep Site 'A' Deposition Area' task is to monitor the spatial extent and depth of sediment deposition inside and outside the deposit area within Mostyn Deep. When required, this is to be done through the collection and analysis of bathymetric survey data in the period before and after deposition. The extent of the area was defined in the Mostyn Channel Monitoring Protocols (SMP, 2008) as the deposition area plus a 250 m buffer around the outside of the area perimeter. At an early stage in the programme, however, it was agreed (with the Environment Agency Wales (EAW) now within NRW) that this task was dependant on the extent of the dredging commitment and that these surveys were only needed when the Port was maintaining the channel at the depths of greater than 2 m below CD.

On this basis, no surveys have yet been formally undertaken under this task heading. That said, however, the Port has actually conducted regular bathymetric surveys of the Mostyn Deep deposition area during the EB4 surveys (Section 2.11) and relevant data has been presented in the annual reports under LA2 and EB4. These EB4 surveys are scheduled to be undertaken on an annual basis but in 2015, for example they were conducted on three occasions (in January, March and October) rather than just the one. Due to this extra coverage, the data collected under EB4 therefore provides a basis for understanding potential change within the deposition area both before and after deposition.

2.3.2 Recommendations for future monitoring

As this task has not been formally implemented, a separate review has not been undertaken of this task. However, the results from EB4 are described in Section 2.11 and in the annual reports (SMP, 2015). These have shown that there is a rapid dispersion of sediment from the Mostyn Deep area following deposition. This indicates that there is a large 'capacity' in the Mostyn Deep area and this location is likely to be able to accommodate greater volume of sediment deposition. The monitoring programme generally should, therefore, continue to place greater emphasis on examining the conditions at the dredge location rather than the deposit ground. The existing survey principle for this task (i.e. implement the surveys if the deeper dredging option occurs) is therefore considered to be appropriate and does not need to be revised.

2.4 LA3 Mostyn Deep Site 'A' Deposition Seabed Samples

2.4.1 Survey work undertaken 2005 to 2016

The aim of Task LA3 is to monitor the sediment characteristics of the deposition area and the wider Mostyn Deep channel through the collection of sediment samples. This is to understand whether the deposition has any material effect on the physical characteristics of the seabed substratum.

For these studies, samples of surface sediment are collected from ten sites within the Mostyn Deep channel (six locations within the deposition area (Sites labelled 2, 3, 4, 5, 8 and 9 and four outside it (labelled 1, 6, 7 and 10)). The sampling positions are shown in Figure 3. After each survey the samples retrieved are returned to the laboratory for Particle Size Analysis (PSA). The samples are then analysed to understand whether there is any shift the sedimentary profile based on the relationship between key PSA descriptors (i.e. the D85, D50 and D15⁸ values) in successive samples.

The sediment samples have been collected on an annual basis as part of the monitoring during either October or November since 2009 (synchronous with EB4). Sediment samples were also collected on a more variable basis between 2005 and 2008. Under the newly-issued marine licence (Ref: DML1542) this work would be continued on an annual basis.

2.4.2 Monitoring review to 2016

For this review the sediment data that is presented in the latest annual report (SMP, 2015) was plotted to illustrate the relationships between the D15, D50 and D85 fractions of the PSA. The data in this latest report covers the six-year period from 2009 and 2015 and the results are shown in Image 5. This plot has a logarithmic scale to clearly shown the distinctions between the fraction values.

The results indicate that the sediment characteristics of the deposition area have been variable and they also confirm that there have not been any distinct or persistent shifts in substratum composition against the defined thresholds. Some shift in the relationship between D50 and D85 occurred in 2014 at Site 2 (inside deposit area). There was also a change in the D15 and D50 interrelationship at Site 7 (outside deposit area). No changes have been persistent and there is no evidence of a distinct shift in the sea bed composition. This is in-keeping with the findings from the bathymetric surveys which indicate that the deposited sediment has a low residence time (Section 2.11) and is rapidly carried away from the area.



Image 5. Comparison of D15, D50 and D85 values for Mostyn Deep sediments (2009 to 2015)

⁸ These values reflect the proportion (%) of sediment that passes through a stated sieve size. Therefore D85 refers to 85%, D50 50% etc.

2.4.3 Gaps and redundancies in existing monitoring

The project has not identified any major gaps and the scale of the investigation appears to be generally in keeping with the level of evidence and risk. The information provided from this work has however shown no major change to date while the EB4 survey data also shows there is a rapid export of deposited sediment in this area. Therefore the need for, and detail of, work under this task should (like all tasks) be kept under review as described in the following section.

2.4.4 Recommendations for future monitoring

On the basis of this high-level review no substantial and immediate change to the existing survey methods are proposed. Therefore, the collection of sediment samples should continue on an annual basis but be extended to biannual in the event that the deeper channel dredge option (with greater sediment deposit volumes) is taken up. However in future annual reports it will be valuable to plot the result on a spatial map and a chart in order to illustrate the findings and verify whether there are any spatial patterns in the observed results. On the basis of such an analysis, further discussions should be had about whether this work is: a) stopped, b) continued with a reduced number of samples or, c) continued but made contingent on findings from other surveys (especially the results from EB4 which describe morphological change in this area).

2.5 LA4 Cockle Survey Salisbury/Mostyn Bank (NRW Data)

2.5.1 Survey work undertaken 2005 to 2016

The aim of Task LA4 Cockle Survey work is to investigate whether there is any influence from the dredging activity on the commercial shellfish beds on the Salisbury Bank and Mostyn Bank. These two areas (along with others in the Dee Estuary such as Thurstaston, West Kirby and Salisbury Middle) are monitored on an annual basis by NRW (see Image 6). The data collected by NRW is then forwarded for review on a regular/annual basis. During these surveys, NRW record the densities of cockles in a 0.1 m² area at fixed stations (between 200 and 400 annually) within the cockle beds. In addition, sub sampling also collected at each station to calculate mean weight and size class data.

These reports present information on the commercial status of the cockle beds (e.g. opened or closed) as well as summary information on cockle densities in key areas based on NRW data. The results of these NRW cockle surveys are then presented in a summary status report and this 'cockle stocks status' report is appended within the annual monitoring report. The findings from this work are also summarised within the ecological/benthic monitoring reports (in particular to understand the potential implications of the fishery on the benthos).

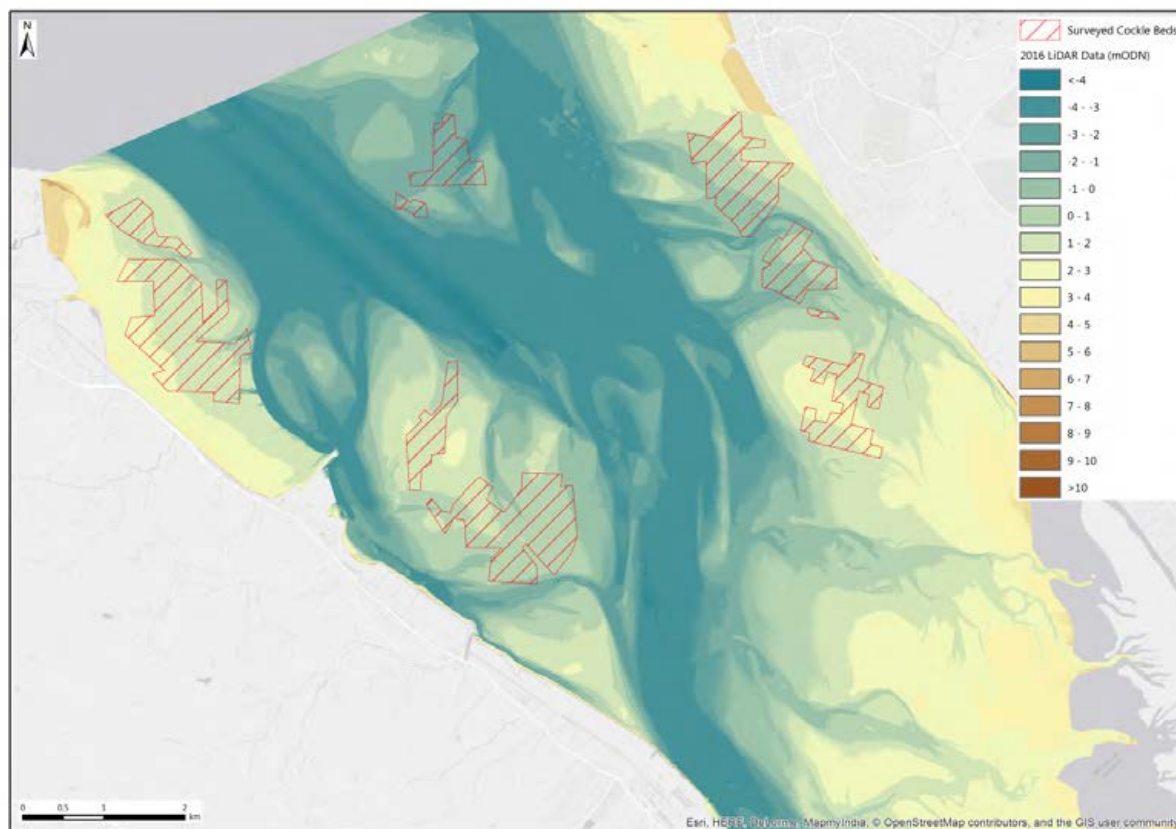


Image 6. Location of commercial cockle beds surveyed by NRW

2.5.2 Monitoring review and recommendations

For this high-level review, no additional analysis of the NRW cockle bed data was identified that could be, or needed to be, undertaken outside of that undertaken for the annual review. The review of the Approach Channel survey results (LA1 surveys discussed in Section 2.2) also the analyses of benthos in (LA5 in Section 2.5), however, do not indicate any broad physical or ecological shifts affecting these beds.

No major gaps or redundancies have been identified for this task and no changes are proposed. It will continue to be valuable to review the NRW cockle data on a regular/annual basis to examine this issue and demonstrate that it has been considered. However, it is recommended the annual reports include extra comparative analysis between the observed temporal physical and ecological changes around the Approach Channel and the temporal changes in the cockle records. This will help to enhance the degree to which interpretations can be made about (any possible) interactions between the Port's activities and the status of beds.

Under separate sections of this review, suggestions are made for adjusting the Approach Channel bathymetric work (Section 2.2) and the benthic sampling work (Section 2.6) to cover the interface areas between the Approach Channel and the Salisbury Cockle bed. These adjustments will help to enhance the evidence base linking physical change around the Approach Channel to ecological conditions around the South Salisbury Bed for example.

It is recognised that there will always be challenges associated with trying to draw cause-effect relationships between the changes at the Approach Channel with any changes that occur in the commercial oyster beds. This is because the latter will be influenced by many other factors including the cockling activities themselves as well as broader natural changes and shifts in cockle recruitment. However, the proposed extra analyses will help to clarify the evidence and the extent to which any such links can be made.

2.6 LA5 Benthic Survey Salisbury/Mostyn Bank

2.6.1 Survey work undertaken 2005 to 2016

The aim of the benthic sampling work is to examine the ecological characteristics of intertidal mudflats and sandflats surrounding the Approach Channel to understand whether they are affected by the dredging work. This is an important element in the monitoring that helps to draw linkages between the physical changes and ecological characteristics of the environment in order to understand whether the nature conservation interests of the Dee Estuary are affected.

The work involves surveying the habitats and collecting samples in accordance with survey methods described by CCW (e.g. CCW (2008) consent guidelines for licence renewal). For the first three years of the programme (2005 to 2007), annual surveys were undertaken in the Autumn. Each survey involved a visual examination of intertidal habitats and the collection of surface sediment samples for Particle Size Analysis (PSA) and for laboratory-based examination on the invertebrate (benthic) species (see Image 7).



Image 7. Benthic sampling work (main photo 2014) and sampling at A4 (inset Autumn 2011)

The benthic and PSA samples were collected from pre-determined locations identified by CCW. These sites were positioned objectively based on Ordnance Survey grid locations along five transects (as shown in Figure 3). During these early years, extra sampling was also undertaken annually to describe the bed elevation and plant communities at marsh fringes on the north side of the Dee estuary. In 2009, the frequency and spatial extent of the surveys were altered in light of the results obtained up

to that point. Under the new approach, surveying and sampling was concentrated more on the local area sub-system (i.e. areas alongside the Approach Channel) which is the area of greatest concern and the area where there is the main risk of any habitat change attributable to channel dredging.

For this more localised approach, the upstream Transect E was removed from the schedule as was the requirement to sample the distant marsh habitats. Transects A to D had several easterly sites removed and extra sites (along new Transects X and Y) were included close the Approach Channel. The new arrangement of sites is shown in Image 8. Although some of the sampling locations were altered, the surveying methods were not changed and the overall approach was designed to follow on as seamlessly as possible in order to preserve a consistency of approach.

For the first survey under the new approach (in 2009), the Port collected additional samples at intermediate locations between the established CCW locations as well as from as many of the 26 sites (see Image 8) as were accessible. This was done to produce a particularly detailed initial 'baseline' description of the environment. During this 2009 survey a total of 43 sites were sampled. From 2009 onwards the surveys became biannual rather than annual with separate Spring and Autumn surveys being undertaken to coincide with the larger equinox tidal periods. Before 2009 ecological sampling was carried out at all sites irrespective of need, whereas the updated biannual approach allows the ecological sampling to be targeted at areas which required investigation (i.e. to understand the interaction between physical and ecological processes locally).

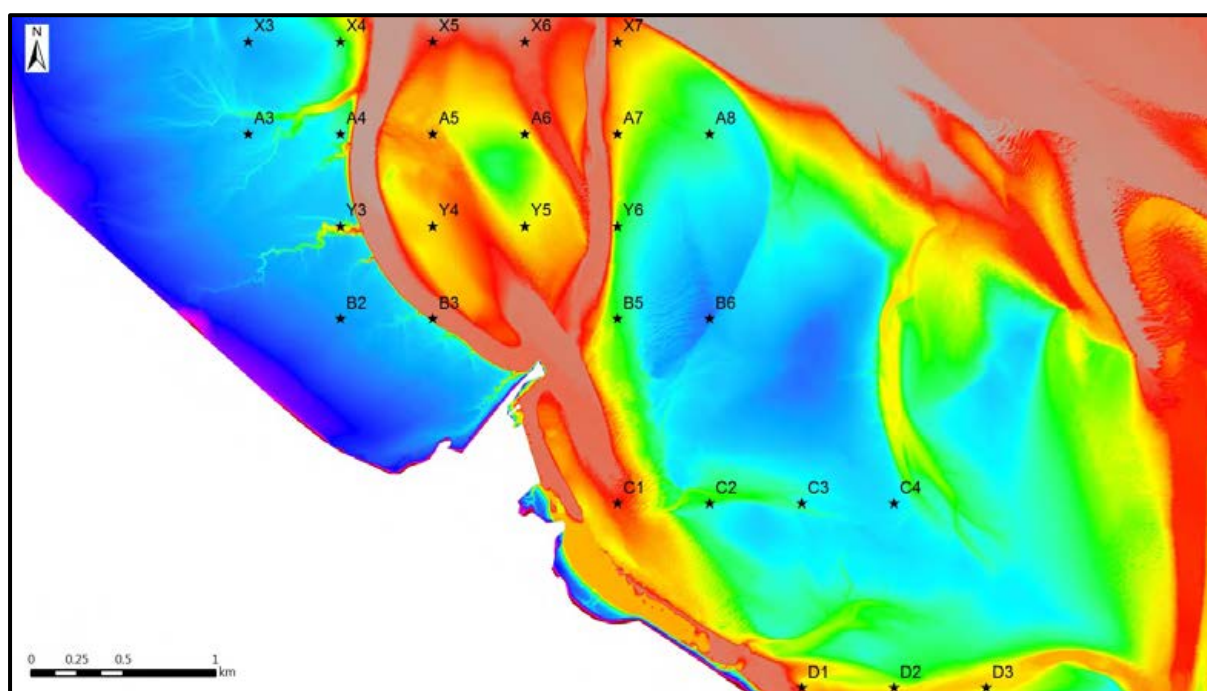


Image 8. Locations of main benthic sampling sites (within full survey area from 2009 onwards)

For the biannual approach the Spring surveys involve identifying physical/visible change to the habitats that could signal a biological effect and these included the retrieval of surface sediment samples from the sites for PSA. The Autumn surveys then involve collecting benthic (core) samples and examining the habitats at sites where a change was observed in the Spring and/or where it was considered necessary to investigate the character of infauna/benthos further.

The results of this work are reported annually and the reports include analysis of the invertebrate assemblages and sediment composition (including the use of multivariate statistics). Wherever possible, the annual reports seek to link any observed ecological changes to the physical shifts that have occurred in the local area sub-system. A total of 12 surveys to date have been undertaken under this revised biannual programme. Many sites have been surveyed on 15 occasions over the last 10 years which means that there is now a useful long-term dataset for this area.

2.6.2 Monitoring review

Survey findings

The regular survey, analysis and reporting work that has been undertaken over the last 11 years provides a good ecological description of the range of intertidal habitats across the local sub-system (i.e. around the Approach Channel). In particular the spatial and temporal changes that have been observed have been described based on walkover surveys and targeted sampling at pre-determined locations.

The work has not identified any effect or change that is attributable to the Approach Channel maintenance work and has, generally, shown that these habitats have been relatively stable and consistent year on year. However, these habitats do vary naturally as a function of the many physical and ecological forces which act on them (e.g. changing wave/storm environments, different seasonal conditions as well as differences in species movement, recruitment and colonisation success). Therefore, the data collected during these surveys illustrates how the sedimentary conditions and the infaunal species vary over time at a range of individual locations. While the majority of sites have not shown any distinct change over the course of the surveys, some key exceptions and observation are as follows:

- At Site B5 on Salisbury Middle (see Image 8) there has been a distinct and progressive habitat change from muddy to sandy conditions. This was accompanied by typical alterations to the invertebrate composition. This change occurred in response to a southerly shift in the boundary between the sandier and muddier habitats on this bank;
- On the eastern side of Transect C (Sites C3 and C4) there was a progressive change in the habitat (characterised by a general enrichment) which is likely to be related to the closure of the Salisbury Bank Cross channel (see Figure 2). This closure process will have resulted in slower, and less-scouring, tidal flows across this part of the bank and resulted in more stable conditions;
- The physical conditions at the upstream Transect D are generally more variable than they are at other locations and the habitats in this area show signs of greater natural variation in response to dynamic channel movements (ABPmer, 2014).

Where changes have been observed they have been considered to be a function of natural variability and not an indication of change brought about by the Approach Channel dredging work. The Approach Channel has clearly migrated and conditions have changed in the locality as new channels have developed (as described in Section 2.2) but this has not led to distinct changes in the broad-habitat distributions, the substratum types or the individual benthic assemblage outside of what is to be expected from natural variability.

Developing objective interpretation techniques

During the monitoring programme, and especially in recent years, NRW and Cefas have enquired about whether a more objective approach can be taken to the derivation of levels of acceptable change. In particular, they have asked whether it is possible to develop objective criteria or 'defined cut-off values' from the Spring field survey data that can then identify the sampling regime required for the Autumn surveys.

In response to past enquiries on this subject, extra analyses have been included in the annual reports to explore such techniques. These extra analyses included different methods of examining and presenting the PSA data or describing the functional characteristics of the benthic invertebrates⁹. However, no approach has been agreed and settled upon. For the purposes of this review therefore, this issue has been considered further with reference to approaches undertaken at other sites.

One example, that could be used is the technique developed by Cooper (2013) to assess the effects of aggregate extraction activities. This uses a range of sediment parameters that are characteristic of different assemblage types to help define limits of change¹⁰. Another approach (called a 'Trilinear Sediment Classification Change') is used for the assessment of dredging licence areas in the Severn Estuary at North Middle Ground and Bedwyn Sands. These areas consist of predominantly intertidal and shallow subtidal sand and, if half the sites in the dredge area show a change from one broad sediment type (e.g. from muddy sand to sand mud based on the Folk classification system) this triggers the requirement for the sampling of benthic communities in the Autumn.

Similarly, analysing change in particle size distribution has been used as a Stage 1 threshold for Task LA3 (Mostyn Deep Site 'A' Deposition Area Seabed Samples). For this element of the Mostyn monitoring work, thresholds for changes in sea bed sediment composition are identified based on changing balance between the PSA D15, D50, and D85 values (see Section 2.4). If a site shows a change in particle distribution over a defined threshold this would trigger ecological sampling in Autumn. Based on these examples, a similar approach has been developed in past Mostyn Monitoring Reports which involved making judgments of change based on the Wentworth Classification system (ABPmer, 2014) and GRADISTAT analysis software (see Image 9). This showed, for example, how sites such as B5 changed from silty sand to sand from 2009 onwards (as described above).

Each of these techniques provides some value in objectively describing sedimentary change (and currently the GRADISTAT approach is preferred) but used on their own they could well lead to misleading or unclear indications of habitat change. Therefore it is not thought to be suitable for ecological investigation at Mostyn to apply these strategies without more conceptual information. Instead it is considered important that a large degree of subjective judgement (based on on-site observation) is retained when decisions that are made about whether and where habitat changes have taken place and where Autumn sampling should take place. This on-site visual examination is considered to be an important element of the survey work.

It is beyond the scope of this high-level review to finalise a new approach and such a strategy is best developed in consultation with NRW and Cefas. However, it has been proposed elsewhere in this

⁹ These functional characteristics include details about how the species feed and the ecological niche that they fill rather than just their abundance. The past ABPmer analysis used broad groupings (e.g. 'errant polychaetes' or 'sand dwelling mobile crustaceans') based on taxonomy and key feeding strategies.

¹⁰ Using available sediment data, the percentages of major sediment fractions (i.e. coarse gravel, medium gravel, fine gravel, coarse sand, medium sand, fine sand, silt/clay) are calculated for individual samples based on the Wentworth classification. The upper and lower limits are then used to define the range of sediment composition found in association with each faunal assemblage, and hence the upper and lower limits of acceptable change within extraction or dredged areas.

review that more linkages are made between the various physical surveys (especially the bathymetric work which provides an indication of bed level changes) and going forward it is expected that such analysis (alongside the field observations) will provide a greater weight of objective evidence with which to make judgments about changes and about which sites should be revisited in the Autumn.

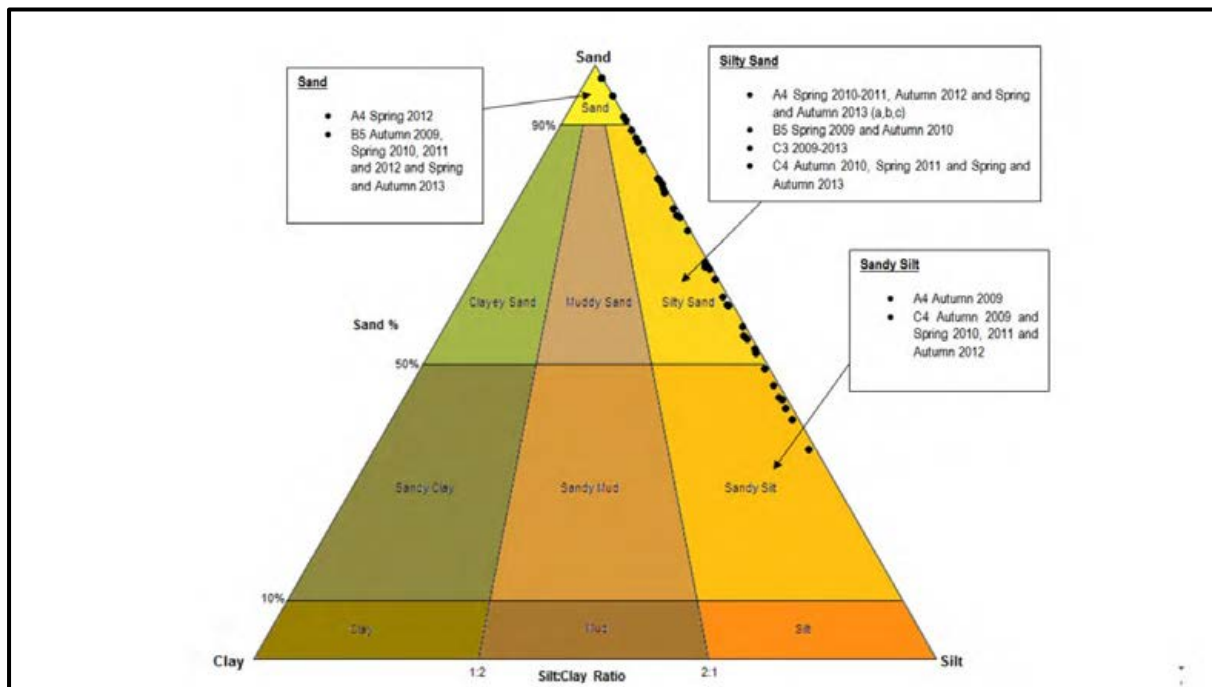


Image 9. Sediment types at Sites A4, B5, C3 and C4 (2009-2013) using 'GRADISTAT' analysis

Testing the Cefas Biological Trait Analysis (BTA)

For the purposes of this review it can also be briefly noted that other techniques exist that could be applied to examine the Autumn ecological data (i.e. in years when ecological sampling occurs and the results need to be analysed). An informal discussion on this aspect (and the above subject of sediment testing) was undertaken with Stefan Bolam at Cefas during this review. In response Stefan kindly provided the Cefas Biological Trait Analysis (BTA) tool for testing. The BTA tool uses a matrix containing eight separate traits (morphology, longevity, larval development, egg development, living habitats, sediment position, feeding mode and mobility) for a large number of benthic genera. Each trait is subdivided into a variable number of modalities, giving a total of 36 modalities.

To test this BTA matrix for this review, it was integrated with the existing Mostyn species abundance datasets to create a 'trait-per-sample site' matrix which was used to test for changes in ecological functionality of the different sample sites. Comparison between sites were made using Plymouth Routines in Multivariate Ecological Research (PRIMER) software. The aim was to test whether this BTA matrix improved the ability to further understand the ecological change occurring at the sites further and, if so, whether it should be used in the future monitoring.

Analysis was made of data from all previously sampled sites as well as of data from the most regularly sampled sites (A4, C3, C4 and B5). A Multidimensional Scaling (MDS) output from this analysis is shown in Image 10. This plot provides similar results to those obtained from the abundance only studies as presented in preceding reports (ABPmer, 2014). It shows how sites such as B5 and C3 changed over the course of the surveys (hence the points for this site are relatively widespread on the plot). Conversely sites such as A4 (close to the Approach Channel) had a more stable and consistent mudflat environment that did not change much over time (hence the points for this site are relatively

close together on the plot). Therefore, this extra analysis has resulted in the same conclusions as per past studies which were based on species abundance alone. It is an interesting new way to look at the data but it is one that reinforces, and doesn't change the past conclusions.

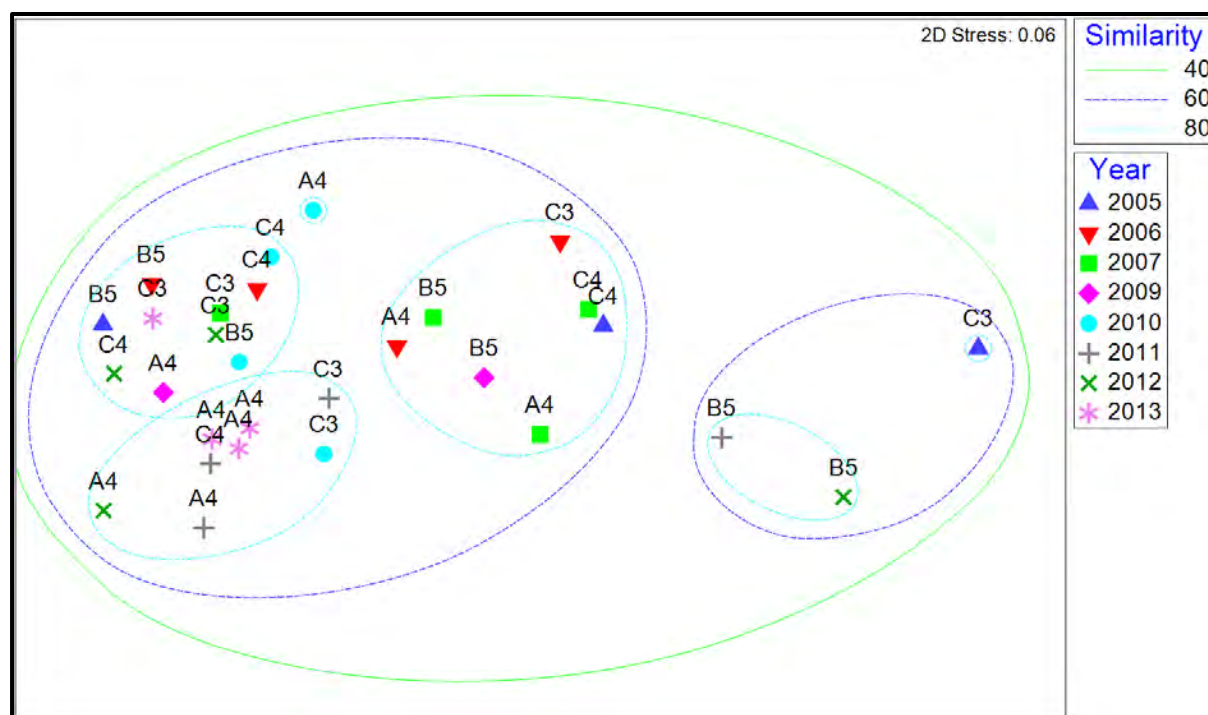


Image 10. MDS plot of biological trait data for Sites A4, C3, C4 and B5 (showing similarity levels)

2.6.3 Gaps and redundancies in existing monitoring

The benthic survey work is considered to be appropriate to the scale of the works and nature of the risks and is not thought to have any notable gaps. The process of considering the habitat composition in the Spring before then sampling in the Autumn where required is also considered to be sound. It is recommended, therefore, that this work continues on the existing basis. However given what has been learned over several years, there is an expectation that Autumn surveys are unlikely to be needed (or will be an exception rather than a rule).

2.6.4 Recommended future monitoring

It is recommended that there is no substantial change to the benthic survey approach in particular this will help to ensure a consistency of approach over the years and that will help with making judgements about cause and effect into the future. It is recommended that the majority of the sites should remain where they are at present with no substantial changes to the methods. However, the value of Transect X is considered to be limited, it lies along the exposed seaward faces of Mostyn and Salisbury banks where the site has been consistently characterised by sandy habitats and often large sand waves. Given the lack of any notable variation over time (albeit in what is actually quite a mobile sandy environment) and also the nature of the habitat it seems unnecessary to continue sampling here.

Instead it would be useful to relocate the sites in Transect X southwards to an area between Transect C and D. New sites in this area (Labelled 'W1' to 'W5') would then provide extra information (alongside Transects C and D) on the conditions upstream of the Approach Channel (see Image 11). In

the future if the Approach Channel is deepened further it would be expected to draw more tidal water upstream past the Port and into the Transect D and W areas. This could cause a shift in tidal channel dynamics in this area and especially in areas which lie upstream of the Salisbury Bank (which acts as a relatively fixed-point feature in the heart of the estuary). It would be beneficial to obtain some extra baseline data from this location to better understand the habitats of this zone and facilitate monitoring of future dredging interactions (especially if the channel is deepened).

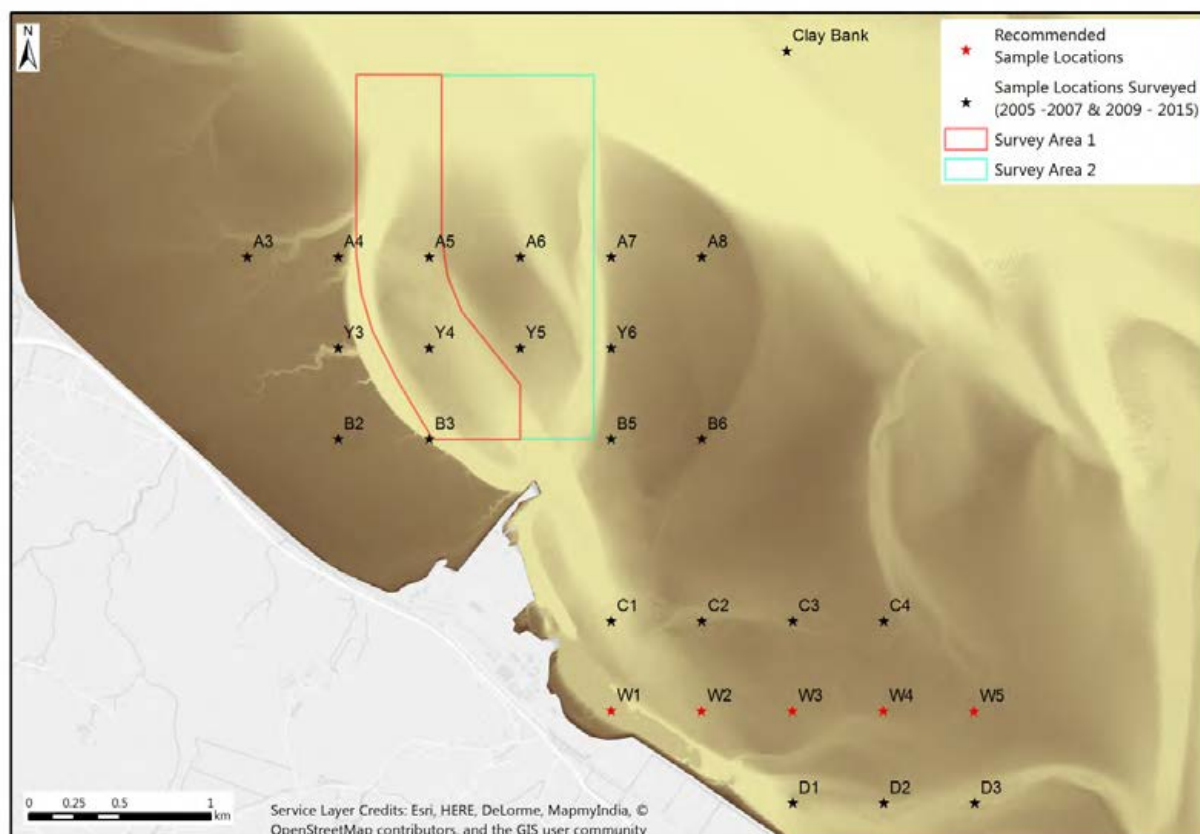


Image 11. Possible adjustment to the benthic sampling sites (new 'W' transect replaces Transect X)

Sites in this new area would also extend into the cockle beds and would help to underpin future evaluations of the links between channel maintenance and shellfisheries work. Of course, it will need to be borne in mind that the cockling activities will have an impact on the benthos in their own right. However, sampling in the new 'W' zone will help understand broader changes to this area and the degree of habitat mobility at present and in the future.

It is also recommended that before and after the next Spring survey the approach to analysis and interpretation of the resulting data is discussed in with Cefas. This discussion is needed to explore and agree the approach and the interpretation process. This has been a subject of regular discussion in the past and has been further reviewed in this report. It is considered difficult to derive a viable and appropriate set of objective parameters which on their own indicate significance of change and help identify the sites where ecological sampling should be undertaken in the Autumn based on results from the Spring. Instead it will always be important to draw upon subjective surveyor advice in this case. The visual evidence of change and judgements made by the surveyor on site should continue to be crucial elements of the work. In this respect having an experienced ecologist is important and, understandably, was a requirement of the original CCW scope of works.

In the future interpretations of the data will need to always consider the natural complexity and variability of intertidal habitats and the fact that there are so many physical, ecological and anthropogenic factors which can cause disturbance. Another challenge is that where ecological change does occur then the observed responses to natural factors are typically indistinguishable from those arising from anthropogenic activities. This is another reason why judgement about changes should be based not just on the data but on surveyor observation.

For the same reason it is important that the ecological survey work is not reviewed in isolation but considered against results of the other physical surveys. This is needed to make judgements about the relevance and importance of observed changes against the project objectives (i.e. determining the influence of the channel dredging).

2.7 LA6 Port Area Survey and Local Cockle Survey

2.7.1 Survey work undertaken 2005 to 2016

As set out in the original monitoring schedule extra tasks were included to understand the linkages between Port dredging activities and local cockle resource/fishery. The two key aims for this part of the programme were as follows:

- To monitor the potential localised effect of dredging on the western flank of Salisbury Middle by collecting bathymetric data; and
- To monitor changes in cockle abundance of the western area of Salisbury Bank through undertaking cockle surveys.

For the monitoring, bathymetric and cockle surveys were to be carried out, where required, before and after each main dredge campaign (and also coincident with LA1 surveys of the Approach Channel). The bathymetric work is carried out after every dredge campaign. However, from an early stage in the programme, it was agreed that this was dependant on the extent of the dredging commitment. It was agreed with the Environment Agency Wales ((EAW) now within NRW single body) that surveys would only be required when dredging was undertaken to 4 m below CD. It was agreed that such surveys were not needed when the Port maintained the channel at the shallower depth of 2 m below CD.

As the deepening to 4 m below CD has not happened, no surveys under this task have been undertaken to date. However, data on the cockle beds is regularly collected by NRW and included in the monitoring. In particular, cockle data collected by NRW and the status of the cockle fishery is reviewed regularly.

2.7.2 Recommendations for future monitoring

For the future, it is recommended that this established approach is continued with bathymetric work as required and cockle monitoring only carried out in the event of deeper dredging work taking place.

2.8 EB1 LiDAR/Swathe Survey of Seabed Levels

2.8.1 Survey work undertaken 2005 to 2016

The aim of the EB1 surveys is to monitor changes in the general morphology of the estuary system to understand the interactions between the local changes around the dredge area and the wider system. The main element of this work involves carrying out full-estuary Light Detection and Ranging (LiDAR) surveys on an annual basis. LiDAR uses pulsed radar from aircraft to measure land elevations (in this case the levels of the visible intertidal areas above the low water level).

This LiDAR data (which maps the broad-scale intertidal changes to a typical accuracy of ± 15 cm) is combined with the other bathymetric work undertaken in selected parts of the outer estuary to create a partial 'ground model' of the estuary. This ground model is then used for regular (typically annual) examination and numerical modelling studies (SMP, 2008).

The 2015 Annual Monitoring Report suggested a reduced frequency of LiDAR surveys to every two years but also recommended that the model was enhanced by adding extra bathymetric datasets from the outer estuary. The newly-issued marine licence (Ref: DML1542) has indicated that LiDAR data should continue on an annual basis (Image 2).

2.8.2 Monitoring review

For this review, there has been no formal review of the modelling work. However, the LiDAR survey data that has been undertaken by the Port over the course of the monitoring programme was collated. Some of this data was already held by ABPmer having been used to describe conditions around the Approach Channel as part of the benthic ecology studies (LA5). The remaining information was provided by the Port for this study; this included the most recent 2016 LiDAR survey which has not been reviewed previously. On receipt of the LiDAR data the individual datasets were checked to ensure they were accurate and compatible by examining selected reference to high elevation 'ground truthing' points. Following this data collation and QA process a full estuary LiDAR dataset was obtained for the 2007, 2011, 2013 and 2016 surveys. For the remaining years (2006, 2009, 2010, 2015) only a partial dataset was available or obtained at this time¹¹. Further details of the scope of each survey is presented in tabular form in Appendix D.

Using the available LiDAR data supplied by the Port, difference plots were created which illustrated the changes in intertidal elevations between different years. Comparable plots have been produced for the annual reports so the individual analyses are not presented here. However, using the best datasets from 2007, 2013 and 2016 the following difference comparisons were made to describe change over different periods of time as follows:

- **Two years:** Figure 7 presents the net difference between 2011 and 2013
- **Six years:** Figure 8 presents the net difference between 2007 and 2013
- **Nine years:** Figure 9 presents the net difference between 2007 and the new 2016 survey (the earliest and latest years for which a full estuary dataset was made available).

¹¹ This full-estuary data has been collected during the monitoring but has not been obtained for this review.

From difference plots like these it is possible to highlight some of the key morphological changes that have been observed in the estuary over the monitoring period. However, care needs to be taken when interpreting this analysis because the banks within the estuary exhibit a high level of temporal and spatial variation. Therefore selecting just two fixed points in time (i.e. the dates of two surveys which are compared) can lead to misleading interpretations of change. Also each survey is undertaken at different states of the tide and no depth information is provided for the subtidal area. However, this analysis can be useful for illustrating distinct and persistent morphological changes or for describing area of inherent dynamism.

These plots reaffirm the changes around the Local Area sub-system which have been described in other parts of this review. These include the migration of the Approach Channel into Mostyn Bank and the formation of the 'Eastern Channel' (as per Section 2.2), the 'accretional' changes in other areas of the Salisbury Bank and in the closed Salisbury Cross Channel (that led to observed changes to benthos at Site B5, C3 and C4); and accretion over the Clay Bank (as described further in Section 2.12). These are all areas that have been studied in greater detail as part of other tasks and it is useful that this LiDAR reinforces the findings from this other work.

Across other parts of the estuary there are areas of change and channel dynamism upstream in front of Greenfield and more so at the top end of the estuary near Flint. The changing nature of the channels around Flint in the upper estuary are particularly indicated by Figure 7 which shows how a large amount of relative change in this area over the shorter two-year period (2011 to 2013). By contrast other areas of the estuary are relatively stable over this 2 year timeline.

The area in front of Greenfield has been showing some changes with the channel between the Salisbury Bank and the 'Greenfield' Bank evidently more defined. Figure 7 shows this area as disconnected evolving channels up to 2013, whilst Figure 9 shows a more defined single channel feature.

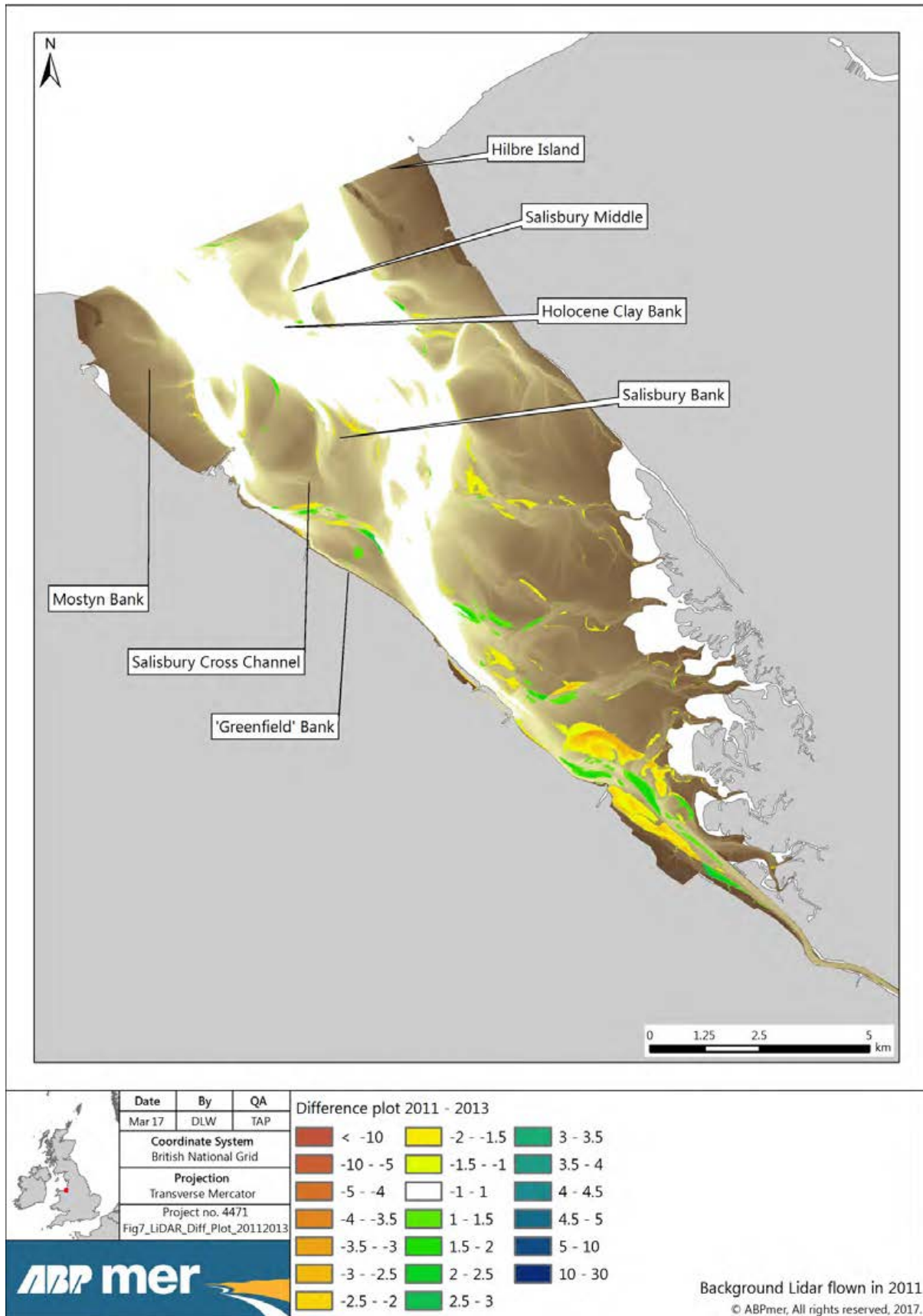


Figure 7. LiDAR difference plot indicating net change from 2011 to 2013

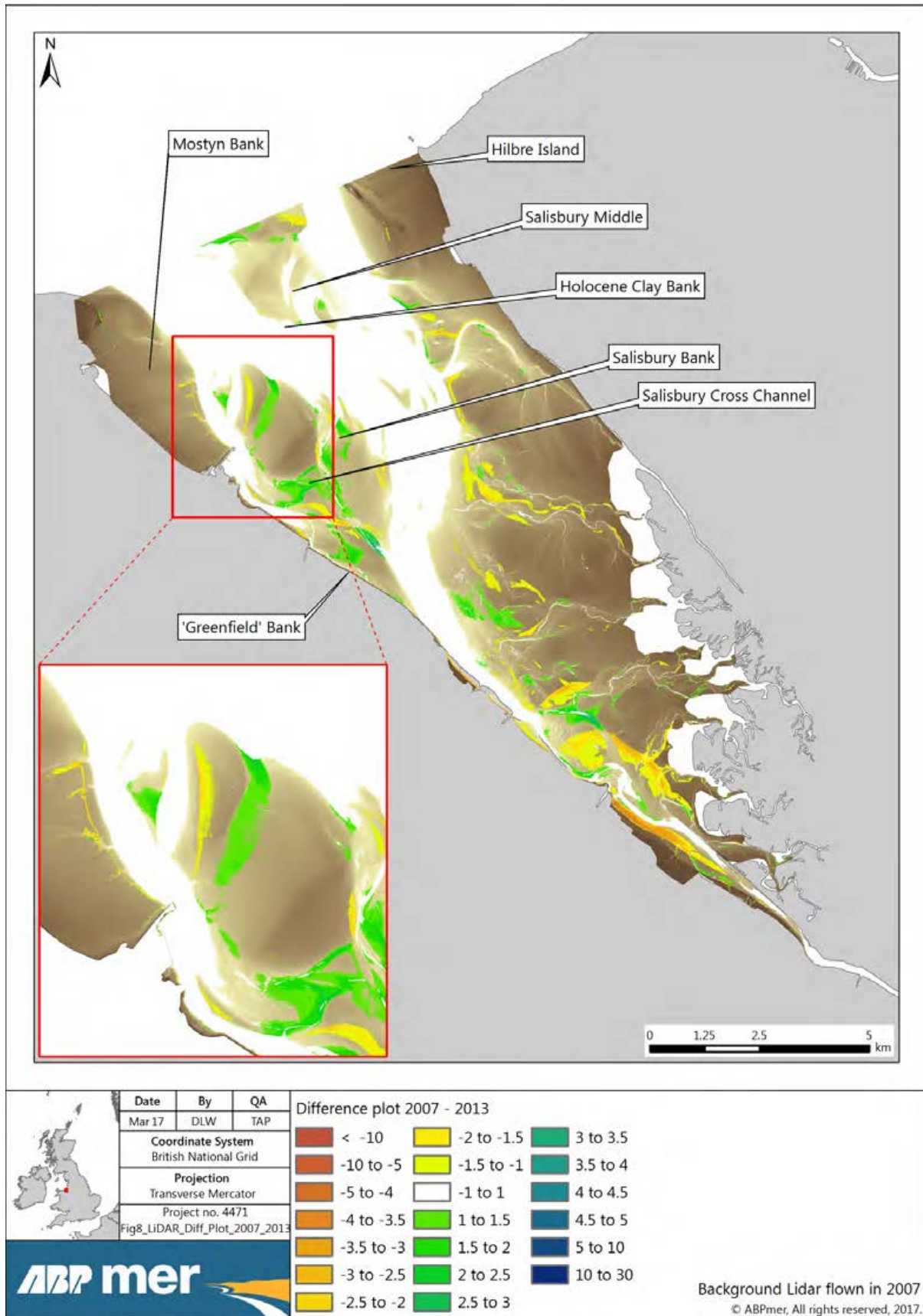


Figure 8. LiDAR difference plot indicating net change from 2007 to 2013

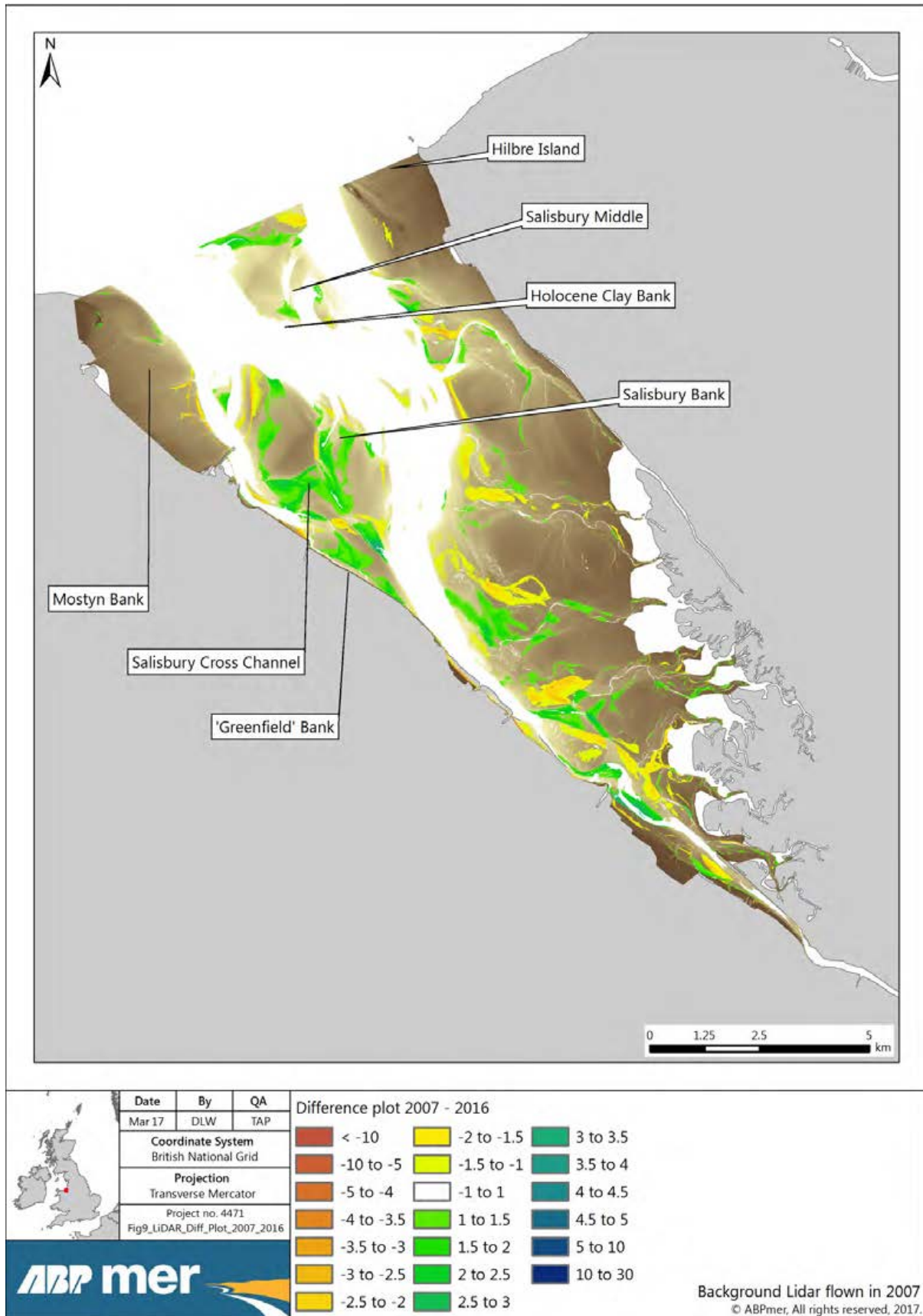


Figure 9. LiDAR difference plot indicating net change from 2007 to 2016

2.8.3 Gaps and redundancies in existing monitoring

The collection of regular LiDAR data is useful for describing conditions across the full estuary system. However there are also a number of limitations with this survey technique as described above. From what has been observed over the last decade (as summarised above and in Section 2.9) this estuary wide work does not need to be the central element of the monitoring. Instead the main component of the surveys should be the regular bathymetric studies of the Approach Channel and surrounding areas as these provide the best evidence in the main area of interest as well as providing good temporal descriptions of change. Also the work done under EB2 provides broader estuary information on an annual basis.

There is not considered to be value in continuing the LiDAR and other estuary-wide modelling work on an annual basis. This frequency of survey is seen as a redundancy based on the evidence. In particular the estuary has been relatively stable over recent years and the general rates of change across the whole system do not merit annual examination. For example there is no major distinction (except in scale) between the patterns of change observed from the LiDAR difference plots over the 2-year 6-year or 9-year timelines reviewed above. For the same reason, it is not considered necessary to conduct numerical modelling on an annual basis given the rates of change that are taking place and the lack of any link between the Approach Channel dredging and the wider estuary conditions based on existing evidence.

When this estuary-wide work is carried out though (at reduced frequencies), the value of the LiDAR and modelling work could be improved by including the outer banks and channels. The conceptual understanding about how the estuary functions is underpinned by interpretations of the outer bank and channel changes and therefore these areas should ideally be included in the future. This improvement in quality and coverage of the LiDAR/modelling work but reduced frequency is described further in Sections 2.8.4 and Section 3.

2.8.4 Recommendations for future monitoring

Following this review, and in line with the suggestions made within the Annual Monitoring Report (SMP, 2015), it is recommended that the LiDAR and modelling elements are adjusted in scope and reduced in frequency. The Estuary Basis area (which defines the boundary of LiDAR surveys and modelling) could be expanded in a seaward direction to encompass the near shore banks and the Welsh and Hilbre Channels (rather than just extending along a straight a line between Point to Ayr and Hilbre). This change is recommended because the changes that take place on these banks and channels are important for understanding the factors influencing change within the wider system. A new proposed boundary is described in Section 3. It is recognised though that the Port is not responsible for these changes, it just needs to be able to understand them to underpin the survey interpretations. Therefore it is hoped that this work can be carried out as a collaboration between the Port's surveys and those carried out by NRW¹².

It is proposed that modelling review work is carried out on a five-yearly cycle with the model boundary conditions updated each time. After the first such updated modelling exercise it is also recommended that future modelling work is not undertaken on an automatic basis but only under circumstances where there is a need to explain changes within the estuarine system that have been observed from other survey work.

¹² For this review, the online LiDAR datasets collected by NRW show irregular and partial coverage of these outer banks but there may be other data that NRW holds which is not online and into the future a more systematic approach in collaboration with the Port could be adopted

To tie in with this five-yearly cycle it is recommended that the LiDAR should be undertaken on 2-year and then 3-year repeating cycles. This will ensure that a LiDAR survey is undertaken every five year to underpin the modelling as well as intermittently. As with other aspects of the monitoring (past, present and future) the frequency of this work can then be reviewed in the light of the evidence on an ongoing basis. To further underpin the modelling some extra bathymetric work will be required. This is described in Section 3.

2.9 EB2 Estuary Transects

2.9.1 Survey work undertaken 2005 to 2016

The aim of Task EB2 is to complement the EB1 tasks and help to further understand the morphological changes in the estuary. This is done by carrying out bathymetric surveys along three fixed cross-estuary transects and using these to examine the changes to the channel and bank locations on a regular basis. These transect are illustrated in Image 12.



Image 12. Location of the three cross-estuary transects

These transect lines were surveyed on a monthly basis from 2005 to March 2009. It was recommended in the Mostyn Channel Monitoring Protocols (SMP, 2008) that the estuary transects surveys should be reduced to bi-monthly (two monthly intervals)¹³. On this basis the surveys were reduced to bi-monthly in 2009 as part of Licence Consent 12/38/ML.

¹³ This frequency has been derived from a consideration of monthly surveys for each of these tasks. The data sets have been analysed for monthly intervals; then for simulated two monthly intervals and a difference plot produced. This work demonstrated that the physical changes over the period are adequately captured by the two-month interval (SMP, 2008).

The 2015 Annual Monitoring Report recommended that the frequency of monitoring surveys for EB2 is reduced from six surveys per annum to four surveys per annum by omitting the March and September surveys. This reduction was recommended on the basis of records reviewed back to 2003 showing these contributed nothing distinctive to the overall record of changes not already provided by the surveys recommended to remain. The newly-issued marine licence (Ref: DML1542) indicated that this work should continue on the basis of three surveys per year (January, May, September) but with a restoration of the bi-monthly approach if deeper dredging is undertaken (see Image 2).

2.9.2 Monitoring review 2017

The Port has provided ABPmer with between 63 and 65 datasets covering the full survey period from 2005 to March 2016. This data was collated and subject to a high level analysis to understand (alongside the LiDAR data overview presented in Section 2.8) whether there has been any key change to the estuary morphology and the hydrodynamics of the system as a whole. There are many ways in which this transect data can be analysed (for this review and for future studies) and many parameters that could be extracted from the data. However, for this review the combined widths of the channels at Chart Datum (CD), MLWS and Mean Sea Level (MSL) were examined. The outputs from this initial analysis are shown in Figure 10.

Figure 10 shows that in the 'North Transect' (which crosses the estuary out from the end of the Mostyn Breakwater) there has been a general trend for widening of the low water channels (by approximately 40% between 2004 and 2013). This trend appears to have reversed during early 2013. At the level of MSL, the estuary width generally increased or remained stable until the end of 2008 before narrowing occurred to the most recent survey for this transect (November 2015). This indicates that a general steepening of the lower half of the channel side-slopes across the estuary has occurred. This particular analysis reveals no particular response that can be attributed to the 2013/14 storm periods and it may be that the estuary accommodated the changes that occurred during that period.

At the 'Mid Transect' (which crosses Salisbury Bank about 2.5 km further up estuary) a similar trend at MSL is observed with a widening of the main channels during 2005. These then 'oscillate' on an approximate 4 monthly basis, particularly around late 2007 and early 2008. Thereafter the combined channel width was stable until about March 2013, before the current trend for narrowing, creating increased constriction of the main channels giving the potential for increased flows. At the mean low water level prior to 2008 the channel widths were relatively stable but became more 'oscillating' on approximately a 4 month basis until the most recent survey for this transect (March 2016). Overall, however, during the 11 years of monitoring there has been little change in the estuary cross-section.

For the 'South Transect' (which crosses the onshore bank near Greenfield) the average width of the channel at MSL has been in the order of 50% lower than those further down estuary and has been much more variable varying (by around 40%) during the monitoring record. The current trend is for channel widening at MSL, similar to the start of the monitoring period. By contrast the low water channel width has been for the most part stable, with a possible slight narrowing occurring at present. Overall, this suggests a marginal shallowing of the bank gradients, (i.e. the opposite to that occurring in the area of the North Transect).

Over the complete monitoring period the results from the transect surveys indicate monthly and annual variability occurs. However, there is little evidence for a significant overall trend for an increase or decrease in channel volume below MSL over time. The North Transect lies closest to the Approach Channel and this high-level analysis does not indicate any changes to the wider estuary morphology that can be attributed to the original capital dredge and the subsequent maintenance of the estuary navigation channel.

2.9.3 Gaps and redundancies in existing monitoring

There are not considered to be any particular gaps associated with this survey work. Although in the next section small suggestions are made for a slight revision to the annual survey timings. As noted above there is value in undertaking further GIS-based analysis of these long-term datasets as part of future annual monitoring work. Such analysis can be used to further inform understanding about estuary wide changes.

2.9.4 Recommendations for future monitoring

As per the latest NRW licence (Image 2) it is recommended that three surveys are undertaken each year but that restoration of bi-monthly surveys occurs if deeper dredging is carried out. The timing of the surveys including especially having one in September to cover the Autumn equinox tides is also appropriate. As with the all other tasks, this regime can be kept under review and appraised against the emerging evidence.

It is worth emphasising also, that there is greater knowledge and understanding that can be gained from ongoing re-analysis of the existing data. As noted above there are many other ways this existing data could be analysed and other summary parameters of change could be defined. One other analysis would involve considering the cross-sectional areas of change at CD, MSL and MHWS along with consideration of the relative changes in the proportion of the cross-sections between the main channels. Such extra analysis will probably provide greater detail on the estuary-wide changes that are occurring and more detail about the relative significance of the Mostyn Approach Channel dredging work.

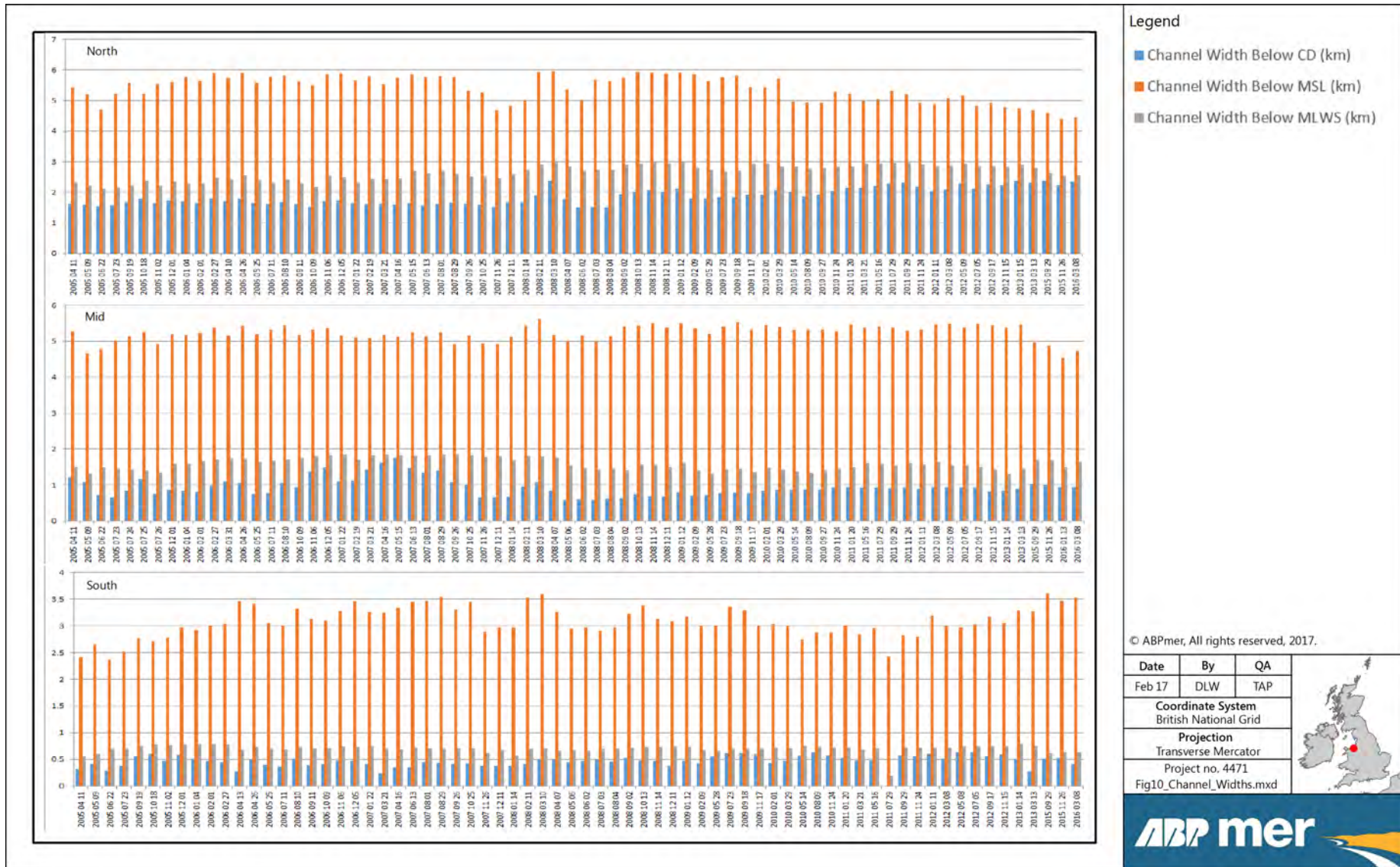


Figure 10. Comparison of the cumulative channel widths along each EB2 transects over time

2.10 EB3 Mid-Hoyle/Welsh Channel Confluence

2.10.1 Survey work undertaken 2005 to 2016

The aim of the EB3 surveys is to monitor channel movement within the Mid-Hoyle Channel and Welsh Channel confluence. This is being studied because it is considered to be a key signal of change in the outer estuary and coastal waters. The relative difference in flows through the Welsh Channel in the west and the Hilbre Channel in the east, and how these change in time, are expected to affect the overall morphological trends in the estuary. Whilst these channels are well defined and deep near the entrance the relative flux (flood and ebb) through them is thought to vary depending on the 'state' of the Mid Hoyle Channel entering the Welsh Channel and the bar across the Hilbre Channel to the east. As the Mid Hoyle Channel would predominantly affect the flow that would enter and leave the Mostyn sub system, changes in this channel were considered to potentially have an effect in the area of the Mostyn Approach Channel. As a consequence monitoring of the bathymetric change in this area was included in the monitoring programme.

To examine this area, bathymetric surveys are regularly undertaken using a single-beam echo sounder. Surveys have been carried out in the Mid-Hoyle and Welsh Channel on a biannual basis since 2009. Under the newly-issued marine licence (Ref: DML1542) this work would be undertaken on an annual basis for dredging up to but not exceeding 2 m below CD Dredge. The bi-monthly approach would be restored for channel depending to greater than 2 m below CD) should this be required (see Image 2).

2.10.2 Monitoring review 2017

For this review, the Port has provided nine annual datasets for 2006 to 2016 (but excluding 2007 and 2008). These datasets were subject to the same GIS-based analysis as was presented in Section 2.2.2 (for Task LA1 Dredged Channel Survey) and the resulting comparative contour plot is shown as Figure 11 while the difference plot is shown as Image 13).

The contour plot (Figure 11) illustrates how there has been a gradual easterly migration of the Mid-Hoyle Channel near the Welsh Channel confluence between 2010 and 2016 at a rate of around 40 m/year. This observation is consistent with the results presented in the bi-monthly and annual monitoring reports. This easterly migration of the channel has been observed since early 2000 however the migration rate has diminished since 2005 (SMP, 2015).

This migration is clearly evident in Transect 1 of Figure 11 which runs through the 'deep' pocket in the channel. This diagram also shows that the deepest area has shallowed by around 2 m between 2010 and 2016 and has become smaller in area whilst moving to the south east. Either side of the 'pocket' the transect shows there has been no material change in level and the east side of the channel changed little between 2015 and 2016.

Transect 2 across Welsh Deep shows little consistent change over the south side of the channel during the monitoring period. To the north of the thalweg there has been around 1.5 m of accretion increasing to about 3 m at the top of the side slope. The change, however, on the 'bar' to the Mid Hoyle Channel has been negligible. This information tends to indicate that:

- The West Hoyle Channel is possibly confined within a 'hard bed'¹⁴ which confines the movement of the channel. It is possible that in 2016 this could be the furthest eastward extent that this potential 'hard bed' will allow. As a consequence the channel may narrow and deepen against the bank before possibly moving back westwards in the future;
- Since 2010 there is little evidence of a change of depth at the 'bar' into the Welsh Channel. As a consequence, during the period of monitoring the overall change in the Mid Hoyle Channel is unlikely to have had a substantial enough change to cause any significant effect on the flow through the Welsh Channel. It is therefore unlikely that changes in the Mid Hoyle Channel would have affected the Mostyn Approach Channel sub system;
- Within the Welsh Channel the accretion on the north side with little change to south suggests an uneven flow regime throughout the channel or a different direction (flood to ebb) dominance on either side of the channel; and
- The level of the West Hoyle Spit has remained relatively stable suggesting sediment is moving from west to east over the spit to settle in the Mid Hoyle Channel, hence moving it east. If the eastward migration is halted by a 'hard bed' as suggested above then it is possible that the Mid Hoyle Channel would infill within *circa* the next five years.

The signs of shoaling in the Mid Hoyle Channel indicate that the flows through this channel may be reducing. This suggests that the risks are reducing of this becoming a dominant channel (over and above the Welsh Channel) and altering the local hydrodynamic regime. This easterly migration is also apparent within the difference plot (Image 13) which shows how there has been net erosion along the easterly margin of the subtidal channel at the edge of the West Hoyle Bank but accretion along the tip of the West Hoyle Spit, which has evidently extended across the entrance to the west of Hoyle Channel from the Welsh Channel. A new area of erosion has occurred which appears to be cutting into the northern side of the West Hoyle spit. If this continues it may create a secondary channel the area. Some possible oscillatory/variable erosion and accretion is also evident on the south side of the Welsh Channel. This may indicate sand waves moving along the channel edge.

¹⁴ This would need to be confirmed

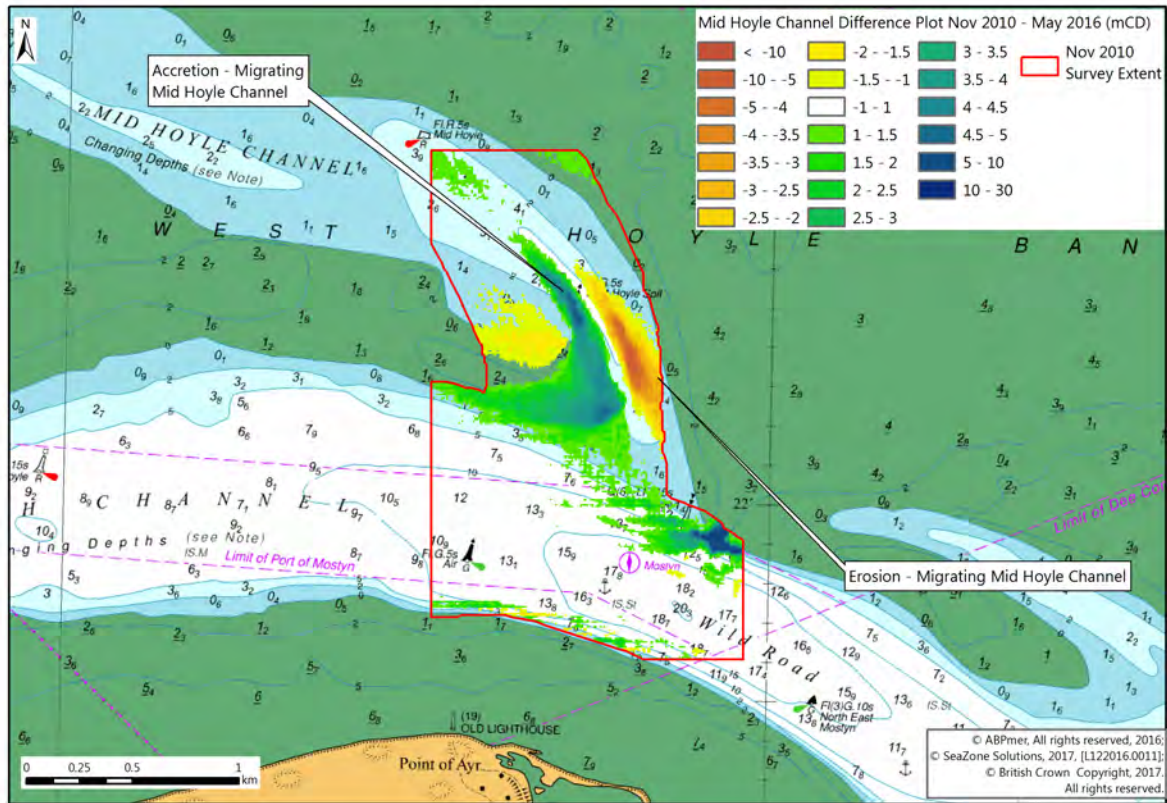


Image 13. Bathymetry difference plot indicating net change from November 2010 to May 2016

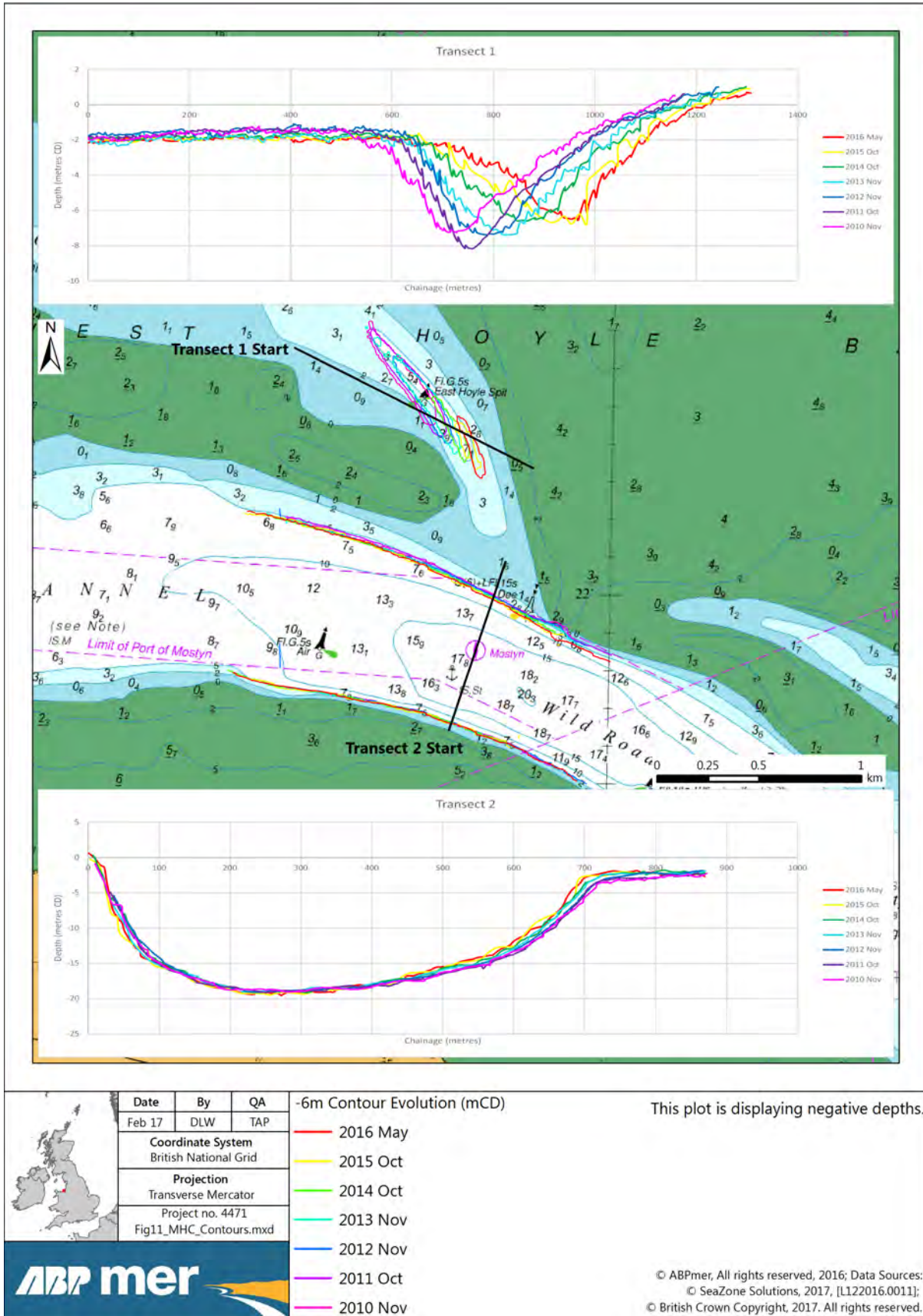


Figure 11. Bathymetric survey results describing change in Mid-Hoyle/Welsh channel confluence 2009 to 2016

2.10.3 Gaps and redundancies in existing monitoring

The preceding high-level review has identified a number of trends and rates of change in the Mid-Hoyle and Welsh Chanel confluence. It is possible that these may be coming towards a 'turning point' although at present there is no definitive evidence for this. It will be important to continue examining this Mid-Hoyle Channel area to confirm this understanding and also to assess whether it will become a dominant route for the flooding tidal waters (at the present time though there is no indication that the latter process is happening). If it does so it would influence Mostyn Deep and the Approach Channel areas.

For these reasons this work should continue, and the proposal to undertake it on an annual basis is appropriate any more detailed analysis is not appropriate in the context of the rate of change. The Mid-Hoyle Channel is progressing at a relatively slow rate and having annual investigations will not result in any detrimental effect in forecasting issues. It is likely that a key change may occur in the future if the Mid-Hoyle channel and its confluence with the Welsh Channel progresses to eastern end of Welshman's gut area where there is a spit on the southern side of Salisbury Middle. At this point there could a new shift in the balance of flood ebb flows between these three channels (Welshman's gut is currently closed). As this key point is some 1 km away any such changes is several years (possibly more than a couple of decades) away and that assumes that a tipping point has not occurred and the channel continues to progress in its current direction of travel.

2.10.4 Recommendations for monitoring (and modelling)

It is recommended that no major change is made to the bathymetric survey work method as this is providing a valuable and clear description of morphological change in this area of interest. Continued annual monitoring will provide necessary indication of change in the context of risk. It is recommended, however, that the boundary of the surveys is extended so that they cover equivalent elevations, as high as is reasonable and safely accessible, at each side of the channel in each year. The proposed frequency of these surveys can also be reduced to annual as noted in the preceding section. If the channel continues to show slow change this survey element could be removed in years when LiDAR data is collected but again this will need to be subject to further review.

Separately, it is also recommended that the modelling is extended to cover this part of the outer estuary (as outlined in Section 2.8). This is because, while we understand the physical changes taking place at the Mid-Hoyle Channel and Welsh Channel, the precise implications of these changes in terms of the flow speeds and flood/ebb volumes are less well understood. Our existing understanding is based on interpretations of morphological change.

Although a lot of detailed survey and modelling work has been carried out, the patterns and balances of flows through the Mid-Hoyle Channel and the other key channels have never been fully modelled. It is recommended (in keeping with recommendations in recent annual report (SMP, (2015)) that future modelling is undertaken to examine this further. To achieve this, the model should have greater spatial coverage than in the past. It should encompass the key morphological features of the estuary (rather than just stopping at a -line between the Point of Ayr and Hilbre Island). Having an outer estuary boundary that more encompasses the complete effect of the main channels will improve the interpretations that can be drawn from the modelling results. In general it will also be possible to update the modelling through this process as improved simulations become available.

While the detail and method of the modelling can be changed, it is recommended (as suggested in Section 2.8) that the frequency of the modelling tasks should be reduced. It is recommended that a 5-yearly cycle is more appropriate with LiDAR collected at 2 to 3 yearly cycles to fit in with the 5-year modelling process. As is currently the case, there would continue to be annual surveys (including

annual bathymetric surveys of the Mid-Hoyle Channel) and annual reviews which will provide ongoing verification that this timescale is appropriate and to suggest revisions where required.

Finally, it is noted that if the numerical modelling is to be modified in extent then extra data will need to be collected to extend the bathymetry details. The main information that will be necessary is the depths of the tidal channels (which will be needed to compliment the latest LiDAR). It is therefore recommended that in the first year when the new modelling undertaken the Mid-Hoyle bathymetric survey is extended to cover a number of the key channels and hydrodynamic 'pinch points'. This would entail getting extra data through the rest of the Mid-Hoyle Channel and out through the Hilbre Channel.

2.11 EB4 Mostyn Deep

2.11.1 Survey work undertaken 2005 to 2016

The aim of the EB4 task is to describe the morphological conditions within Mostyn Deep and including areas within and around where dredge sediment is deposited. This is done to understand whether there are any effects in this area arising from the dredge campaigns or any change to the morphology of this area. Any changes in this area could indicate wider alterations in the outer estuary such as the influences from the eastward evolution of the Mid-Hoyle Channel (as described in Section 2.10). It could also reflect wider changes in the influences of the Welsh and Hilbre Channel or the balance of flows entering the Dee Estuary. The monitoring therefore serves to indicate the effects of the disposal operations while also providing information on the continuing estuary evolution in the area.

This task provides information that is also used to underpin analyses under Task LA2 as described in Section 2.3. The work involves carrying regular bathymetric surveys to describe the morphology of this area. The Mostyn Deep has been surveyed on an annual basis in October or November as part of the monitoring since 2009. The Mostyn Deep was also surveyed on a more variable basis between 2005 and 2008. The newly-issued marine licence (Ref: DML1542) indicated that this work should continue on an annual basis into the future under all proposed dredging scenarios (see Image 2).

2.11.2 Monitoring review

For this review the Port has provided ABPmer with the annual data from 2009 to 2016 and including an extra survey in 2015. As part of the review, a contour plot (Figure 12) and difference plot (Image 13) were created based on the same analysis methods that was described in Section 2.2.2 (for the LA1 Dredged Channel Survey) and applied in Section 2.10.2 (for the EB3 Mid-Hoyle Channel Survey).

The contour and transect plot suggests that the Mostyn Deep channel has remained relatively stable over the 2009 to 2016 period as defined by the 6 m below CD contour. The results of this work carried out to date (as presented in the annual reports including SMP, 2015) indicate that the sediment which is deposited here has a short residence time and is evidently swept away rapidly after deposition. This is expected for this location given that it is a main outer estuary channel.

Figure 12 and Image 14 seek to describe any longer term morphological changes. They show that, on the south side of Mostyn Deep through to the base of the slope on the north side the depths have been relatively stable (but varying randomly within a range of about 1 m). On the north slope however, there has been evidence of continuous accretion from the edge of the eastward aligned spit feature that runs across the entrance to the former Welshman's Gut. Between 2009 and 2016 depths reduced by over 3 m at the top of the channel side slope. The difference plot shown in Image 14

indicates that spatially this accretion was marginally straightening the channel whilst also widening the spit.

This pattern of change indicated by these outputs (with evident net accretion on the north shore) is comparable to observations to the west (in front of the Mid-Hoyle Channel (see Section 2.10)). These plots tend to indicate that these changes are not directly associated with the movement of the Mid-Hoyle Channel but are a symptom of net sediment movements along the edge of the Salisbury Bank and West Hoyle Bank.

To the eastern end of the monitoring area of Mostyn Deep the difference plot (Image 14) in the vicinity of the entrance to the Mostyn Approach Channel shows an area of distinct erosion (in excess of 4 m) within the base of the channel creating a channel depth of 9 m below chart datum leading towards the maintained Port Channel. To the north-east, sedimentation of 1-2 m has occurred diagonally across the channel. This change in bathymetry suggests there has been an increase in flow directed through the Mostyn Approach Channel with a reduction in the larger channel further to the east of the entrance, thus potentially reducing the flow eastwards across the Salisbury Bank.

This area is at the up-estuary end of the Mostyn Deep, where the seabed rapidly shallows out of the depression. This creates an area where flood tidal flows will be accelerating, creating both increased erosion potential and turbulence. With the creation of the single dredged channel from the Port to the confluence with Mostyn Deep, a greater proportion of the flow will pass towards the southern side of the Deep, increasing the turbulence and leading to seabed lowering in this area. The lesser sedimentation is a local consequence of this erosion. This change accords with the expectations of the local influence of the dredge channel influence in this area. Further transect and time-series analysis linked to the dredging records and the changes in the Mostyn sub system would be required to establish the timeline and current trend in this change to determine any potential ongoing links with channel evolution.

Mostyn Deep is also the location of the deposit ground for dredge arisings from the Port of Mostyn. This material is deposited on a grid basis to ensure the material is spread throughout the whole disposal site area. During the study period, the monitoring does not identify any bathymetric changes that can be directly attributed to the disposal operations. The disposal sediment is therefore considered to have been widely dispersed throughout the estuary as was predicted by the initial modelling studies. As a result it is concluded that the disposal of the dredge arisings at the Mostyn Deep has no material effect on the morphological evolution of the Dee Estuary.

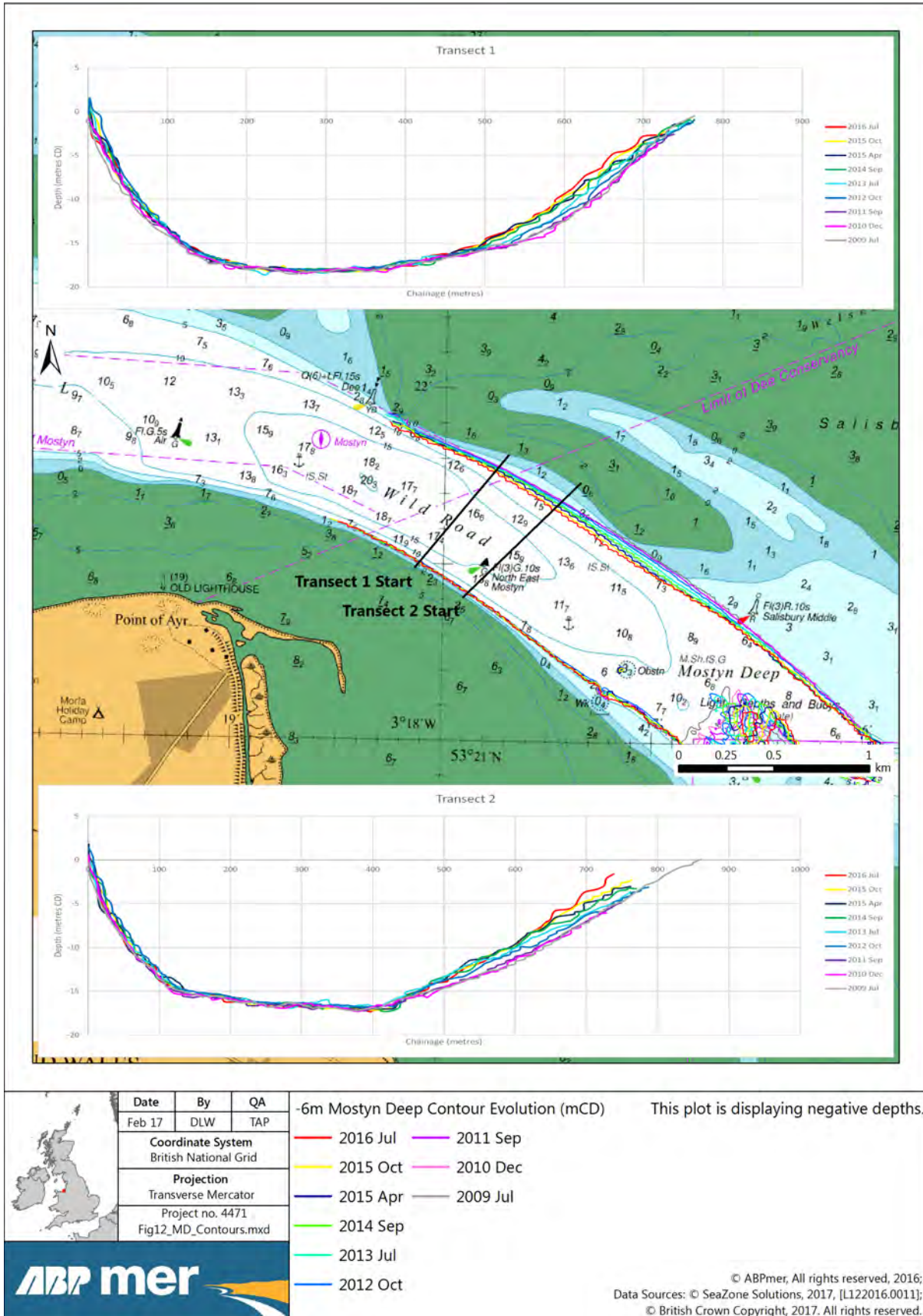


Figure 12. Bathymetric contour plot describing change in Mostyn Deep area 2009 to 2016

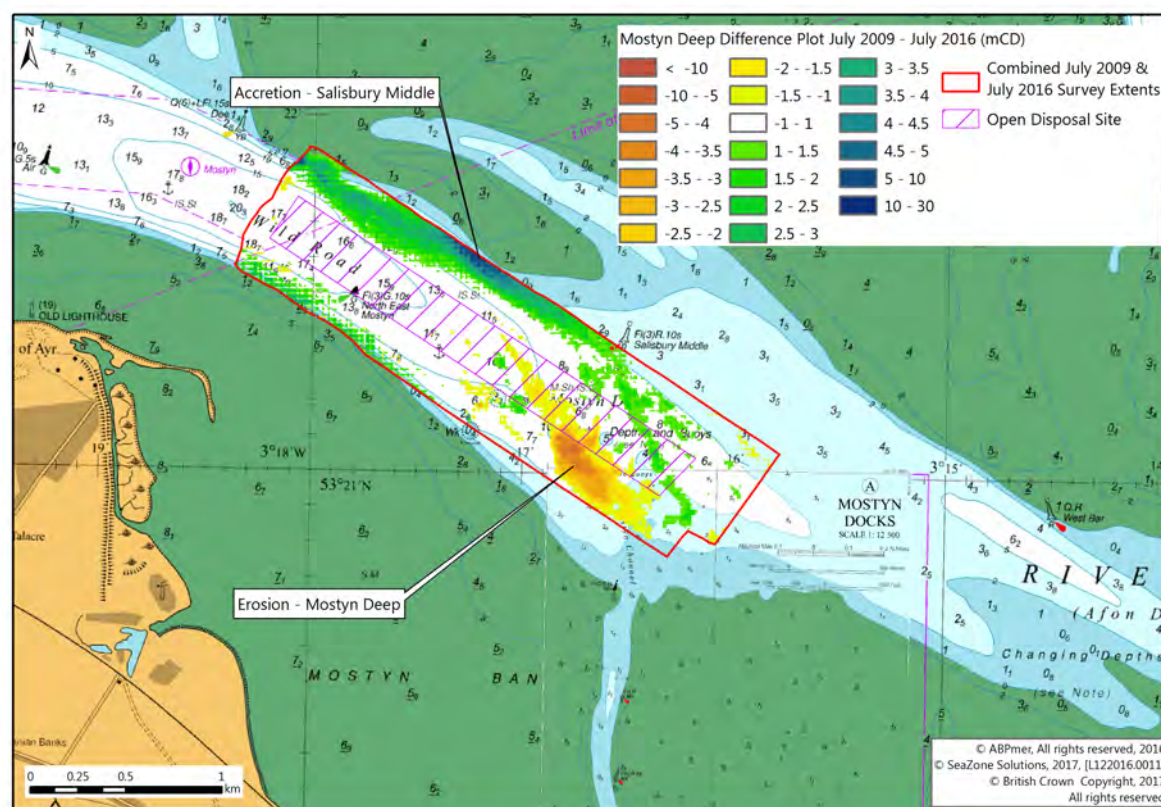


Image 14. Bathymetry difference plot indicating net change from July 2009 to July 2016

2.11.3 Gaps and redundancies in existing monitoring

Following this high-level analysis of the monitoring of both EB3 and EB4 it is evident that sufficient surveys are available to determine the bathymetric changes in the Welsh Channel/Mid Hoyle areas and in Mostyn Deep. There is no need for more detailed or more frequent surveys but there is value in carrying out further data analysis of these datasets to gain a greater understanding about the changing conditions in these areas over time. The existing analysis suggest that there is value in greater and more detailed combined reviews of the results from these areas around the entrance to the Port of Mostyn Approach Channel.

Such future analyses could build on the long-term data review work already undertaken in this report and could include studies of time-series changes from transects at a range of locations. This helps to describe changes over time and space and can include details of the timing and location of dredging and disposal activities in order to visualise the monitored effects. This information would then allow greater long-term understanding of trends and would give a greater insight into the evolutionary character of the Dee Estuary (as opposed to separately presenting annual datasets and describing annual changes).

2.11.4 Recommendations for future monitoring

It is recommended that the surveys continue on an annual basis for both dredging not exceeding 2 m below CD and for dredging 2 to 4 m below CD. As described in the preceding section it is recommended that further time-series based analyses of the available data is carried out (see also Section 3.2.3).

In Section 2.10.4 recommendations are presented for adjusting future hydrodynamic modelling work and for including these outer banks. An added extra value of this extended modelling scope is that it will provide further details about the hydrodynamic conditions within the Mostyn Deep area. This will help to inform our understanding of the dispersive nature of the flows in this area and provide a guide to evaluating any future morphological changes that might occur.

It is understood that different area of Mostyn Deep can have different flow characteristics and levels of flood and ebb dominance. An updated model may be able to distinguish these areas going forward. Certainly it will be valuable to include data from the Mostyn Deep bathymetric surveys (and other surveys of the Mid Hoyle Channel and Approach Channel) with the model to describe the hydrodynamic conditions in these interacting areas.

2.12 EB5 Holocene Clay Bank

2.12.1 Survey work undertaken 2005 to 2016

Task EB5 involves monitoring the extent of exposed clay on the Holocene Clay Bank feature. This has been done to assess the status of piddock colonisation of the area and to understand the rates of clay erosion being experienced in this site. Under the existing monitoring programme, this bank was surveyed on an annual basis from 2005 to 2007¹⁵. The survey frequency was then increased to biannually between 2009 and 2012 to be in alignment with the revised LA5 benthic survey programme (Section 2.11). As the site became covered in a thick layer of sand (which buried the exposed clay), only annual visits have been carried out since 2013.

The newly-issued marine licence (Ref: DML1542) indicated that this work should continue on an annual basis. These annual surveys would occur under the current dredging regime but there would be a return to a biannual survey approach if deeper dredging is undertaken (see Image 2).

2.12.2 Monitoring review

The monitoring has shown that the Holocene Clay Bank is clearly a dynamic area that experiences intermittent periods of sand accretion/coverage (at varying depths) alternating with periods of bed lowering leading to clay exposure. The extent in hectares of clay that has been exposed over the course of the monitoring work (and in preceding years) is shown in Image 15 while the overall location of the exposed clay areas are also illustrated in Figure 13.

Over the survey period, processes have changed from general eroding to largely accreting. During the early surveys (1999 to early 2000s) the Clay Bank feature alternated regularly between being exposed and covered by sand although, at that time, the periodicity of the exposure/burial cycle was not well understood. Thereafter from 2003 to 2013, the underlying clay was apparently exposed on a permanent basis (although there may well have been periods of some sand coverage outside of the survey visits). Since early 2013 it has been covered with a thick layer of sand (based on the observation from surveys).

¹⁵ In addition to these surveys undertaken as part of the established monitoring programme regular site visits have also been carried out in the past by CCW and then NRW as part of their biotope mapping and research commitments in the estuary.

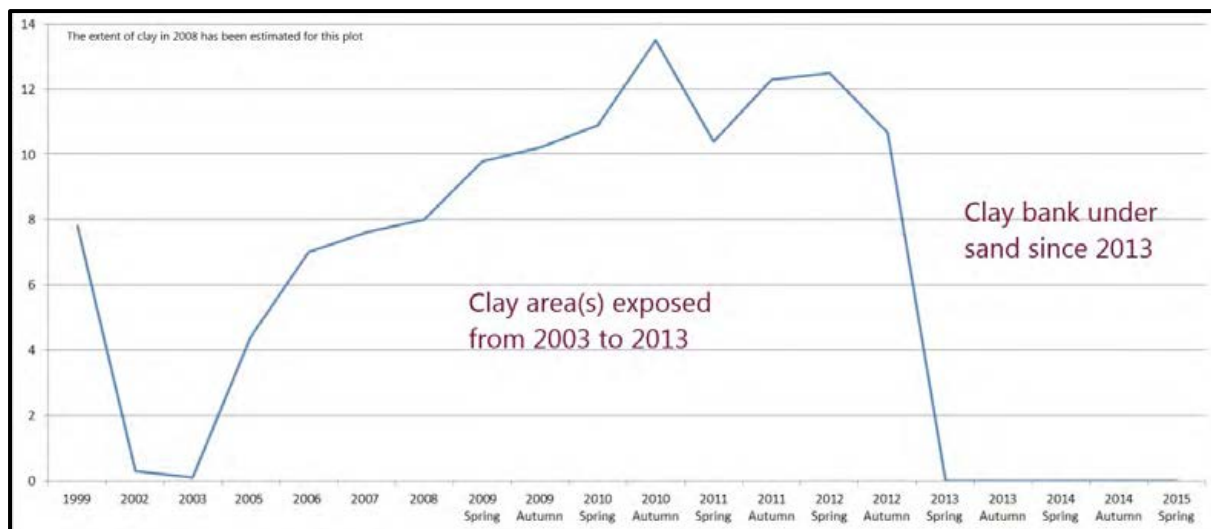


Image 15. Changes in the extent (ha) of exposed of the Holocene Clay Bank since 1999

During periods when some of the clay is exposed then the 'cliffed' south western edge has typically shown a progressive erosional retreat (see Figure 13). Also during these periods of exposure piddock species also tend to colonise the bank although the rate and extent of their recruitment is difficult to quantify and evidently depends on multiple factors such as the duration of clay exposure, the depth of overlying sand and the availability of larvae.

The changes in the sand coverage are expected to be a symptom of wider changes in the morphology and influence of the Welsh and Hilbre Channels. This site is likely to be a key pinch point in the outer estuary system that influences, and responds to, changes in the balance of flows through the outer estuary channels. The underlying clay would also appear to provide an important geomorphological control on the bank and channel configuration. There is no indication/evidence of any link between the dredging of the Approach Channel and the changes occurring on the Holocene Clay Bank.

2.12.3 Gaps and redundancies in existing monitoring

The clay bank site was included in the original monitoring programme because it was an area of particular interest ecologically within the Dee Estuary SAC. The site has been interesting in ecological terms and it has shown how rapidly piddock can colonise when habitat is available. However, further investigation of the ecology of the area is not considered to be needed now that we have this understanding. Understanding the site and its behaviour however will have continuing value in physical terms (because the feature is a key pinch point as described above).

2.12.4 Recommendations for future monitoring

It is recommended that future annual investigations are undertaken examining the physical conditions on site. This is because conditions at this site provide useful information on the changes occurring at this central position within the outer estuary banks. The surveys could be undertaken in a more 'light touch' basis than previously and should involve the collection of boat-based photographic records and notes to describe the conditions being experienced on site. The position of the photograph¹⁶ should be recorded and the conditions on site only need to be recorded qualitatively as either:

¹⁶ In the agreed monitoring protocols there a fixed location for photographing the bank was identified as the nearby West Buoy. However, due to the distance of this buoy from the bank a photographic from this location is insufficiently detailed to describe the conditions on site. It will be necessary to approach the bank more closely and take the photograph where it is safe to do so and mark the GPS position.

- The clay edge and bank are both concealed due to thick coverage of overlying sand;
- The clay edge is exposed but wider bank is concealed due to thick coverage of overlying sand;
or
- The clay edge and wider bank area are exposed or have only a shallow 'dusting' of sand cover.

This will provide the outline understanding about the extent of clay that is visible which can be tied into the broader understanding about the changes in the outer estuary. The conditions on site (both in the past and into the future) can also be examined with reviews of available LiDAR data. The results obtained should be integrated more into the analyses of the broader changes in the outer estuary. This will help to better understand the temporal changes being observed and the reasons for them.

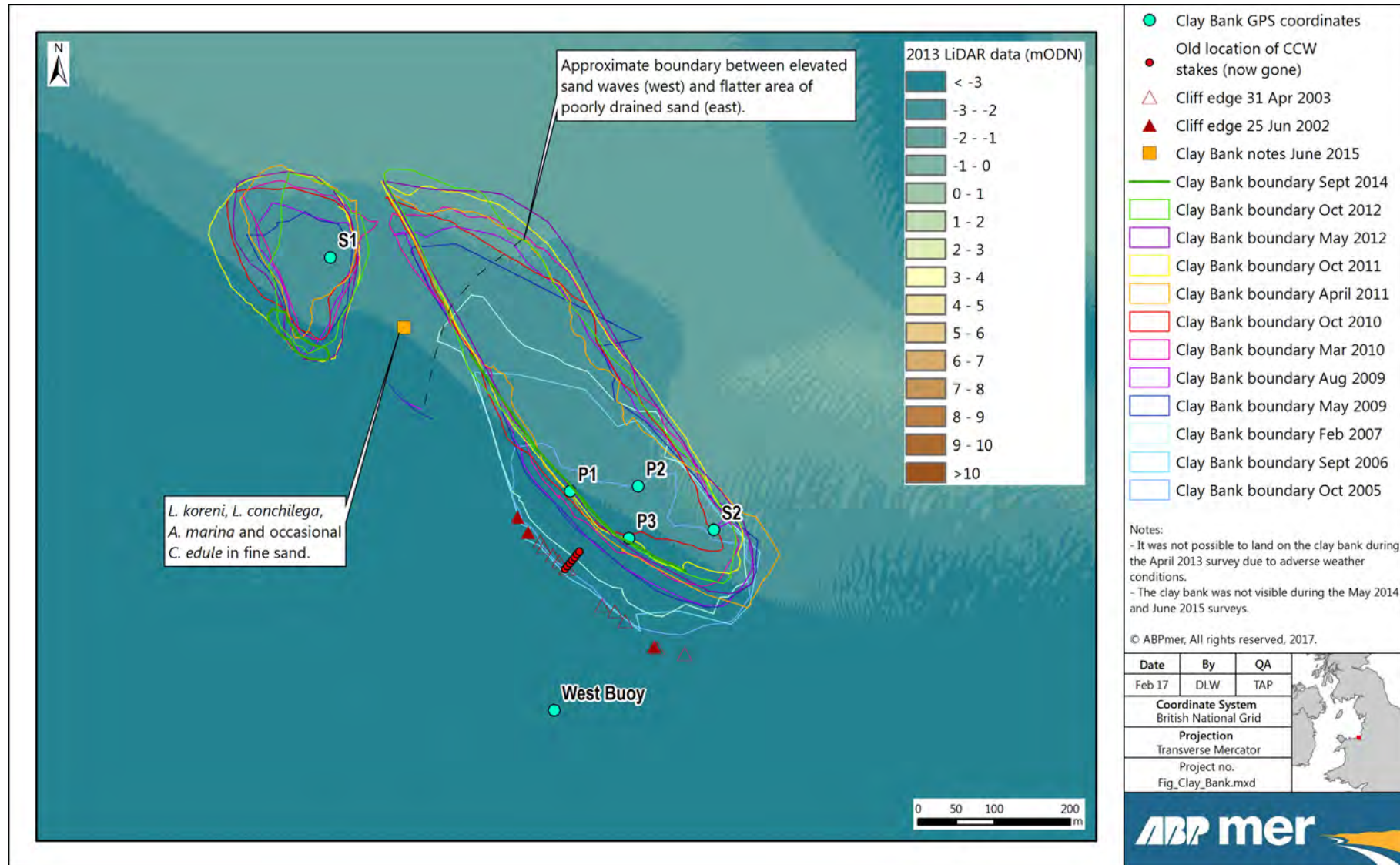


Figure 13. Changes in the location and extent of Holocene clay bank since 2002

3 Conclusions and Recommendations

3.1 Synopsis of Local and Estuarine Conditions

The extensive monitoring work that has been carried out over the last 11 years provide a detailed description of the conditions within the locality of the Approach Channel and across the wider estuary. For this review some extra high-level analysis has been conducted and in summary this work has shown the following:

- In recent years the estuary has overall been relatively stable;
- The Approach Channel is gradually moving to the west into Mostyn Bank, especially at its outer (landward/upstream) section;
- Southern end of Mid-Hoyle Channel is moving east;
- Erosion is occurring on the south side of Mostyn Deep near the Approach Channel and a 'bar' is evidently forming across the deep to the east.; and
- The benthic communities are relatively stable although subject to inherent natural variations which are now well described.

3.2 Outline Recommendations

In light of the findings from this review, the following sections set out some of the main recommendations for the ongoing monitoring programme.

3.2.1 Adopt a reduce monitoring programme

In general it is recommended that the reduced monitoring programme (as set out in the NRW licence) is adopted. However, extra reductions are also warranted for the estuary-wide LiDAR and modelling elements. The individual recommendations for each monitoring tasks and other changes are listed in the Executive Summary and are not repeated here. The following sections further review some of the key principles and considerations for the ongoing monitoring regime.

3.2.2 Take a longer view for survey scheduling

For future survey planning and scheduling, it is considered better to have longer multi-year timeframes rather than shorter annual cycles. This is because evidence from other estuary systems, and results from the Dee Estuary monitoring work, all indicate that estuarine systems respond slowly to interventions. There are separate recommendations in this report for work over 2 year, 3 year and 5 years cycles as well as multiple activities within each year. It would be valuable to develop a plan for the next decade (that is kept under regular/annual review). As part of this process consideration will need to be given to ensuring that the timing of selected surveys (i.e. the months that they are carried out) accords with timings of past surveys. This will ensure a level of consistency that will assist with ongoing interpretation (e.g. in Section 2.9.4 the need for the Estuary Transect surveys to continue coinciding with Autumn equinox periods, as in the past, is noted).

3.2.3 Continue the data collation/integration process (perhaps using WebGIS)

As this is a detailed monitoring programme that has involved the collection of large complex datasets over a long time, it has not been a simple task to retrieve and collate all the survey results. However, now that a lot of this data collation has been undertaken for this study it would be very worthwhile to identify a way of continuing to bring together this information within a single and accessible resource. One option might be to present it in the form of a 'WebGIS' system. This would involve having an online website where the outputs can be mapped, viewed and interrogated. The underlying data can then be retrieved as required and subject to adherence to the Port of Mostyn's commercial property rights. As a very simple example of this approach is illustrated by a simple trial version that has been created for the Port of Cork¹⁷.

3.2.4 Maintain key monitoring principles (but continue to be flexible)

Since the latest (2008) monitoring protocols were drawn up there have been local changes to the alignment of the Approach Channel, some wider changes to features such as the Mid-Hoyle channel and also that a lot of lessons have been learned from the extensive work undertaken. Therefore, it has been an important exercise (as requested from NRW) to undertake this review and consider whether any changes need to be made.

The main recommendation following this review though is that there should be no major alteration to monitoring strategy. The work done is detailed and delivers the information needed to make judgements about the role of the channel dredging in the context of the full-estuary functionality. It is also particularly valuable to preserve the key principles and approaches of the monitoring work to ensure that there is a consistency of approach over time. This will assist with interpreting data and making informed management decisions.

Also, based on the review it is concluded the central principle of monitoring at two scales (to understand the local sub-system effects and the wider estuary influencing factors as described Section 2.1) should be maintained. For these reasons the key surveying elements (i.e. the 'Local Area' sub-system tasks and the 'Estuary Basis' system-wide tasks) should continue. Over time however, it will be important to keep revisiting the monitoring scope and to understand what survey elements needed to be added, changed or removed as required. This approach is already being adopted and should continue. It is also recommended however that there should be some shifts in emphasis and in the frequency of some survey and analysis elements. These recommendations are outlined in the following sections.

3.2.5 Include extra (cumulative) analysis of temporal change

For future reporting work, it will be helpful to include some more analysis of the data that already exists and of the data that is to be collected in the future. In particular, for future reporting work it will be valuable to continue (and build on) some of the analyses that have been included in this review.

The transect analyses are especially helpful for describing the temporal changes to some key features using all the available data. It would be very useful to continue to apply these techniques over time so that long-term trends (and variations) can be described with, as far as is possible/reasonable, the data from the full survey period being presented each time. This is in contrast to presenting annual results/datasets and annual reviews each year and it would mean that the visual descriptions of the information (as well as the interpretations of them) build up clearly year upon year.

¹⁷ <https://abpmer.maps.arcgis.com/apps/webappviewer/index.html?id=f082ce7896c8476d8f5ca8d6cf110064>

In the future these time-series analyses would incorporate extra survey data as it is retrieved and could include temporal analyses from a range of different transect locations. It could also include analyses which highlight the relative timing of dredging and disposal operations against the timings of the observed changes. It will also be valuable to collectively interpret these time-series results from the Approach Channel (LA1), the Mid-Hoyle Confluence (EB3), the Holocene Clay Bank (EB5) and the Mostyn Deep (EB4). This will help to determine whether there is any connectivity between these local changes.

3.2.6 Focus most on local sub-system (using single-beam bathymetry)

The priority for future work should be more on maintaining a detailed understanding of the local system around the Approach Channel and then only secondly looking outwards to the wider estuary to gain a broader understanding on a less frequent basis. The work to date provides confidence that the Approach Channel dredging has not triggered any wider estuary effects and that such wider influencing changes are taking place over slow (several years/decades) timescales. Also, it is the local area where changes are most likely to occur and where there is the greatest risk of consequence from the dredging activities. For these reasons, the local area surveys have been considered first within this review and this approach should be preserved.

In practical terms this will mean that there should be a greater reliance on the local bathymetric work (which provides a much better description of channel shapes and local changes than LiDAR data for example). This principle should be embedded in the thinking for the ongoing monitoring and for considerations about changes in scope.

The bathymetric surveys should also continue to be collected using the single beam approach. The idea of using swathe/multibeam has been highlighted by NRW/Cefas and the attractiveness of this as a tool is understood because in areas where it can be effectively used it can produce valuable and impressive 3D description of subtidal estuarine features. However, multibeam is only really effective in deeper waters because the longer distance of water column penetration allows for broader sweeps of the bed surface to be made on each passage of the survey vessel. In the shallower areas of the outer Dee Estuary channels the coverage zone for multibeam will be very narrow and as a result it will not provide any better information than the existing single-beam in an effective/efficient way. To maintain consistency with the past and because there is no extra value in a change, it is strongly recommended that single-beam is maintained as the preferred and most practical approach.

3.2.7 Extend boundary of local sub-system

As the Approach Channel has shifted westwards, the boundaries of the local subsystem survey areas (LA1 especially) should be increased in this direction while also not losing coverage of the areas to the east of this channel where changes are also clearly occurring. This western boundary increase will help to capture changes occurring following the gradual migration of the Approach Channel. As described in Section 2.2.4 this would involve capturing the western edge of the channel where it meets Mostyn Bank.

It will also be useful to include annual bathymetric surveys of the channels upstream of the Port (i.e. to understand how these are changing. This is because these may be affected in the future (especially if a deeper dredge needs to be undertaken).

The area in front of the Approach Channel (i.e. in Mostyn Deep) also warrant ongoing consideration of any trends but not through a change to existing boundaries of the surveys but through integrated review of existing data collected under tasks LA1, EB3 and EB4. It is worth noting that this area could probably receive much larger volumes of sediment if required to do so. The rate and volume of

sediment deposition is unlikely to be a major constraint to the overall programme of dredging works. Instead the greatest focus should be on the dredging area (and the existing monitoring programme largely already reflects this emphasis).

3.2.8 Extend boundary of estuarine basis and reduce frequency

The extent of the Estuary Basis system should be adjusted seawards (from its current boundary between Point of Ayr and Hilbre, see Figure 3) so that it captures the banks and channels in front of the estuary. This will help to understand the changes occurring in these areas which are important given the fundamental role they play in the morphology and overall functionality of the wider Dee Estuary. To achieve this, the new boundary should cover much of the West and East Hoyle Banks. This would then include the key low water channels (Welsh Channel, Mid-Hoyle Channel, Hilbre Channel and the Welshman's Gut area). It should also include the East Hoyle Spit which is likely to have an influence on the Hilbre Channel.

Extending this area will be relevant for the LiDAR surveys and the modelling work. It will also mean that there is a need to collect some extra bathymetry data to provide information on the depths of the main channels (for use in modelling and later interpretive work). Following on from the point made in the preceding section (about focusing on the local system), it is strongly recommended that the frequency of the LiDAR and modelling work is reduced. This work needs to understand broad trends and influencing factors rather than to make judgements on the local Approach Channel dredging work. For these reasons it does not need to be undertaken annually. Instead it is proposed that this work is done on a five yearly cycle with modelling every five years and LiDAR surveys every 2 and then 3 years. Reducing LiDAR frequency is also in-keeping with the principles of focusing more on the local subsystem for which bathymetrical surveys is the most valuable tool¹⁸ as described in Section 3.2.2. It is hoped that this work is undertaken as a collaboration between the Port and NRW because it provides contextual information about the functionality of the full estuary.

3.2.9 Enhance the link between physical and ecological analyses

More generally, it is also advisable to seek opportunities to enhance the interaction between observations of physical change and measurements of the ecological conditions. The past reports by ABPmer have sought to do this by considering how the changes in benthic assemblages are linked to the key morphological shifts that have been seen and monitored on site (see Section 2.6.2). It will be very useful in the future to have more links between the latest observed physical changes (e.g. changes in bed elevations where recorded) and, where available the outputs from the hydrodynamic modelling to inform interpretations of the results from the benthic studies and clay bank area surveys.

3.2.10 Keep the thresholds approach under review

The existing programme has used a two stage approach to evaluate change under each of the key monitoring tasks. A Stage I threshold change relates to exceedance above a defined level for a task. If the monitoring results continue to show an exceedance in a Stage I threshold for a task that is considered 'significant' with respect to one of the related 'early-warning' parameters this can advance the threshold status to Stage II. The threshold status can also be advanced to Stage II if the change is considered above the forecast level of dredging and deposition effects within the defined ambient or local areas when compared to adjacent estuary behaviour. The values and criteria for each of these thresholds is summarised in Appendix E.

¹⁸ Reducing LiDAR surveys from annual to biennial is also in-keeping with the approach being taken by the Environment Agency

The bimonthly progress reports used a traffic light system to alert exceedance of these thresholds:

- Red - threshold exceedance alert, action required;
- Amber - threshold exceedance recorded, under observation; and
- Green – satisfactory.

Stage I exceedance would trigger an amber alert which would enable consultation with NRW if considered appropriate by them. Stage II would trigger a red alert which would require consultation with NRW and further agreed action (mitigation or additional monitoring).

It is recommended that the use of threshold criteria is continued. However, as part of the progress reporting such criteria should also be accompanied by discussion in the context of wider estuarine trends. In addition, 'significant' change for many of the early-warning parameters may be due to the natural evolution of the estuary rather than dredge related change. Therefore, while these thresholds are considered a useful indicator of change their value in the context of our ongoing understanding should be kept under review. During the future reporting work it might be that a better and more visual way of presenting the information and identify change (without creating long and unnecessarily detailed reporting document) can be achieved.

3.2.11 Keep but adjust the primary and secondary parameters

Under the existing monitoring programme a range of primary and secondary parameters have been identified which are seen as yard sticks or 'harbingers' of change (Barber *et al* 2009). If there is an alteration to these parameters then they signal a morphological adjustment in the estuary that has consequences for the interpretation of the survey results. It is recommended that this concept of reviewing primary and secondary parameters is maintained.

However, in light of the current conditions and the results of the surveys carried out over the last 11 years (and more) it is recommended that the following changes are made. This includes recommendations for the preservation, addition or removal of parameters.

- **Primary – Hydrodynamic Balance between the Welsh and Mid-Hoyle Channels.** This is important as the balance of the flows in the outer channels are key to understanding within estuary functioning.
- **Secondary – Position of the Mid-Hoyle Channel.** This is very valuable as the location of the Mid-Hoyle Channel and the nature of its changing alignment and morphology are important for understating the balance of flows in the outer estuary.
- **Secondary – Position of Welshman's Gut.** Although it has now closed, it was historically one of the key channels in the outer estuary and any changes to the condition of this channel will be a symptom of, or will presage, a wider alteration in the balance of flows in the outer estuary and possibly then a change to functioning of the inner estuary.
- **Secondary – Holocene Bank.** This area should continue to be considered as it appears to be pinch point that responds to the changing conditions in the outer estuary system.

It is recommended that the following estuary parameter is removed:

- **Secondary** Salisbury Bank Cross-channel. Remove this as it has now closed.

It is recommended that the following new 'Local Conditions' area is added:

- **Primary – The Alignment of the Western Flank to the Approach Channel Along the Edge of Mostyn Bank.** This is more of a descriptor for the Approach Channel condition rather than a harbinger of change but it is worth highlighting (as noted in Section 3.2.5)
- **Primary – The Development of Channel to the East of the Approach Channel.** It will be important to continue reviewing how the channels are evolving to the east of the Approach Channel especially as this channel has been gradually moving (see Section 2.2 and Appendix C). The behaviour of these eastern channels to the east these will have consequences for how the Approach Channel may evolve and also for where it is best to continue the dredging work.
- **Primary – The Conditions with Mostyn Deep.** Consider the changes that are occurring in the Mostyn Deep area to understand the implication of these changes and the interactions with the Approach Channel dredging work.

3.2.12 Keep but review difference between 2 m CD and 4 m CD monitoring

During the monitoring period to date, the Port has maintained the Approach Channel at depths of no greater than 2 m below CD. Currently there is no foreseen commercial requirement to deepen the channel further towards 4 m below CD. Therefore, as things stand, this situation is unlikely to change within the lifetime of the marine consent, which will now runs for just over 2 more years (until 31 March 2019). Under the present regime, the agreed approach is that, if the channel does need to be dredged to the full consented depth, then the Port will revert to a more detailed monitoring programme (Image 2). This approach should be continued until March 2019.

Beyond March 2019, the principle of having a more detailed programme in the event that the Port takes up the option for deeper dredging should be maintained. For the consent renewal process however, it is recommended that the scope of this more detailed monitoring should be reviewed reframed (with reductions in survey frequency identified where appropriate) in light of the findings from all surveys and reviews including those undertaken over the next 2 years).

3.3 Conclusion

Over the last 11 years the Port of Mostyn has been undertaking a very comprehensive monitoring programme. This monitoring has been particularly detailed when compared to other ports in other estuaries. Much of this analysis has been valuable to provide assurances about the survey findings given the particular morphological complexities of the Dee Estuary.

To date this detailed survey work has indicated that the dredging and disposal work is potentially having local-scale influences but is not, from the evidence collected and analysed, resulting in greater system-wide consequences (or affecting the integrity of the Dee Estuary). In conclusion, and in light of the monitoring findings it is recommended that the work and the broad principles of the monitoring work are continued. However, a number of useful reductions and adjustments could be made to the scope of the work and the analysis as outlined in Section 3.2. The reductions in scope that are proposed by NRW should be adopted along with other changes as highlighted in main text of the report and outlined in the Executive Summary.

4 References

ABPmer (2014) Mostyn Dredge and Disposal: Ecological Phase 2 Monitoring Work (2013 Autumn Equinox Survey) Report. ABP Marine Environmental Research Ltd, Report R.2223 May 2014

ABPmer (2016) Proposal for undertaking monitoring review as requirement of Marine Licence No. DML1542. Ref 12079, July 2016.

ABPmer Maps Arcgis: <https://abpmer.maps.arcgis.com/apps/webappviewer/index.html?id=f082ce7896c8476d8f5ca8d6cf110064>

Barber PC, Cheshier T, Scott C. & Wilkens J, (2009). Dee Estuary Expatiation. Paper for ICE Conference on Coasts Marine Structures and Breakwaters Edinburgh September 2009.

CCW, (2008). Conditions for consent given to the Port of Mostyn for proposed dredging and disposal activities in the Dee Estuary. Countryside Council for Wales, 25 November 2008. Summary of ecological monitoring conditions

Cooper, K. M. (2013). Setting limits for acceptable change in sediment particle size composition: Testing a new approach to managing marine aggregate dredging. *Marine Pollution Bulletin*, 73(1), 86-97.

SMP (2008) Maintenance of Navigation – Mostyn Channel Monitoring Protocols, Revision 4.0 dated December 2008. Shoreline Management Partnership.

SMP (2015) Maintenance of Navigation Annual Monitoring Report (November 2014 to November 2015). Shoreline Management Partnership.

SMP (2016a) Monitoring Bi-Monthly Progress Report 42 Feb 2016. Shoreline Management Partnership.

SMP (2016b) Monitoring Bi-Monthly Progress Report 43 May 2016. Shoreline Management Partnership.

SMP (2016c) Monitoring Bi-Monthly Progress Report 44 July 2016. Shoreline Management Partnership.

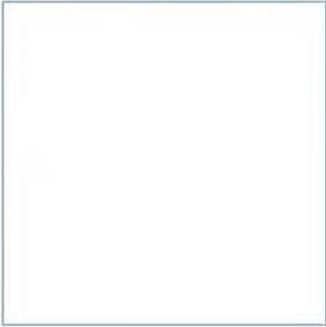
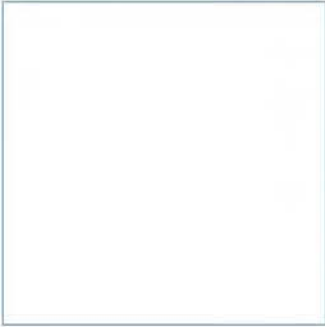
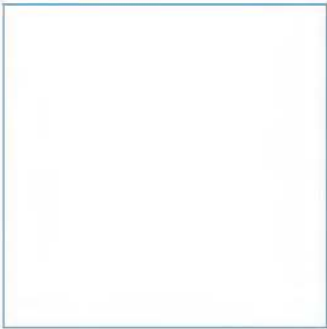
5 Abbreviations/Acronyms

asc	ASCII file
BTA	Biological Trait Analysis
CCW	Countryside Council for Wales
CD	Chart Datum
Cefas	Centre for Environment, Fisheries and Aquaculture Science
DSM	Digital Surface Model
DTM	Digital Terrain Model
dxf	Drawing eXchange Format
EAW	Environment Agency Wales
EB	Estuary Basis
GIS	Geographic Information System
GPS	Global Positioning System
GRADISTAT	Grain Size Distribution and Statistics Software
ha	Hectare(s)
LA	Local Area
LiDAR	Light Detection and Ranging
MDS	Multidimensional Scaling
MHWS	Mean High Water Springs
MLT	Marine Licencing Team
MLWS	Mean Low Water Springs
MSL	Mean Sea Level
NRW	Natural Resources Wales
ODN	Ordnance Datum Newlyn
PRIMER	Plymouth Routines in Multivariate Ecological Research software
PSA	Particle Size Analysis
QA	Quality Assurance
Ramsar	The Convention on Wetlands (Ramsar, Iran, 1971)
SAC	Special Area of Conservation
SMP	Shoreline Management Partnership?
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
TA	Technical Advisers
WebGIS	Technology to Display and Analyse Spatial Data on the Internet
WID	Water Injection Dredging
BS	British Standards
NRW MT	Natural Resources Wales Marine Licencing Team
NRW TA	Natural Resources Wales Technical Advisers
OSGB	Ordnance Survey Great Britain
PDF	Portable Document Format
PoM	Port of Mostyn Ltd

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Appendices



Innovative Thinking - Sustainable Solutions

A Marine Licence (DML1542)



MARINE AND COASTAL ACCESS ACT 2009: PART 4 – MARINE LICENSING

Marine Licence: **DML1542**

The Natural Resources Body for Wales ("NRW") acting on behalf of the Licensing Authority hereby authorise:

**THE PORT OF MOSTYN LIMITED
MOSTYN
HOLYWELL
FLINTSHIRE
CH8 9HE**

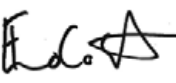
Company Registration No: **2804520**

(Hereinafter referred to as "the Licence Holder") to dredge and deposit in the sea the substances or articles the particulars of which are set out at paragraph 1 of the attached Schedule of Conditions. The Licence is subject to the conditions of use set out, or referred to, in the said Schedule.

This Licence shall be valid from the beginning of the day of, **1 June 2016** (hereinafter referred to as the start date of this Licence) to the end of the day of **31 March 2019**, (hereinafter referred to as the end or expiry date of this Licence).

For the purposes of this Licence and attached schedule and unless indicated otherwise:-

- (i) all times shall be taken to be Greenwich Mean Time (GMT), and,
- (ii) all co-ordinates shall be taken to be latitude and longitude degrees and minutes to two decimal places.

Signed: 

For and on behalf of NRW acting on behalf of the Licensing Authority

Date of issue: 10 May 2016

SCHEDULE of CONDITIONS

1. Particulars of the Deposit Operation

- 1.1 Area of navigational dredge and place of production of the substances or articles for deposit:

NAVIGATION CHANNEL, AREA A, MOSTYN RIVER DEE

On a line located by joining the points

53° 20.990' N 03° 16.390' W

53° 19.170' N 03° 15.400' W.

Being the navigation Channel between Buoys M1 and South Salisbury Buoy, Port of Mostyn.

To a maximum depth of - 4.0 meters Chart Datum

- 1.2. Description of the substances or articles for deposit:

CAPITAL AND MAINTENANCE DREDGINGS, as described in application dated 4 September 2015

- 1.3. The Licence Holder or any Agent or Contractor acting on their behalf under this Licence is permitted to deposit a quantity not exceeding **2,700,000 tonnes** of the substances or articles specified at sub-paragraph 1.2 of this Schedule, at the Deposit Area(s) detailed at paragraph 1.4 and up to the maximum quantity specified for each Deposit Area specified at paragraph 1.6.

- 1.4 The Deposit Areas authorised under this licence are:

MOSTYN DEEP (MAINTENANCE), IS102

at:-

Within the area bounded by joining the points

53° 21.650' N 03° 18.210' W

53° 20.940' N 03° 16.350' W

53° 21.050' N 03° 16.180' W

53° 21.770' N 03° 18.080' W

Up to a maximum quantity of **2,700,000 Tonnes** may be deposited as set out in paragraph 1.6 of this schedule.

- 1.5. Tank/hopper washings may only be discharged in the area(s) specified at paragraph 1.4
- 1.6 Within the overall quantities authorised for deposit set out in paragraph 1.3, and the authorised Deposit Area set out in paragraph 1.4 the following limits also apply:

Licence No: DML1542

Dated: 01 June 2016

1.6.1 Up to **900,000 tonnes** may be deposited between **01 April 2016** and **31 March 2017** at the following authorised Deposit Areas:

<u>Area Code</u>	<u>Area Name</u>	<u>Maximum Qty (tonnes)</u>	<u>Type</u>
IS102	MOSTYN DEEP (MAINTENANCE)	900,000	Main Site

1.6.2 Up to **900,000 tonnes** may be deposited between **01 April 2017** and **31 March 2018** at the following authorised Deposit Areas:

<u>Area Code</u>	<u>Area Name</u>	<u>Maximum Qty (tonnes)</u>	<u>Type</u>
IS102	MOSTYN DEEP (MAINTENANCE)	900,000	Main Site

1.6.3 Up to **900,000 tonnes** may be deposited between **01 April 2018** and **31 March 2019** at the following authorised Deposit Areas:

<u>Area Code</u>	<u>Area Name</u>	<u>Maximum Qty (tonnes)</u>	<u>Type</u>
IS102	MOSTYN DEEP (MAINTENANCE)	900,000	Main Site

2. Agents or Contractors Responsible for the Loading, Transportation, Storage or Deposit of the Substances or Articles

- 2.1 The name and address of all Agent(s) and Contractor(s) acting on behalf of the Licence Holder, which shall be engaged in the loading, transportation, storage and deposit of substances or articles specified in sub-paragraph 1.2 of this Schedule, shall be notified to, NRW acting on behalf of the Licensing Authority before they commence any such operation.
- 2.2 The name(s) and operator(s) of any vehicle(s) or vessel(s) which shall be engaged in the loading, transportation and deposit of the substances or articles specified in sub-paragraph 1.2 of this Schedule, shall be notified to NRW acting on behalf of the Licensing Authority before they commence individually any operation to which this Licence **DML1542** refers.
- 2.3 Only those operator(s) or contractor(s) and vehicles whose details have been notified to NRW acting on behalf of the Licensing Authority may operate under the terms of this Licence. Any changes must be notified to and be approved by NRW acting on behalf of the Licensing Authority in writing prior to operating under this Licence.
- 2.4 Any person in charge of the loading of a vessel or any intermediate storage of the substances or articles prior to their deposit in the sea shall maintain a written record on the premises relating to individual cargoes or loads (received or dispatched). This written record shall include the following details:
 - 2.4.1 date and time each load was received or dispatched and the quantity;
 - 2.4.2 general description of the substances or articles and the name of the producer(s) or holder(s);
 - 2.4.3 registration numbers of vehicles delivering loads;

- 2.4.4 consignment note numbers (if any);
 - 2.4.5 the reference number of the Licence issued under, Part 4 of the Marine and Coastal Access Act 2009, which permits the substances or articles being loaded or stored to be deposited in the sea;
 - 2.4.6 name(s) of vessel or identification code and type of container into which substances or articles are loaded;
 - 2.4.7 signature(s) and status of the person or persons authorising loading of substances or articles to the vessel or container;
 - 2.4.8 the results of any checks carried out on the substances or articles prior to authorisation of loading.
- 2.5 The Licence Holder and any agent or contractor responsible for loading, transportation or storage must ensure that only authorised personnel have access to the substances or articles for deposit.
- 2.6 All vessels employed to perform the deposit operation permitted by this Licence **DML1542** shall be so constructed and equipped as to be capable of the proper performance of these operations in compliance with the conditions set out in the Schedule to this Licence **DML1542**. Details of the vessels that may operate under this Licence **DML1542** are set out in sub-paragraph 2.2, and the standard equipment to be on all vessels operating under this Licence **DML1542** are set out in section 9.
- 2.7 The Master or the Officer of the Watch of each vessel, as specified in sub-paragraph 2.2 of this Schedule, undertaking the deposit of any substances or articles specified in sub-paragraph 1.2 of this Schedule, shall maintain a written log of operations recording, in the English Language, the following information:
- 2.7.1 the name of the vessel;
 - 2.7.2 the quantity and type of each substance or article loaded for deposit;
 - 2.7.3 the date and time of departure from the port or site at which the substances or articles are loaded for deposit in the sea and time of arrival (and date if different) at the Deposit Area on each occasion that it proceeds to and from such area;
 - 2.7.4 latitude and longitude position (in degrees and minutes and decimal of a minute to at least one decimal place) of the vessel at intervals of not more than 20 minutes throughout the deposit operation which for the purpose of this Licence **DML1542** shall be the commencement of loading (including the dredging) each consignment of material for deposit in the sea through to the completion of the placement or deposit of the material in the Deposit Area;
 - 2.7.5 the time taken to complete the deposit operation and a statement of the reasons for any delays;
 - 2.7.6 courses and speeds together with any alterations throughout each deposit operation (multiple changes may be recorded as "various");
 - 2.7.7 the rate of discharge or deposit, together with any variations, throughout deposit operations;
 - 2.7.8 weather, sea-state, wind and tidal set, and rate throughout deposit operations;
and

- 2.7.9 the signature of the Master at the foot of each log sheet or page of the record.
- 2.8 All deposit vessels are required to carry an Admiralty Chart of appropriate scale to be used in navigation on which the co-ordinates of the licensed Deposit Area(s), as detailed in sub-paragraph 1.4, should be marked.

3. Distribution of Copies of this Licence DML1542

- 3.1 The Licence Holder is required to ensure that a copy of this Licence **DML1542** and attached Schedule, any special conditions and any subsequent revisions or amendments thereto is given to:
- 3.1.1 any Agent or Contractor, as detailed in sub-paragraph 2.1 of this Schedule, responsible for the loading, transport storage or deposit of the substances or articles for deposit as described in sub-paragraph 1.2 of this Schedule; and
- 3.1.2 the Master of any vessel employed in pursuance of this licence.
- 3.2. Copies of this Licence **DML1542** shall also be available at the following locations:
- 3.2.1 at the address of the Licence Holder;
- 3.2.2 at any site office, located at or adjacent to the site of the works, used by the Licence Holder, agent(s) or contractors(s) responsible for the loading transportation or deposit of those substances or articles detailed at paragraph 1 of this Schedule; and,
- 3.2.3 at the office of the transport manager with responsibility for any vehicle(s) from which licensed deposits are to be made.
- 3.2.4 on board each vessel from which deposits and removals are to be made.

4. Inspection of the Operation

- 4.1 The written record referred to in paragraph 2.4 shall be available for inspection by authorised Marine Enforcement Officers at all reasonable time at the premises where the substances or articles are stored prior to loading for deposit at sea.
- 4.2 This written log referred to in paragraph 2.7 of the Schedule and all other relevant documents shall be available on board the vessel(s) to which they relate at all reasonable times for inspection by authorised Marine Enforcement Officers.
- 4.3 The documents referred to in paragraph 3 shall be available for inspection at all reasonable times by authorised Marine Enforcement Officers at the locations stated in that paragraph.
- 4.4 The Licence Holder must provide access, and if necessary appropriate transportation at reasonable notice, to the disposal vessel to facilitate any inspection that NRW acting on behalf of the Licensing Authority considers maybe necessary subject to meeting any mandatory health and safety obligations.
- 4.5 The Licence Holder must allow officers of the Maritime and Coastguard Agency, Marine Enforcement Officer or any other person authorised by NRW acting on behalf of the Licensing Authority to inspect the works at any reasonable time, subject to condition 4.4 above.

Licence No: DML1542

Dated: 01 June 2016

- 4.6 The Licence Holder must notify NRW acting on behalf of the Licensing Authority and Marine Enforcement Officers **10 days** before the licensed operation, or an individual phase of the operation is expected to commence.
- 4.7 The Licence Holder must notify NRW acting on behalf of the Licensing Authority and authorised Marine Enforcement Officers within **10 days** of completion of each phase of works.
- 4.8 The Licence Holder must notify the UK Hydrographic Office of the timetable and location of the work within 10 working days prior to works commencing, to permit the promulgation of Maritime Safety Information and the updating of nautical charts and publications.

5. Returns to be made to NRW acting on behalf of the Licensing Authority

- 5.1 Certified returns of quantities of substances or articles deposited under this Licence **DML1542** are required to be submitted on the disposal return form by 31 January and 31 July each year. The returns must specify the full Licence number and amount deposited each calendar month at each authorised Deposit Area. Where no deposit is made in a given period a NIL return is required.
- 5.2 If this Licence **DML1542** expires during the course of the calendar year and is not renewed or superseded by a further Licence relating to the works specified in paragraph 1, a certified return of quantities of substances or articles deposited under this Licence **DML1542**, shall be submitted not later than 28 working days after the expiry date of this Licence **DML1542**.

6. Force Majeure

- 6.1 If, by reason of "force majeure" the substances or articles as specified at sub-paragraph 1.2 of this Schedule are deposited otherwise than at the authorised deposit area specified at paragraph 1.4 of this schedule, full details of the circumstances shall be notified within 48 hours to NRW acting on behalf of the Licensing Authority.

"force majeure" may be deemed to apply when, due to stress of weather or any other cause, the master of a vessel determines that it is necessary to deposit the substances or articles because the safety of human life and/or of the vessel is threatened.

7. Changes to this Licence

- 7.1 In the event of the Licence Holder becoming aware that any of the information on which the granting of this Licence **DML1542** was based has changed or is likely to change, he/she shall immediately notify NRW acting on behalf of the Licensing Authority of the details.
- 7.2 Should the Licence Holder wish any of the particulars set down in paragraph 1 of the Schedule to be altered he/she shall immediately inform NRW acting on behalf of the Licensing Authority and receive written consent to the change before taking any further action.

8. Contacts

- 8.1 Except where otherwise indicated, the primary point of contact with NRW acting on behalf of the Licensing Authority and the address for returns and correspondence shall be:-

**Marine Licensing Team
Natural Resources Wales
Cardiff Permitting Centre
29 Newport Road
Cardiff**

Licence No: DML1542
Dated: 01 June 2016

Wales
CF24 0TP

Email: marinelicensing@naturalresourceswales.gov.uk

- 8.2 For the purposes of this Licence any references to Marine Enforcement Officers shall mean the relevant officers located at:-

Welsh Government
Fisheries Office
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9. Project Specific Conditions

- 9.1 The Licence Holder must ensure that the quantity of material deposited does not exceed 24,000 tonnes (12,000m³) in any 24-hour period.
- 9.2 The Licence Holder must ensure that Mostyn Deep disposal site (IS102), must be divided into 25 metre by 75 metre cells. The placement of material within these cells must follow a randomised sequence, excluding the perimeter cells designed to provide a safety margin. Each cell must initially only receive one 400 cubic metre load of dredged material; thereafter the sequence may then be repeated on a rolling basis.
- 9.3 The Licence Holder must ensure that the co-ordinates of each deposit are recorded from the dredging vessels positioning system and are submitted to NRW acting on behalf of the Licensing Authority as part of the monitoring reports described in 9.4.
- 9.4 The Licence Holder must submit reports of the disposal operation to NRW acting on behalf of the Licensing Authority following each disposal campaign and within 4 weeks of the last deposit.
- 9.5 The Licence Holder must submit a methodology and scope of a review of the previous 11 years monitoring data including the LiDAR surveys, (from the date of issue of FEPA Licence 32187/05/0 and Flood Defence Consent NE200300068 16/08/2005), to NRW acting on behalf of the Licensing Authority for written approval at least 12 weeks following issue of this Licence. The proposed methodology and scope must include proposals to update the "Maintenance of Navigation – Mostyn Channel Monitoring Protocols, Revision 4 dated December 2008" (Mostyn Channel Monitoring Protocols) – summarised in Annex A, in line with the Review.
- 9.6 The Licence Holder must submit the Review within an agreed timescale, undertaken in accordance with the methodology and scope as approved by NRW acting on behalf of the Licensing Authority in condition 9.5. The Review must propose any relevant updates to the Mostyn Channel Monitoring Protocols Revision 4 dated December 2008 – summarised in Annex A, to NRW Acting on behalf of the Licensing Authority for written approval.

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- 9.7 The Licence Holder must then under take monitoring in accordance with those approved, updated Mostyn Channel Monitoring Protocols.
- 9.8 The Licence Holder must undertake a programme of monitoring to assess the effects of the disposal operations permitted by this licence as described at 9.11 below and in the Maintenance of Navigation - Mostyn Channel Monitoring Protocols, Revision 4.0 dated December 2008 (and subsequent revisions) commensurate with the reported dredge depths (summarised in Annex A as revised).
- 9.9 The Licence Holder must ensure that if at any time dredging exceeds a depth of -2.0m CD, the Licence Holder must revert to the monitoring regime defined in Annex A for the -2.0 m to -4.0 m CD dredge until such time as NRW acting on behalf of the Licensing Authority advise otherwise in writing.
- 9.10 The Licence Holder must ensure that monitoring reports are produced in accordance with the timescales set out in Annex A for either the -2.0 m CD or -2.0 m to -4.0 m CD dredge, and sent to NRW acting on behalf of the Licensing Authority, for written approval. Each report should contain the volume dredged and the dredge depth achieved since the previous monitoring period and a full analysis and interpretation of the data contained therein.
- 9.11 The Licence Holder must adhere to Section 7 of the agreed Mostyn Channel Monitoring Protocol which defines a threshold for each parameter and an 'alerts' system for reviewing changes in these parameters beyond the threshold.
- 9.12 Should a threshold exceedance event be experienced where Port of Mostyn dredging is considered to be the cause the Licence Holder must:
- 9.12.1 Submit a proposal of subsequent management or mitigation actions to NRW acting on behalf of the Licensing Authority for written approval.
- 9.12.2 Undertake the management or mitigation actions in line with the approved proposals.
- 9.13 The Licence Holder must make use of ploughing / water injection dredging techniques wherever practicable to minimise the quantity of material requiring sea disposal. The Licence Holder must ensure that all such activities are reported to NRW acting on behalf of the Licensing Authority within the reports described in 9.5 and should include the dates, locations (marked on navigational charts), details of the depth of material and estimates of the volumes of material moved.
- 9.14 The Licence Holder must ensure that no more than 100,000 Tonnes / 50,000m³(whichever is lower), of material dredged from the area defined in section 1.1 is removed from the estuary per annum in line with the Marine Licence application received 7 September 2015 for the duration of this licence.

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Dated: 01 June 2016

- 9.15 The Licence Holder must ensure that all reasonable precautions are taken to prevent the disposal of man-made debris to sea.
- 9.16 The Licence Holder must ensure all plant and equipment used are clean prior to their arrival on site to minimise the risk of introducing non-native species into the marine environment.
- 9.17 The Licence Holder must ensure suitable bunding and storage facilities are employed on all vessels to prevent the release of fuel oils, lubricating fluids associated with the plant and equipment into the marine environment.
- 9.18 The Licence Holder must ensure that any incident that may result in an environmental impact or detriment must be reported immediately to NRW on our 24 hour hotline 0800 807060 providing date, time, location, description of incident, impact or potential impact, any mitigation already implemented along with a contact name and telephone number
- 9.19 The Licence Holder must ensure a contingency plan is in place (e.g. spill kits) to contain any accidental spillage of oil, fuel or any other chemical used during the course of the works.
- 9.20 The Licence Holder must comply with the Guidance Note, Marine Aggregate Dredging and the Historic Environment, issued by BMAPA and EH in April 2003, the related protocol for reporting Finds of Archaeological Interest, issued in August 2005 and any subsequent replacements of those documents.
- 9.21 The Licence Holder must submit a Written Scheme of Investigation (WSI) to NRW acting on behalf of the Licensing Authority at least 8 weeks prior to any dredge exceeding -2m CD for written approval. The WSI must consider finds being made on the seabed and on board dredging vessels. The WSI must relate specifically to the Port's Operations and must be made available for inspection by NRW acting on behalf of the Licensing Authority and Marine Enforcement Officers upon request and at the locations specified in paragraph 3.2.
- 9.22 The Licence Holder must notify: Natural Resources Wales acting on behalf of the Licensing Authority. Cadw, Clwyd Powys Archaeological Trust (CPAT), the Royal Commission for Ancient and Historic Monuments Library and Enquiries Service, and the Portable Antiquities Scheme Officer at the National Museum of Wales for "first-aid" conservation advice should any object of archaeological interest be discovered during dredging or during the course of landing dredged material.
- 9.23 The Licence Holder must ensure all works are carried out in accordance with the jointly agreed procedures contained within Sections 3.01, 3.11 and 6.03 of the Dee Conservancy Marine Safety Management System and Sections D2.0, D6.0 and G2.0 of the Mostyn Docks Limited Safety Management System.
- 9.24 The Licence Holder must ensure the Mostyn Approach Channel remains open for safe navigation throughout the works period.
- 9.25 The Licence Holder must ensure all aids to navigation marking the safe navigation of the channel remains in position and operational throughout the works period. Any temporary buoy movements to facilitate dredging operations are to be discussed and agreed with NRW's Harbour Master

EXPLANATORY NOTES

*This page does not form part of this Licence **DML1542** or its associated schedule but the Licence Holder is recommended to read the following guidance notes.*

1. The granting of this licence does not absolve the Licence Holder from obtaining such other authorisations, consents and approvals which may be required under any other legislation, controls or regulations.
2. Under Section 72 of the Marine and Coastal Access Act 2009, NRW acting on behalf of the Licensing Authority may vary or revoke this Licence if it appears to the Authority that the Licence Holder is in breach of any conditions in it or for any other reason that appears to the Authority to be relevant.
3. A person who contravenes Section 65 (1) of the Marine and Coastal Access Act 2009, or fails to comply with any condition of a Marine Licence, commits an offence under Part 4, Chapter 3, Section 85 of the Marine and Coastal Access Act 2009.
4. It is a defence, Under Part 4, Chapter 3, Section 86 of the Marine and Coastal Access Act 2009, for a person charged with an offence under Section 85 (1) to prove that:
 - a) the activity was carried out for the purpose of securing the safety of a vessel, aircraft or marine structure or for the purpose of securing life, and,
 - b) that he/she took steps within reasonable time following the incident to inform NRW acting on behalf of the Licensing Authority of:
 - (i) the fact that the activity was carried out,
 - (ii) the locality and circumstances in which it was carried out, and
 - (iii) any substance or objects concerned.
5. If the works authorised by this Licence are unlikely to be completed by the expiry date of this licence, the Licence Holder should apply for a replacement licence at least **4 months** prior to the expiry date of this Licence.

Annex A

Monitoring Plan for estuary basis definition (EB)

Section 5 of the Mostyn Channel Monitoring Protocols tabulates the monitoring requirements for estuary evolution now stipulated by licence DML1542 as follows:

NB: This table has been amended from the Mostyn Channel Monitoring Protocols, Revision 4, December 2008 to incorporate a reduced monitoring frequency for the dredge depths not exceeding -2.0m CD. Dredge depths exceeding -2.0m CD to -4.0m CD remain unchanged.

Task	Frequency at Dredge Depth		Spatial Extent	Analysis	Evolution Issues
	Up to but not exceeding -2.0m CD	-2.0m to -4.0m CD dredge			
EB1 LiDAR/Swathe Survey of seabed levels	Annual	Annual	Northern limit = straight line joining Hilbre Point to Point of Ayr. Southern limit = 369000	Contour plot, Difference plot to previous survey(s); Numerical model run of morphological tide	A, B, C, D, E, F
EB2 Estuary Transects	Every 4 months	Bi-monthly	North, Middle and South transects as presently defined.	Channel/Bank parameters, Datum level area(s) above seabed	A, B, D (part)
EB3 Mid-Hoyle/Welsh channel confluence	Annual survey (coincident with LiDAR/Swathe survey)	Bi-annual with one survey coincident with LiDAR/Swathe survey)	Northern limit = 388000 Western limit = 312000 Eastern limit and southern limits to tie in with Mostyn Deep Survey.	Contour plot; Difference plot to previous survey; Integration with LiDAR/Swathe survey.	E
EB4 Mostyn Deep	Annual (Synchronous with Mid-Hoyle/Welsh channel confluence survey six months apart from EB1)	Annual (Synchronous with Mid-Hoyle/Welsh channel confluence survey six months apart from EB1)	Flanks to 1.0m above CD and upstream limit to 316500.	Contour plot; Deference plot to previous survey; Comparison to LiDAR/Swathe survey.	C, E, D (part)
EB5 Holocene Clay	Annual (Synchronous	Bi-annual (one survey to	Area of exposed	Plot extent of clay area	C

Bank	with spring Benthic Survey Salisbury/Mostyn Bank LA5)	coincide with LiDAR/Swathe survey of seabed levels)	clay around (317300, 384400)	exposed and overlay on previous surveys – assess the extent and status of paddock colonisation of the area and erosion rate of clay edge (if appropriate).	
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LiDAR data must be submitted to review large-scale morphological change. This is required for the dredging activity and is also relevant to the assessment of the disposal operations and should be included within the analyses and interpretation where available.

Evolution Issues:

- A) the low water channel upstream of Greenfield is presently stable in location even in the vicinity of Flint Point and the minor channel through Salisbury Middle has effectively closed;
- B) the central estuary continues to be volatile but the twin (or more) major channels introduced in 2004/05 rather than one major channel previous arrangement are persistent;
- C) the Holocene clay bank is actively eroding providing unique changes to seabed levels in the centre of the estuary;
- D) the Welsh channel has increased its energy profile and the Hilbre channel has reduced its energy profile since 2003 with both channels relocating towards the centre of the estuary (as recorded by north transect off the Mostyn breakwater);
- E) the Mid-Hoyle channel is migrating eastwards and is the only significant trend change within the estuary approaches;
- F) there is a net import of sediment into the estuary each year but the annual rate is variable;

Monitoring Plan for local and ambient effects definition for dredging and deposition (LA)

Section 5 of the Mostyn Channel Monitoring Protocols tabulates the monitoring requirements for local and ambient effects now stipulated by licence DML1542 as follows:

NB: This table has been amended from the Mostyn Channel Monitoring Protocols, Revision 4, December 2008 to incorporate a reduced monitoring frequency for the dredge depths not exceeding -2.0mCD. Dredge depths exceeding -2.0mCD to -4.0mCD remain unchanged.

Task	Frequency at Dredge Depth		Spatial Extent	Analysis	Local /Ambient Issues
	Up to but not exceeding - 2.0m Chart Datum Dredge	-2.0m to – 4.0m Chart Datum Dredge dredge			
LA1 Dredged Channel Survey	Every 4 months	Bi-monthly	Northern limit = 384000; Southern limit = 382000; Western limit = 250m west of channel centreline; Eastern limit = 316400 Survey lines to be 100m apart except for longitudinal sections A to K to be set 50m apart (see Figure 3). Survey spatial limits shown on Figures 1 & 2 of the Mostyn Channel Monitoring Protocols	Selected cross-section and longitudinal section profiles overlaid on previous surveys with correlation to dredge campaign locations and volumes.	Local – spatial extent and depth of dredging campaigns; lateral extent of profile changes due to dredging. Ambient – seabed level changes adjacent to channel over the area of impact forecast by the numerical model.
LA2 Mostyn Deep Site 'A' Deposition Area	Before/After each Dredge Campaign	Before/After each Dredge Campaign	Deposition Area (as defined by licence) plus 250m around outside of area perimeter.	Selected cross-section and longitudinal section profiles overlaid on previous surveys.	Local – spatial extent and depth of deposition, spatial extent and depth of any dispersion outside deposition area. Ambient – using EB4 results to assess spread

					of deposition material.
LA3 Mostyn Deep Site 'A' Deposition Area Seabed Samples	Annual (Synchronous with EB4)	Annual (Synchronous with EB4)	Six locations within the deposition area. Four locations outside the deposition area but within Mostyn Deep.	Visual description; Particle size analysis; Comparison with previous PSA data.	Local – change in characteristics of seabed sediment in the deposition area. Ambient – change in characteristics of seabed sediment in Mostyn Deep.
LA4 Cockle Survey – Salisbury/Mostyn Bank (to be supplied by NRW)	Annual	Annual	Within area adjacent to impact forecast by numerical model as shown in Figure 15 of the Mostyn Channel Monitoring Protocols	Reconciliation of data with results of EB1 and LA1.	Local – effect of channel profile on cockle beds. Ambient – effect of channel changes to hydrodynamics on seabed levels in cockle survey area.
LA5 Benthic Survey Salisbury/Mostyn Bank	Twice yearly (Bi-annual)	Twice yearly (Bi-annual)	Within and adjacent to area of impact forecast by numerical model as shown in Figure 15 and defined in Table 'EE' and Annex 'G' of the Mostyn Channel Monitoring Protocols.	Reconciliation of data with results of EB1 and LA1.	Local – effect of channel profile on benthos of flanks. Ambient – effect of channel changes to hydrodynamics on seabed levels in forecast area of impact and on colonising benthos.
LA6 Port area survey and local cockle survey	Before/after each main dredge campaign and at four monthly intervals coincident with LA1.	Before/after each main dredge campaign and at four monthly intervals coincident with LA1.	Northern limit = 382000; Eastern limit = 316500 to 381200; Southern limit = Warwick Point.	Selected cross-section and longitudinal section profiles overlaid on previous surveys with correlation to dredge	Local – effect of channel dredging on the western flank of Salisbury Bank. Ambient – the cockle-abundance of

					campaign locations and volumes.	the western area of Salisbury Bank.
					Reconciliation of data with results of EB1 and LA1.	

This monitoring plan is intended to provide an 'early warning'. Once a significant change in the estuary basis or significant deviation from forecast effects of dredging and deposition is flagged-up, then management (and mitigation, if appropriate) of the change can be enacted.

Monitoring Timetable – Typical Year for dredge up to but not exceeding – 2.0m CD dredge

Task	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EB1				■	■							
EB2	▲			▲					▲			
EB3				■	■							
EB4										■	■	
EB5				■	■							
LA1		□				□				□		
LA2	(As Appropriate)											
LA3										■	■	
LA4	(NRW to provide)											
LA5			■	■					■	■		
LA6	(As Appropriate)											
Progress Reports		○				○				○		
Annual Report											●	

Monitoring Timetable – Typical Year for – 4.0m CD dredge

Task	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EB1				■	■							
EB2	▲		▲	▲		▲		▲		▲		
EB3				■	■					■	■	
EB4										■	■	
EB5				■	■					■	■	
LA1		□		□		□		□		□		□
LA2	(As Appropriate)											
LA3										■	■	
LA4	(NRW to provide)											
LA5			■	■					■	■		
LA6	(As Appropriate)											
Progress Reports		○		○		○		○		○		○
Annual Report											●	

Progress and Annual reports must contain a table of dredge volumes and the dredge depth achieved since the last monitoring period.

Ecological Monitoring (Annex G of the Mostyn Channel Monitoring Protocols, Rev 4.0) - Summary

1. Spring Equinox Sediment and Habitat Surveys (Mostyn Bank and Salisbury Middle): The sediment particle size and the visual habitat characteristics are to be monitored in the vicinity of the inner channel to identify any change in the muddy habitat on the sediment flats. A resolution of 500m by 500m grid sampling is proposed (Figure 2 and Table 1 of the Mostyn Channel Monitoring Protocols). This is ideally to be completed during the spring equinox tides. It is recognised that not all the sites on this grid will be readily accessible because they are subtidal or very low in the tidal frame but the surveyor should survey on as large a tide as is feasible during this equinox period and achieve a good coverage of the sites.

It is recognised that LiDAR surveys will be separately undertaken and, where the tidal elevation, visual habitat composition and or the sediment particle size have been seen to change (in a manner relative to natural variability that could signal an ecological consequence), then subsequent infaunal sampling at such sites will be needed during September of the same year. The scope of the September survey will need to be agreed in consultation with NRW acting on behalf of the Licensing Authority and thus the results need to be turned around by the end of June in each year to allow for a Regulator's view and for the planning of the autumn equinox surveys.

2. Autumn Equinox Sediment and Habitat Surveys (Mostyn Bank and Salisbury Middle): Where, in the spring months, the sedimentary analysis, LiDAR or swathe bathymetry indicate a substantial change (i.e. ones where, with due recognition of natural variability, the changes presage a possible ecological consequences that requires further investigation), then further particle size, infauna samples (and, if needed, measures of other sedimentary parameters) should be taken at these locations to describe the communities that are present and allow the ecological consequence to be understood. Methodology provided in Annex G of the Mostyn Channel Monitoring Protocols, Rev 4.0).

3. Spring and Autumn Equinox Sediment and Habitat Surveys (Holocene Bank Surveys): Record the extent of clay bank that is exposed from the sand. A twice-yearly survey in conjunction with other ecological surveys (ideally timed to coincide with the spring and autumn equinox surveys) and in response to any sand inundation events identified by paragraph 4. Record the presence of piddocks in the clay.

4. Holocene Bank Sand Levels Recording: Frequent observation of the sand levels on the clay bank to be carried out. The means by which this is achieved can be agreed between Port of Mostyn and CCW, but a suggested method is for observations (preferably including a photograph) to be taken from the vicinity of the West Buoy, looking north eastwards across the clay bank, at low water (<2.0mACD tide) at every possible opportunity.

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History and Scope

This is an annex to the schedule of Licence **DML1542**

Maintenance of Navigation – Mostyn Channel Monitoring Protocols, Revision 4.0 dated December 2008 – Summary

Monitoring Objectives:

- a) to monitor the evolution of the estuary and local and ambient effects of the model studies of dredging and deposition on the integrity of the estuary and on the conservation objectives for the SAC (especially those for the 'Estuary' feature which has objectives for spatial distribution of estuarine communities and the extent of notable hard substrata communities and for the 'Mudflats and Sandflats' feature which have objectives for proportions of mud and sandflat communities and the abundance of typical species);
- b) to compare monitoring results with the estuary basis (i.e. the seabed level survey) used for model studies and the forecast effects from those studies of the dredging and deposition and quantify any differences; to assess the significance of such differences and, if necessary, review the forecast of dredge and deposition effects on the integrity of the estuary;
- c) to inform the development of additional mitigation measures that may be required to avoid or reduce adverse impacts on the estuary;
- d) to inform future applications for maintenance of navigation to the port.

Detailed environmental monitoring of the dredging and disposal operations has been undertaken since August 2005. The principle tasks within this monitoring were:

1. Dredged channel survey – monthly
2. Estuary transect survey – monthly
3. Estuary seabed level surveys – annual
4. Salisbury Bank current monitoring – before and after a dredge campaign
5. Biological survey – invertebrates - annual
6. Biological survey – cockles – annual
7. Biological survey – saltmarsh – annual
8. Mostyn Deep seabed level surveys – variable
9. Mostyn Deep sediment sampling – variable

In respect to the continuation and evolution of the monitoring protocols the March 2007 report contained the following recommendations:

- a) To place the dredge channel and flank surveys on to a two monthly interval rather than one month.
- b) To place the estuary transect surveys on to a two monthly interval rather than one month.
- c) To carry out a swathe bathymetry survey of Mostyn Deep and the depositions area in late April/early May of each year deposition takes place
- d) To alter the number of sample sites for the benthic communities assessment and the procedure for saltmarsh habitat assessment as set down in the ABPmer report (April 2008 – SMP Monitoring, 2008a).
- e) To ensure that LiDAR survey and swathe bathymetry surveys are coordinated in time and extent and take place in late April/May each year.
- f) To move any future consent termination date to November so that a monitoring report can be prepared in advance using the April / May surveys of that year referred to above.

The Environmental Statement (ERM 2007) contains a further recommendation of:

- An annual re-run of the numerical model using updated bathymetry to assess natural process change in the estuary.

The April 2008 monitoring report also included recommendations for:

- An agreed set of 'early warning' parameters of significant estuary evolutionary change in respect of forecast dredging and deposition effects (see Figure 16 of the Mostyn Channel Monitoring Protocols).

Listed are the relevant key interest features and their conservation objectives considered in the appropriate assessment. Appropriate monitoring requirements are listed (in parenthesis) against the favourable condition criteria.

1) SPA features and conservation objectives

The following SPA features need to be considered: Internationally important wintering populations of oystercatcher and knot.

The conservation objectives describe two supporting habitat attributes that should be monitored for impacts of dredging and disposal:

The feature will be considered in favourable condition when, subject to natural variation, the following conditions are met:

1. The extent of intertidal flats and spatial distribution of their constituent sediment community types is maintained. (**Tasks EB1, EB2, EB3, EB4**)
2. The abundance and dispersal of prey species are maintained at levels sufficient to support the population size. (**Task LA4, LA5, LA6**)

The above conditions also contribute to the conservation objective to maintain bird numbers. Bird numbers on the Dee Estuary are monitored annually by the Wetland Bird Survey (WeBS), but detailed bird monitoring in the vicinity of the channel is not required. Fine-scale bird distribution is subject to factors elsewhere in the estuary, as well as external factors. The SPA monitoring programme is therefore built around direct measurement of habitat extent and quality.

2) SAC features

Interest feature 1: The conservation objective for the estuary

The conservation objective for the "estuaries" feature of the Dee Estuary SAC is to maintain the feature in favourable condition, as defined below:

The "**estuaries**" feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:

- i. the aggregate total extent of all estuarine communities within the site is maintained;(**Tasks EB1, EB3, LA4, LA5, LA6**)
- ii. the spatial distribution of estuarine communities within the site is maintained;(**Tasks LA4, LA5, LA6**)
- iii. the extent of individual estuarine habitat features within the site is maintained;(**Tasks EB5, LA4, LA5, LA6**)

Interest feature 2: The conservation objective for mudflats and sandflats not covered by seawater at low tide

The conservation objective for the "mudflats and sandflats" feature of the Dee Estuary SAC is to maintain the feature in favourable condition, as defined below:

The "**mudflats and sandflats**" feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:

- i. the total extent of mudflat and sandflat communities within the site is maintained; (**Tasks EB1, EB2, EB3**)
- ii. the proportions of individual mudflat and sandflat communities within the site are maintained;(**Tasks EB1, EB3, LA4, LA5, LA6**)

- iii. the topography of the intertidal flats and the dynamic processes of channel migration and sinuosity across the flats are maintained;(Tasks EB1, EB2, EB3)
- iv. the abundance of typical species of the mudflat and sandflat feature within the site is maintained. (Tasks LA4, LA5, LA6)

Interest feature 3: The conservation objective for *Salicornia* and other annuals colonising mud and sand

The conservation objective for the “*Salicornia* and other annuals colonising mud and sand” feature of the Dee Estuary SAC is to maintain the feature in favourable condition, as defined below:

The “*Salicornia* and other annuals colonising mud and sand” feature will be considered to be in favourable condition when each of the following conditions (i) to (v) are met:

- i. the total extent of pioneer saltmarsh vegetation communities within the site is maintained (partly by Task EB1);
- ii. the presence of pioneer saltmarsh vegetation communities as part of transitions from intertidal sediment communities to higher saltmarsh is maintained;
- iii. the abundance of the typical species of the pioneer saltmarsh vegetation communities is maintained;
- iv. the abundance of the notable species of the pioneer saltmarsh vegetation communities is maintained;
- v. the overall extent and abundance of common cord grass *Spartina anglica* is not increasing within the pioneer saltmarsh zone.

Interest feature 4: The conservation objective for Atlantic salt meadow

The conservation objective for the “Atlantic salt meadow” feature of the Dee Estuary SAC is to maintain the feature in favourable condition, as defined below:

The “Atlantic salt meadow” feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:

- i.the total extent of Atlantic salt meadow vegetation communities within the site is maintained (partly by Task EB1);
- ii.the proportions of individual Atlantic salt meadow vegetation communities within the site are maintained;
- iii.the zonation of Atlantic salt meadow vegetation communities and their transitions to fresh water and terrestrial vegetation is maintained;
- iv.the relative abundance of the typical species of the Atlantic salt meadow vegetation communities is maintained;
- v.the abundance of the notable species of the Atlantic salt meadow vegetation communities is maintained.

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MARINE AND COASTAL ACCESS ACT (2009). REQUEST TO REVIEW THE 2014 ANNUAL MONITORING REPORT FOR THE PORT OF MOSTYN

Reference Number: 12/38/ML-1

From: Jemma-Anne Lonsdale
Cefas, Lowestoft Laboratory
Date: 16th June 2016
Tel: 01502 524491
E-mail: jemma.lonsdale@cefass.co.uk

To: Zoe McMellin - NRW (by e-mail)

1. With reference to the above application and your request for comments dated 25th May 2016.
2. The following monitoring report has been reviewed alongside previous advice provided by Cefas:
The Port of Mostyn Limited, Maintenance of Navigation Annual Monitoring Report December 2015.ref no.?
3. In providing these comments I have sought the views of colleagues internally with expert knowledge in benthic ecology and coastal processes.

Introduction

4. Before a licence was issued for these works studies were undertaken by the Port of Mostyn to understand whether the evolution of the estuary, in particular the more recent geomorphological trends, would be affected by dredging of the channel and disposing of the material at Mostyn Deep (IS102) disposal site. The conclusions were that the dredged channel resulted in some increased flow energy using the Salisbury Bank cross-channel, although this was not deemed to be significant. It was also deemed that the use of the deposition area would not result in shallowing of Mostyn Deep provided that an annual capacity was observed. Since the consent was granted in 2005, monitoring carried out until 2012 has shown that: the Salisbury Bank cross-channel has closed; the new low water channel that opened in 2004/5 is still present; the Holocene clay bank is still exposed and its south-western flank is being eroded; the Mid-Hoyle continues to migrate slowly eastwards.

Comments

Benthic Ecology

5. Regarding the survey of Mostyn Bank and Salisbury Middle, a number (26) of (repeat) stations were sampled for sediment particle size by taking scrapes of the surficial sediments. These sediments were then processed for full particle size analysis (PSA). The rationale behind the survey being that any station showing a significant change from the previous year will be selected for an ecological-based assessment the following autumn (i.e., involving assessment of the invertebrate fauna).
6. The report does not state exactly how the location of the sample sites was determined, while the GPS will allow one to return to the same station, it is difficult to take a random sample that is not biased by the surveyor on intertidal habitats unless taken 'blind'. Surveyor are more likely to take samples from drier regions if there are areas of standing water, which means this



no longer becomes a random sample. This issue is important given that no replication is undertaken. I would recommend in future, sediment scrapes from 3 or 4 locations at the station are pooled to provide a better estimate of the sediments at the station, this may already occur, however this level of detail is not presented in the report.

7. The sampling and layout of stations appears fundamentally sound in principle, however, a much clearer rationale regarding how decisions are made as to whether a change in PSA should entail subsequent biological monitoring is needed. Currently, the outcomes of PSA monitoring of the 26 sampling stations during the Spring is descriptive, and while it is useful to describe that a station has increased silt/clay content from a previous year (for example), the relationships between the magnitude of change in PSA with actual ecological significance is not known. This lack of transparency regarding a criterion for station faunal re-sampling compromises the whole Spring monitoring programme and limits its ability to meet the aims. This is demonstrated at B6 where the report states “*Silt content at Site B6 in 2015 (5%) was lower than the levels recorded in recent surveys (approximately 20-30%). However, observations suggest that the site has remained flat muddy sand habitat with abundant L. conchilega, S. plana and C. edule observed.*” Where is it documented that a decrease in silt/clay content of 15-25% from previous years does not trigger subsequent re-sampling for fauna the following autumn? The text referring to the species present (*L. conchilega, S. plana* etc.) does nothing to clarify this situation as it has been stated that the rationale for the decision is based on PSA.
8. In consequence, one is not in a position to refute decisions taken as to whether any station should be sampled for the biology in the subsequent autumn as there is no measure of the magnitude of change in PSA that would trigger re-sampling for fauna.
9. Therefore conclusions of the benthic monitoring undertaken in Spring 2015 are difficult to review i.e. “*In view of these findings, it is not recommended that any of these sites are revisited for biological sampling in the Autumn this year*” as I do not know how large a change is either required to trigger this or is ecologically important.
10. Regarding the Holocene Clay Bank, the results appear to indicate that the trend recently observed for the bank to become covered in sand has continued, to the extent that in 2015 it was completely covered with no clay exposed.

Coastal Processes

11. The monitoring objectives are clearly stated in section 1.0, page 1 (and again in 4.0, page 11).

The monitoring objectives are:

(i) To monitor the evolution of the estuary and local and ambient effects of the model studies of dredging and deposition on the integrity of the estuary and on the conservation objectives for the cSAC (especially those for the ‘Estuary’ Feature which has objectives for spatial distribution of estuarine communities and the extent of notable hard substrata communities and for the ‘Mudflats and Sandflats’ feature which have objectives for proportions of mud and sandflat communities and the abundance of typical species);

(ii) to compare monitoring results with the estuary basis (i.e. the seabed level survey) used for model studies and the forecast effects from those studies of the dredging and deposition and quantify any differences; to assess the significance of such differences and, if necessary, review the forecast of dredge and deposition effects on the integrity of the estuary;

(iii) to inform the development of additional mitigation measures that may be required to avoid or reduce adverse impacts on the estuary;

(iv) to inform future applications for maintenance of navigation to the Port.

12. The survey specifications are appropriate for addressing the monitoring objectives, however as stated in previous advice I consider the report would benefit more a more detailed description of the specifications to increase transparency and confidence in the results.
13. The survey specifications are briefly described in the report (Table A and B, pages 2 and 3) but detailed specifications are not presented. Annex H contains a brief description of the survey specifications (section 2, pages 17 to 18), but detailed survey specifications are not provided. Such specifications were requested in 2015. The purpose of requesting more detailed survey specifications is to support the level of confidence in the assessments arising from the survey findings. Survey specifications should include (but not be limited to) information such as: how were horizontal and vertical positioning accuracy achieved? Were positioning errors quantified? What checks on positional accuracy were carried out? How were tidal reductions achieved? What calibration checks were carried out on survey equipment? Were the surveys conducted to any recognised standards (such as IHO standards for hydrographic surveys)?
14. Each piece of monitoring should be continued. This follows the recommendations in Annex H (3.6, page 25 and 4.1.2, page 27) that the sediment sampling at all locations continues in 2016, and that monitoring tidal energy balance between the Welsh and Hilbre Channels continue (5.0, page 25).
15. I do not recommend any further monitoring is required in addition to the existing programme, however an alternative approach that should be considered is the use of a multibeam echosounder in place of the currently employed singlebeam echosounder to assess changes in the dredged channel. The reason for suggesting this change is to overcome the limitations of singlebeam echosounders when measuring bathymetry in areas with steep slopes (as described in 4.0, page 15). The use of a multibeam echosounder would reduce the likelihood of survey error, allowing changes in the morphology of the channel to be more accurately monitored.
16. Over the period 2005 to 2013 the bathymetric monitoring has shown that:
 - the Salisbury Bank cross-channel has effectively closed;
 - the new low water channel that opened-up in 2004/5 persists to present;
 - the Holocene clay bank remained exposed and erosion continued along its south-western flank from 2005 to 2012;
 - the easterly migration of Mid-Hoyle continues but slowly. (4.0, page 13).
17. The general overview of the navigation channel and its eastward flank suggests that the bank and channel system has changed little since dredging commenced (4.0, page 16). Annual depth changes in Area 1 (showing natural changes) are 200mm or less and the maximum change observed over a five-year period is less than 250mm. In Area 2 the patterns of change are similar indicating that natural processes dominate seabed behaviour and the effects of dredging are small (4.0. page 18).
18. Natural changes continue to occur, notably:
 - Mid-Hoyle channel easterly migration is slow;

- Erosion of the clay bank in mid-estuary continues along its Welsh channel flank but the bank was covered in sand again in 2015 continuing from 2013, having previously been exposed clay since 2007;
 - New channel development is in evidence along the eastern flank of Salisbury Bank and the Hilbre Channel has moved westward to effectively strengthen its link with its course further downstream and to utilise the new central estuary channel established in 2004/5 and diminish flows in the older central estuary channel located further to the east. (5.0, page 24)
19. These changes are not considered to be the result of dredging given the fact that the dredging in the navigation channel has been well below consented volumes.
20. The use of a multibeam rather than singlebeam echosounder should be considered for the channel surveys, as discussed above.
21. The report makes a number of recommendations (6.0, page 28).
- I. The Annual Monitoring Report for 2015 is accepted.
 - II. The investigation of bathymetric changes by incorporating newly acquired bathymetric data into the strategic Irish Sea model to allow updating of estuary model boundary data should be carried out and presented in the next annual report, as suggested.
 - III. relates to cockle survey arrangements and lies outside my area of expertise.
 - IV. suggests reducing the frequency of surveys in tasks LA1 and EB2 from six surveys per annum to four. The rationale for this reduction is accepted and I have no objection to this change to the monitoring programme.
 - V.) suggests reducing the frequency of surveys in task EB1 from annually to biennially. It is my belief that this change should not be made and that the LiDAR/swathe survey interval should remain annual. The reason for this is to maintain a clear picture of changes occurring in the system which is, as shown by the monitoring conducted, dynamic.

Summary

22. For benthic ecology, the monitoring report does not indicate exactly how the location of the sediment sample sites were determined. Currently, the outcomes of PSA monitoring during the Spring is descriptive, and while useful to describe that a station has increased silt/clay content from a previous year (for example), the relationships between the magnitude of change in PSA with actual ecological significance is not known. This lack of transparency regarding a criterion for station faunal re-sampling compromises the Spring monitoring programme and limits its ability to meet the aims.
23. For coastal processes, the survey specifications are appropriate for addressing the monitoring objectives, however as stated in previous advice I consider the report would benefit more a more detailed description of the specifications to increase transparency and confidence in the results. The applicant has considered the use of a multibeam echosounder in place of singlebeam echosounder in future monitoring campaigns to assess changes in the dredged channel

Minor Presentational Comments

24. Given the complexity of the monitoring carried out the inclusion of a chart showing the locations of the monitoring tasks, labelled with their designations (e.g. EB1, LA1 etc.) would aid the reviewer with an overview of the monitoring presented.

Should you wish to discuss any aspect of this minute please do not hesitate to contact me.

Jemma-Anne Lonsdale
Marine Environmental Impact Assessor

<i>Quality Check</i>	<i>Date</i>
A.Birchenough	16/06/2016

From: [McMellin, Zoe](#)
To: [Jim OToole](#)
Cc: [Fiona Wynne-Jones](#); dr_barber@btconnect.com
Subject: 12/38/ML/1 / DML1542 Annual Report response

Good Morning Jim, I have a response from our Technical colleagues and Cefas regarding PoM Annual report 2015.

NRW Technical Experts

Ecological

With respect to the ecological features of the site the 2014/15 Annual Monitoring Report does not offer any new information over and above what we have already reviewed in the bi-monthly reports. We wish to re-iterate the comments that we have made for the bi-monthly reports about the survey area needing to be shifted westwards to better cover the erosion on Mostyn Bank. We are currently awaiting a response from the Licence Holder on this point.

Ecological – Commercial Cockle Beds

NRW have supplied cockle survey data to the Licence Holder for inclusion in this Annual Report.

The dredging work undertaken by the Licence Holder is an emotive subject with cockle licencees, as they insist the decline of the Salisbury Bed is linked with the dredging programme. It is fair to say that certainly over the last 6 years, the substrate has changed, possibly contributing to a large decline in cockle stocks. The bed itself is getting smaller with the downstream boundary moving slowly upstream. Whether the change in substrate, decline in stock and bed movement is linked to the dredging programme is unknown.

References are made to EAW with regard to the cockle monitoring, we advise that this should be amended to read NRW in the next report.

Geomorphological

1. There was no hydraulic modelling undertaken for 2014 as previously commented upon, however this has been re-instated in the 2015 report. The hydraulic modelling is primarily associated with monitoring parameter EB1. The justification was that minimal dredging was undertaken during 2014, however less has been undertaken this year. The report recommends the modelling and bathymetry is reduced to every two years. NRW recommends that the monitoring is kept in accordance with newly issued Marine Licence DML1542.

2. With regard to the recommendations made in section 6.0 of the report (pages 28 / 29) we have the following recommendations to make from a geomorphological perspective:

- Point (ii): We agree with the commitment to *'to investigate bathymetry changes outside the estuary numerical models downstream to allow updating model boundary data'*.
- Point (iv): Any agreed reduction in monitoring frequency for the -2m CD dredge has been documented in the amended dredging licence DML 1542. If dredging activity were to increase beyond -2m CD the original monitoring protocol would need to be followed (again see dredging licence DML 1542).
- Point (v): We advise that whilst there remains a possibility of a -4m CD dredge, the monitoring undertaken under task EB1 should continue on a yearly basis.

3. In our comments on the 2013/14 Annual Monitoring Report we stated that:

'There were changes shown through the bathymetry of significant level differences and in particular increase in sediment volumes within the estuary during 2014. Of interest is an increase of sediment levels in intertidal areas and decrease in subtidal areas. Although it is not mentioned in the report, I would hypothesise this is due to the Winter 2013/14 storms, where we saw large beach losses along the North Wales coast.'

It can be seen in the current report that the sediment flux levels have reduced through 2014-15, and therefore, what was seen in 2013-14 was likely due to the large storms seen during that time.

4. To summarise, there were 3 dredge campaigns during the monitoring period 2014-15 totalling a removal of:

Channel: 95,552m³

Harbour: 8,083m³

Compared to 4 dredge campaign in 2013-2014 as below:

Channel: 106,796m³

Harbour: 39,479m³

In conclusion, there have been changes in the estuary over the monitoring period, however, this is likely to be predominately due to natural processes.

Summarised comments from Cefas regards the Annual report:

"We agree with recommendation (ii) in Section 6.0 of the report to investigate bathymetry changes outside the estuary numerical models downstream to allow updating model boundary data for the next annual report. Furthermore we would recommend the whole monitoring area, approach and methodology be reviewed given over 10 years of baseline data, changes in channel positions and advances in modelling.

1. The report makes a number of recommendations (6.0, page 28).

I. The Annual Monitoring Report for 2015 is accepted.

II. The investigation of bathymetric changes by incorporating newly acquired bathymetric data into the strategic Irish Sea model to allow updating of estuary model boundary data should be carried out and presented in the next annual report, as suggested.

III. relates to cockle survey arrangements and lies outside my area of expertise.

IV. suggests reducing the frequency of surveys in tasks LA1 and EB2 from six surveys per annum to four. The rationale for this reduction is accepted and I have no objection to this change to the monitoring programme.

V.) suggests reducing the frequency of surveys in task EB1 from annually to biennially. It is my belief that this change should not be made and that the LiDAR/swathe survey interval should remain annual. The reason for this is to maintain a clear picture of changes occurring in the system which is, as shown by the monitoring conducted, dynamic.

Summary

2. For benthic ecology, the monitoring report does not indicate exactly how the location of the sediment sample sites were determined. Currently, the outcomes of PSA monitoring during the Spring is descriptive, and while useful to describe that a station has increased silt/clay content from a previous year (for example), the relationships between the magnitude of change in PSA with actual ecological significance is not known. This lack of transparency regarding a criterion for station faunal re-sampling compromises the Spring monitoring

programme and limits its ability to meet the aims.

3. For coastal processes, the survey specifications are appropriate for addressing the monitoring objectives, however as stated in previous advice I consider the report would benefit more a more detailed description of the specifications to increase transparency and confidence in the results. The applicant has considered the use of a multibeam echosounder in place of singlebeam echosounder in future monitoring campaigns to assess changes in the dredged channel

Minor Presentational Comments

4. Given the complexity of the monitoring carried out the inclusion of a chart showing the locations of the monitoring tasks, labelled with their designations (e.g. EB1, LA1 etc.) would aid the reviewer with an overview of the monitoring presented.”

I anticipate these responses will provide clarification on future requirements and may assist in producing the scoping document for the 10 year review of monitoring data.

Kind regards

Zoe McMellin

Trwyddedu Môrol / Marine Licensing

Gwasanaeth Trwyddedu / Permitting Service

Cyfoeth Naturiol Cymru / Natural Resources Wales

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From: [McMellin, Zoe](#)
To: [Jim OToole](#); [Colin R Scott](#)
Cc: [Fiona Wynne-Jones](#); [Rowlands, Delyth](#)
Subject: DML1542 Scoping proposal comments
Date: 02 August 2016 11:11:30

Good morning in line with conditions 9.5 and 9.6 of Marine Licence DML1542 and In response to the submission of the scoping proposal submitted on 11 July 2016 the following comments have been provided by NRW Technical Experts:

The overall proposal appears satisfactory, **and assuming that NRW is able to have a four week period to review**, there should be no problems in providing comments on the report in time for a meeting with ABPmer / Dr Barber in October / November.

We advise that the following points should be addressed within the monitoring review:

- The modelling, which has not been mentioned in the proposal, should be included in the monitoring review scope. There have been many advances in the past 11 years and we wish to ensure that the model used is still fit for purpose.
- We recommend that a review of how the monitoring work is presented should be undertaken. There is an opportunity here to make the presentation of data a bit clearer, particularly the transect data which can be difficult to follow. It would also be useful if dredge / disposal volumes and locations could be included in future monitoring reports.
- As suggested in section 2.2.5 of the proposal we recommend that the -4m dredge and the -2m dredge review are discussed separately for clarity.
- The pros and cons of keeping the long-term data set versus adopting more modern techniques i.e. multi or single beam bathymetry should be considered.

It may be beneficial to have a telecon / meeting at the beginning of September to discuss the progression of the review to ensure all that has been proposed is included, provide any clarification on NRW requirements and to ensure the monitoring review is not selective. Dr Barber raised a concern regards what would happen should NRW disagree with the outcomes of the monitoring review. Although ABPmer / Dr Barber propose to remain impartial, this may be difficult in practice as they are in effect reviewing their own work. Something we can discuss at the telecon. Please advise of your availability week beginning 5 September 2016.

Kind regards

Zoe McMellin
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From: [McMellin, Zoe](#)
To: [Colin Scott](#); [Jim OToole](#)
Cc: [Brazier, Paul](#); [Litt, Emmer](#); [Rowlands, Delyth](#)
Subject: Meeting notes
Date: 28 September 2016 09:30:09

Sorry I thought this left my outbox yesterday.

Please find some brief notes on our telecon yesterday. Thank you for your time.

Behind the time with regard to review production.

CS has a meeting with Phil Barber (12/10) regards identifying all the monitoring undertaken to date and the tasks to complete.

CS expecting to update us as he goes along but prepare one final document for review.

JOT raised the question regards reducing monitoring further as -2m is never exceeded. JOT proposed moving the Lidar and numerical modelling to every 2nd year.

EL advised while the option to dredge to -4m remains then the necessity to monitor in line with current -2m regime remains – unless evidence produced in the review suggests this is no longer necessary.

EL advised to use comments from annual reports both from NRW and Cefas in addition to the comments made on the review scope sent early August.

ZM advised that historical records of annual review comments may be difficult to obtain although those that will be of most use will be those recent comments.

PB suggested reviewing the geophysical and ecological results in succession – what do the results show in terms of habitat mapping?

EM would like the reviews to clearly indicate when dredging has been undertaken and the quantity dredged – to view cause and effect.

EL advised to be aware of the pitfalls when using drones for survey work.

CS considered it remiss to ignore new technology but may use with caution where appropriate.

CS advised that it would not only be himself and PB reviewing their own data. More people will be involved in the review to provide impartiality.

EL suggesting reviewing the modelling data against the bathymetry data to ascertain how accurate historical models have been.

EL advised that changing bathymetry monitoring methods may lose the consistency of the data already obtained. (single beam to multi beam bathymetry).

JOT advised that he was expecting the review of the monitoring data to be submitted in early December. (NRW will consider in four weeks. We need to be conscious of the Xmas leave period. Most people will be off for a large part of the two weeks beginning the 19th December – need to ensure that NRW advisory have a full four weeks to look at the report).

ZM reiterated the requirement to direct queries regarding the review to the Technical Experts through the Marine Licensing Team.

Kind regards

Zoe McMellin

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From: [McMellin, Zoe](#)
To: [Jim OToole](#); [Fiona Wynne-Jones](#)
Cc: [Colin Scott](#); dr_barber@btconnect.com
Subject: BI-MONTHLY PROGRESS MONITORING REPORT NO. 44
Date: 05 October 2016 09:34:53

Good Morning Just a few minor comments points regards the latest bi monthly report from the technical advisors:

1. Annex III provides information on the dredge campaign, however, there are no units associated with the data presented. We recommend that this is amended in future reports for clarity.
2. Please could clarification be provided as to the meaning of 'single', 'double' and 'triple' on page 2 of Annex III.
3. Could a simple map be provided to demonstrate where the 'channel' and 'harbour' are?

Kind regards

Zoe McMellin
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B Port Dredge Campaigns 2002 to 2015

Table B1. Volume of dredge arisings (m³) from the Approach Channel and harbour since 2002

Dredge Campaign Reference	Date	Approach Channel (m ³)	Harbour Area (m ³)	Buoy Locations for Approach Channel Dredge
Not specified	Jan/Mar 2002	23,406		Not specified
Not specified	Feb/Mar 2003	121,148	54,947	Not specified
Not specified	Jun/Jul 2003	174,955		Not specified
Not specified	Dec 2003	20,970	8,266	Not specified
Not specified	Sep/Oct/Nov 2005	147,482*		Not specified
Not specified	Feb/Mar 2006	82,440*		M2,M4
Not specified	Jun 2006	22,000*		M2,M3
Not specified	Feb/Mar 2007	48,322	44,268	M3
Not specified	Jan 2008	39,754		M3, M6, M4
A09 (10/69/F)	Jul/Aug 2009	82,647	6,828	M3, M5
B10 (10/69/F)	Apr/May 2010	160,000		M2, M3, M6
B10A (10/69/F)	Jul 2010	50,008	8300	M3, M6
C10 (10/69/F)	Sep 2010	89,879	10,258	M3, M6
D10 (10/69/F)	Nov 2010	34,104	14,574	M3, M6
A11 (10/69/F)	Apr 2011	71,783	15,595	M3, M6
B11 (10/69/F)	Jun 2011	32,732	7,436	M3, M6
C11 (10/69/F)	Aug 2011	40,104	11,011	M3, M6
A13 (10/69/F)	Feb/Mar 2013	89,110	40,313	M3, M6
A13 (12/38/ML)	Apr 2013	41,979	23,236	M3, M6
B13 (12/38/ML)	Jun 2013	18,317	14,703	M3, M6
C13 (12/38/ML)	Aug 2013	13,173	13,636	M3, M6
D13 (12/38/ML)	Oct 2013	18,181	12,279	M3, M6
E13 (12/38/ML)	Dec 2013	34,593	11,540	M3, M6
A14 (12/38/ML)	Feb 2014	23,771	9,850	M3, M6
B14 (12/38/ML)	Jul 2014	18,483	14,450	M3, M6
C14a (12/38/ML)	Oct 2014	29,949	3,639	M3, M6
C14b (12/38/ML)	Nov 2014	30,616	4,444	M3, M6
A15 (12/38/ML)	Mar 2015	34,987		M3

*No distinction between channel or harbour provided

Source SMP, 2015 and data provided by the Port of Mostyn

C Approach Channel Area (LA1) Changes

To examine changes in and around the Approach Channel in greater detail, the results of the bathymetric surveys (as available from 2009) were reviewed further. They were used to describe the rates of 'thalweg' (line of deepest depth that marks out the channel alignment) migration and depth change. This analysis is based on an interrogation of the transect plots that are shown in Figures 5 and 6 of the main report. The results are presented in Table C1.

Table C1. Migration of Approach Channel February 2009 to October 2016

Transect No	Distance (m)	Depth (m)	Rate of Migration (m/yr)	Rate of Depth Change (m/yr)
1*	19	-0.65	2.5	-0.08
2	186	-0.6	24	-0.08
3	290	-1.35	38	-0.13
Mostyn Bank (2.5 m above CD)				
1**	74	-	9.5	-
2	148	-	19	-
3	271	-	35.5	-
Positive values indicate westward movement when referring to channel alignment channel or a deepening when referring to depth.				
* A turning point is evident 2013/14 – maximum western extent 2013 at <i>circa</i> 30 m. Maximum depth 2.75 m below CD (0.85 deeper than 2009).				
** Mostyn Bank shows continuous west migration above 1 m above CD but eastward movement after October 2014 below.				

Table C1 shows the rates at which the Approach Channel has migrated in the generally westerly direction between 2009 and 2016. In the north (Transect 1) towards the outer most part of the channel, the thalweg has moved west at an average rate of 2.5 m/year. Average rates increase in a southerly direction to about 35.5 m/year at Transect 3. At the same time the maximum depths have reduced at an average rate of around 0.08 m/year in the north and faster at 0.13 m/year to the south.

The rate of erosion into Mostyn Bank at the level of 2.5 m above CD has been faster than the thalweg change in the north but slower (10-20%) than the corresponding change to the south. The greatest migration is in the approximate area of Transect 3 (Figure 6) where 271 m of horizontal erosion of Mostyn Bank occurred between February 2009 and October 2016. Throughout this period of migration, the channel width (as recorded about 1 m above CD) has remained relatively constant at around 140 m, showing that erosion of Mostyn Bank has been 'offset' by accretion of the intertidal to the east.

From the data in Table C1 and the plots in Figure 5 there is, possibly, some small evidence of a 'turning point' in the overall trend at the north end of the channel (Transect 1), with a change to eastward migration and shallowing of the channel/thalweg since 2013/14. Accretion on the lower levels (below 1 m above CD, close to MLWS i.e. the subtidal) of the edge of Mostyn Bank is evident post 2014. The higher intertidal elevations however were still eroding in October 2016. There is no similar evidence of a 'turning point' at the more southerly transects.

Figures 5 and 6 also show the 'remnants' of the 2001 capital dredged channel. The plot shows continual accretion has occurred, emanating from the northern end during the survey period. For the most part the orientation of the channel has not substantially changed, but has infilled.

Greater change is evident in the other channels to the east of the main Approach Channel. During the survey period a shallow 'Inlet Channel' (Location A) on Figure 5 has become marginally deeper and has 'penetrated' through the sand bank in a south-east direction. At the same time this north to south oriented channel (which was around 1 m below CD in 2010) substantially shallowed (over 2 m in 3 years) and moved eastwards. Around 2013/14 the thalweg again began to deepen whilst still migrating eastwards and southwards. In 2015 and 2016 a distinct channel, moving eastwards, with a depth of around Chart Datum becomes evident. This 'Eastern Channel' (Location B on Figure 5) connects Mostyn Deep and the scour area around the end of the Mostyn Breakwater.

In between the Approach Channel and the Eastern Channel, the top of the bank at Transect 1 (Figure 5) has remained relatively stable at around 2 m above CD. The central area at Transect 2 (Figure 5) has generally lowered and flattened/widened (4 m to 3.5 m above CD). The southern section however has generally, and consistently, accreted to the highest level of *circa* 4.5 m above CD, albeit rates of change have slowed greatly since *circa* 2013. The plot also shows at this location the western edge, where it formed the edge of the 2001 dredged channel has been relatively stable, whereas the channel to the east of the bank has infilled and migrated further east.

Further insight to the changes that have occurred is provided by Transect 4 (Figure 6), which is a longitudinal profile along the area of the Eastern Channel. This indicates that from 2010 to about 2013/2014 this channel was generally deepening along its length, with depth increases of the order of 2 m. Since, however, the general trend has been for accretion which would appear to have started in the central deeper section and progressed north and south, with the main channel deepening to the east of the longitudinal profile.

Overall, during the period of monitoring since 2009 distinct morphological change has occurred in the Approach Channel survey area. Generally the Approach Channel has migrated westwards, rotating about a location just to the north of the start of Transect 1, eroding into the edge of Mostyn Bank by a greater distance in a southerly direction. As the channel has moved it has been necessary to adjust the position of the navigation buoys which mark the main channel. The changing location of these buoys (and therefore the defined channel) is illustrated in Figure 7 of the main report.

The Approach Channel has generally shallowed during the period despite the relatively low level of maintenance dredging. Overall the width of the channel has remained relatively stable due to accretion down the side slope from the bank to the east. To the west of this bank the accretion is also evident 'pushing' the north south channel (Eastern Channel) to the east. A channel running north west – south east has cut through since *circa* 2014 augmenting the flood flow at the southern end helping create further erosion and deviating the channel slightly further east at the southern end.

During the survey period the bank between the two channels has increased in volume by widening on both sides and accreting in height particularly to the south. There is evidence from both channels that a 'turning point' in this current morphological evolution has occurred around 2013/14 particularly in the north of the area. This change is less evident to the south and may not have started by the 2016 survey.

The changes in bathymetry monitored do not seem to be influenced by the current dredging regime, or if they are the effect is small with respect to the natural variation occurring and may be helping slow the natural migration by reducing flow speeds by maintaining slightly deeper depths. The remnants of the 2001 capital dredge are still evident albeit have continued to infill over time and would not appear to be influencing the current morphological change. Should a 'turning point' have occurred the opening of the Eastern Channel would have potentially reduced the bulk flow through the existing Approach Channel. It is therefore possible that this could infill, whilst the straighter

Eastern Channel further develops. Should this occur the current maintenance dredge requirement is likely to increase and the erosion of the edge of Mostyn Bank is likely to reduce.

Detailed analysis of similar data going back to 2001 and before would be needed to determine the actual influence the channel had on the morphology, in order to try and estimate what a similar dredge to 4 m below CD would have done should this be required in the future [from page 15 original text]. The monitoring undertaken to date does suggest the area is a small self-contained sub system of the estuary, however this will need to be confirmed to see if there is any correlation of changes in other areas that could be linked.

D Outline of Port of Mostyn LiDAR Data

Table D1. Review of the Lidar datasets examined fir this review

Year	Data Format	Extent	Resolution
2016	Held in .asc format and provided as DSM and DTM. Each of these are made up of 507 individual .asc files. We were also provided with shaded relief images of the data, and a .dxf file of contours derived from the LiDAR.	Most of the Dee. The extent had been clipped to the edge of the estuary	1 m
2015	Held in .asc format over a total of 115 individual files. Over half of these files are 'DSM' rather than 'DTM'. This means vegetation hasn't been removed which is not an issue for most intertidal areas but can give incorrect elevations for more terrestrial areas.	South-East section of the Dee, around Flint. Also N section of the Dee, around West Kirby Beach	Some 1 m and some 0.5 m. To have a single surface we had to use 1 m.
2013	Held in .asc format over a total of 148 individual files.	Most of the Dee Estuary	1 m
2012	No data held. Only contains a survey report.	-	-
2011	Held in .asc format over a total of 248 individual files.	Most of the Dee Estuary	1 m
2010	Data held in .csv format. This can be plotted as points but due to the spacing between points the best resolution we can derive is 10 m.	4 km around the port	10 m
2009	Data held as a point shapefile. This can be converted to a raster using the resolution that the points are spaced at, which is 1 m.	1.5 km around the port	1 m
2007	Data held in 'D_Ascii' and 'V_Ascii' format. Unclear which is filtered and unfiltered so both have been mosaicked to examine differences. Each comprised of 58 files.	Most of the Dee Estuary	1 m
2006	Grid file of the LiDAR information around the port. Also contains .csv files. Unclear whether the grid file was created from the csv or the other way around.	Extends around 1.5 km from the port.	1 m

E Stage 1 and Stage 11 Threshold Criteria

Table E1. Outline of threshold criteria for Mostyn Monitoring programme

Task	Stage I Thresholds	Stage II Threshold Criteria
LA1 Dredged Channel Survey	<ul style="list-style-type: none"> ▪ Channel Flank – elevation change exceeding 1 m ▪ Direct Impact Corridor-width change exceeding 100 m 	Increases in seabed level within the ambient areas defined for dredging and deposition above forecast, not reflected outside these areas in general estuary behaviour or seabed level changes outside the 300 m wide dredged central corridor not reflected in general estuary changes in the area.
LA2 Mostyn Deep Site 'A' Deposition Area	No threshold defined.	No threshold defined.
LA3 Mostyn Deep Site 'A' Deposition Area Seabed Samples	Particle size distribution change based on the changing balance between D15, D50, and D85 values.	Non-dispersion of deposited sediments from Site 'A' over a six month period;
LA4 Cockle Survey – Salisbury/Mostyn Bank	Any significant change over a twelve-month period not reflected outside the forecast area of dredged channel ambient impact.	No specific parameter defined change considered in context of cockling intensity and wider physical change.
LA5 Benthic Survey Salisbury/Mostyn Bank	Any significant change over a twelve-month period not reflected outside the forecast area of dredged channel ambient impact.	No specific parameter defined although change assessed in the context of wider estuarine physical change.
EB1 LiDAR/Swathe Survey of seabed levels	Not applicable in progress reports since the model results will be subject to detailed assessment as a normal course within the annual monitoring report and thereby provide a culmination of the year's monitoring. There is no Stage I threshold for Task EB1 but in the event of the model results showing any significant increase in dredge and/or deposition impact then a Stage II condition would immediately apply and be presented in the annual report.	<ul style="list-style-type: none"> ▪ Lateral shifting of the location and relative location of Hilbre and Welsh channels. ▪ Re-opening of the Salisbury Bank cross-channel. ▪ Re-opening of the Welshman's Gut
EB2 Estuary Transects	Channel and Bank <ul style="list-style-type: none"> ▪ Offset change exceeding 150 m ▪ Width change exceeding 150 m ▪ Depth change exceeding 1.5 m 	Alteration to the location and alignment of the main low water channel off Greenfield. Lateral shifting of the energy balance in the central estuary manifest by bank and channel Relocations.

Task	Stage I Thresholds	Stage II Threshold Criteria
EB3 Mid-Hoyle/ Welsh channel confluence	Any movement of Mid-Hoyle channel confluence with Welsh Channel westward.	Reversal of the migration trend for Mid-Hoyle channel.
EB4 Mostyn Deep	Any nett accretion over the twelve month period that was equal to or greater than a mean depth change of 2.0 m over the area of the 5.0 m below CD contour.	Increases in seabed level outside but adjacent to the deposition area not reflected elsewhere in Mostyn Deep.
EB5 Holocene Clay Bank	Any mean monthly clay erosion of the south-western edge of the bank by more than 5.0 m between successive surveys.	

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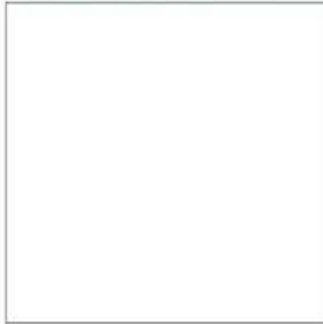
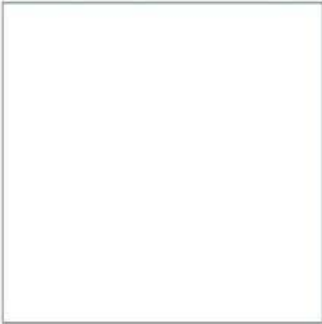
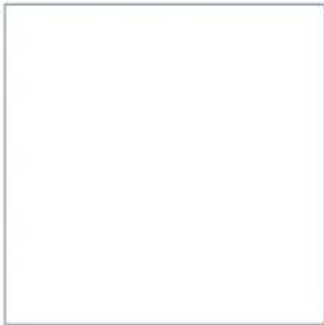
D Maintenance Dredge and Disposal Surveys: Annual Review of Monitoring during 2022 (ABPmer, 2022a)

Port of Mostyn

Maintenance Dredge and Disposal Surveys

Year-end annual review of monitoring during 2022
(DML1542v2 and DML2001)

December 2022



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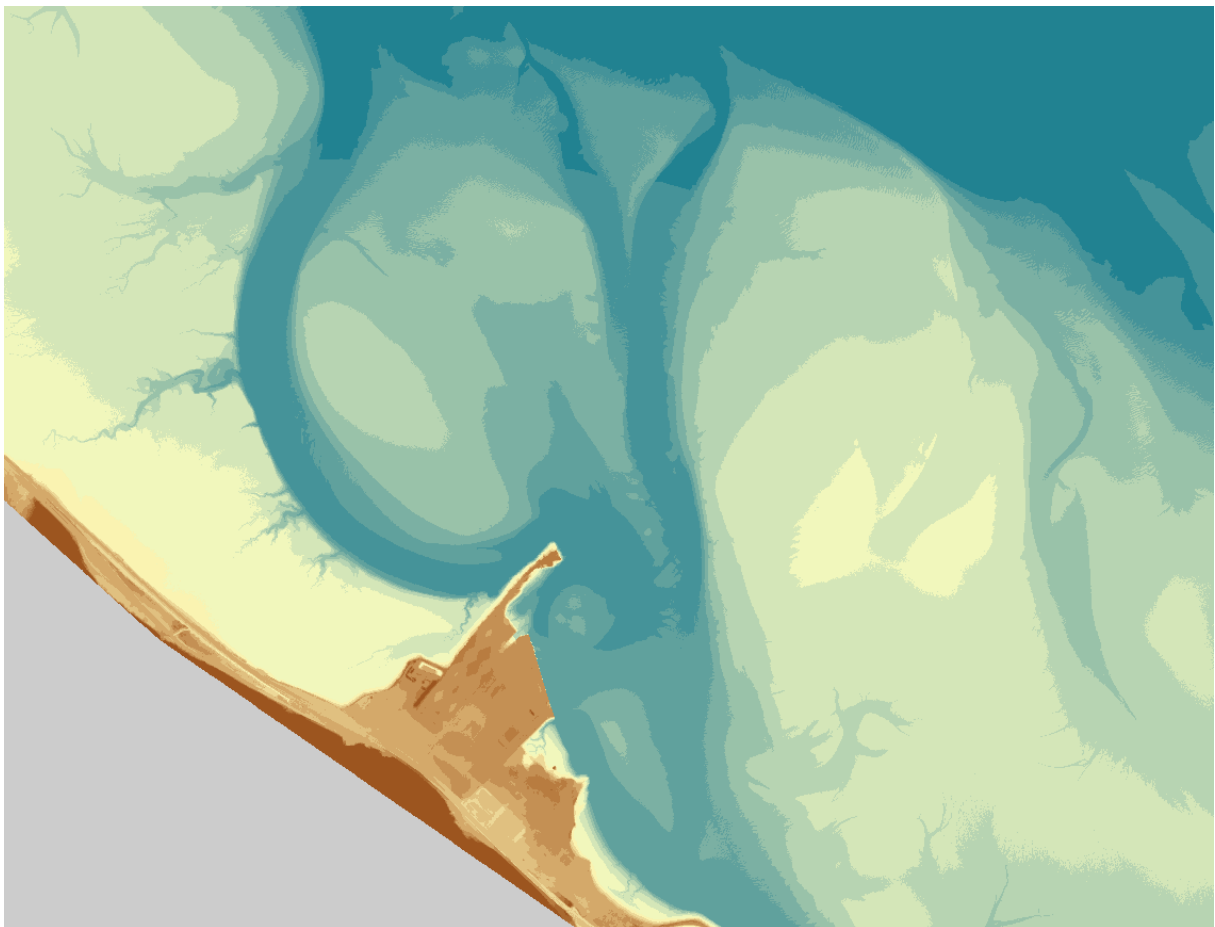


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Maintenance Dredge and Disposal Surveys



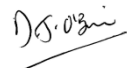
Year-end annual review of monitoring during 2022
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December 2022



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1 Introduction

This report provides the annual review of the maintenance dredge and disposal surveys, covering the monitoring work being carried out by the Port of Mostyn to accompany their licensed Approach Channel works. This ongoing, and long-term, monitoring programme is progressed as a condition of marine licences issued by Natural Resources Wales (NRW) and the current phase of the monitoring is an extant condition of NRW Marine Licence DML1542v2 and the associated DML2001.

The protocols for this survey work were established 12 years ago (SMP, 2008) and the results are regularly reported and disseminated to NRW within standardised progress notes and annual (or biennial) reports. The methods employed are also subject to ongoing review and discussion with NRW.

In response to these discussions, the protocols are subject to some adjustment where required. For example, some changes were made following a review that was carried out, as a licence condition, five years ago (ABPmer, 2017). This review examined results from the preceding 11 years of the programme (2005 to 2016). The programme scope continues to be actively reviewed and the most recent NRW review was undertaken after circulation of the last detailed report in December last year (ABPmer, 2021d).

This preceding report (ABPmer, 2021d) included a detailed review of data collected up to December 2021. Since submission of the previous report, three further Progress Notes (covering data collected up to November 2022) and a separate review of the benthic habitat survey work have also been prepared (ABPmer 2022) and is issued with this Annual Report. The present report has now been prepared and provides an overarching summary of the ongoing data collection up to the end of 2022.

1.1 Monitoring update

The established current monitoring programme has nine key components. These examine the Local Area (LA) and the Estuary-Wide (EB) conditions. The name, reference code and status of these key survey elements are described here along with a summary of the survey work that has been completed during 2022 (extents of the various recent surveys are provided in Figure 1):

- **LA1 (Approach Channel bathymetry):** The October 2022 Progress Note included analysis of surveys up to (and including) October 2022. This report provides an overall summary of the LA1 surveys collected during 2022;
- **LA3 (Mostyn Deep PSA):** Annual sampling of the seabed sediment was undertaken by the Port of Mostyn in Q4 2021, with subsequent analysis reported in the February 2022 Progress Note (and summarised here). Recent samples are programmed for collection during December 2022, with the results of the processing due to be included in the February 2023 Progress Note;
- **LA4 (NRW Cockle survey):** Surveys of the cockle bed have been undertaken by NRW during March 2022, with the report provided as Appendix to the June 2022 Progress Note. This report includes a summary of the latest survey results;
- **LA5 (Benthic Survey Salisbury/Mostyn Bank):** A benthic survey was undertaken during Spring 2022 and the survey report (ABPmer, 2022b) is issued to NRW alongside this Annual Report (delayed slightly due to particle analysis equipment awaiting repair);
- **EB1 (LiDAR/Swathe Survey of seabed levels):** As defined in the licence conditions, the most recent LiDAR estuary survey was completed during February 2021 and subsequent numerical

modelling was undertaken and reported in ABPmer (2021c). The next survey is due to be completed in 2024;

- **EB2 (Estuary bathymetry transects):** The most recent survey has been carried out by Port of Mostyn in October 2022 (delayed from September due to survey vessel undergoing repairs). The results of the transect analysis are included in the relevant Progress Notes, and summarised in this report;
- **EB3 (Mid-Hoyle bathymetry):** A new survey was carried out by Port of Mostyn in June 2022 and reported in the June 2022 Progress Note. The summary results of the subsequent bathymetric analysis are included in this report;
- **EB4 (Mostyn Deep bathymetry):** A new survey of the Mostyn Deep has been carried out by Port of Mostyn in June 2022 and reported in the June 2022 Progress Note. The summary results of the subsequent bathymetric analysis are included in this report; and
- **EB5 (Holocene Clay Bank):** Anecdotal observations have continued, and a photographic record was taken in June 2021, with summary information included in this report and in ABPmer, 2022.

In addition to the above survey activity (carried out in discharge of the Licence conditions), the Port have also been undertaking surveys of the main approach channel (termed the Salisbury Channel) at approximately monthly intervals throughout 2022.

1.2 Scope of this review

This report provides a summary overview of the monitoring surveys and analyses that have been undertaken during 2022 (as described above). Additional reporting has already been completed (including the three annual Progress Notes) and the technical report for the benthic survey (LA5; ABPmer, 2022) accompanies this Annual Monitoring Report. Where relevant (e.g. for the newly collected LA3 sediment samples), additional survey data is still being processed and analysis will be included in the next Progress Note, scheduled for February 2023.

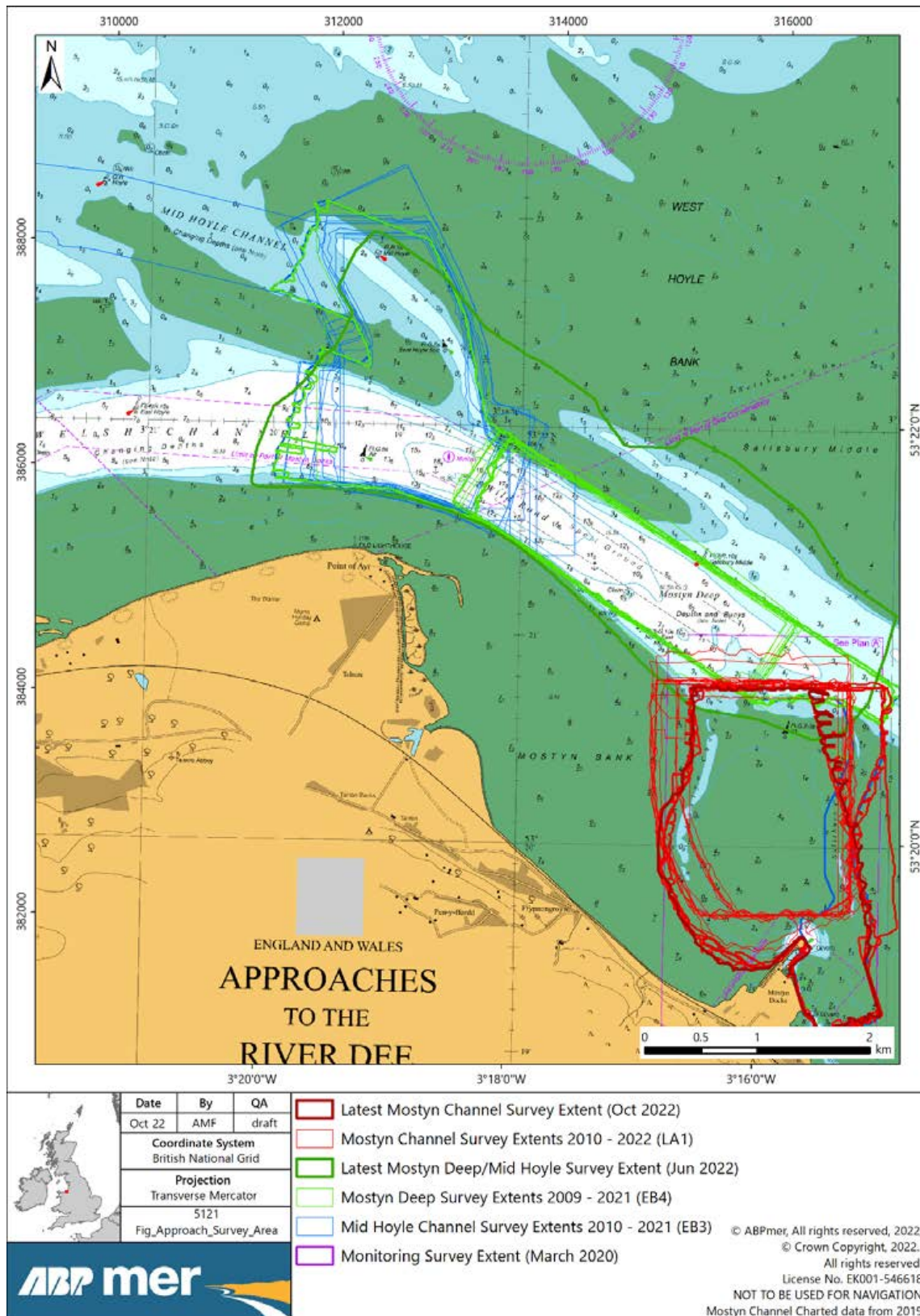


Figure 1. Extents of Channel (LA1, EB3 and EB4) surveys

2 Monitoring Survey Data Collection

As described in the above summary, this report provides a summary description and analysis of the annual monitoring data collected during 2022.

2.1 LA1 Dredged channel survey

The aim of the LA1 Dredged Channel Surveys is to monitor the depth changes within the Port's navigation approach channel. The survey extents, covering the LA1 survey area (between 2010 and the most recent October 2022 surveys), are shown in Figure 1. Since the monitoring programme began, there has been a westerly shift in the alignment, and a shallowing, of the Mostyn Approach Channel. The main area of westerly migration is along the southern end of this channel. The northern end of the channel, on its western side, appears to be relatively stable, when compared to these locations further to the south. At the same time, the Salisbury Channel has opened up to the east of Salisbury Bank. Due to the continuing evolution of the original Mostyn Channel, it is the Salisbury Channel that is now used by the Port of Mostyn for vessel access.

The LA1 surveys have historically (since commencement of monitoring conditions) been surveyed using singlebeam echosounder equipment. More recently, the Port of Mostyn now use a multibeam echosounder (MBES) system for the capture of the monitoring survey data. This provides full bed coverage and allows for a more regional assessment of bed level change, using the higher-resolution MBES data. Additionally, the continued comparison of historic profiles along cross-line Transect 20 has been included in the analysis, since this profile provides the most useful insight into the continued westerly migration of the Mostyn Channel, into the intertidal region of Mostyn Bank.

The difference in bed level, across the LA1 survey area, between October 2010 and October 2022 is shown in Figure 2. It should be noted that the original 2010 survey covered a smaller extent than the present surveys do (a result of the subsequent migration of the Mostyn Channel and the opening of the eastern Salisbury Channel). It is also noted that the 2010 data is an interpolated bathymetric surface which uses the original single-beam survey lines to infer bed levels across the survey area. The more recent MBES survey, instead, provides full bed coverage.

Although the extent of the original survey is not sufficient to fully capture the present alignment of the approach channels, it is still evident from Figure 2 that the Mostyn Channel has migrated from its original position to the west over the 10+ years between surveys. Infill of the original channel is shown in Figure 2, along with erosion over the new alignment just visible along the western extent of the 2010 survey. To the east, the opening of the Salisbury Channel is also apparent along the northeast and eastern edge of the 2010 survey extent.

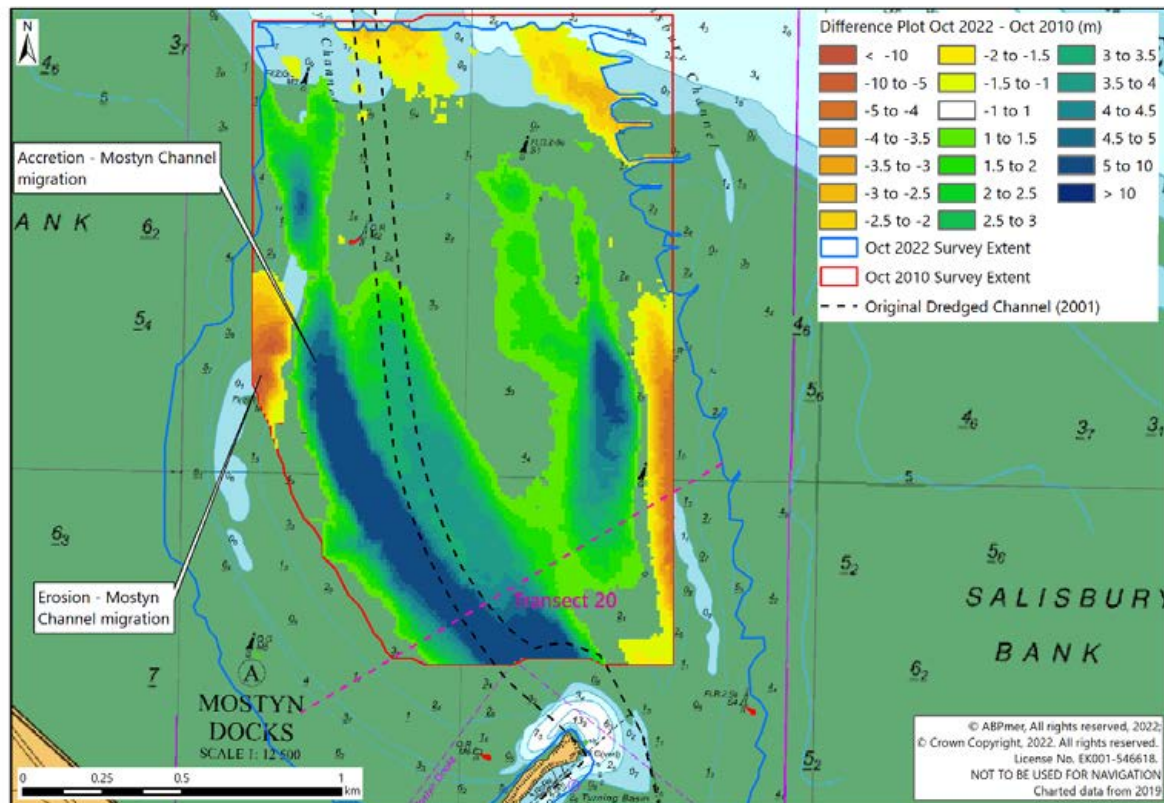


Figure 2. Bathymetry difference plot indicating net change October 2010 to October 2022

With the extended survey extents now used to capture the full extent of the approach channels, analysis of the change in bed elevation between the MBES surveys conducted in June 2022 and the most recent from October 2022 is shown in Figure 3.

Whilst the magnitudes and extents of change are generally limited over the 4-month period between surveys, there remains evidence of the continued westerly migration of the Mostyn Channel. This is shown by the area of erosion along the southwestern edge of the survey extents. Slight changes within the Salisbury Channel are also evident to the eastern side of the difference plot.

The recent historic variation along Transect 20 (see Figure 3 for location) is shown in Figure 4. This plot shows the change in bed elevation since October 2018, and clearly shows the continued westerly migration of the Mostyn Channel in each of the subsequent plotted surveys. Since the March 2021 survey, the deepest point of the Mostyn Channel, along Transect 20, has shallowed slightly and migrated approximately a further 100 m to the southwest by the October 2022 survey. In a reversal of the recent trend, the latest October 2022 survey reveals the Mostyn Channel to have deepened by around 0.9 m along Transect 20 since the June 2022 survey. Along the north-eastern end of the Transect 20, the Salisbury Channel is shown to have deepened slightly and migrated approximately 30 m to the east during the period between March 2021 and October 2022.

The Salisbury Bank, in between the two channels, shows some slight accretion to the east of the Mostyn Channel, with generally consistent elevations to the west of the Salisbury Channel. Outside of the migration of the Mostyn Channel, the bed elevation changes are within the threshold values defined in the monitoring Licence conditions (± 1 m from the previous (June 2022) survey data). Figure 5 shows a subset of the LA1 survey area, detailing two profiles through the IS103 (breakwater) disposal site.

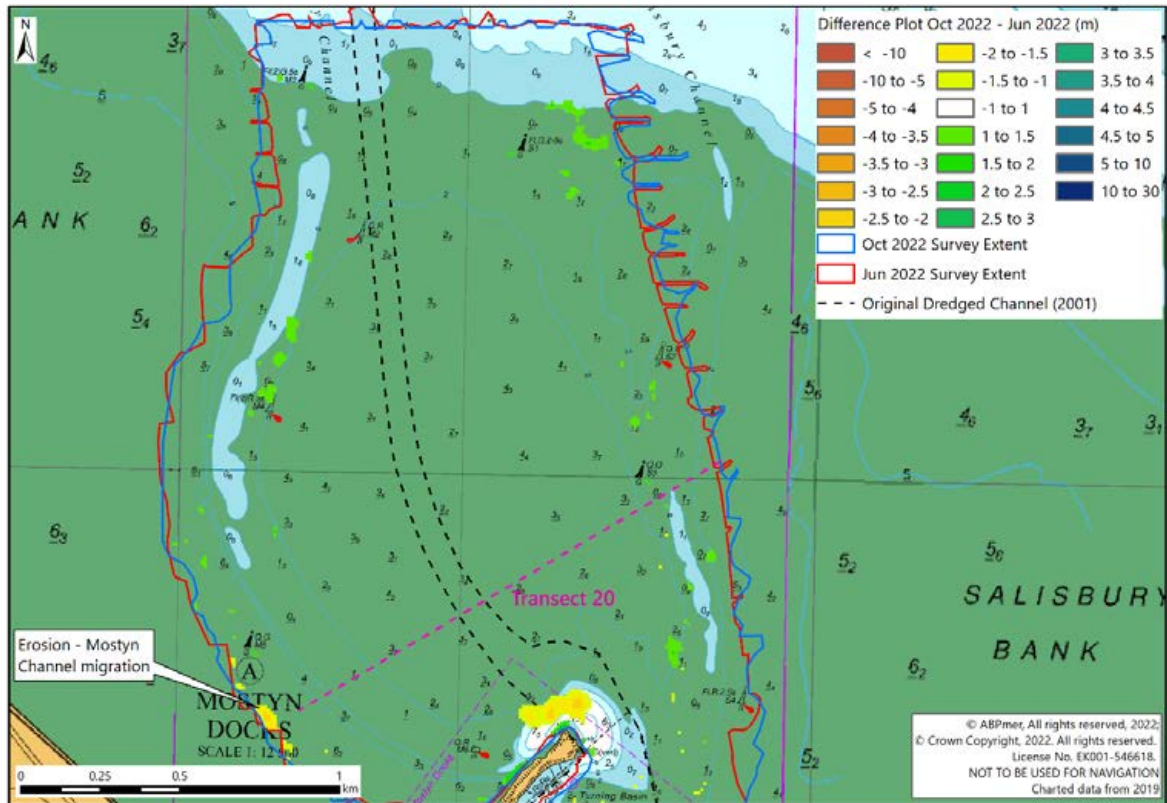


Figure 3. Bathymetry difference plot indicating net change June 2022 and October 2022

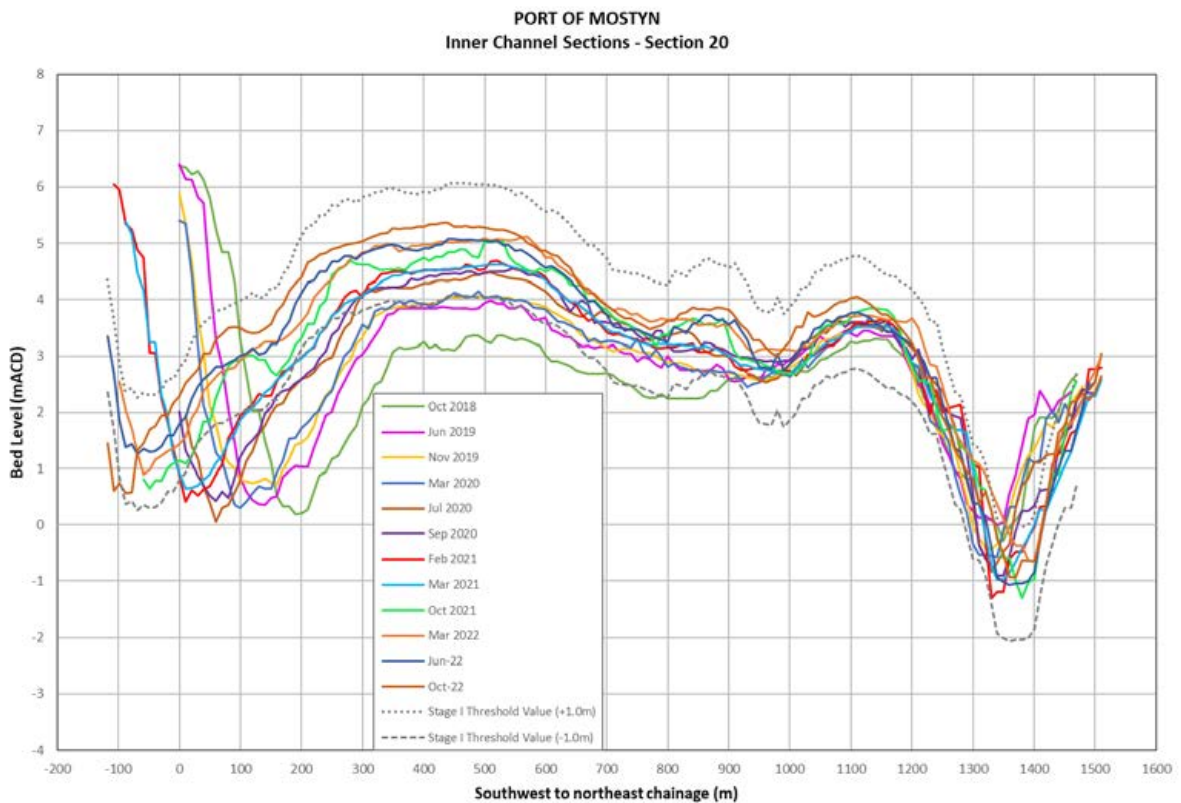


Figure 4. Spatial and temporal variation in bed level along Transect 20

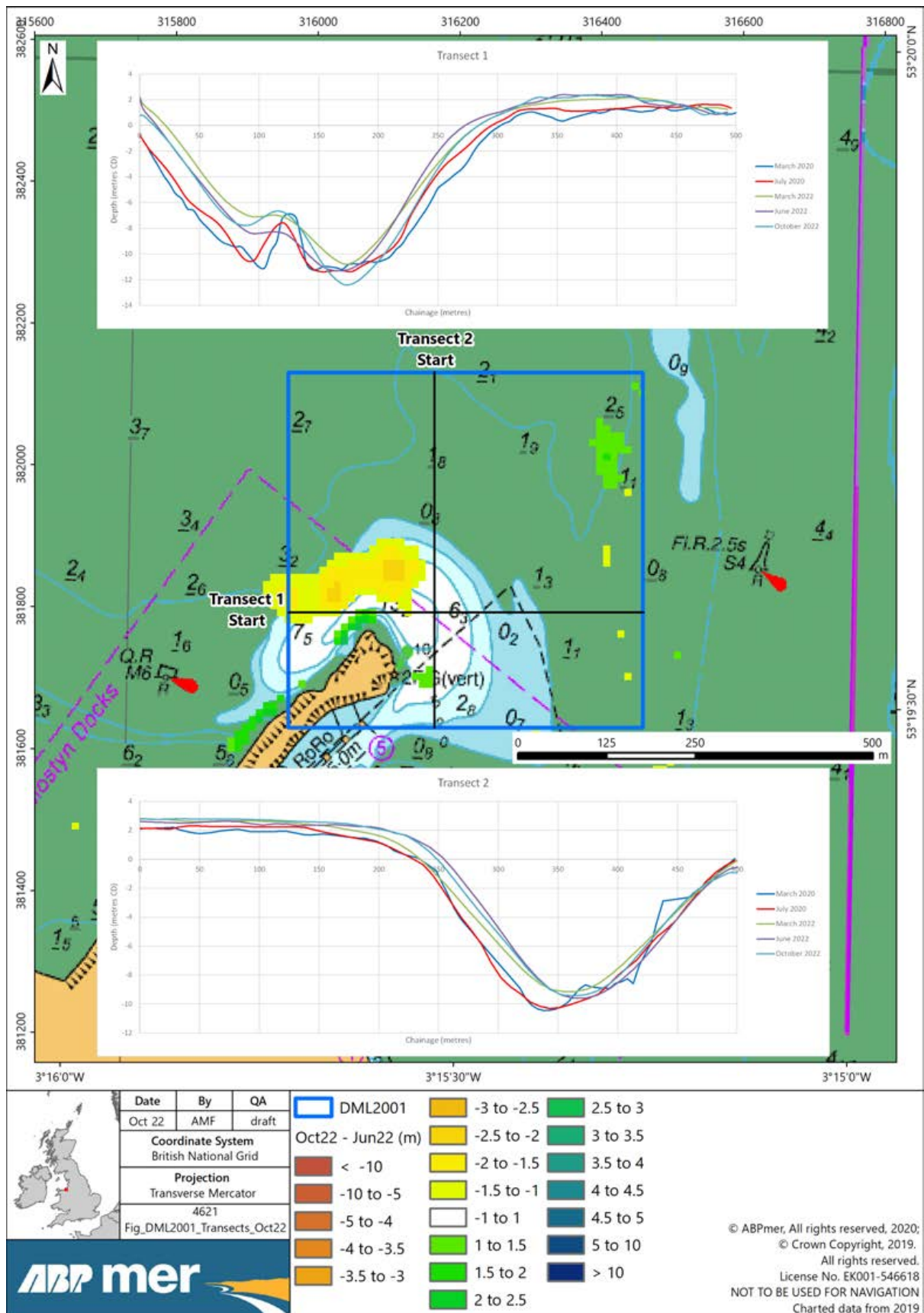


Figure 5. Subset of LA1 survey covering the IS103 (Breakwater) disposal site

2.2 LA3 Mostyn Deep Site 'A' seabed samples

The aim of Task LA3 is to monitor the sediment characteristics of the deposition area and the wider Mostyn Deep channel, through collection of sediment samples. This is to understand whether the deposition has any material effect on the physical characteristics of the seabed substratum.

Seabed samples are collected from the 10 established sampling locations and subject to Particle Size Analysis (PSA). The site locations are shown in Figure 6.

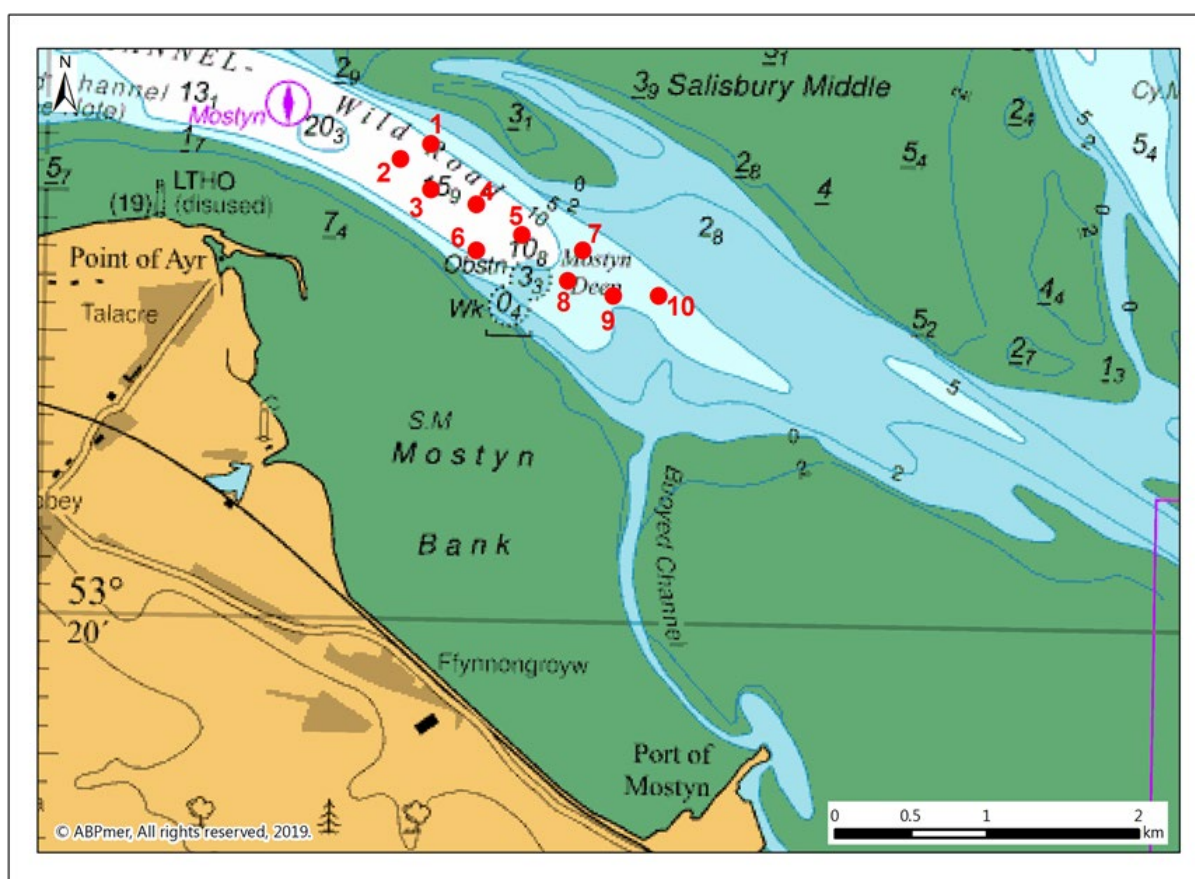


Figure 6. Location of the ten established Mostyn Deep seabed sampling sites (LA3)

The latest analysed samples were collected in December 2021, with the next set of sampling scheduled for collection at the start of December 2022 (with results to be subsequently reported in the February 2023 Progress Note). Comparison of the most recently analysed PSA results against repeat baseline samples collected since 2009 indicates that:

- D₁₅ values within the deposition area generally continue to exhibit a slight fining trend, which is also evident outside of the deposition area. The coarsening that was previously observed at Site 7 has been maintained in the latest sampling, with the site still showing a character similar to that seen pre-2018. Observed changes at all sites remain below the stated thresholds;
- D₅₀ values inside of the deposition area remain generally stable, with some sites showing a slight fining and others a slight coarsening since the previous sampling. Outside of the deposition area, Site 7 has maintained the previously noted stability to values seen pre-2018. Variance at all sites remains below the stated thresholds; and

- Changes in the D_{85} parameter are also relatively small with some fining and some coarsening. No changes are observed above threshold, remaining variable both within and outside of the deposition area. Larger changes are likely to be a result of individual pebbles in the gravel fraction. Results from the latest sampling reflect the mixed-material nature of Mostyn Deep.

2.3 LA4 Cockle survey – Salisbury/Mostyn Bank

The aim of this work is to check whether there have been any notable changes to the cockle populations in the estuary using data that is collected by NRW. The location of the surveyed cockle beds is shown in Figure 7.

The latest survey report from Spring 2022 have been provided by NRW and the findings are summarised below.

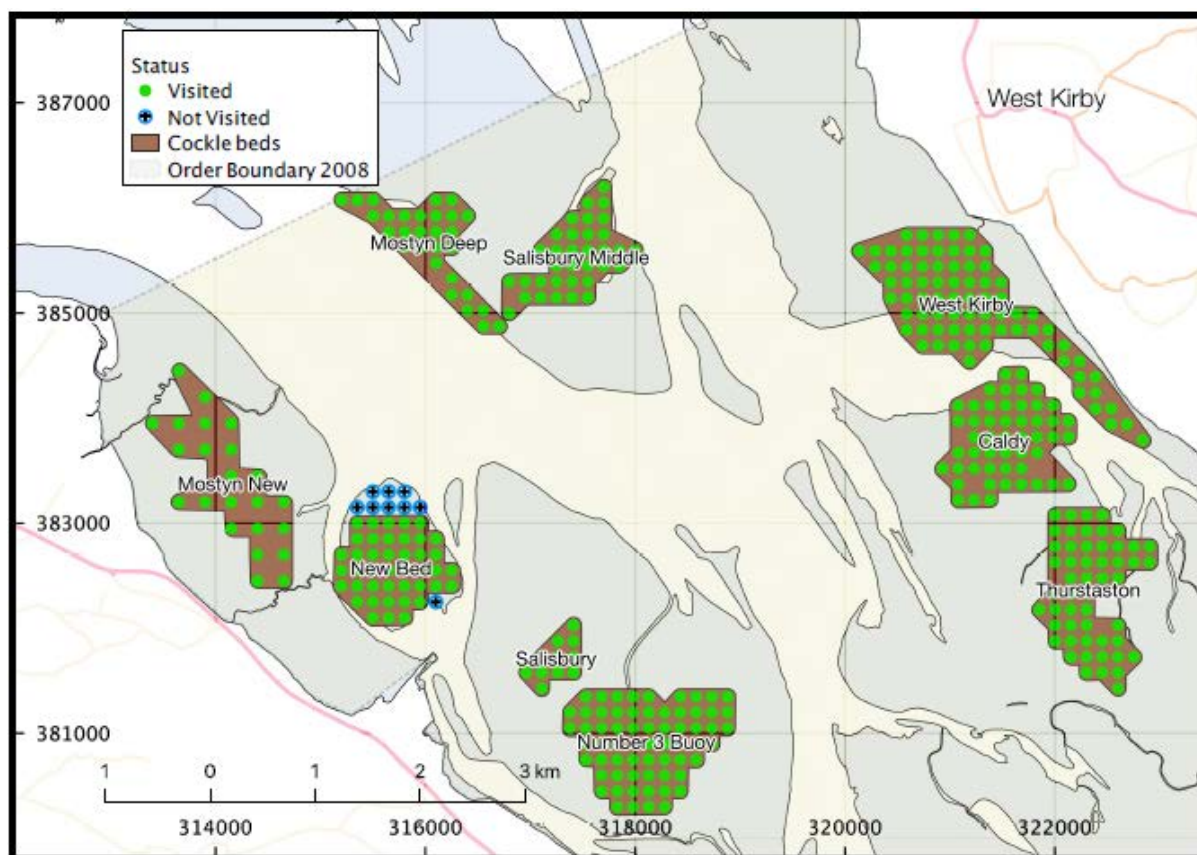


Figure 7. Location of Dee Estuary cockle beds surveyed by NRW in March 2022

The calculated total biomass of cockle stocks were 8,088 tonnes, in comparison to 13,525 tonnes in spring 2021. The total cockle count was 2.24 billion (2.44×10^9), in comparison to 2.44 billion (2.44×10^9) in spring 2021.

A notable feature of the cockle population structure from this survey is that the seasonal growth had not started by the time of the survey, this may cause some confusion when comparing annual trends. Adjusting for this feature, there was a high proportion of biomass of year 3 cockles (78%), in comparison to year 1 (15%) and year 2 cockles (7%). Expectations would be for a higher year 1 and 2 biomass; this may become apparent during accelerated spring growth.

Year 1 cockles represent 60% of the cockle population in comparison to year 2 cockles at 5%.

Year 1 and year 2+ cockles sizes varied as follows; Mostyn Deep (medians 21 mm and 37 mm), Salisbury Middle (medians 19 mm and 37 mm), Caldy (medians 26 mm and 29 mm), Thurstaston (23 mm and 27 mm), West Kirby (24 mm and 26 mm), Mostyn (22 mm and 24 mm), New Bed (25 mm and 24 mm), No 3 Buoy (26 mm and 30 mm) and Salisbury (25 mm and 28 mm).

Harvestable stocks, in order of increasing magnitude, were as follows; Salisbury (14 tonnes), Mostyn Deep (78 tonnes), Mostyn (134 tonnes), Thurstaston (196 tonnes), Salisbury Middle (484 tonnes), No 3 Buoy (505 tonnes), New Bed (892 tonnes), West Kirby (968 tonnes), Caldy (1,398 tonnes).

Cockle spatial distribution in the Dee Estuary is characterised by over-dispersion (clustered, as a pose to random or linear distribution) this can be seen in the graphical representations of biomass and count generated by IDW spatial analysis. While the majority of the inlet has low cockle presence, there are isolated areas supporting high densities. The most likely explanation of the variation in cockle presence within the estuary would be linked with sediment structure, elevation within the tidal range and estuary hydrodynamics. This is an important factor in larvae settlement and is quite commonly observed in biological distribution data.

For future surveys it is recommended commissioning a modification of the survey grid to take into account the changing physical structure of the estuary, both to improve data resolution and to maximise data collection efficiency.

Consequently, the following recommendations have been proposed for future NRW cockle surveys:

- Remove sites from survey which are consistently submerged within the main channel;
- Incorporate new sites into the survey where new cockle habitat has been identified;
- Incorporate monthly monitoring of stocks to continually assess fishery health and link the results to licence conditions if stocks are found to have changed throughout the course of the season; and
- Assess implications of fishery 'zoning' and management based on active and closed zones.

2.4 LA5 Benthic survey – Salisbury/Mostyn Bank

The aim of the benthic sampling work is to examine the ecological characteristics of intertidal mudflats and sandflats surrounding the Approach Channel to understand whether they are affected by the dredging work. The locations of the survey sites are shown in Figure 8.

The latest benthic survey was completed in June 2022, with findings reported in detail in ABPmer (2022). In summary, the survey results showed that:

- During the Spring 2022 survey only relatively minor changes in habitat were recorded with key characteristics remaining broadly similar to previous monitoring at the majority of sites.
- In summary, tide-swept sandflat habitat continued to extend through much of the intertidal areas surrounding the central and outer Approach Channel. This included much of the central and eastern sections of Transects A, B and Y (Sites A5-A8, B4-B6 and Y6), the western sections of Transects C and W (Sites C1-C2 and W1-W2) and Transect D (Sites D2-D3).
- There was stable mudflat habitat, as observed during previous years, along the inner sections of the eastern Mostyn Bank (Sites A3 and B2) and on the eastern margins of the Mostyn Channel (B3). Observations also suggest that the muddy sand habitats of the middle of Salisbury Bank (W4, C3 and C4) have remained largely unchanged in recent years.

- The main habitat changes were focused within the area between the Mostyn Channel and Salisbury Channel (Y5) and the W Transect (broad areas where changes were also observed in 2021) as described in more detail below:
 - **Site Y5:** Muddier and more ecologically rich conditions were observed in 2022 compared to previous years with the site also higher in elevation. This represents a change in habitat, from clean sandflat to more stable muddy sand (with higher densities of fauna such as sand mason, common cockle and lugworm *Arenicola marina* casts recorded); and
 - **Site W3:** The site has shown a high degree of interannual variation in sedimentary conditions in recent years (fluctuating between clean sand and muddy sand conditions). In 2022, muddier conditions were observed at the site compared with 2021 with infauna such as cockles and sand mason also recorded (which were also not present in 2021).

As in past years, these changes are deemed to be a function of natural morphological shifts in these locations, rather than a response to the very limited dredging work that takes place.

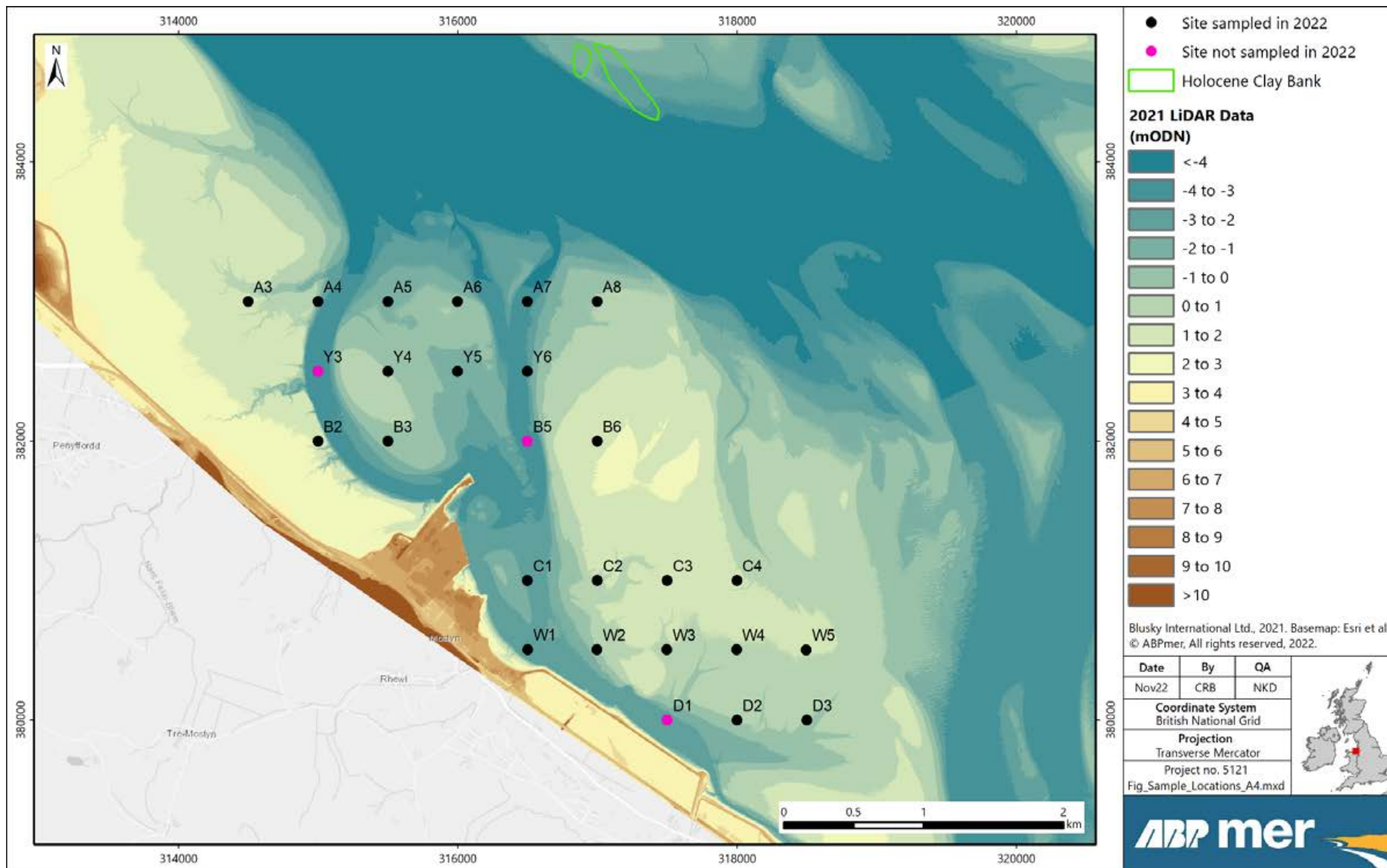


Figure 8. Location of LA5 benthic sediment sampling sites

3 Estuary-wide Results

The following sections summarise the findings of the annual repeat 'Estuary-wide' (EB) survey campaigns.

3.1 EB1 LiDAR/Swath survey of seabed levels

As defined in the licence conditions, the most recent EB1 LiDAR estuary survey was completed during February 2021 and subsequent numerical modelling was undertaken and reported last year, in ABPmer (2021c). The next survey is due to be completed in 2024.

3.2 EB2 Estuary transects

The aim of the EB2 monitoring is to help understand the estuary-wide morphological changes occurring within the estuary. This is done by carrying out bathymetric monitoring along three cross-estuary transects (Figure 9) to describe changes in the bank and channel widths and elevation changes between surveys and over time. The results of this work are summarised below.

Along the northern transect (Figure 10), the bathymetric profile from the October 2022 survey remains very similar to that from the previously (May 2022) collected data. Widths and elevations of the various banks and channels (including the Salisbury Bank, Salisbury Channel and the wider Welsh and Hilbre Channels as they approach their confluence) have generally remained consistent across the five months in between surveys.

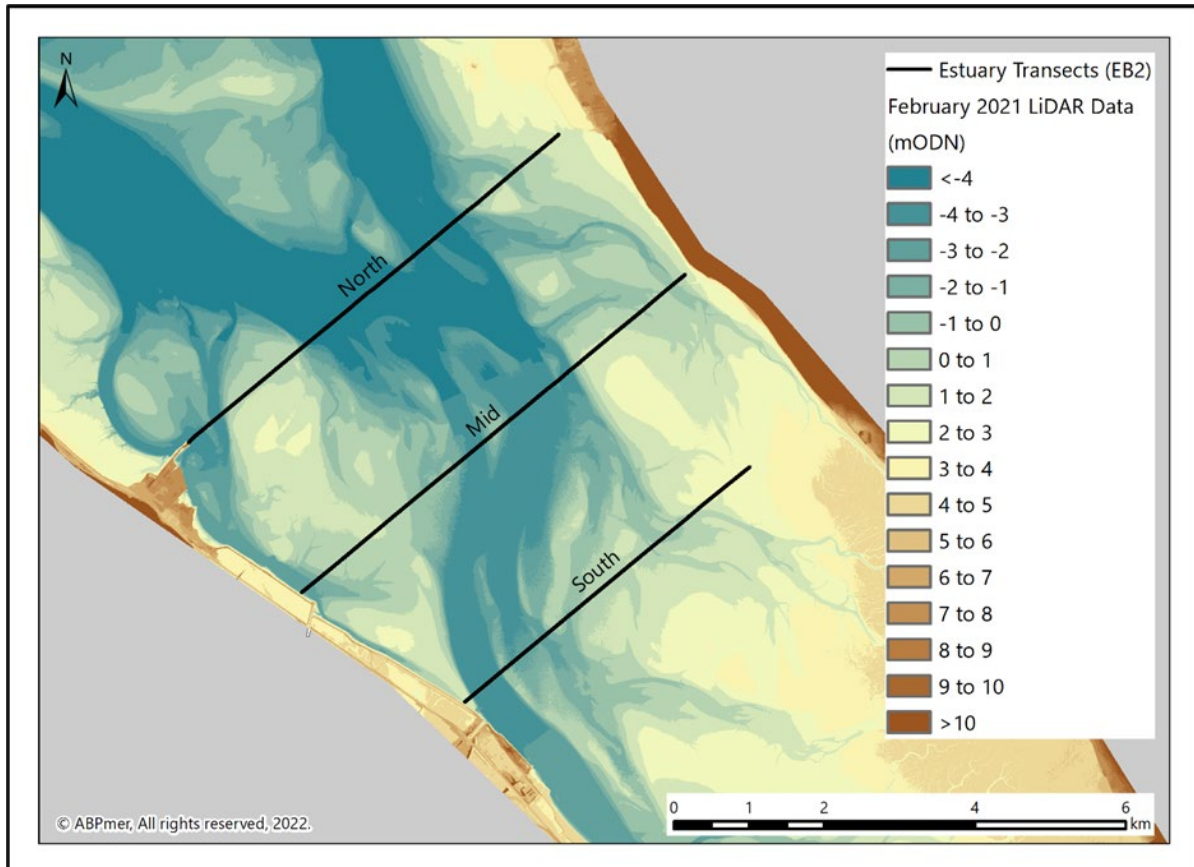


Figure 9. Location of the three cross-estuary transects

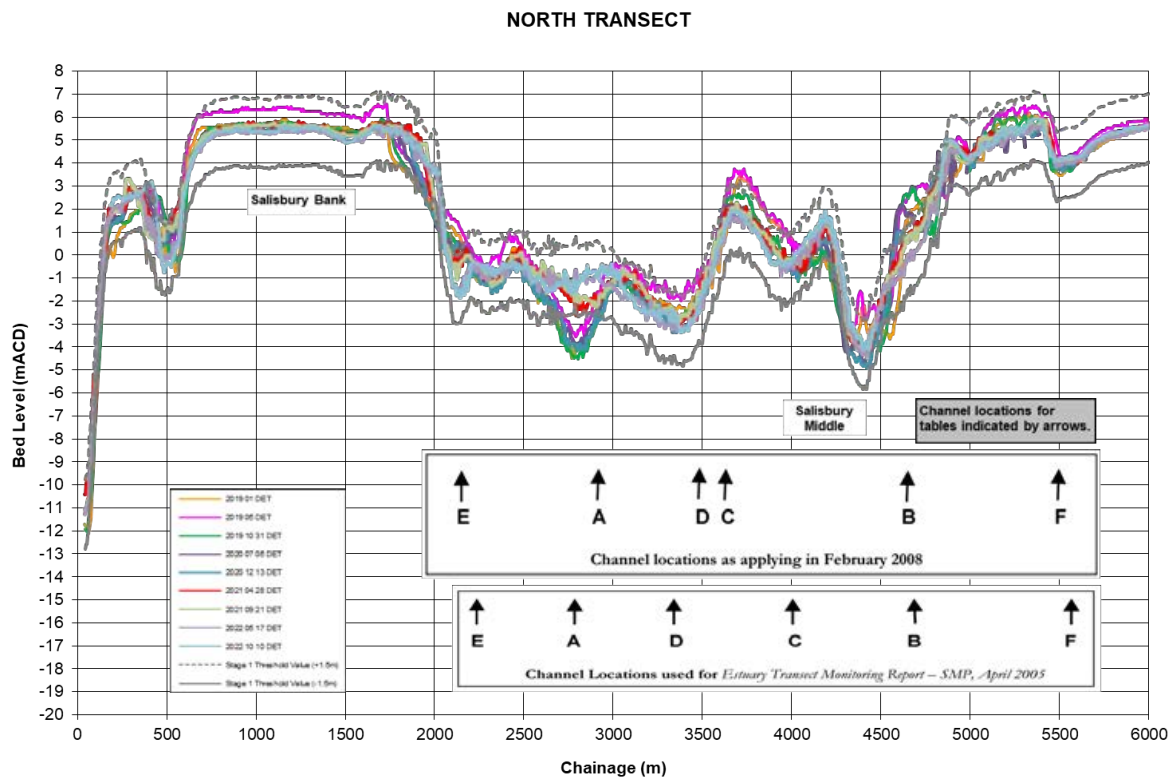


Figure 10. Comparison of change along the North Dee Estuary Transect (January 2019 to October 2022)

Along the central Dee Estuary Transect (Figure 11), the bathymetric profile from the October 2022 survey has remained generally consistent along the northern and southern extents of the estuary, notably over the Salisbury Bank and Dawpool Bank. Within the central part of the transect, in and around the main estuary channel, slight changes are evident between the May and October surveys. In general, the banks and channels in this part of the estuary have shifted slightly to the north in the intervening five-month period and channel depths have deepened slightly.

In the context of the historic variability, the changes observed are similar to previously described adjustments (e.g. ABPmer, 2021d) and the changes are within the defined threshold limits.

Slight changes are also evident along the southern transect (Figure 12). Elevations of the main channel up-estuary of the Port have deepened slightly, whilst widths are generally similar between the May and October 2022 surveys. To the north of this channel, the shallow intertidal has shallowed slightly over the five-month period. Further north, the Dawpool Bank remains generally consistent across the recent survey periods. At the northern extent of the transect, the bank edge has remained generally consistent in the October 2022 survey data.

As with the changes observed along the other two transects, the variations on the southern transect are similar in magnitude to historic variations (e.g. ABPmer, 2021d) and within the threshold limits defined.

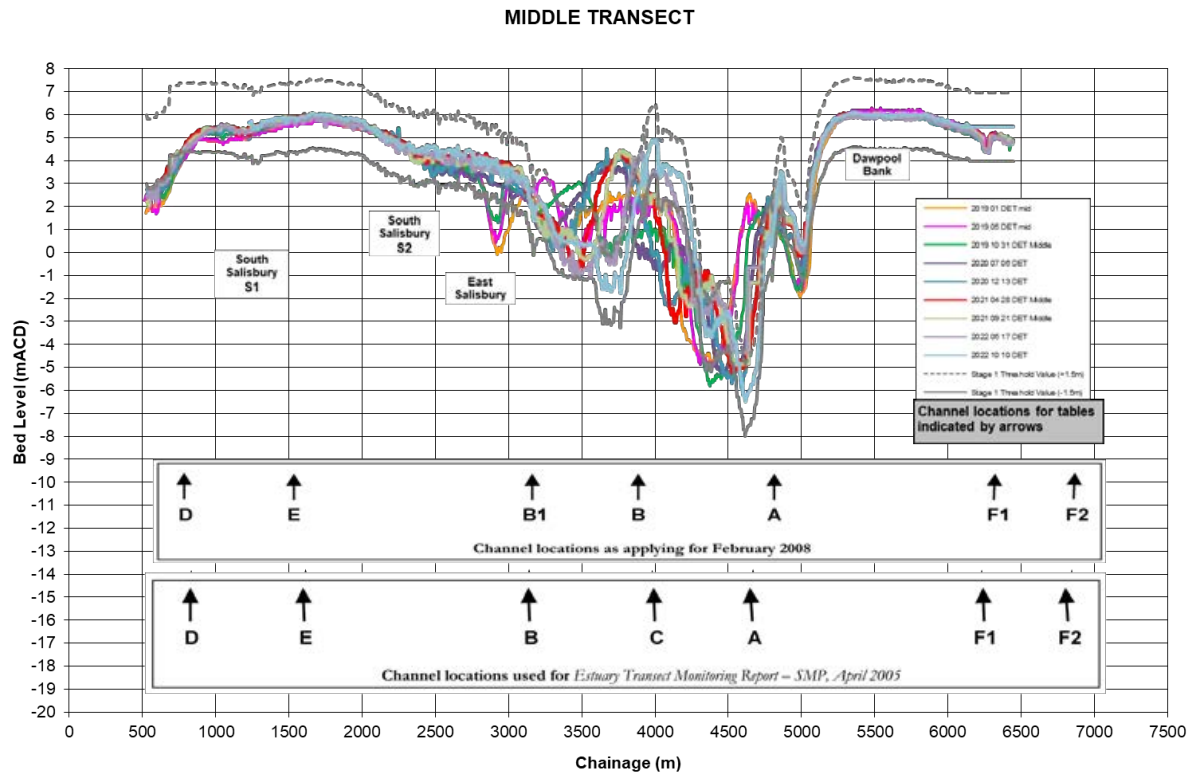


Figure 11. Comparison of change along the Middle Dee Estuary Transect (January 2019 to October 2022)

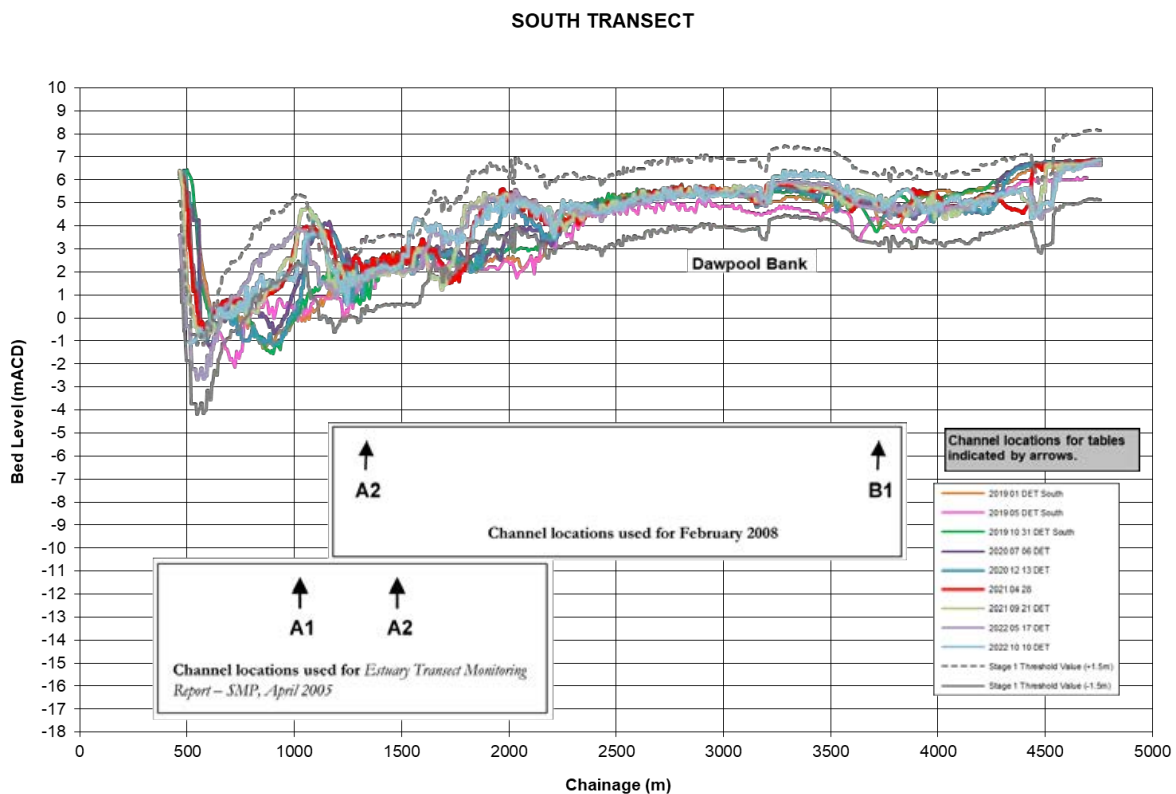


Figure 12. Comparison of change along the South Dee Estuary Transect (January 2019 to October 2022)

3.3 EB3 Mid-Hoyle/Welsh Channel confluence

The aim of the EB3 surveys is to monitor channel movements within the Mid-Hoyle Channel and Welsh Channel confluence. The overall change in bathymetry in this area between November 2010 and the most recent survey in June 2022 is shown in Figure 13.

The channel has generally been continuing to migrate eastwards and shallowing since the first monitoring survey in 2010. Since May 2016 the Mid-Hoyle Channel has continued to shallow with the deeper water continuing to move south and eastwards within the confines of the channel, albeit at a slowing rate (Transect 1 in Figure 14). The migration of the east side of the channel has effectively stopped, but not the west side. This has caused a narrowing and shallowing of the channel. This pattern of change was still evident at the June 2022 survey, and the rate of shallowing has continued to slow slightly since the previous survey period.

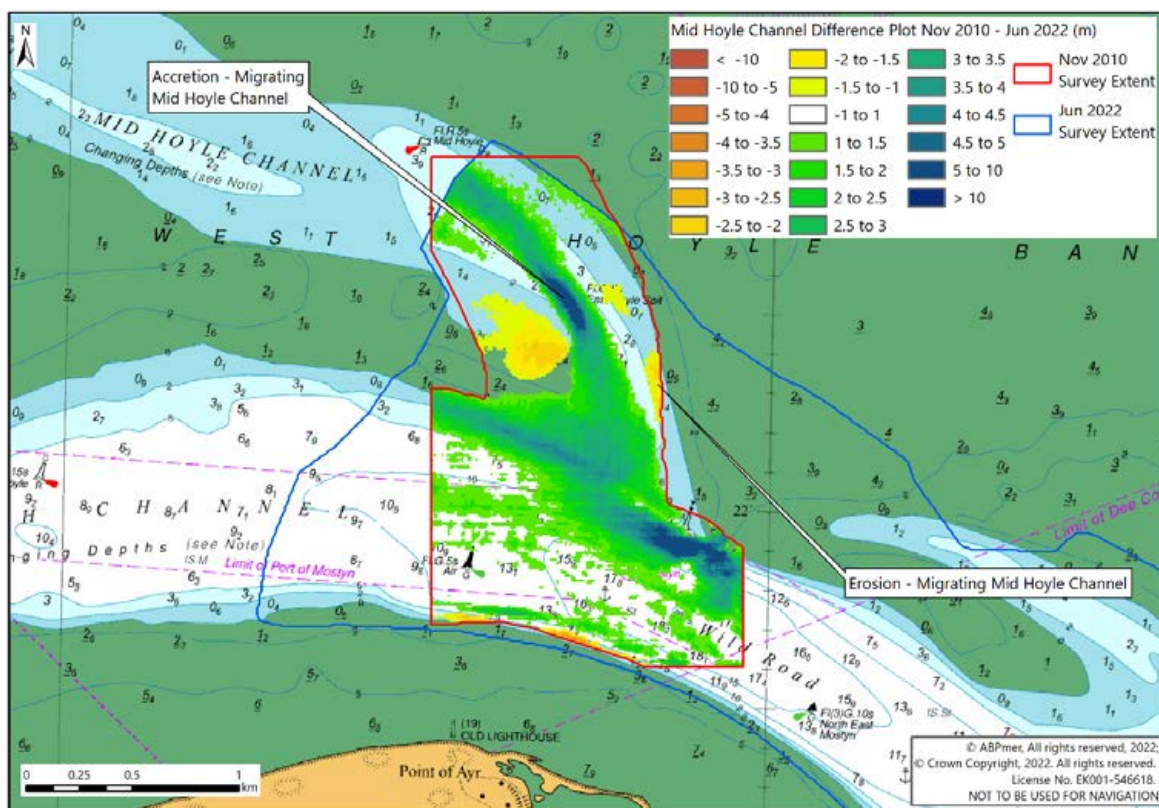


Figure 13. Mid-Hoyle/Welsh Channel confluence bathymetric difference plot indicating net change November 2010 to June 2022

Little change has occurred at the elevation of the start of the intertidal (i.e. around 0.5 mCD). Across the confluence with the Welsh Channel, the pattern is a continuation of the accretion seen for the Mostyn Deep (EB4), i.e. sedimentation on the side slope.

Transect 2 on Figure 14 clearly shows that accretion is historically evident in the deep areas of the northern half of the Welsh Channel in front of the entrance to the Mid-Hoyle Channel. Over the most recent period, the erosion observed in the November 2021 survey appears to have been reversed, with elevations returning to the July 2019 values. Overall, there has been little change in the on-going processes occurring in this area (except perhaps most recently) and the previous changes monitored do not meet the monitoring progress report thresholds for further analysis.

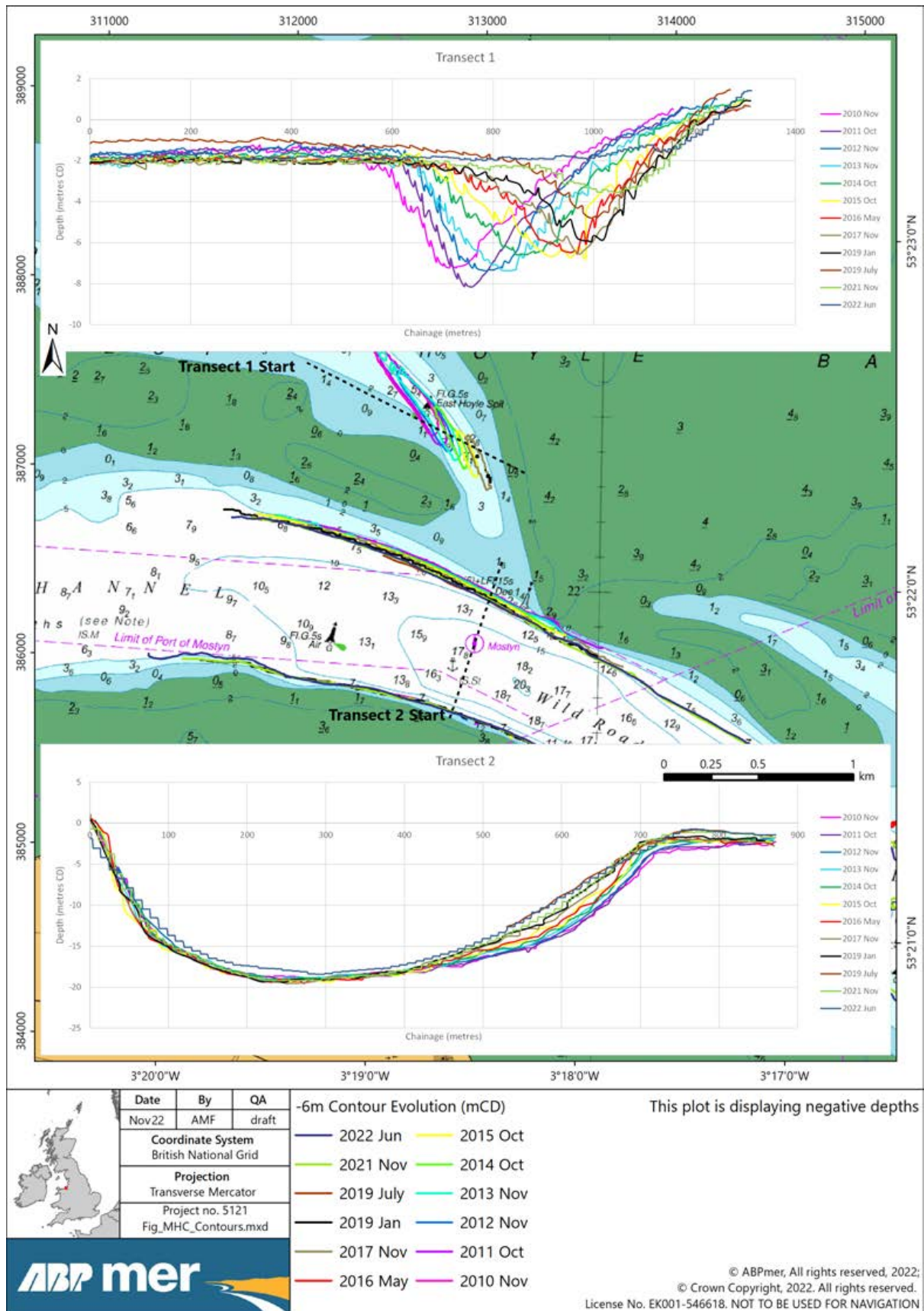


Figure 14. Bathymetric results describing change in Mid-Hoyle/Welsh Channel confluence 2009 to June 2022

3.4 EB4 Mostyn Deep bathymetry

The aim of the EB4 task is to describe seabed levels within and around the Mostyn Deep disposal ground. This is undertaken to understand whether there are any effects in this area arising from the disposal campaigns and also to describe any wider changes to the seabed morphology in this area.

For this component of the monitoring, bathymetric surveys of the Mostyn Deep area are carried out. The overall change in bathymetry since monitoring analysis began (July 2009) to the June 2022 survey is shown in Figure 15. The changes monitored represent the natural on-going change, occurring within the area, associated with the present changes occurring both in the Mostyn Channel and the Salisbury Channel (see LA1 surveys, described above).

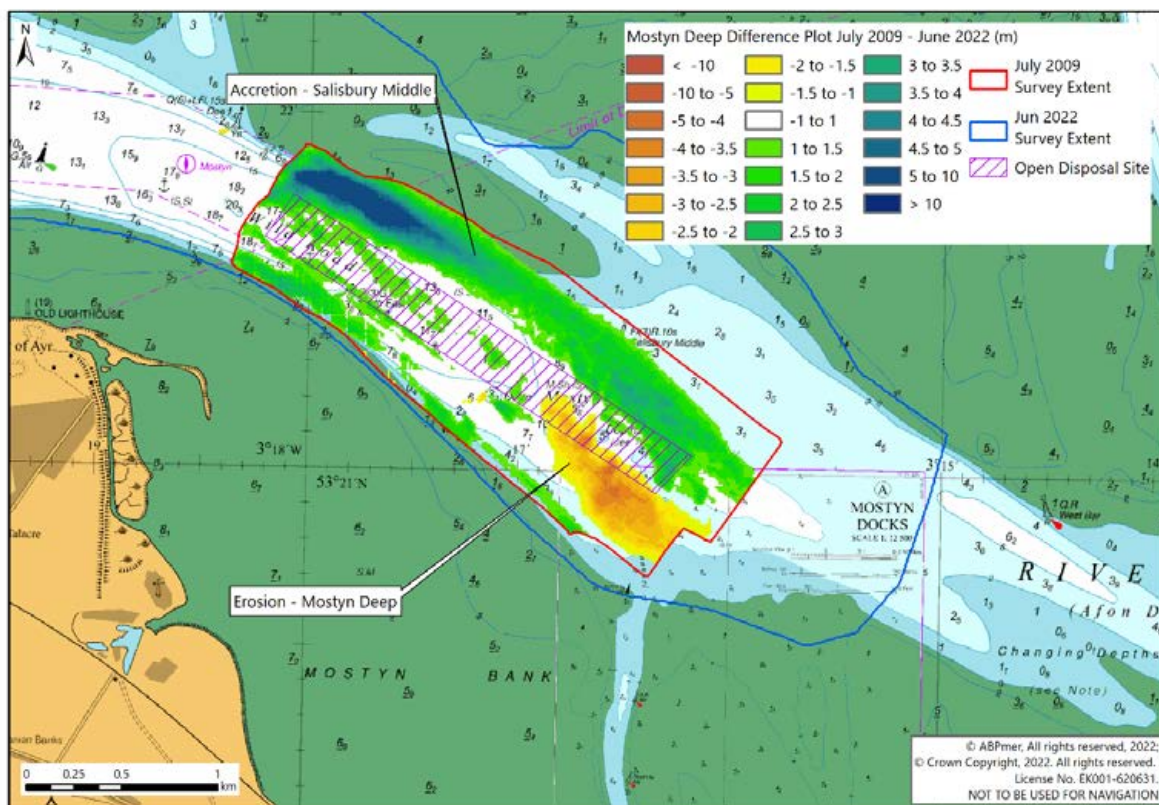


Figure 15. Mostyn Deep bathymetric difference plot indicating net change July 2009 to June 2022

Figure 15 and Figure 16 indicate that the patterns of change in Mostyn Deep have generally remained similar as for those described within the previous assessments, with accretion against the northern side of Mostyn Deep and erosion evident towards the entrance to the Mostyn Channel. The area of accretion remains quite distinctive on the northern *circa* 200 m of the Wild Road deep against the side slope up to Salisbury Middle. Some of the erosion reported in the deeper parts of the channel from the November 2021 survey are seen to have reversed in the June 2022 survey. Overall, the northern slope of the Mostyn Deep Channel remains generally as observed since the August 2019 survey.

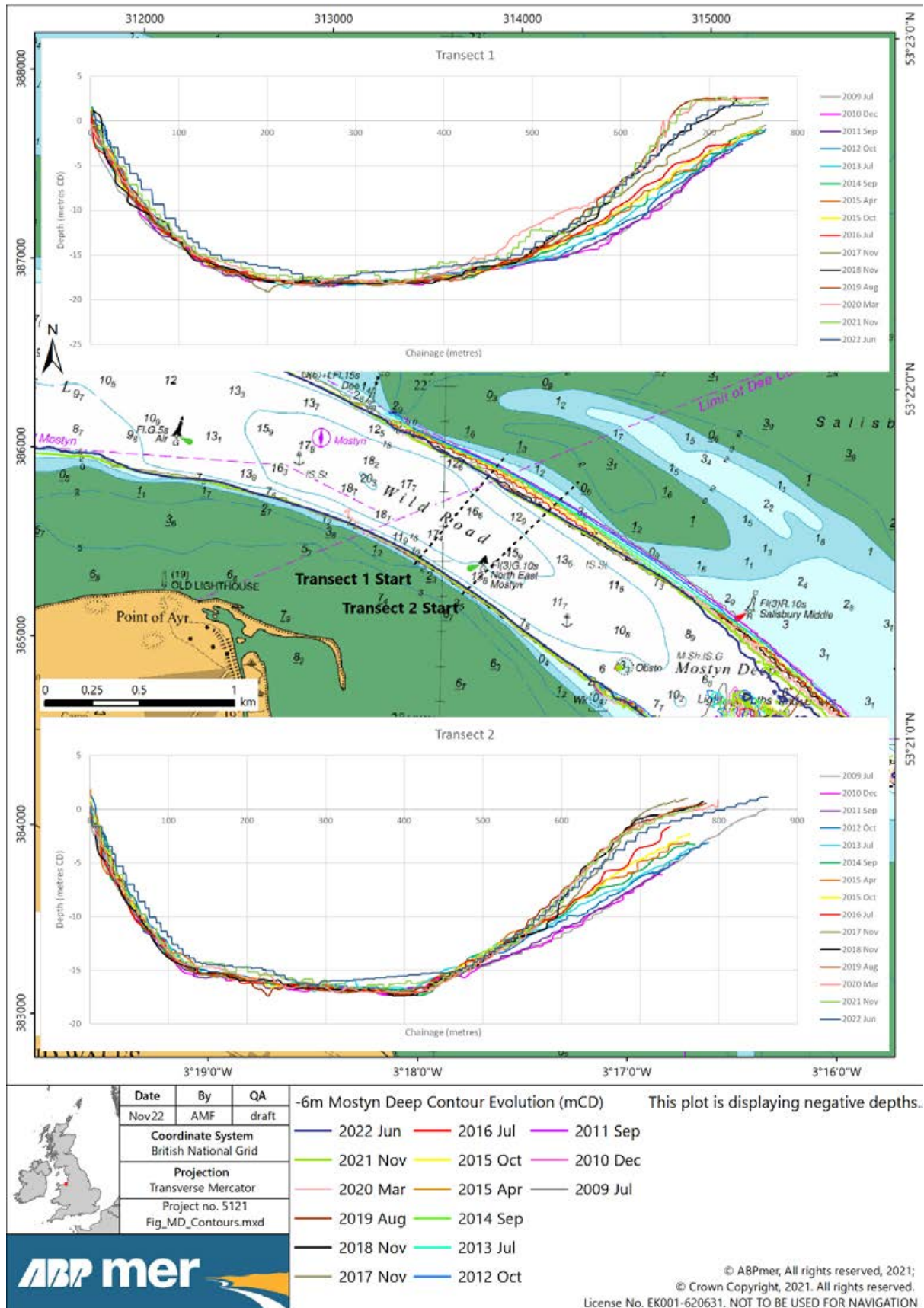


Figure 16. Bathymetric contour describing change in Mostyn Deep area 2009 to June 2022

3.5 EB5 Holocene Clay Bank

The physical and ecological conditions at the Holocene Clay Bank fluctuate over time and this has been recorded during the entire monitoring period. The aim of these surveys is to describe conditions on the Holocene Clay Bank, which is located on the Salisbury Middle and is a sub-feature of the Dee Estuary European Marine Site. This site is visited to understand the physical and ecological conditions of this exposed clay feature.

Originally these surveys were carried out annually or biennially to describe the abundance of piddock species within the clay habitat and also to describe the extent of the clay bank and the rate at which the exposed clay edge was eroding. In recent years, however, the clay has been covered by a relatively thick layer of sand. It has therefore been agreed with NRW that during such periods of sand coverage only *ad hoc* observations, rather than more detailed site visit and sampling work, are appropriate at this location. More detailed surveys and quantitative analyses of the site are only required as and when the bank becomes exposed again.

The Holocene Clay Bank was observed during the benthic survey (carried out during July 2022; ABPmer, 2022) and continued to be covered in a thick layer of sand; a situation that is expected to persist into the near future. The most recent observations of the site (see Figure 17), indicate that the area remains covered in sand. This site will continue to be observed on an *ad hoc* basis, with the nature of the substrate reviewed again as part of the annual Spring 2023 surveys.



Figure 17. Image of the 'clay bank' area from July 2022 indicating sand cover is maintained

4 Annual Dredging Records

The 2022 dredging activity, to date, under the existing licences, is summarised in Table 1. During this period, a total dredge of just over 32,000 tonnes has been extracted, with all of this material removed to shore.

Table 1. Log of dredging and disposal activity during this monitoring period (January to December 2022)

Campaign (Licence)	Dates	Ref#	Location	Disposal Volume (tonnes)		Total Volume (tonnes)
				To shore	Offshore	
Jan-22a (DML1542v2)	10 Jan – 17 Jan	A22	Approaches to pontoons	1,410	0	1,410
Jan-22b (DML1542v2)	26 Jan – 28 Jan	B22	Approaches to pontoons	1,275	0	1,275
Feb-22a (DML1542v2)	7 Feb – 15 Feb	C22	Approaches to pontoons	4,025	0	4,025
Feb-22b (DML1542v2)	24 Feb – 27 Feb	D22	Approaches to pontoons	660	0	660
Mar-22a (DML1542v2)	8 Mar – 16 Mar	E22	Approaches to pontoons	1,055	0	1,055
Mar-22b (DML1542v2)	24 Mar – 29 Mar	F22	Approaches to pontoons	1,045	0	1,045
Apr-22a (DML1542v2)	11 Apr – 14 Apr	G22	Approaches to pontoons	Cancelled due to technical issues		
Apr-22b (DML1542v2)	22 Apr – 27 Apr	H22	Approaches to pontoons	Cancelled due to technical issues		
May-22a (DML1542v2)	4 May – 13 May	I22	Approaches to pontoons	5,975	0	5,975
May-22b (DML1542v2)	23 May – 26 May	J22	Approaches to pontoons	3,135	0	3,135
Jun-22a (DML1542v2)	6 Jun – 10 Jun	K22	Approaches to pontoons	3,180	0	3,180
Jun-22b (DML1542v2)	20 Jun – 24 Jun	L22	Approaches to pontoons	1,375	0	1,375
Jul-22a (DML1542v2)	5 Jul – 7 Jul	M22	Approaches to pontoons	2,030	0	2,030
Jul-22b (DML1542v2)	22 Jul – 27 Jul	N22	Approaches to pontoons	Cancelled due to technical issues		
Aug-22a (DML1542v2)	4 Aug – 10 Aug	O22	Approaches to pontoons	Cancelled due to technical issues		
Aug-22b (DML1542v2)	18 Aug – 24 Aug	P22	Approaches to pontoons	1,535	0	1,535
Sep-22a (DML1542v2)	5 Sep – 7 Sep	Q22	Approaches to pontoons	880	0	880
Sep-22b (DML1542v2)	19 Sep – 23 Sep	R22	Approaches to pontoons	Cancelled due to bore hole rig proximity		
Oct-22a (DML1542v2)	3 Oct – 7 Oct	S22	Approaches to pontoons	Cancelled due to bore hole rig proximity		
Oct-22a (DML1542v2)	17 Oct – 21 Oct	T22	Approaches to pontoons	1,495	0	1,495
Nov-22a (DML1542v2)	31 Oct – 3 Nov	U22	Approaches to pontoons	1,385	0	1,385

Campaign (Licence)	Dates	Ref#	Location	Disposal Volume (tonnes)		Total Volume (tonnes)
				To shore	Offshore	
Nov-22b (DML1542v2)	14 Nov – 18 Nov	V22	Approaches to pontoons	1,665	0	1,665
Dec-22a (DML1542v2)	30 Nov – 4 Dec	X22	Approaches to pontoons	Cancelled due to technical issues		
Dec-22b (DML1542v2)	13 Dec – 20 Dec	Y22		To be completed		
TOTAL				32,125	0	32,125

During each campaign, dredge depths of up to 2 m below Chart Datum were achieved, although in some cases finished bed levels were shallower than this (as determined by vessel access requirements).

The approximate extent of the recent dredging campaigns is provided in Figure 18.

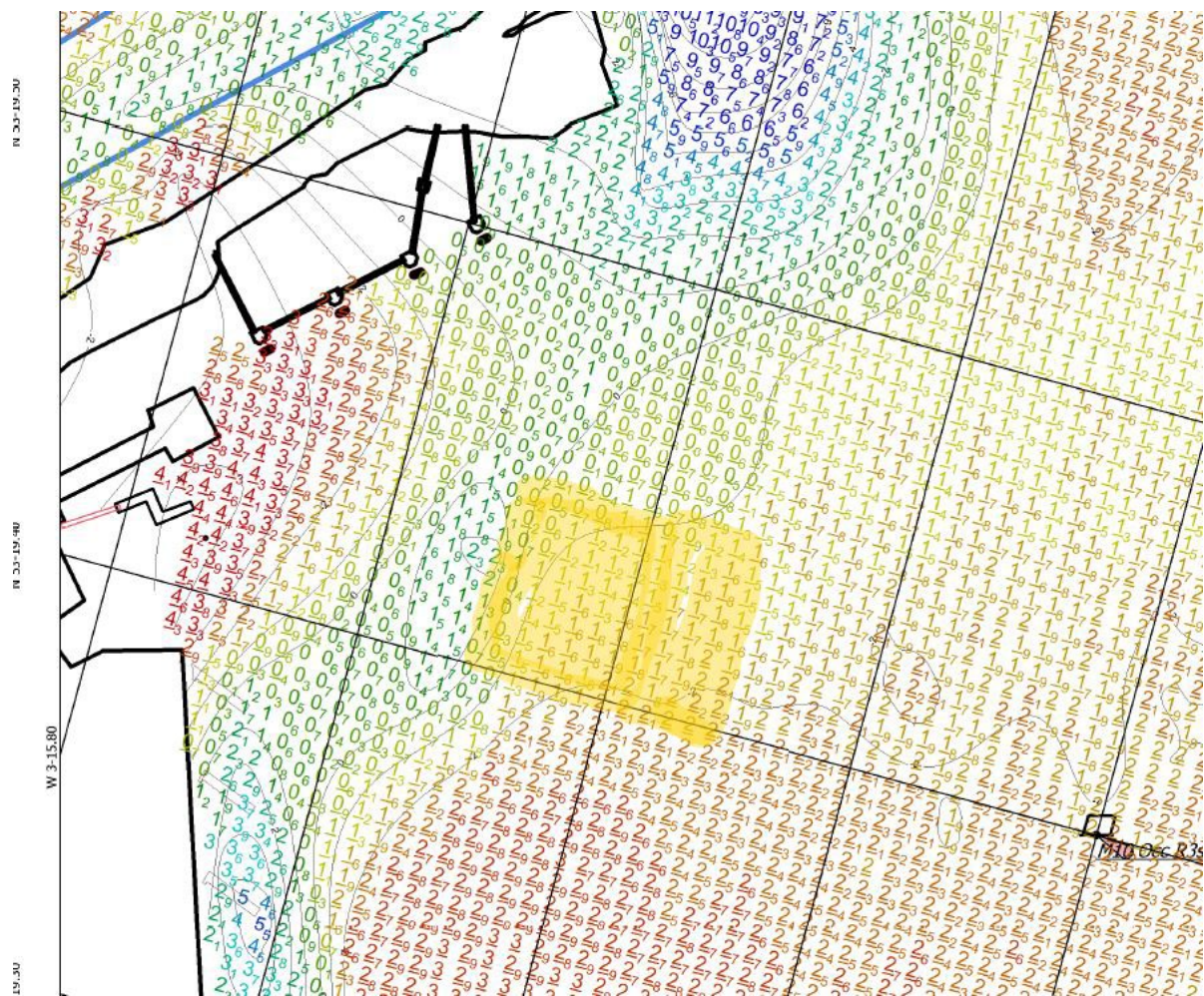


Figure 18. Dredge area for recent 2022 dredge campaigns

5 Next Steps

In the immediate future, the existing monitoring regime will continue, with repeat LA and EB survey campaigns, interim Progress Notes and annual reporting. Alongside the present monitoring, the Port is in the process of submitting an application (with associated assessment) for the Mostyn Energy Park Extension (MEPE) development.

As part of this assessment, the future monitoring regime is intended to be aligned across all of the Port activities. As part of this process, it is anticipated that the Port's existing (and possible future MEPE) licences will be combined into a single licence. This process would aim to collate the DML1542v2 and DML2001 licences, with a review of each of the individual licence conditions, in order to better reflect various aspects of the Port operations and the outcomes of the MEPE assessment phase.

6 References

ABPmer, 2017. Review of Dredge and Disposal Monitoring. Overview of survey work carried out by the Port in the Dee Estuary from 2005 to 2016. ABPmer Report No. R2713. A report produced by ABPmer for Port of Mostyn Ltd., March 2017.

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ABPmer, (2021c). Mostyn Dredge and Disposal – Hydraulic Modelling Studies 2021: Review of annual bathymetric survey and numerical modelling work for Marine Licence DML1542v2 ABPmer Report No. R.3756. A report produced by ABPmer for The Port of Mostyn Limited, November 2021.

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ABPmer, (2022). Mostyn Dredge and Disposal: Spring Ecology Survey 2022. Monitoring for Tasks LA5 and EB5 of NRW Marine Licence DML1542v2 ABPmer Report No. R.3946. A report produced by ABPmer for The Port of Mostyn Limited, November 2022.

SMP, 2008. Maintenance of Navigation. Mostyn Channel Monitoring Protocols. A report produced by Shoreline Management Partnership for Port of Mostyn. December 2008.

7 Abbreviations/Acronyms

ACD	Admiralty Chart Datum
CD	Chart Datum
EB	Estuary Wide
LA	Local Area
LiDAR	Light Detection and Ranging
MBES	Multibeam Echosounder
NRW	Natural Resources Wales
ODN	Ordnance Datum Newlyn
PSA	Particle Size Analysis
Q	Quarter
SMP	Shoreline Management Partnership

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

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E Annual Monitoring: June 2023 Progress Note (ABPmer, 2023)

MONITORING PROGRESS REPORT

Port of Mostyn Ltd.				PROGRESS REPORTING		
Project	Maintenance Dredge/Deposition	Period	From	March 2023	To	June 2023
Report prepared by:	ABPmer	Date	03 Jul 2023	Report No.	1	Pg. 1 of 6

1. TRAFFIC LIGHT – MOVING SUMMARY							
Monitoring Task	Monitoring Regime – 2.0m below CD dredge limit						Threshold Exceedance Report
	-5	-4	-3	-2	-1	Current	
EB2 Estuary Transects							N/A
LA1 Channel Bathy							N/A

Monitoring Task	Bi-annual			Threshold Exceedance Report
	-2	-1	Current for this report	
EB3 Mid-Hoyle Bathy				NA
EB5 Holocene Clay Bank			NA	NA

Monitoring Task	Annual		Threshold Exceedance Report
	Previous	Current for this report	
EB1 Estuary LiDAR		NA	NA
EB4 Mostyn Deep Bathy			NA
LA3 Mostyn Deep PSA			NA
LA4 NRW Cockle Report		NA	NA
LA5 Benthic Survey		NA	NA

Monitoring Task	Dredge Campaign – N/A		Threshold Exceedance Report
	Previous Campaign	Current for this report	
LA2	Not required for dredging < 2.0m below CD dredge limit	Not required for dredging < 2.0m below CD dredge limit	NA
LA6	Not required for dredging < 2.0m below CD dredge limit	Not required for dredging < 2.0m below CD dredge limit	NA

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Port of Mostyn Ltd.				PROGRESS REPORTING			
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2) TIMETABLE CONCORDANCE													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	
Task													
EB1 Estuary LiDAR													
EB2 Estuary Transects													
EB3 Mid-Hoyle Bathy													
EB4 Mostyn Deep Bathy													
EB5 Clay Bank													
LA1 Approach Channel Bathy													
LA2	←----- (As appropriate: Not required for dredging < 2.0m below CD dredge limit) ----->												
LA3 Mostyn Deep PSA													
LA4 NRW Cockle Report													
LA5 Benthic Survey													
LA6	←----- (As appropriate: Not required for dredging < 2.0m below CD dredge limit) ----->												
Progress Reports													
Annual Report													

TASKS	
Current	Next
LA1 Channel Bathy and additional (beyond scope) surveys of Hilbre Swash and Salisbury Channel (May 2023).	LA3 PSA sampling scheduled for Autumn 2023
EB2 Estuary Transect survey completed in June 2023. Results included in this Progress Note.	LA4 Cockle Report – requested from NRW, to be included once final report available
EB3 Mid-Hoyle bathymetry survey completed in June 2022, with analysis included in this Progress Note.	LA5 Benthic Survey completed May 2023. Data processing, analysis and reporting currently underway.
EB4 Mostyn Deep bathymetry survey completed in June 2022, with analysis included in this Progress Note.	EB5 Holocene Clay Bank observations have been delayed by unfavourable tidal conditions. Planned for July 2023
June Progress Note - this report.	Progress Note – next note due October 2023. To contain analyses of data collected since June 2023 Progress Note
	Annual Report – next annual report scheduled for November 2023



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Port of Mostyn Ltd.				PROGRESS REPORTING		
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3. MONITORING PLAN REQUIREMENTS

Task Ref	Description	Reported Here (Y/N)	Status: (Red/Amber/Green)	Threshold Exceedance Report
EB1	Estuary Seabed Level Survey	N	NA	NA
EB2	Estuary Transects	Y	Green	NA
EB3	Mid Hoyle/Welsh Confluence	Y	Green	NA
EB4	Mostyn Deep	Y	Green	NA
EB5	Holocene Clay Bank	N	NA	NA
LA1	Dredged Channel Survey	Y	Green	NA
LA2	Mostyn Deep Site 'A'	N	Survey Not Required	Survey Not Required
LA3	Mostyn Deep Seabed Samples	N	NA	NA
LA4	Cockle Survey	N	NA	NA
LA5	Benthic Survey	N	NA	NA
LA6	Berthing Area Survey	N	Survey Not Required	Survey Not Required

4. PROGRESS NARRATIVE

Task Ref	Narrative	Appendix
LA1	MBES survey completed in May 2023, plus extra surveys of Hilbre Swash and Salisbury Channel (beyond the scope). Monitoring for DML1542 and DML2001.	A
LA5	Benthic ecology survey completed in May 2023. Data processing and reporting currently underway, with report to be submitted in due course.	NA
EB2	MBES Estuary Transect survey completed in May 2023, analysis included in this Progress Note.	B
EB3	MBES Mid-Hoyle Channel survey completed June 2023; analysis included in this Progress Note.	C
EB4	MBES Mostyn Deep survey completed June 2023; analysis included in this Progress Note.	D
-	Tabulated details of dredge campaigns and disposals over this monitoring period	E

MONITORING PROGRESS REPORT

Port of Mostyn Ltd.				PROGRESS REPORTING		
Project	Maintenance Dredge/Deposition	Period	From	March 2023	To	June 2023
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5) MONITORING OVERVIEW

Reconciliation of results in this report with 'early-warning' parameters and estuary basis summary as set out in SMP 'Mostyn Channel Monitoring Protocols' (2008).

Monitoring Protocols report (rev. 4.0) December '08 relevant extracts:

EXTRACT 1

Task	Frequency	Spatial Extent	Analysis	Evolution Issues
EB2 Estuary Transects	Bi-monthly	North Middle and South transects as presently defined	Channel/Bank parameters; Datum level area(s) above seabed	A, B, D (part)

Task	Frequency	Spatial Extent	Analysis	Evolution Issues
LA1 Dredged Channel Survey	Bi-monthly	Northern limit = 384000; Southern limit = 382000; Western limit = 250m west of channel centreline; Eastern limit = 316400. Survey lines to be 100m apart except for longitudinal sections A to K to be set 50 m apart (see Figure 3). Survey spatial limits shown on Figures 1&2.	Selected cross-section and longitudinal section profiles overlaid on previous surveys with correlation to dredge campaign locations and volumes.	Local - spatial extent and depth of dredging campaigns; lateral extent of profile changes due to dredging. Ambient - seabed level changes adjacent to channel over the area of impact forecast by the numerical model.

MONITORING PROGRESS REPORT

Port of Mostyn Ltd.				PROGRESS REPORTING		
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5. MONITORING OVERVIEW (...cont.)

EB2 – Estuary Transects		
Transect Ref.	Relevant Features	Stage I Threshold exceedance
North	No significant change from previous survey	N
Middle	No significant change from previous survey	N
South	No significant change from previous survey	N
LA1 – Channel surveys and cross-section		
Channel Section Ref.	Relevant Features	Stage I Threshold exceedance
Section 20	Change to 2010: Bathymetric change over the monitoring period continues to show changes in the orientation and alignment of both the Mostyn Channel (west of the Port) and the Salisbury Channel (east of the Port). Change to October 2022: Bathymetric change between the two recent surveys reveal the small, continued changes along the western edge of the Mostyn Channel where erosion continues into the Mostyn Bank, to the west of the Port of Mostyn. Slight changes in the Salisbury Channel are also observed to the east of PoM.	N
Bathymetric surface difference plots	No disposal has been undertaken at the IS103 (Breakwater) disposal site during the present monitoring period, with all dredge material removed to shore	NA

Threshold Exceedance Report

NA

6. ACTIONS

Task Ref	Action Description	To be initiated by
1	No specific actions identified	NA
2	Additional (beyond scope) Port management surveys to continue, covering Salisbury Channel (on its own), harbour and Hilbre Swash. These are not specifically required by the monitoring conditions but are carried out regularly by the Port of Mostyn in order to understand and manage vessel access.	NA

MONITORING PROGRESS REPORT

Port of Mostyn Ltd.				PROGRESS REPORTING		
Project	Maintenance Dredge/Deposition	Period	From	March 2023	To	June 2023
Report prepared by:	ABPmer	Date	03 Jul 2023	Report No.	1	Pg. 6 of 6

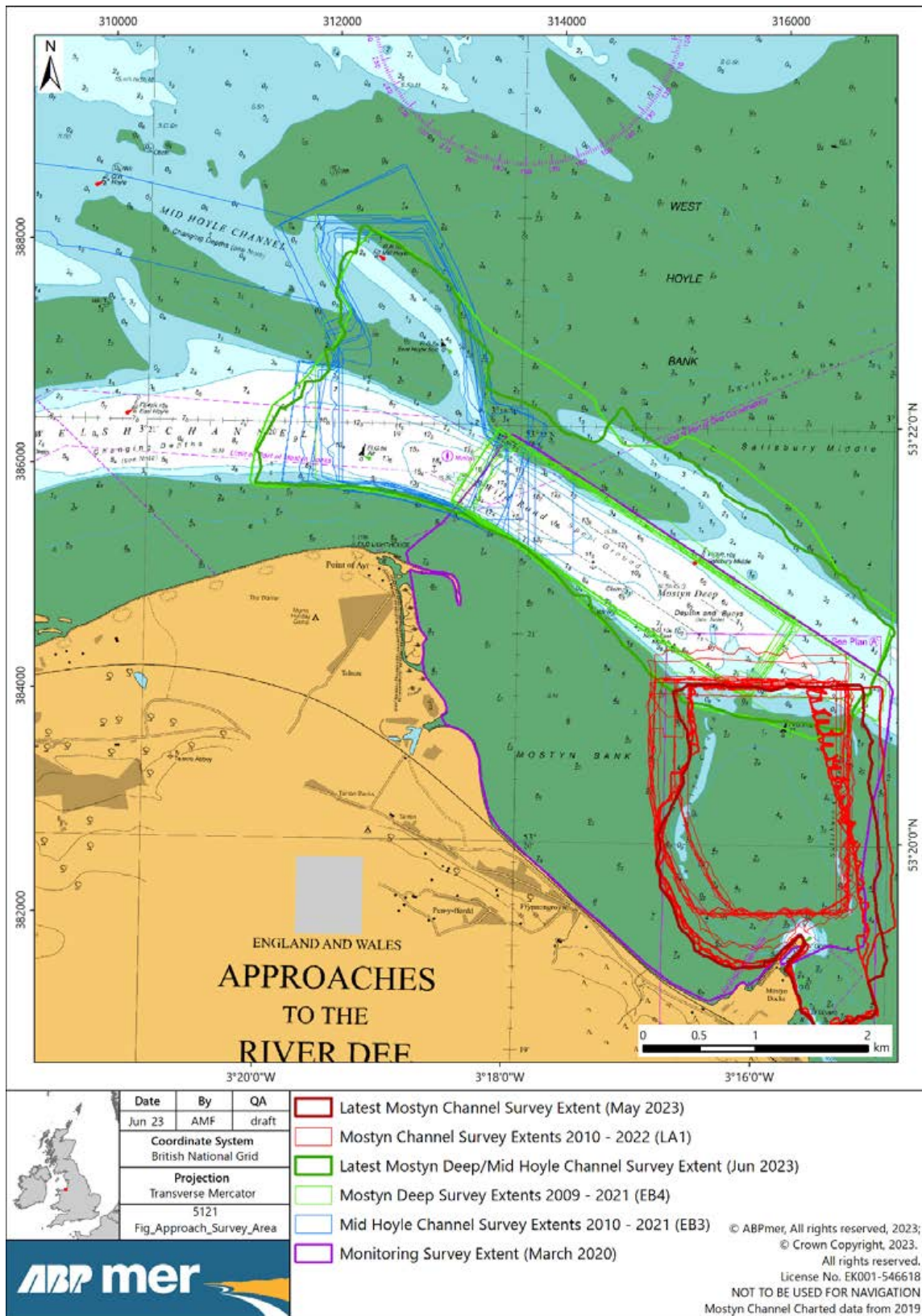
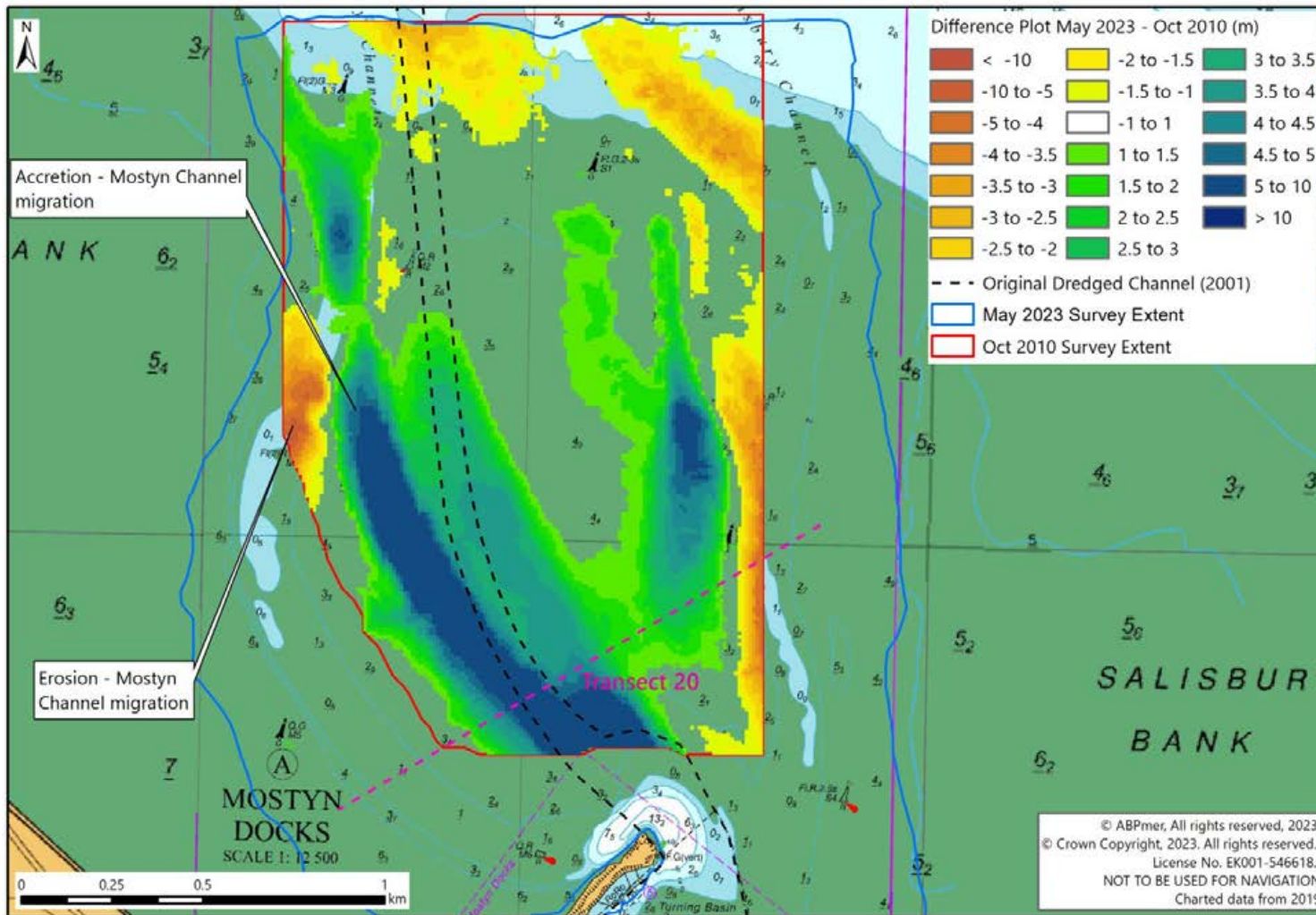


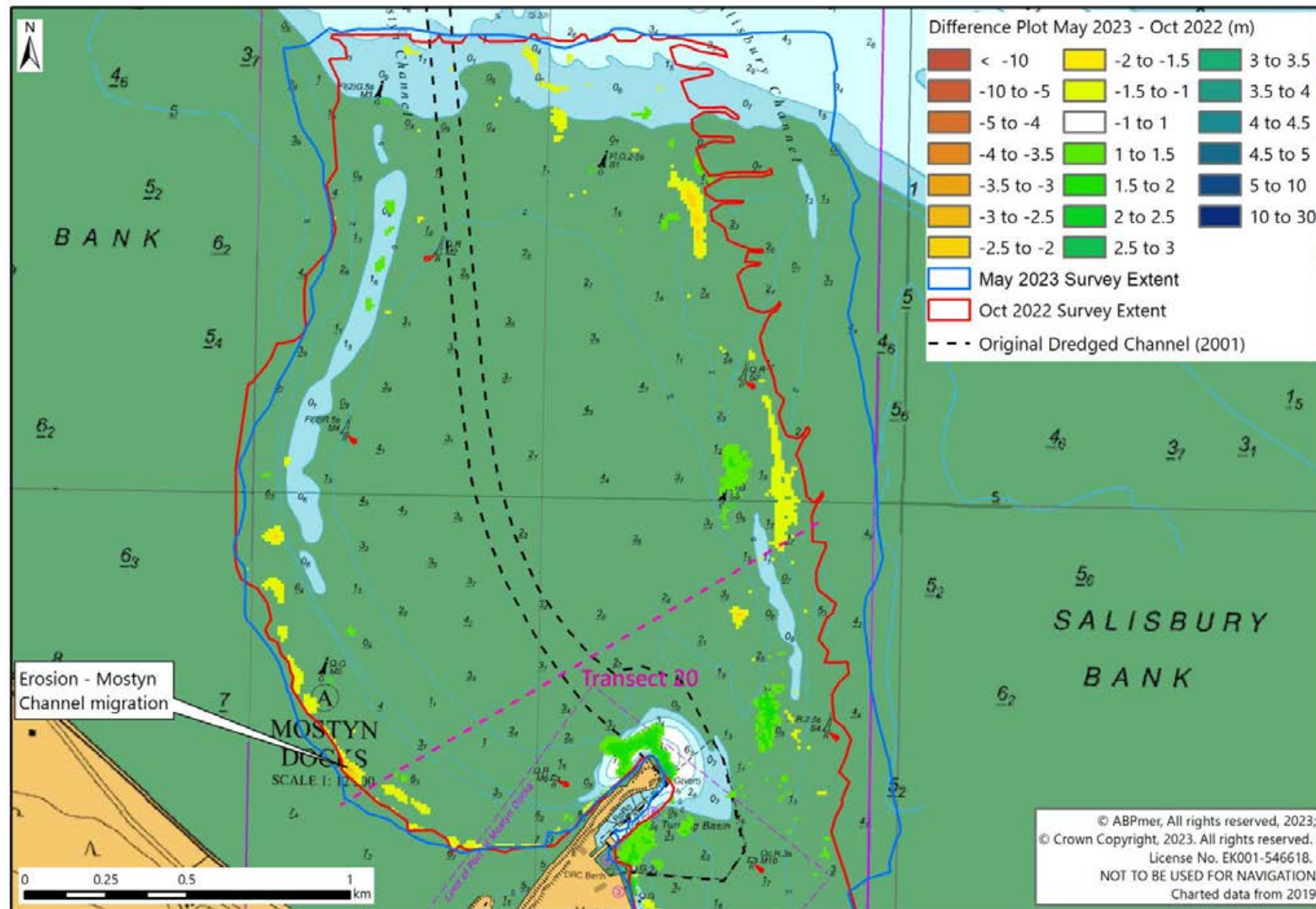
Figure 1. Recent and historic survey extents for LA1, EB3 and EB4 surveys



June 2023 Progress Note: Appendix A – LA1 surveys

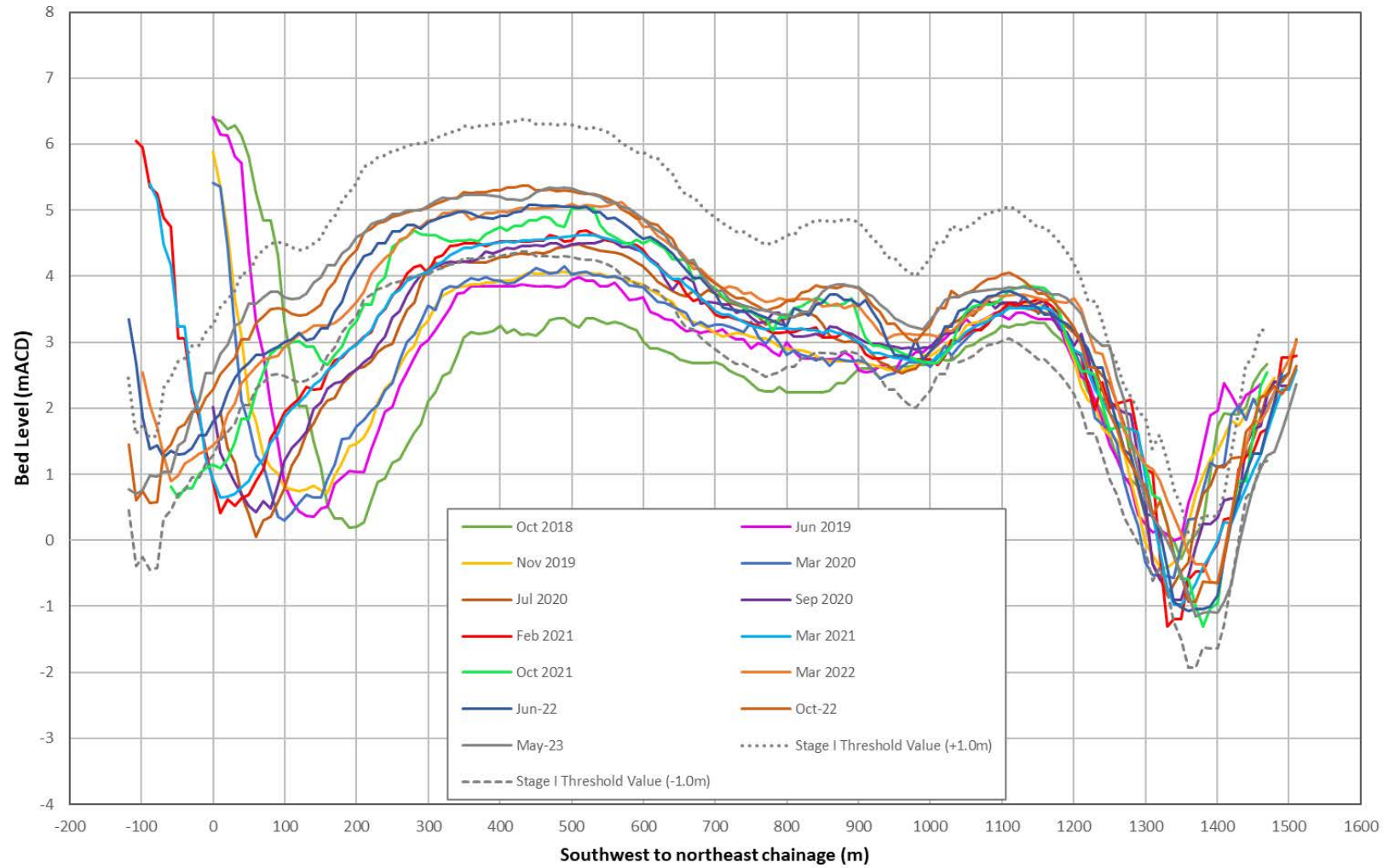


Bathymetric difference plot between October 2010 and May 2023

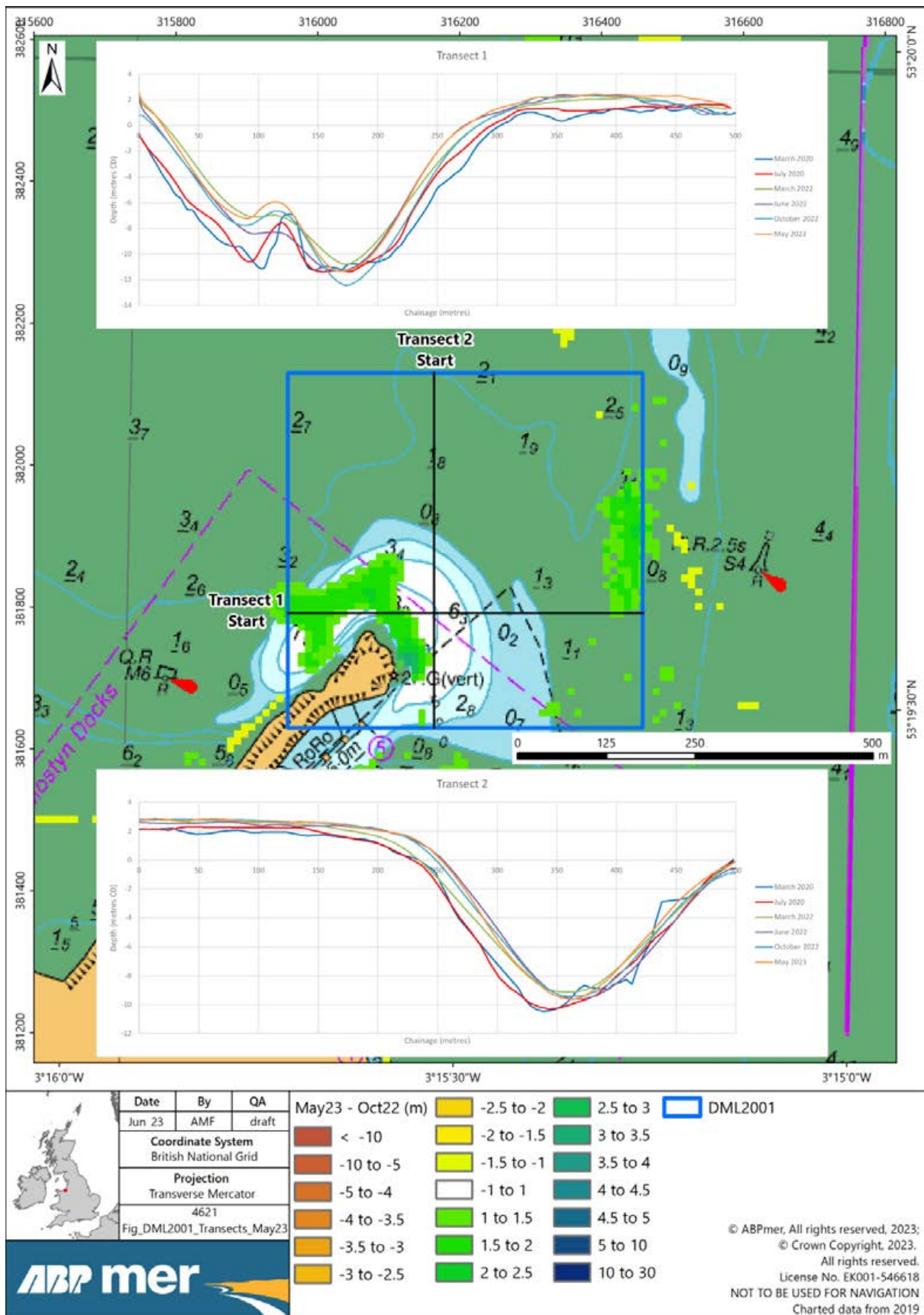


Bathymetric difference plot between May 2023 and October 2022

PORT OF MOSTYN
Inner Channel Sections - Section 20

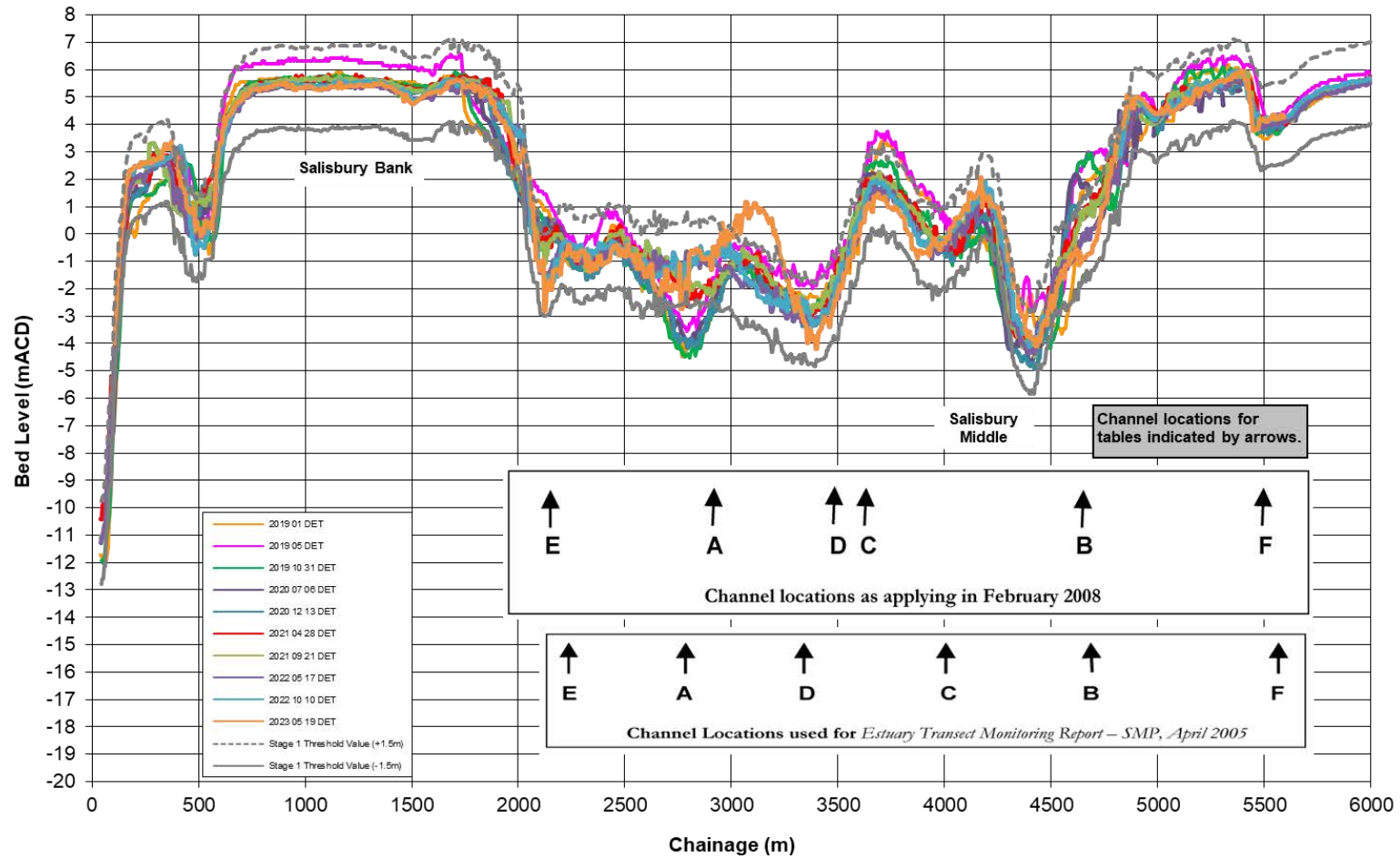


Bathymetric variation plot along Profile 20 between October 2018 and May 2023



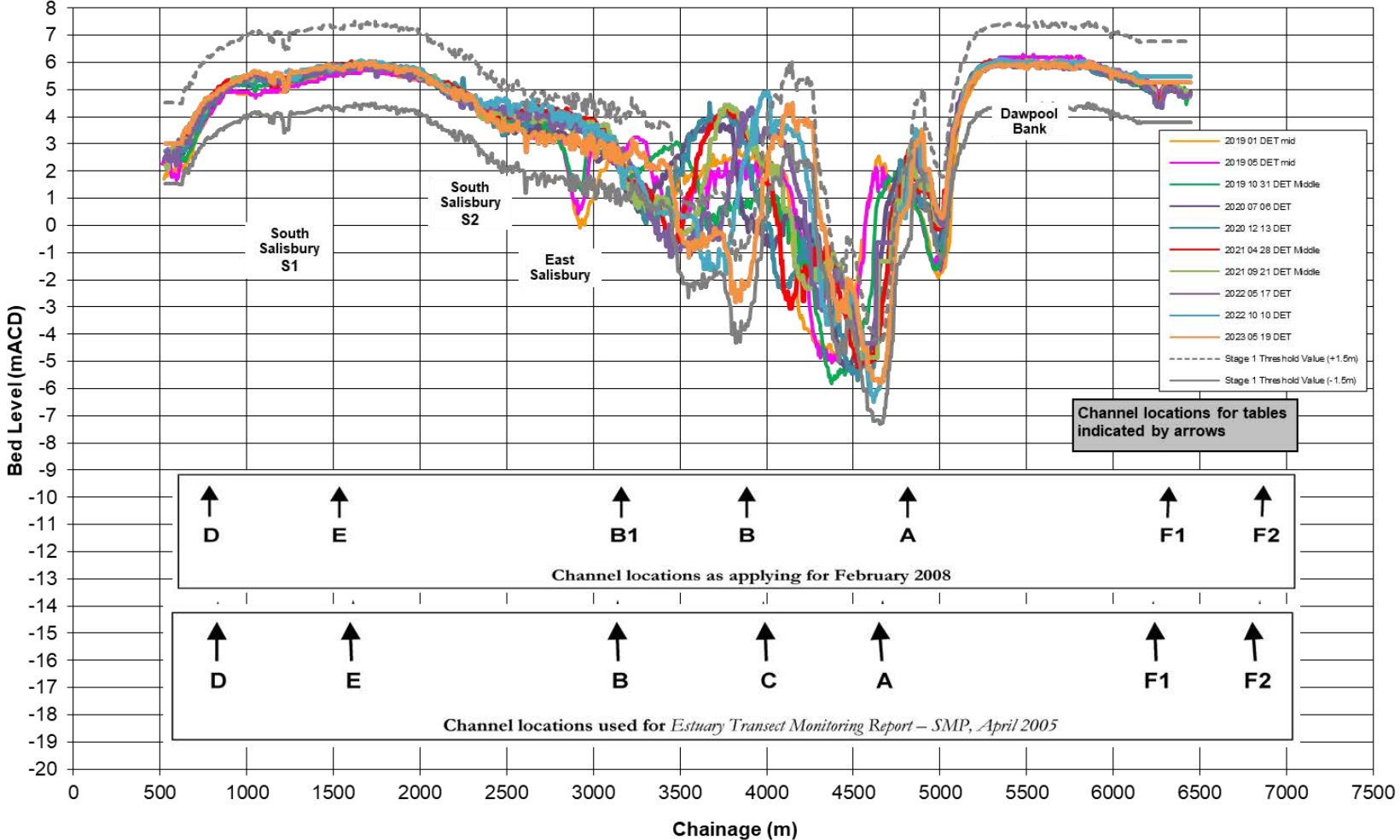
Subset of LA1 survey covering the IS103 (Breakwater) disposal site

NORTH TRANSECT



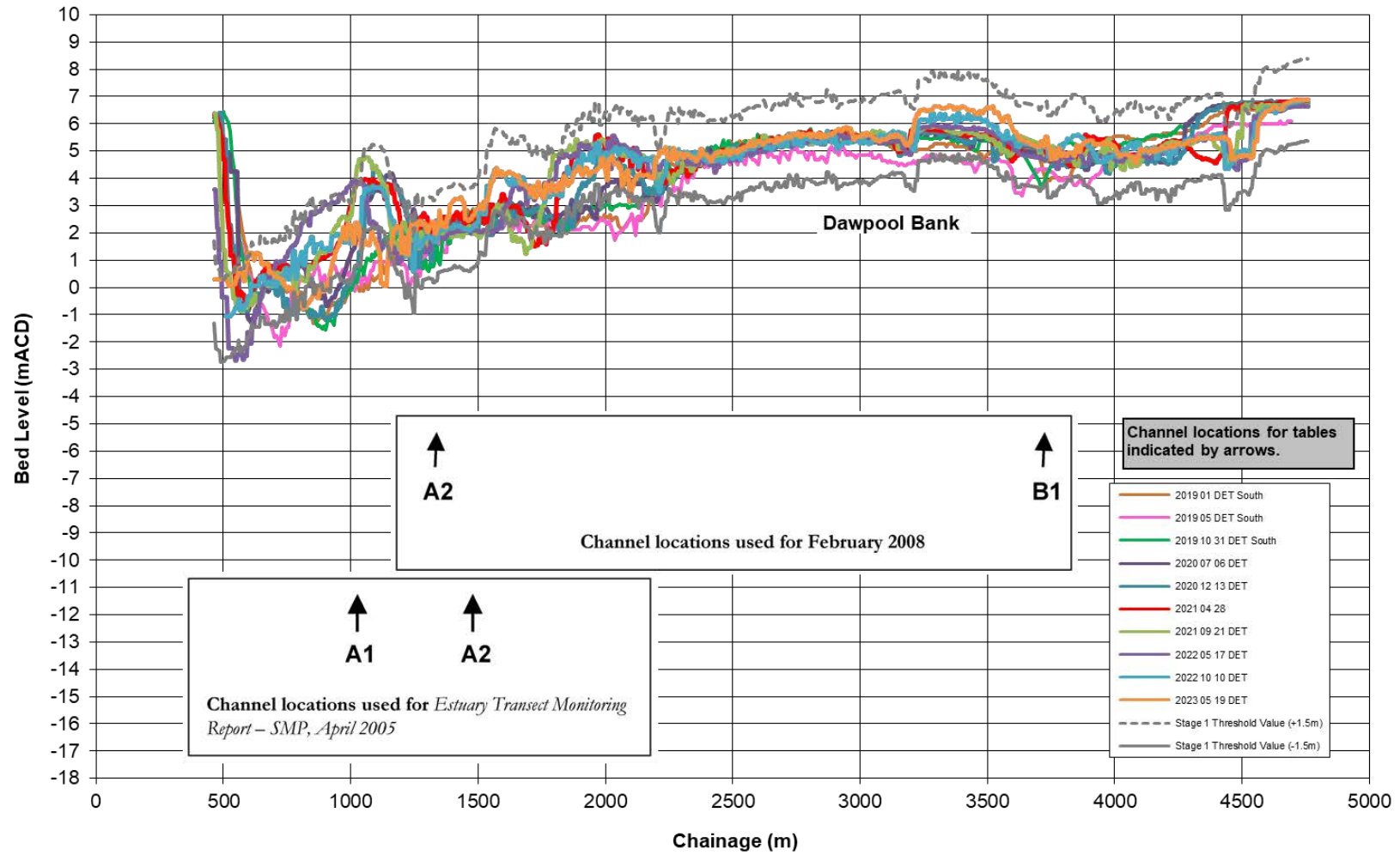
Dee Estuary Transect (North) between January 2019 and May 2023

MIDDLE TRANSECT



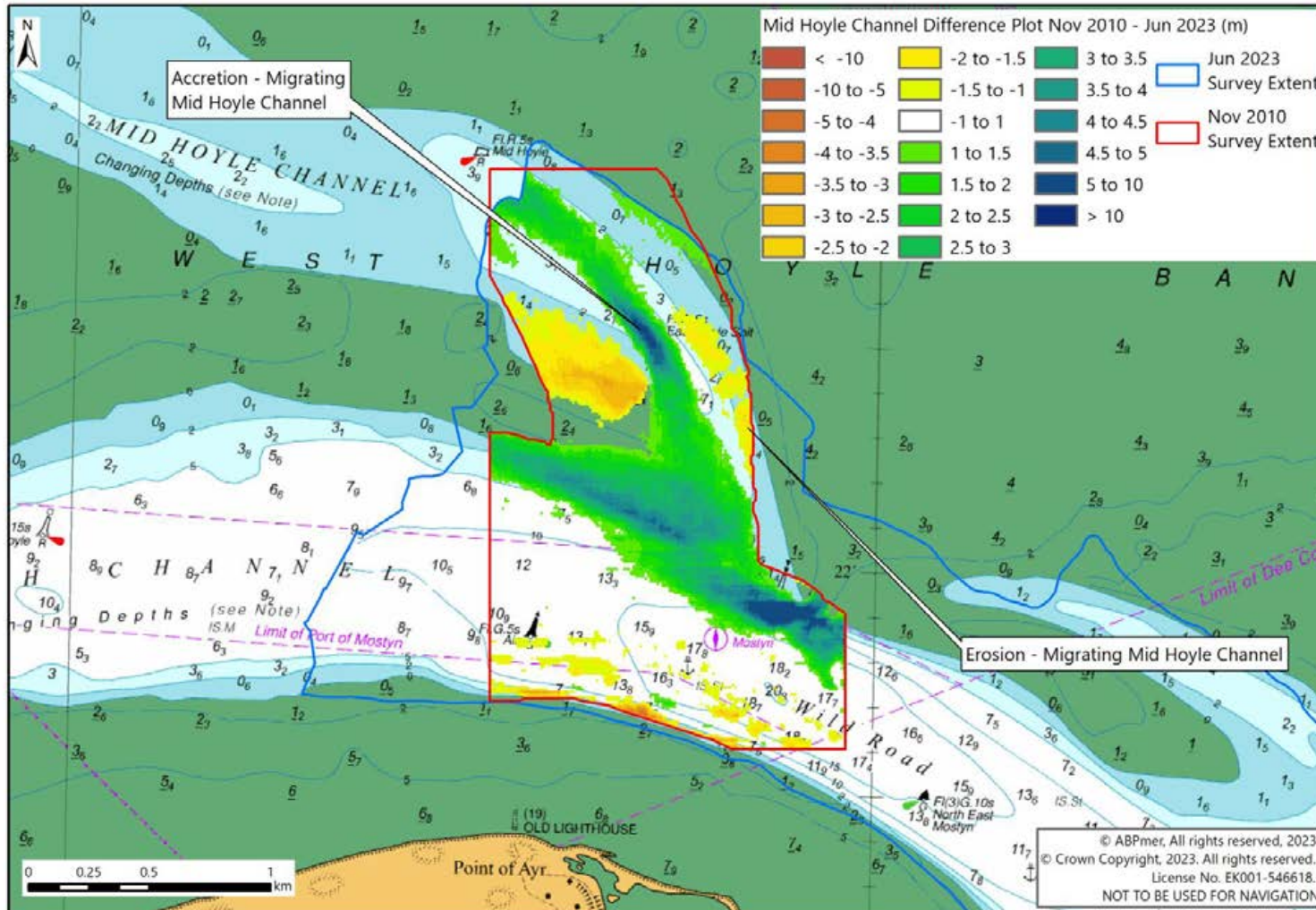
Dee Estuary Transect (Middle) between January 2019 and May 2023

SOUTH TRANSECT



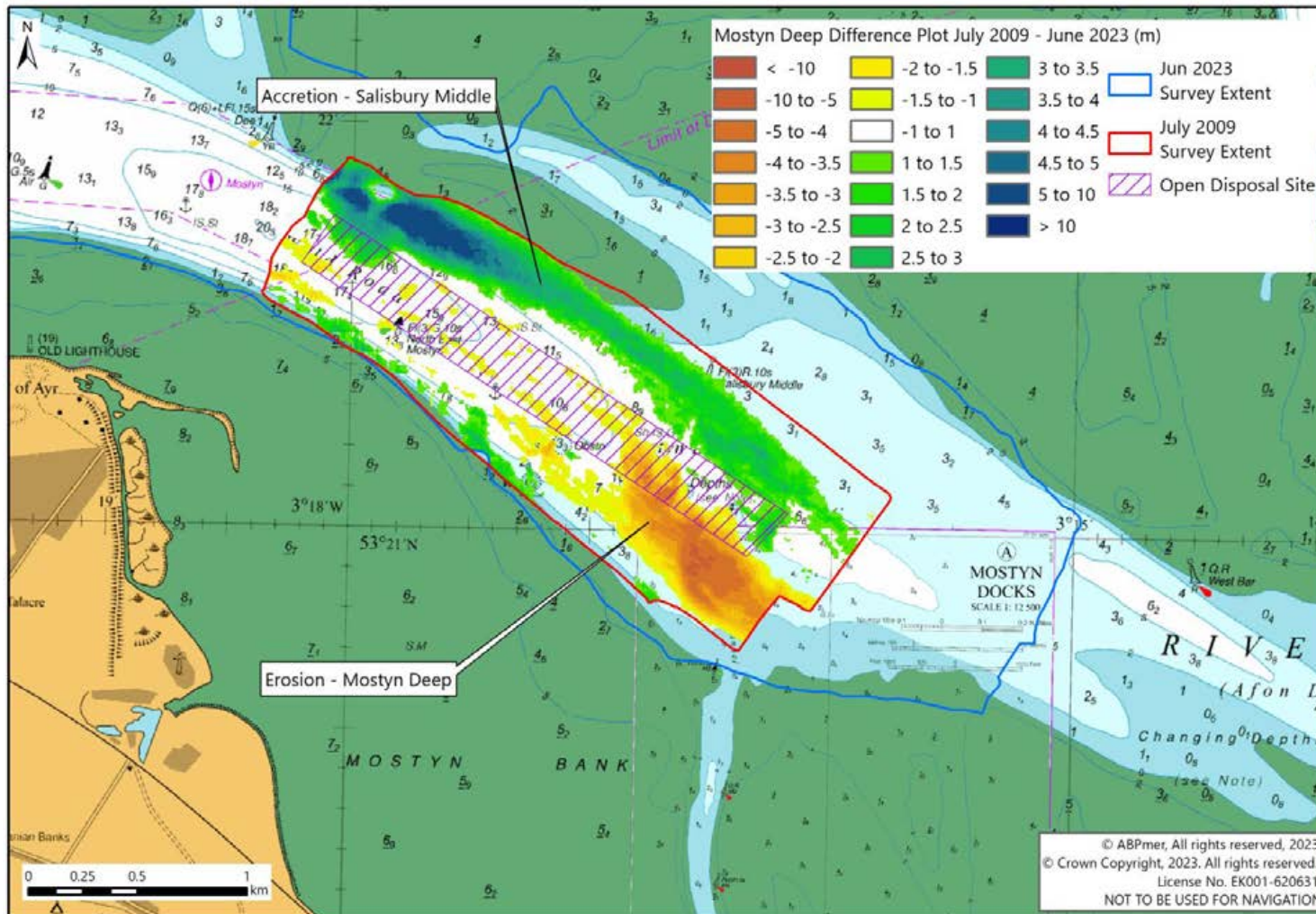
Dee Estuary Transect (South) between January 2019 and May 2023

June 2023 Progress Note: Appendix C – EB3 (Mid Hoyle Channel) survey



Bathymetric difference between November 2010 and June 2023

June 2023 Progress Note: Appendix D – EB4 (Mostyn Deep) survey



Bathymetric difference between July 2009 and June 2023

Appendix E – Log of dredging and disposal activity during this monitoring period (March to June 2023)

Campaign (Licence)	Dates	Ref#	Location	Disposal volume (tonnes)		Total volume (tonnes)
				To shore	Offshore	
Jan-23a (DML1542v2)	16th Jan - 19th Jan	A23	Approaches to pontoons / quay	1,025	0	1,025
Jan-23b (DML1542v2)	30th Jan - 3rd Feb	B23	Approaches to pontoons / quay	1,485	0	1,485
Feb-23a (DML1542v2)	13th Feb - 17th Feb	C23	Approaches to pontoons / quay	1,500	0	1,500
Feb-23a (DML1542v2)	27 th Feb – 3 rd Mar	D23	Approaches to pontoons / quay	3,130	0	3,130
Mar-23a (DML1542v2)	13 th Mar – 17 th Mar	E23	Approaches to pontoons / quay	2,560	0	2,560
Mar-23b (DML1542v2)	27 th Mar – 31 st Mar	F23	Approaches to pontoons / quay	2,430	0	2,430
Apr-23a (DML1542v2)	11 th Apr – 14 th Apr	G23	Approaches to pontoons / quay	Cancelled for maintenance (postponed due to weather)		
Apr-23b (DML1542v2)	25 th Apr – 28 th Apr	H23	Approaches to pontoons / quay	2,590	0	2,590
May-23a (DML1542v2)	10 th May – 15 th May	I23	Approaches to pontoons / quay	Cancelled due to operational reasons		
May-23b (DML1542v2)	24 th May – 31 st May	J23	Approaches to pontoons / quay	Cancelled due to operational reasons		
Jun-23a (DML1542v2)	TBC	K23	Approaches to pontoons / quay			
Jun-23b (DML1542v2)	TBC	L23	Approaches to pontoons / quay			
TOTAL				14,720	0	14,720

During each campaign, dredge depths of up to 2 m below Chart Datum were achieved, although in some cases finished bed levels were shallower than this (as determined by vessel access requirements).

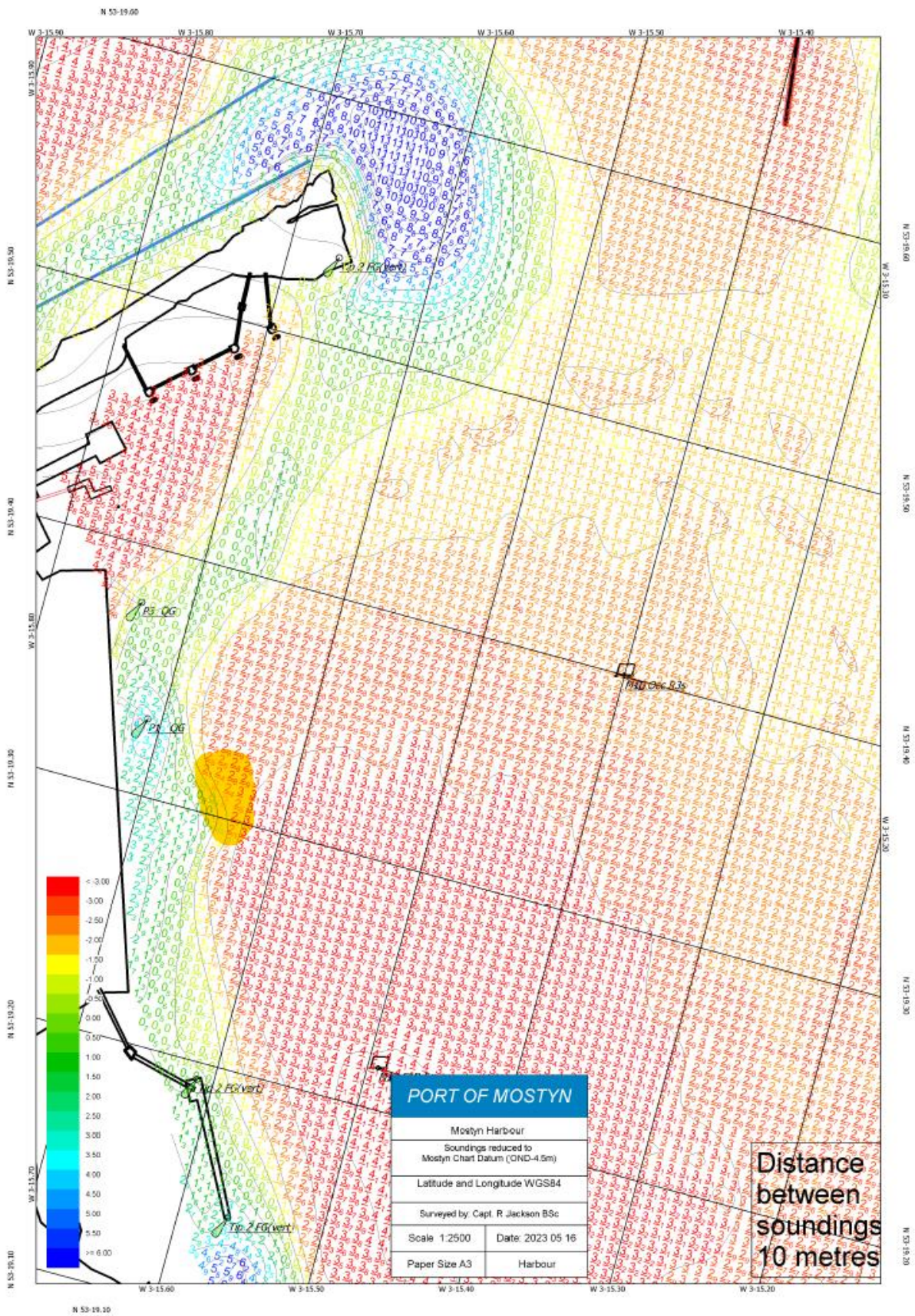


Figure B.1. Dredge area for January to May 2023 dredge campaigns

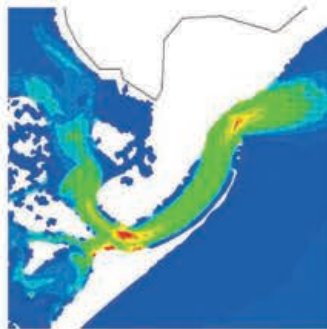
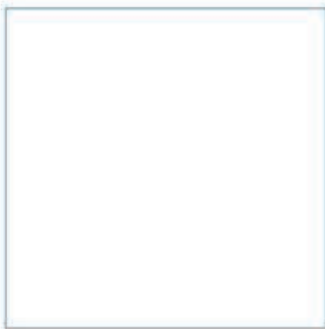
F Mostyn Dredge and Disposal Ecology Survey Report (ABPmer, 2022)

The Port of Mostyn Limited

Mostyn Dredge and Disposal: Spring Ecology Survey 2022

Monitoring for Tasks LA5 and EB5 of
NRW Marine Licence DML1542v2

November 2022



Innovative Thinking - Sustainable Solutions



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Mostyn Dredge and Disposal: Spring Ecology Survey 2022




Monitoring for Tasks LA5 and EB5 of
NRW Marine Licence DML1542v2

November 2022



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1 Introduction

1.1 Project background

This report presents results from ecological surveys carried out on the Dee Estuary during 2022. These were undertaken as a condition of Marine Licence DML1542v2 (as issued on 1 May 2019). This licence provides permissions and sets conditions for dredging and disposal work that is required to maintain navigable approaches to the Port of Mostyn.

The marine licence covers the period from 1 May 2019 to 31 March 2025 and provides consent for both maintenance dredging and (if required) larger capital deepening work (to a depth of -4 mCD) in the Approach Channel. So far, under this latest licence, as well as under preceding respective licences over the last 15 years, only comparatively small levels of maintenance dredging have been undertaken annually. There has been no need, as yet, to carry out any larger capital deepening (ABPmer, 2021).

The latest ecological surveys required under the licence were conducted in fulfilment of Tasks LA5 (Benthic Habitat Survey) and EB5 (Holocene Bank Survey). These surveys are part of a much wider programme of monitoring and reporting that has been progressed over 17 years under the extant and preceding licences. The protocols for this monitoring are outlined in the licences and within relevant supporting documentation and reviews (Shoreline Management Partnership (SMP), 2008; ABPmer 2017a).

Task LA5 involves carrying out field surveys of the seabed (benthic) habitats on either side of the Port's navigable approach channel. This is carried out to evaluate changes in the 'Local Area' (LA). Task EB5 involves site visits and/or field surveys to describe habitats on the intermittently exposed Holocene Clay Bank feature in the Outer Dee Estuary. This is carried out to provide information about wider, and potentially influential, changes on an 'Estuary Basis' (EB). The aim of these surveys, alongside findings from other monitoring elements, is to provide the information needed to assess the effects of channel deepening work on the condition of the Dee Estuary designated sites (CCW and Natural England, 2010).

1.2 Survey work in 2022

The methods employed for each of the two survey tasks during 2022 are summarised in the following sections. If required, further details about the background to the work and the reasons why specific methods are employed can be found in preceding ecological survey reports¹ and in both the SMP (2008) and ABPmer (2017a) documents.

1.2.1 Benthic habitat survey (Task LA5)

The benthic survey work required for Task LA5 involves annual or, if needed, biannual surveys of the intertidal habitats on either side of the navigable approach channel. The survey area and sampling locations are shown in Figure 1.

Morphological features of relevance to the monitoring programme are shown in Figure 2 for context.

¹ There have been 20 such survey reports over the last 15 years (ABPmer, 2006, 2007, 2008, 2009; 2010a & b; 2011a & b; 2012a & b; 2013a & b; 2014a & b; 2015; 2017b; 2018, 2019, 2020, 2021).

The 2022 Spring Equinox Survey was undertaken on 16 June using a two-person survey hovercraft to access the 26 sample locations. These sites are located along six transects:

- Transect A - six sites,
- Transect B - four sites,
- Transect C - four sites,
- Transect D - three sites,
- Transect W - five sites; and
- Transect Y - four sites.

At each site, a single surface sediment sample was retrieved for Particle Size Analysis (PSA), according to a practice that has been used since 2009. Field notes were made at each sampling point, recording details such as the broad sediment type; the specific characteristics of the habitat at the precise point where the samples were retrieved (e.g. within the trough or crest of sand ripples); the general characteristics of the wider habitat; the presence of visible invertebrate fauna and the depth of the anoxic layer. A photographic record of the broader habitat appearance was also made to compare against photographs taken at the same sites previously (see Appendix A). In addition, a high-definition (HD) camera was used to capture video imagery of the survey area.

The samples taken at each site were returned to the ABPmer laboratory for PSA, which was undertaken by laser diffraction (using a Malvern Mastersizer system). The results of this analysis are described in Section 2.1 and are compared against the results of previous surveys.

The results of the most recent (2021) Light Detection and Ranging (LiDAR) survey (Task EB1 of DML1542v2) have also been used to assist with the interpretation of the 2022 Spring Equinox Survey results (and has been used as a background to Figure 1 and Figure 3 to Figure 8).

1.2.2 Holocene bank survey (Task EB5)

The 'Holocene Clay Bank' lies in the Salisbury Middle and is a sub-feature of the Dee Estuary European Marine Site. The location is shown in Figure 1². For Task EB5, this site is surveyed or just briefly visited, as required, to describe the prevalent physical and ecological conditions.

For a few years now, the clay has been buried by a thick layer of sand or sandy mud. It was, therefore, agreed with Natural Resources Wales (NRW) that while this sand coverage is present there is no value in detailed surveys. Therefore, only occasional *ad hoc* observations are appropriate at this location at the present time. More detailed surveys and quantitative analyses of the site are only required when the clay is exposed.

During 2022, *ad hoc* observations of the bank were made in July 2022. The results are described in Section 2.2.

² The mapped extent of exposed clay on this bank (from a previous survey) is also shown in Figure 1.

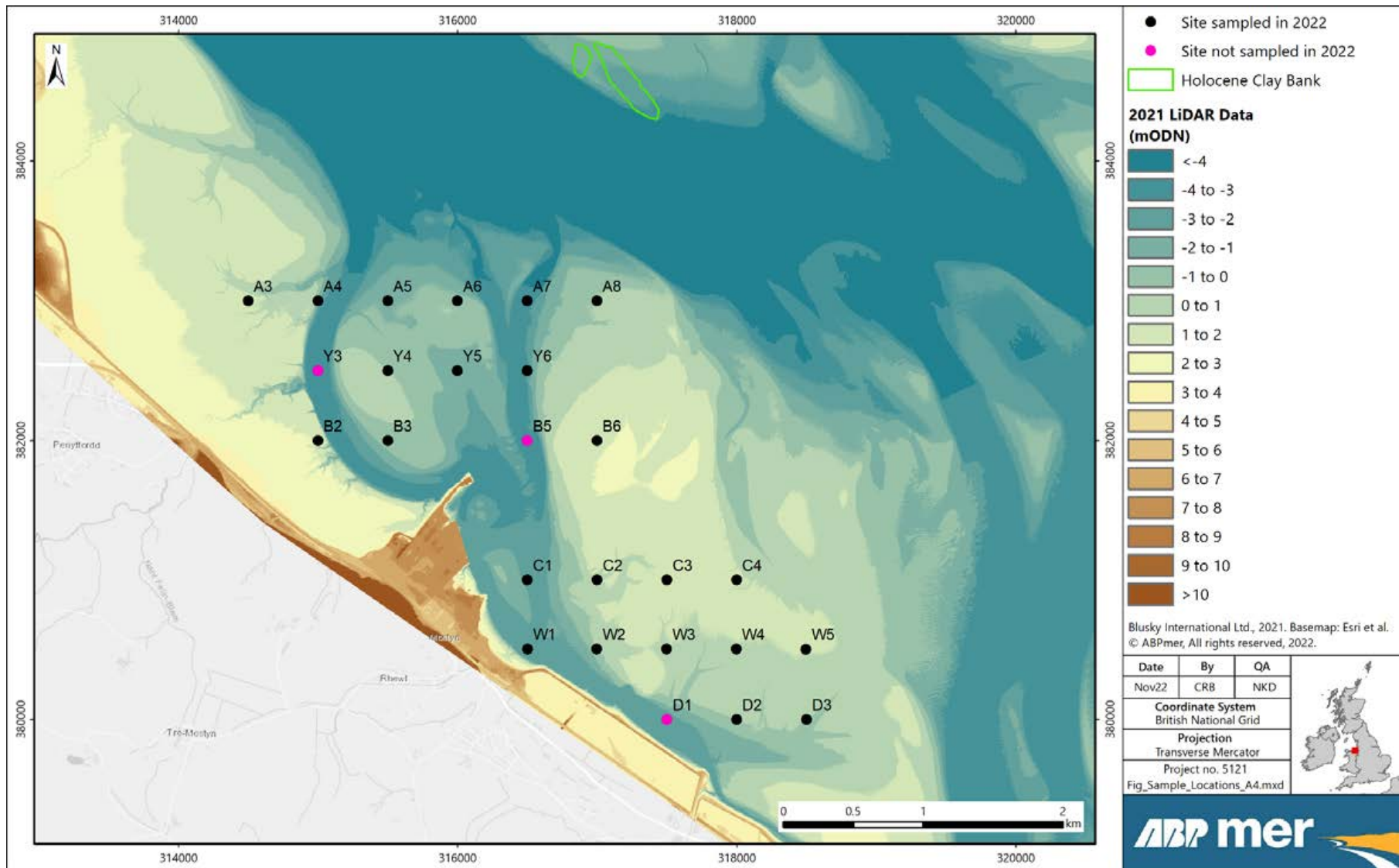


Figure 1. Location of benthic sediment sampling sites

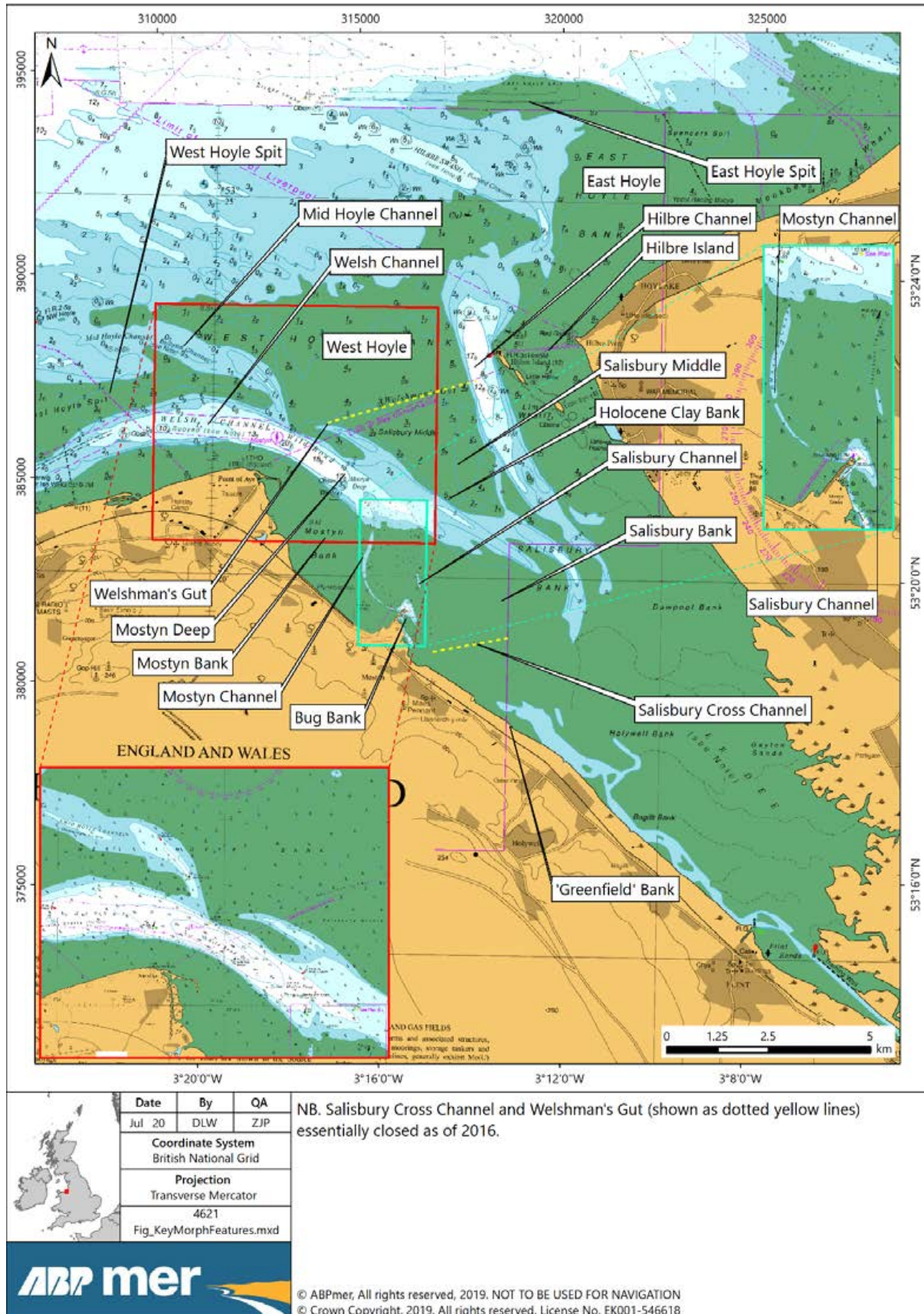


Figure 2. Dee Estuary morphological features of relevance to the monitoring programme

2 Results

2.1 Task LA5 benthic habitat survey

2.1.1 Introduction

The results from this latest survey, as well as comparative summary information from previous surveys, are presented as a series of figures and appendices as follows:

- **Figure 3 to Figure 8:** Describe the proportion of silt recorded annually at each site along each transect;
- **Appendix A:** Contains summary factsheets with information about the habitat and sedimentary conditions at each site over time. They also include photographs and PSA profile outputs. These are produced as a way of collating, and objectively illustrating, the large amount of data that has been collected over the course of this monitoring programme; and
- **Appendix B:** The detailed Mastersizer laser diffraction PSA outputs for the Spring 2022 survey.

In order to provide contextual information, a summary of the results of previous monitoring, focusing particularly on the results of last year's survey, is provided in Section 2.1.2. The results of the most recent survey in June 2022 are then provided in Section 2.1.3

2.1.2 Results from previous monitoring

Over the course of the monitoring programme, the habitat compositions across the whole survey area have remained broadly consistent. Over recent years, the main physical changes in the 'local' survey area have been a progressive shift in the alignment of the Mostyn Approach Channel (the upstream section of which has migrated into the Mostyn Bank) and a gradual deepening of the Salisbury Channel. This Salisbury Channel is close to the alignment of the original dredged channel and is now the one that is being maintained as the main navigable approach to the port. These channel alignments are allowed to develop naturally although they are modulated by dredging work that is undertaken.

In addition to these main and clearly observable channel developments, there have also been more subtle changes in upstream parts of the survey area (where Transects C, W and D are located). These are influenced by dynamic movements of the channel in this area.

In the previous report, which documented the results of the Spring 2021 ecological survey (ABPmer, 2021), the observed alterations to habitats from these physical changes were summarised as follows:

- **Site A4:** This site was located on a sandy slope on the channel margin having been located subtidally near the channel edge in September 2020. It is uncertain whether this change was due to recent sand deposition on the channel edge or due to tidal conditions on the day exposing more sand;
- **Site Y4:** Sandier conditions than in September 2020 were observed although the infaunal assemblage appeared to be broadly similar with species such as common cockle *Cerastoderma edule*, sand mason *Lanice conchilega* and lugworm *Arenicola marina* casts recorded; and

- **Site W3:** The site was sandier and appeared to have returned to more impoverished conditions (as compared to September 2020) with lower densities of lugworm *A. marina* casts and no common cockles *C. edule* recorded. The site was located in proximity to a small channel which could be influencing the interannual variations in sedimentary conditions observed at the site.

2.1.3 Results from June 2022

During the June 2022 benthic survey, 23 of the 26 sampling sites were successfully surveyed. As in past years, some sites could not be visited because they were too low-lying and underwater (i.e. within either the Mostyn Approach Channel or the newer Salisbury Channel) at the time of the survey. On this occasion, the three sites that were not successfully sampled were Sites B5, D1 and Y3 (see Figure 1).

Generally, only relatively small and localised changes in ecological conditions were observed in June 2022, which were again focused within the area between the Mostyn Channel and Salisbury Channel (Y5) and the W Transect (broad areas where changes were also observed in 2021). These changes are described in more detail below:

- **Site Y5:** Muddier and more ecologically rich conditions were observed in 2022 compared to previous years with the site also higher in elevation. This represents a change in habitat from clean sandflat to more stable muddy sand (with higher densities of fauna such as sand mason *L. conchilega*, common cockle *C. edule*, and lugworm *Arenicola marina* casts recorded) (Image 1); and
- **Site W3:** The site has shown a high degree of interannual variation in sedimentary conditions in recent years (fluctuating between clean sand and muddy sand conditions). In 2022, muddier conditions were observed at the site compared with 2021 with infauna such as cockles *C. edule*, and sand mason *L. conchilega* also recorded (which were also not present in 2021).

The results from the PSA data (see Figure 3 to Figure 8 and Appendix A) do not indicate any major sedimentary changes outside of the changes observed on-site. Many sites have relatively low levels of silt compared to what is considered typical for mobile sandflat habitat; however, nothing outside of the ranges previously recorded has been observed in the latest survey.

The full PSA profiles shown in Appendix B also do not indicate any substantial recent changes to the surface sediment at any of the sites³. For example, tide-swept sandflat habitat continued to extend through much of the intertidal areas surrounding the central and outer Approach Channel (Image 2). This included the central and eastern sections of Transects A, B and Y (Sites A5-A8, B4-B6 and Y6), the western sections of Transects C and W (Sites C1-C2 and W1-W2) and Transect D (Sites D2-D3).

³ In past years, discussions have been held with Natural Resources Wales (NRW) and the Centre for Environment, Fisheries and Aquaculture Science (Cefas) about whether these PSA results can provide an objective indicator of change in its own right. This is unlikely to ever be the case because of the influence of other variables. It is notable, for example, that Site Y4 appeared to be visually muddier and more enriched during 2020 and yet the percentage of fine silt and the PSA profile was within the range of previous years. It is still thought to be appropriate, therefore, to continue reviewing habitats and their changes based on a combination of visual observation and PSA analysis. It is also important to link with other bathymetric and topographic work being pursued under this programme.



Image 1. Muddy sand habitat recorded at Y5



Image 2. Tide-swept sandflat habitat at A7

Along the inner sections of the eastern Mostyn Bank (Sites A3 and B2) and on the emerging shoal of deposited material on the eastern margins of the Mostyn Channel (B3), there was stable mudflat habitat, as observed during previous years (Image 3).

There was also again, continued visual evidence of the Mostyn Channel eroding into the Mostyn Bank. This is consistent with recent bathymetric work undertaken in 2022, which has shown that the westerly migration of the Mostyn Channel has continued over the recent survey period⁴. For example, Site B2 is now located on the channel edge due to this continued erosion.

⁴ Between the March 2021 and the June 2022 bathymetric surveys, the deepest point of the Mostyn Channel has shallowed by around 0.6 m and migrated approximately a further 80 m to the southwest. Over the same period, to the east of the Port of Mostyn, the Salisbury Channel is shown to have widened, deepened slightly (by around 0.1 m) and migrated approximately 10 m to the east (ABPmer, 2022).

Observations also suggest that the muddy sand habitats across the middle of Salisbury Bank (W4, C3 and C4) have remained largely unchanged in recent years, aside from minor natural inter-annual variability.

As in previous years, the observed changes are deemed to be a function of natural morphological shifts in these areas, rather than a response to the very limited maintenance dredging that has taken place.



Image 3. View towards the Port of Mostyn showing mudflat habitat around Site B3

2.2 Task EB5 (Holocene bank survey)

The physical and ecological conditions at the Holocene Clay Bank fluctuate over time and this has been recorded during the entire monitoring period. Between 2009 and 2011, there were two discrete patches of exposed clay with sand typically being present as a thin veneer over and around these patches. During these periods when the clay was exposed, its southwest edge generally showed signs of continuing erosion and there was intermittent colonisation by piddock species.

During 2012, the extent and depth of sand coverage increased and, since 2013, the site has been covered in a thick layer of sand or silt with only small patches of exposed clay occasionally present. Comparable conditions were also observed between 2003 and 2005 (ABPmer, 2007).

These changes are considered to be a symptom of wider adjustments in the estuary morphology and influenced by the relative dominance of the Welsh and Hilbre channels. This site is likely to be a key pinch-point in the outer estuary system that influences, and responds to, changes in the balance of flows through the outer estuary channels. The underlying clay would also appear to provide an important geomorphological control on the bank and channel configuration (ABPmer, 2017a).

Observations made during July 2022 showed a thick layer of sand remains present (Image 4). On this basis, no formal survey of the site is required to be carried out this year. The site will therefore be kept under review on an *ad hoc* basis by the Harbour Master at the Port of Mostyn when passing the site until the next formal survey, which is due in the Spring of 2023.



Image 4. View of the Holocene Clay Bank area taken in July 2022

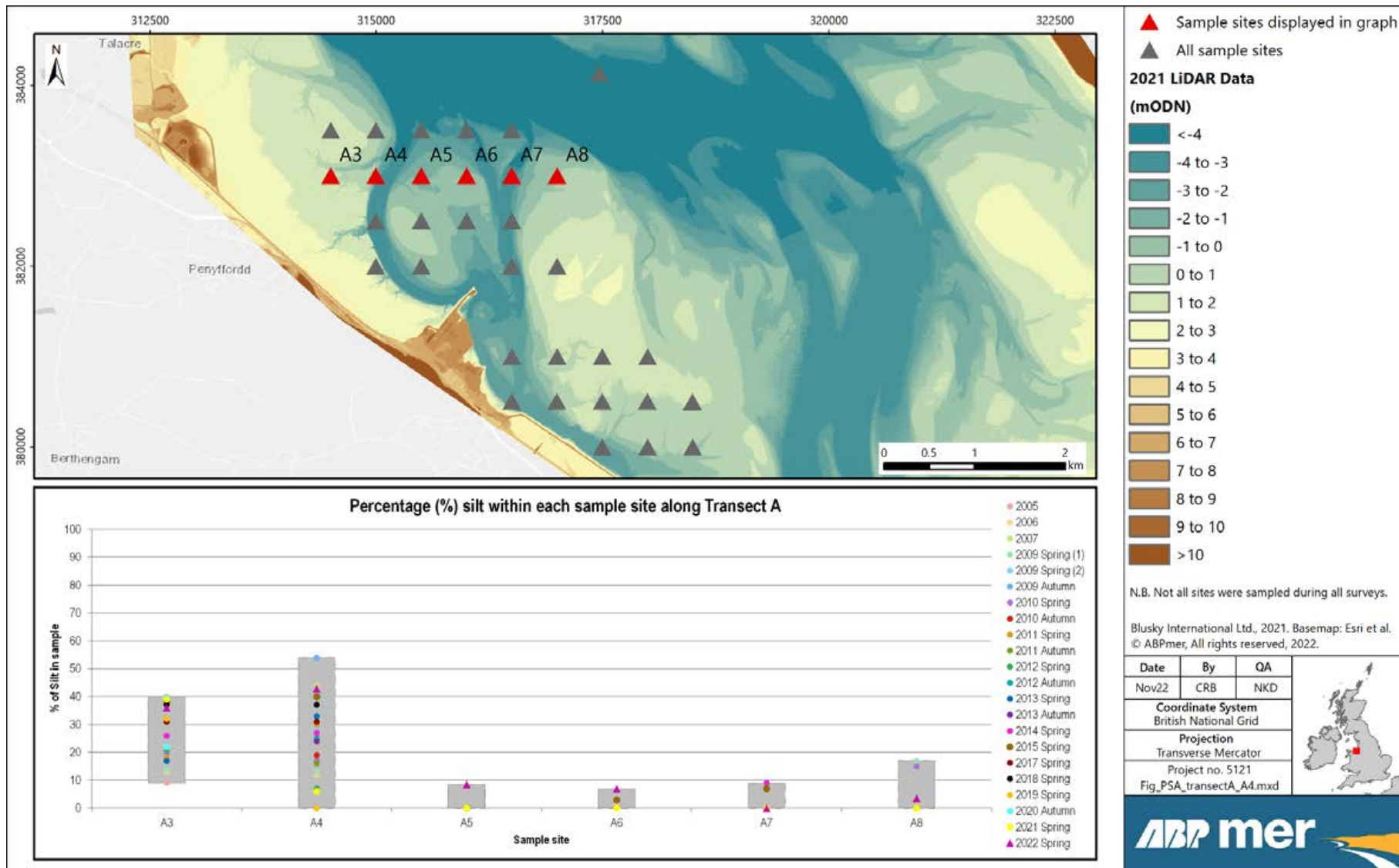


Figure 3. Proportion of silt in Transect A sediment samples

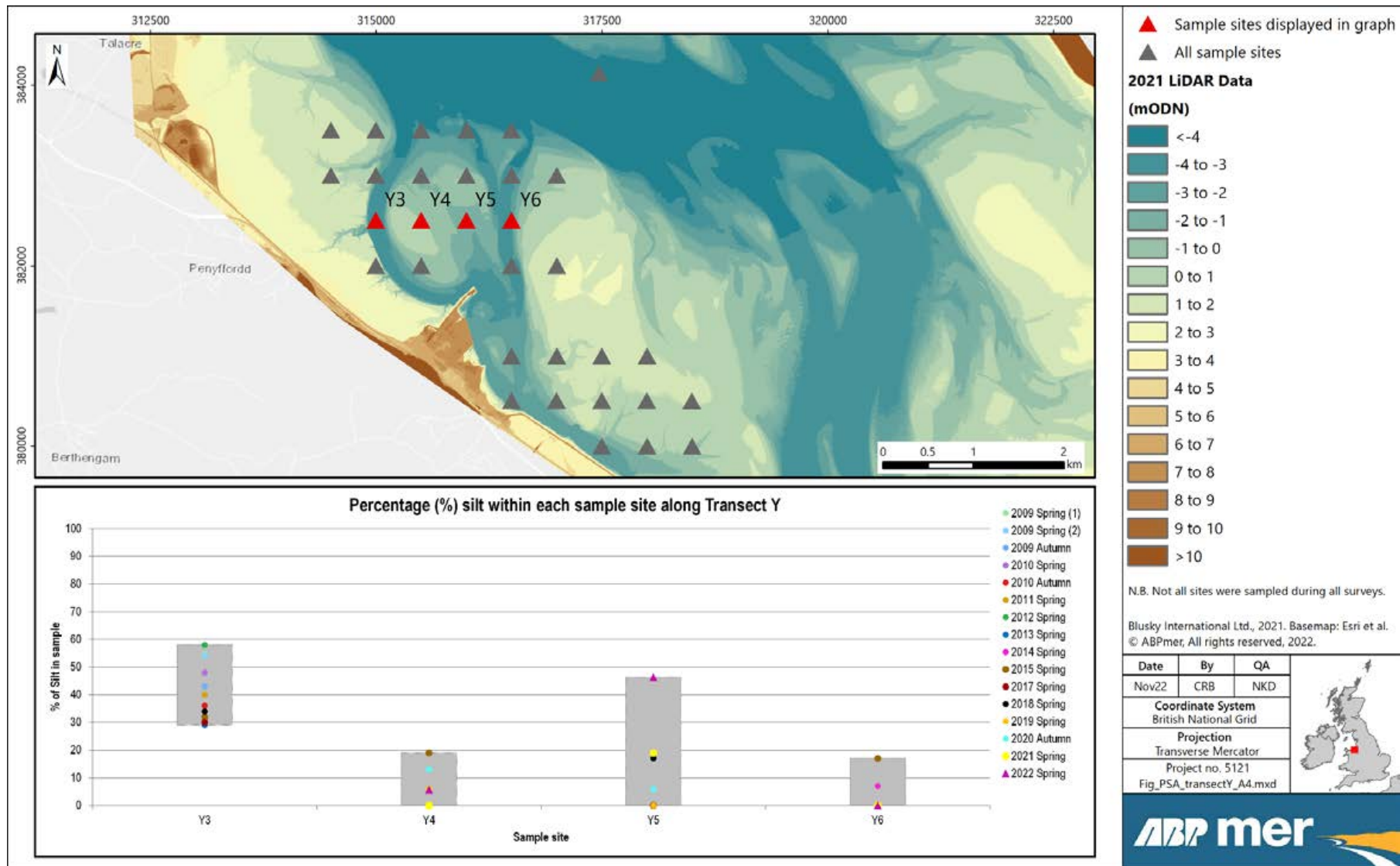


Figure 4. Proportion of silt in Transect Y sediment samples

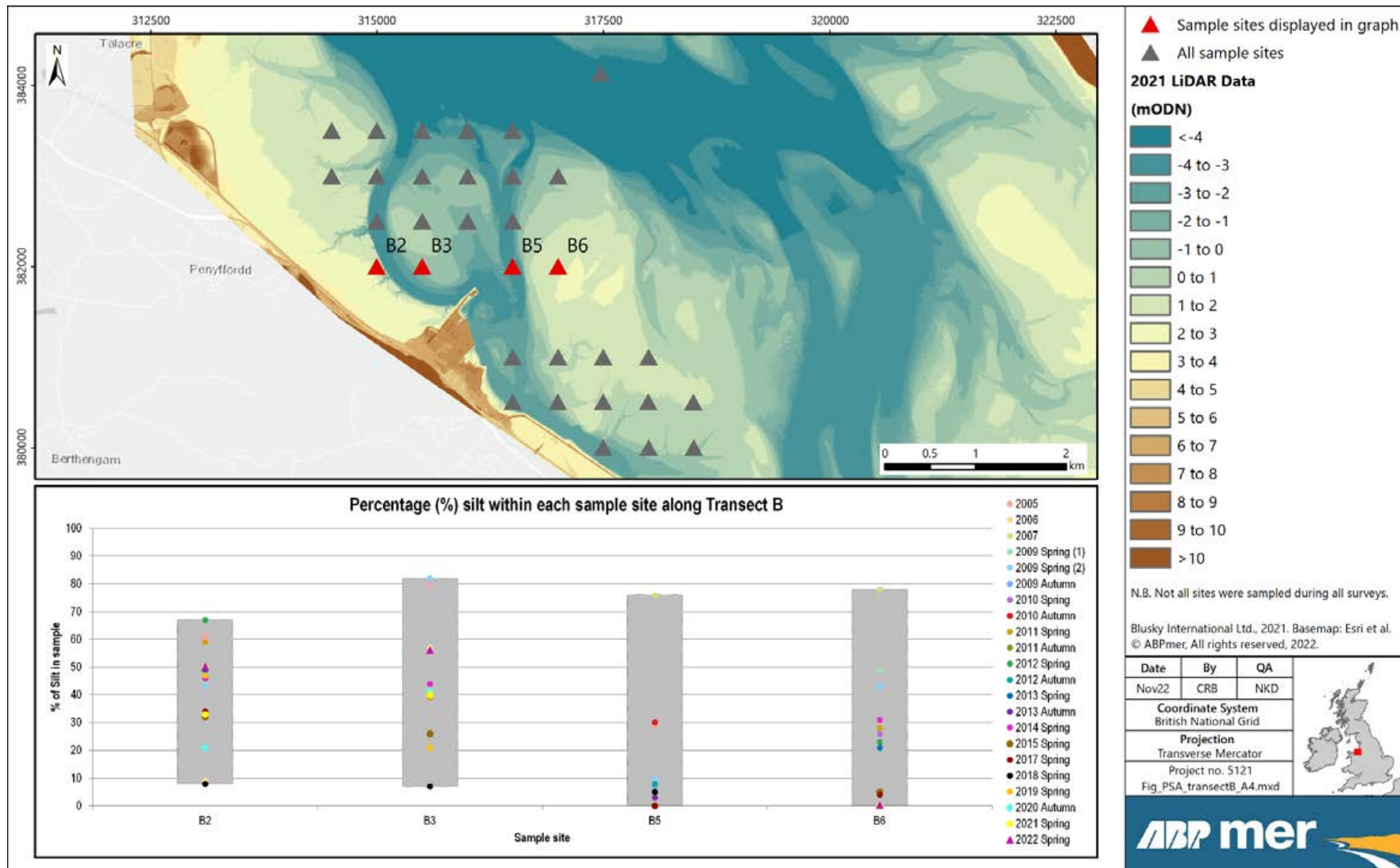


Figure 5. Proportion of silt in Transect B sediment samples

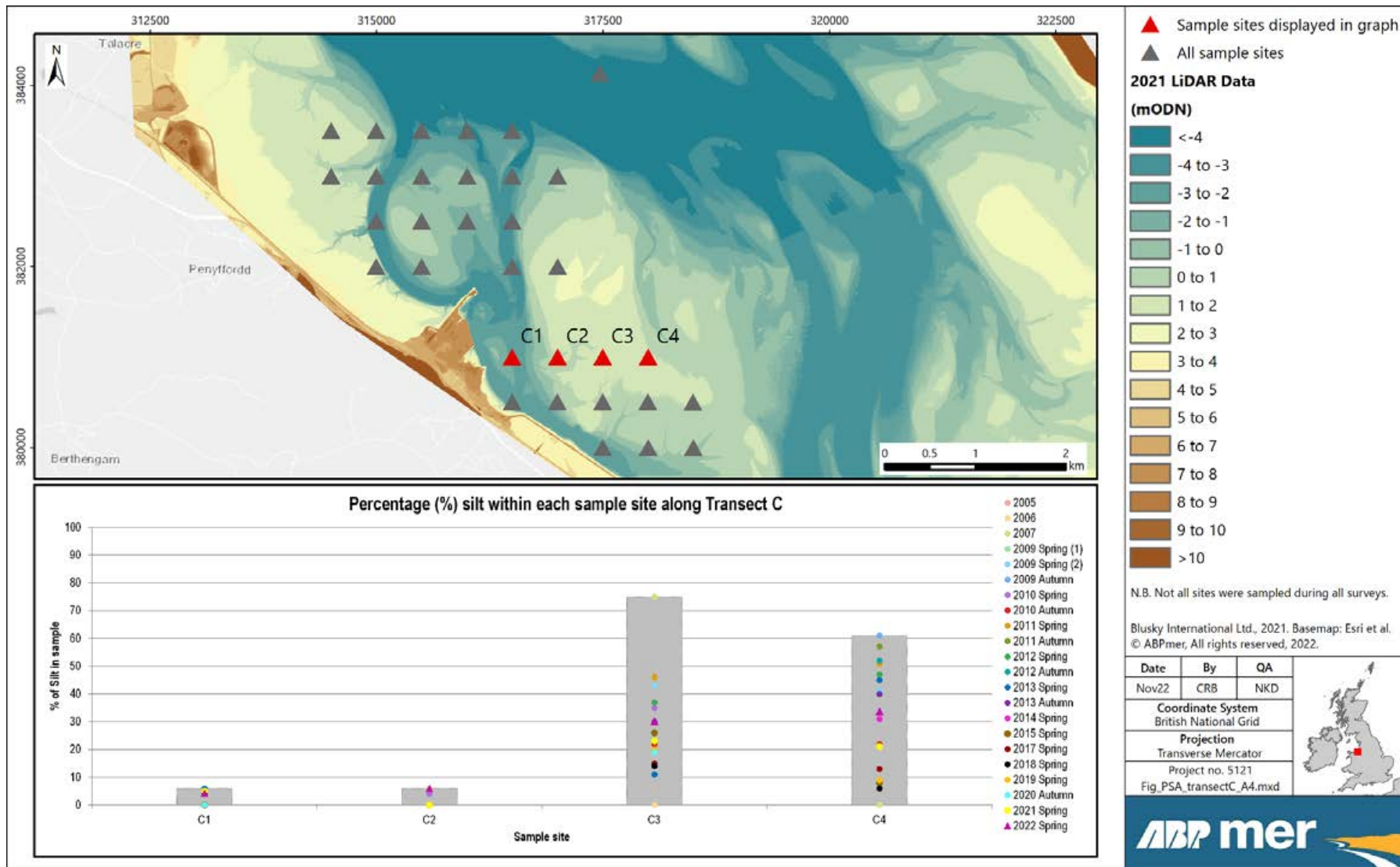


Figure 6. Proportion of silt in Transect C sediment samples

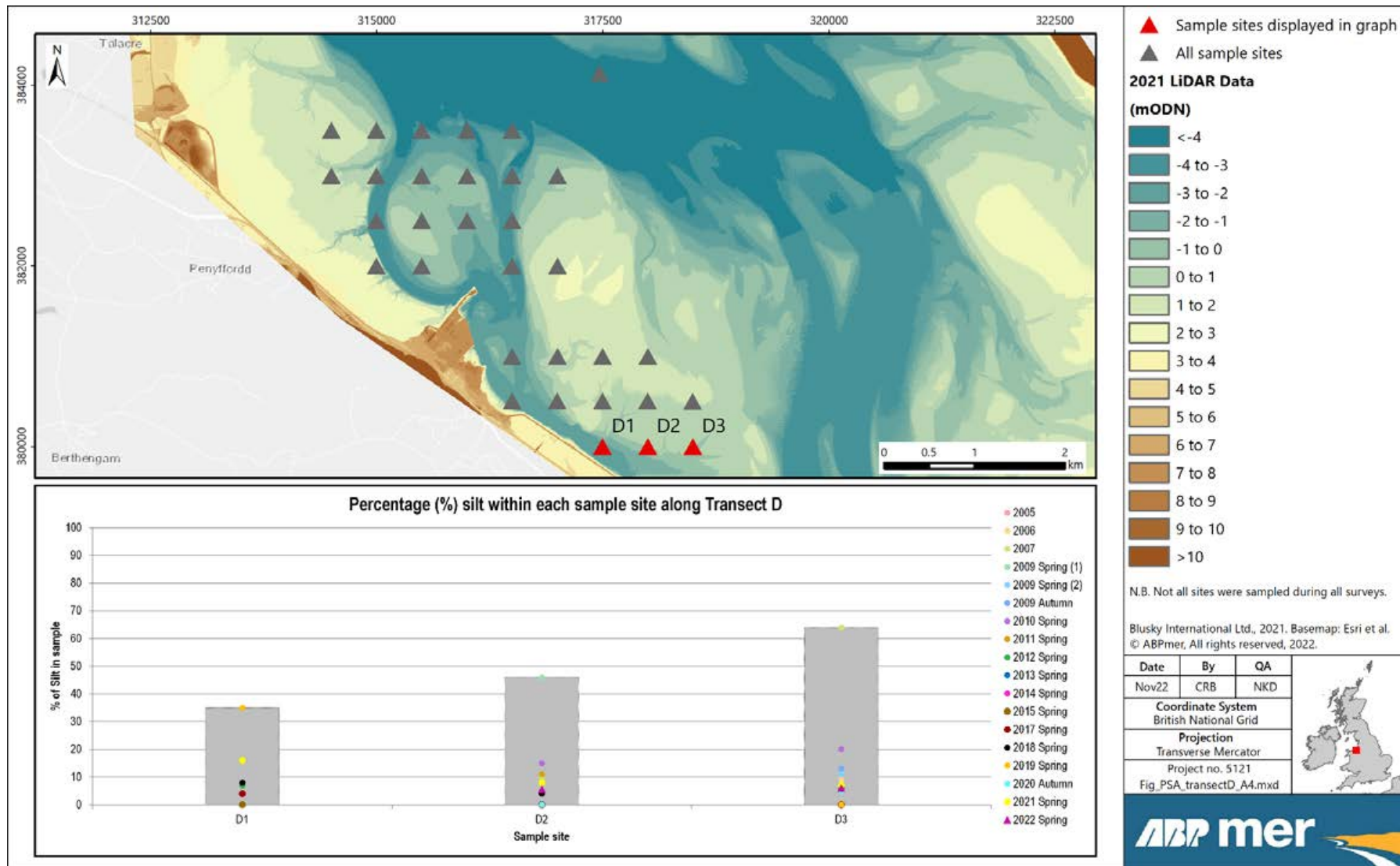


Figure 7. Proportion of silt in Transect D sediment samples

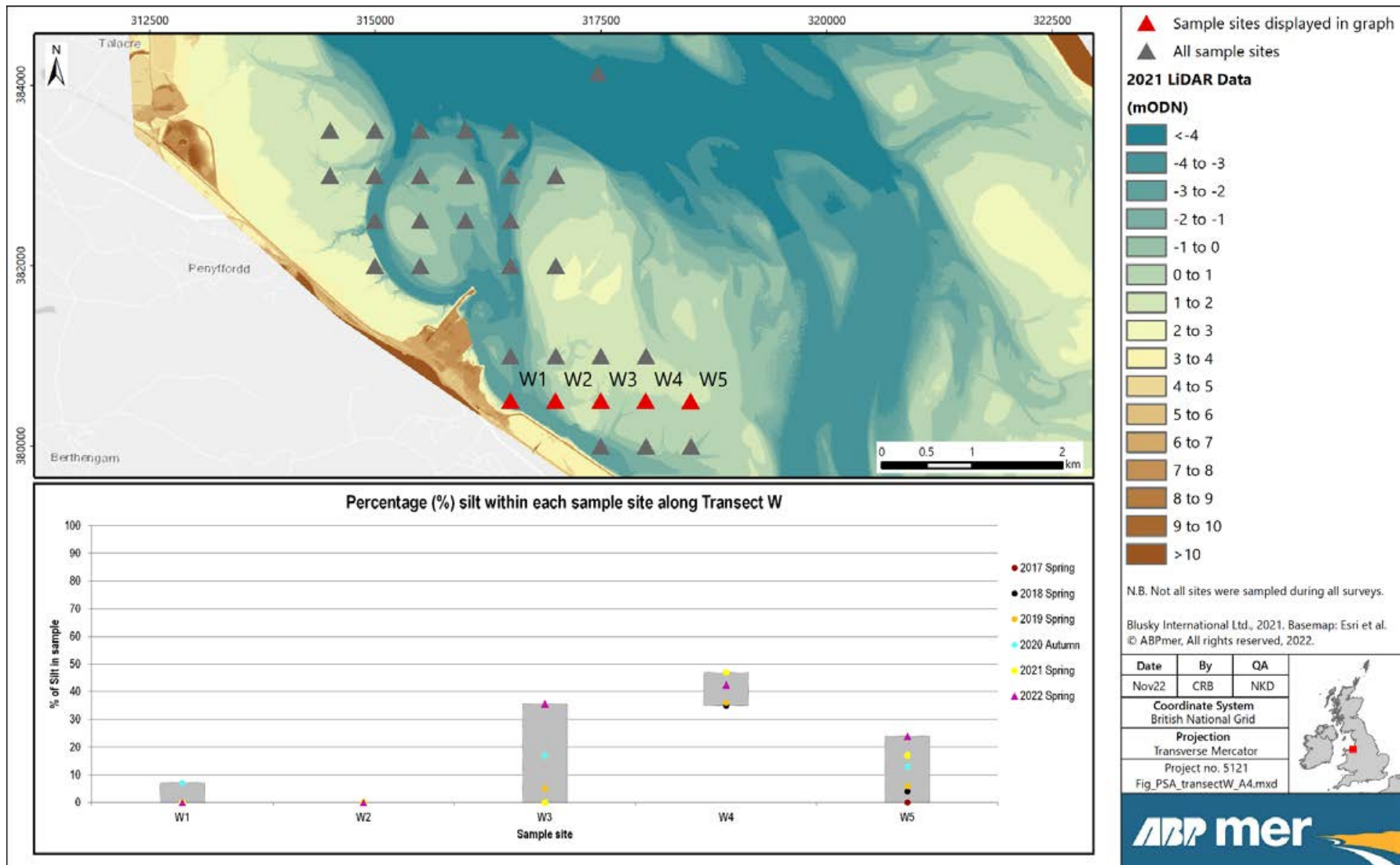


Figure 8. Proportion of silt in Transect W sediment samples

3 Summary

During the Spring 2022 survey, only relatively minor changes in habitat were recorded with key characteristics remaining broadly similar to previous monitoring at the majority of sites.

In summary, tide-swept sandflat habitat continued to extend through much of the intertidal areas surrounding the central and outer Approach Channel. This included much of the central and eastern sections of Transects A, B and Y (Sites A5-A8, B4-B6 and Y6), the western sections of Transects C and W (Sites C1-C2 and W1-W2) and Transect D (Sites D2-D3).

There was stable mudflat habitat, as observed during previous years, along the inner sections of the eastern Mostyn Bank (Sites A3 and B2) and on the eastern margins of the Mostyn Channel (B3). Observations also suggest that the muddy sand habitats of the middle of Salisbury Bank (W4, C3 and C4) have remained largely unchanged in recent years.

The main habitat changes were focused within the area between the Mostyn Channel and Salisbury Channel (Y5) and the W Transect (broad areas where changes were also observed in 2021) as described in more detail below:

- **Site Y5:** Muddier and more ecologically rich conditions were observed in 2022 compared to previous years with the site also higher in elevation. This represents a change in habitat from clean sandflat to more stable muddy sand (with higher densities of fauna such as sand mason, common cockle and lugworm *Arenicola marina* casts recorded); and
- **Site W3:** The site has shown a high degree of interannual variation in sedimentary conditions in recent years (fluctuating between clean sand and muddy sand conditions). In 2022, muddier conditions were observed at the site compared with 2021 with infauna such as cockles and sand mason also recorded (which were also not present in 2021).

As in previous years, these changes are deemed to be a function of natural morphological shifts in these locations, rather than a response to the very limited dredging work that takes place. On this basis and giving due recognition to natural processes (as is required under the monitoring programme), it is recommended that the next benthic monitoring survey is proposed for Spring 2023, in accordance with Marine Licence DML1542v2.

The Holocene Clay Bank continues to be covered in a thick layer of sand; a situation that is expected to persist into the near future. This site will continue to be observed on an *ad hoc* basis, with the nature of the substrate reviewed again as part of the annual Spring 2023 surveys.

The findings presented in this report and the overall programme of monitoring will be discussed further with NRW. The results from these other surveys will be reviewed within ongoing progress and annual reporting work, as required under the extant marine licence.

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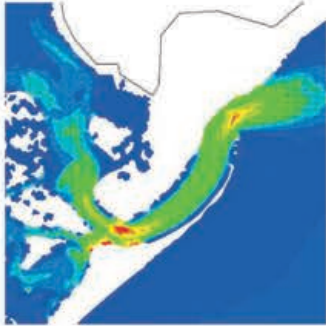
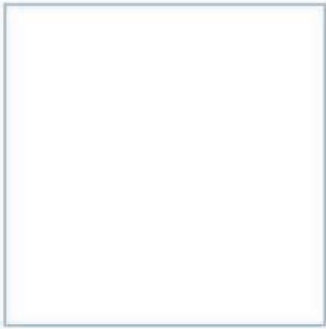
5 Abbreviations/Acronyms

BS	British Standards
CCW	Countryside Council for Wales
CD	Chart Datum
Cefas	Centre for Environment, Fisheries and Aquaculture Science
EB	Estuary Basis
EUNIS	European Nature Information System
HD	High-Definition
ISO	International Organisation for Standards
LA	Local Area
LiDAR	Light Detection and Ranging
MHCBI	Marine Habitat Classification for Britain & Ireland
NRW	Natural Resources Wales
ODN	Ordnance Datum Newlyn
PDF	Portable Document Format
PSA	Particle Size Analysis
SMP	Shoreline Management Partnership
SOP	Standard Operating Procedure

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Appendices



Innovative Thinking - Sustainable Solutions

A Sampling Sites Summary Information

This appendix provides a summary of the ecological and physical conditions observed at the sites, which have been sampled as part of the Ecological Phase 2 Monitoring from 2009 to 2022⁵ (see Figure A1). Reference is also made to data collected as part of the previous phase of monitoring work from 2005 to 2007 where applicable.

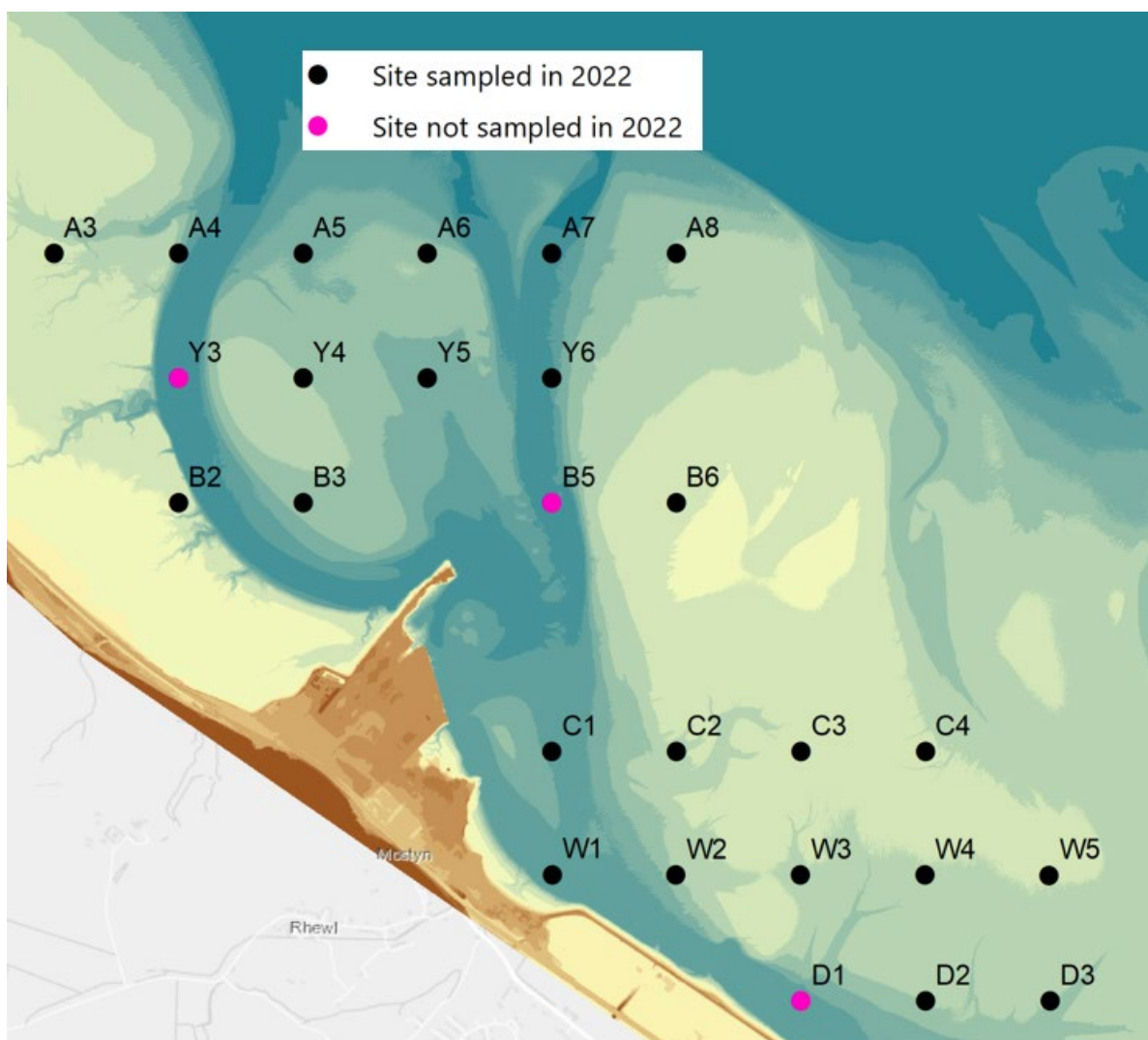


Figure A1. Benthic sampling locations

For each of the sampling sites, information on the following parameters has been provided:

- **Years Sampled:** An indication of the years the site has been sampled as part of dredge and disposal ecological monitoring work;

⁵ It has not been possible to access Site B4 during any of the surveys because it is located in the main channel and has always been underwater at the time survey and for this reason it has not been included in the appendix.

- **Habitat Type:** The broad biotopes which best describe the habitats found at each site to European Nature Information System (EUNIS) habitat class level four under 'The Marine Habitat Classification for Britain & Ireland (MHCBI) 04.05 (Conner *et al.* 2004). The MHCBI 04.05 classification is considered a useful tool to describe habitats and identify change. A description of each of the assigned biotopes based on the criteria in Conner *et al.* (2004) can be seen in Table A1;
- **Silt Level and Range (%):** The silt level in Spring 2021 and the silt range over the years the site has been surveyed;
- **Habitat Images:** Fixed point images showing the broad habitat at each sampling site over time (with surveys since 2013 included in this report);
- **Mastersizer Laser Diffraction Results:** Graphical outputs for each survey year between 2009 and 2021 (describing the sedimentary profile in detail): and
- **Summary:** Text description of the site based on the PSA and invertebrate results, field observations and images.

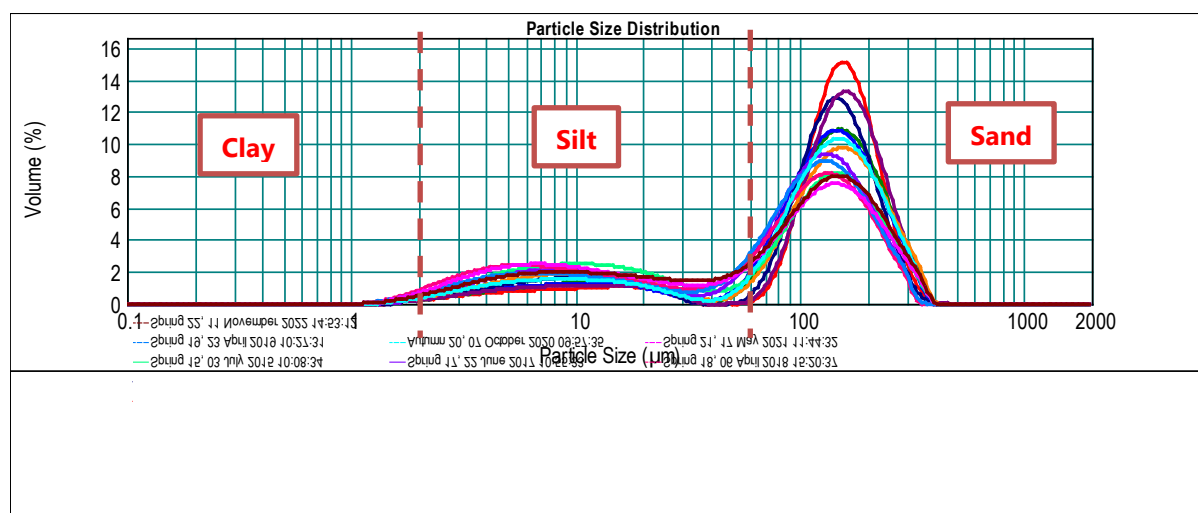
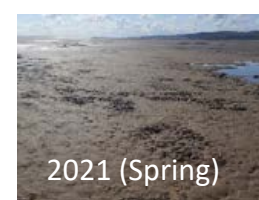
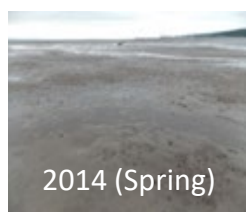
Table A1. Description of the biotopes assigned to the sites as part of the monitoring

Biotope	Physical Description	Biological Description
LS.LSa.MoSa Barren or amphipod-dominated mobile sand shores	Shores consisting of clean mobile sands (coarse, medium and some fine-grained), with little very fine sand, and no mud present. Shells and stones may occasionally be present on the surface. The sand may be duned or rippled as a result of wave action or tidal currents.	Supports a limited range of species with communities of isopods, amphipods and a limited range of polychaetes. Species which can characterise mobile sand communities include <i>Scolelepis squamata</i> , <i>Pontocrates arenarius</i> , Sand digger Shrimp <i>Bathyporeia pelagica</i> , Black-jack <i>Bidens pilosa</i> , <i>Haustorius arenarius</i> and speckled sea louse <i>Eurydice pulchra</i> .
LS.LSa.MuSa Polychaete/bivalve-dominated muddy sand shores	Muddy sand or fine sand, often occurring as extensive intertidal flats on open coasts and in marine inlets. The sediment generally remains water-saturated during low water. An anoxic layer may be present below 5 cm of the sediment surface, sometimes seen in the worm casts on the surface.	The infauna consists of a diverse range of amphipods, polychaetes, bivalves and gastropods with characterising infauna species including common cockle <i>Cerastoderma edule</i> , Baltic tellin <i>Macoma balthica</i> , <i>Pygospio elegans</i> and ragworm <i>Hediste diversicolor</i> .
LS.LMu.MEst Polychaete/bivalve-dominated mid estuarine mud shores	Mid estuarine shores of fine sediment, mostly in the silt and clay fraction (particle size less than 0.063 mm in diameter), though sandy mud may contain up to 40% sand (mostly very fine and fine sand). Littoral mud typically forms extensive mudflats.	Mid estuarine muds support rich communities characterised by polychaetes, bivalves and oligochaetes with characterising infauna species including Baltic tellin <i>M.balthica</i> , ragworm <i>H. diversicolor</i> and <i>Streblospio shrubsolii</i> .

Based on Conner *et al.* 2004

A.1 Site A3

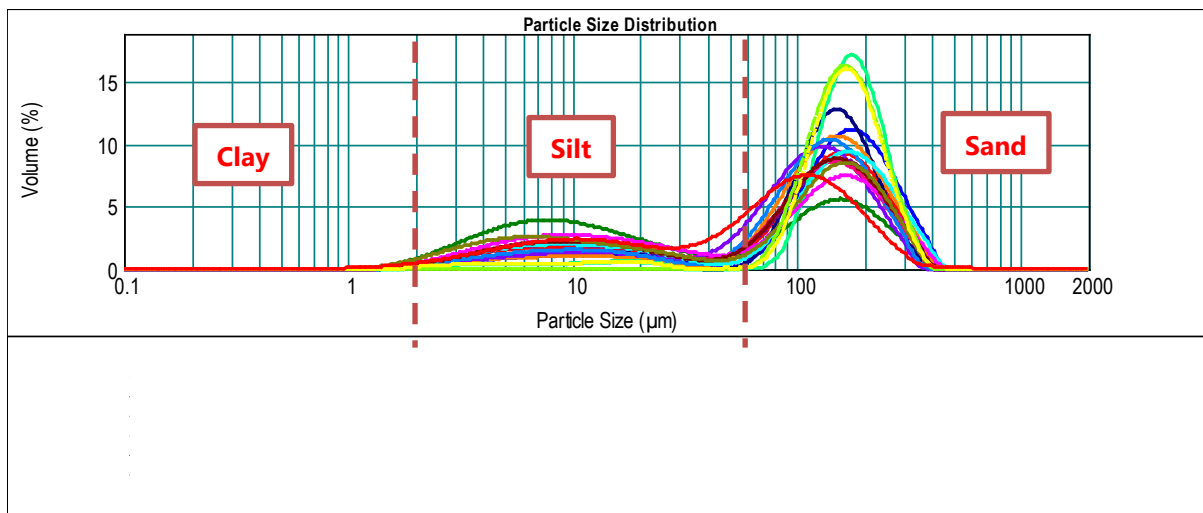
- **Years sampled:** 2005-2007, 2009-2015 (Spring), 2017-2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores)
- **Silt level Spring 2022:** 36%
- **Silt range 2005 to 2022:** 9-40%



Summary: The site has remained muddy sand habitat with a rich infaunal assemblage characterised by mud shrimp *Corophium volutator*, common cockles *C. edule*, peppery furrow shell *Scrobicularia plana* and lugworm *Arenicola marina* throughout the monitoring period.

A.2 Site A4

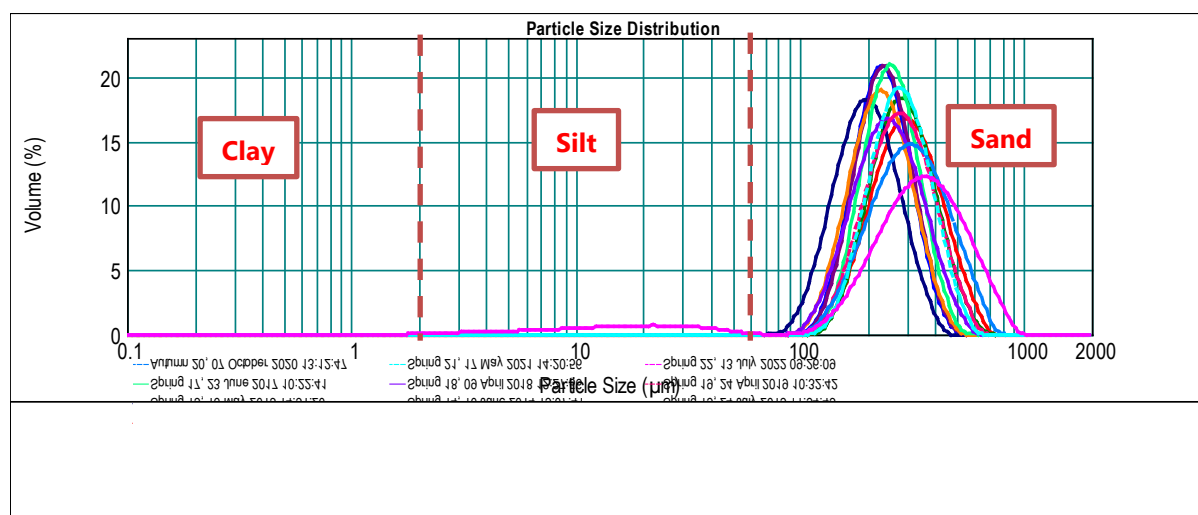
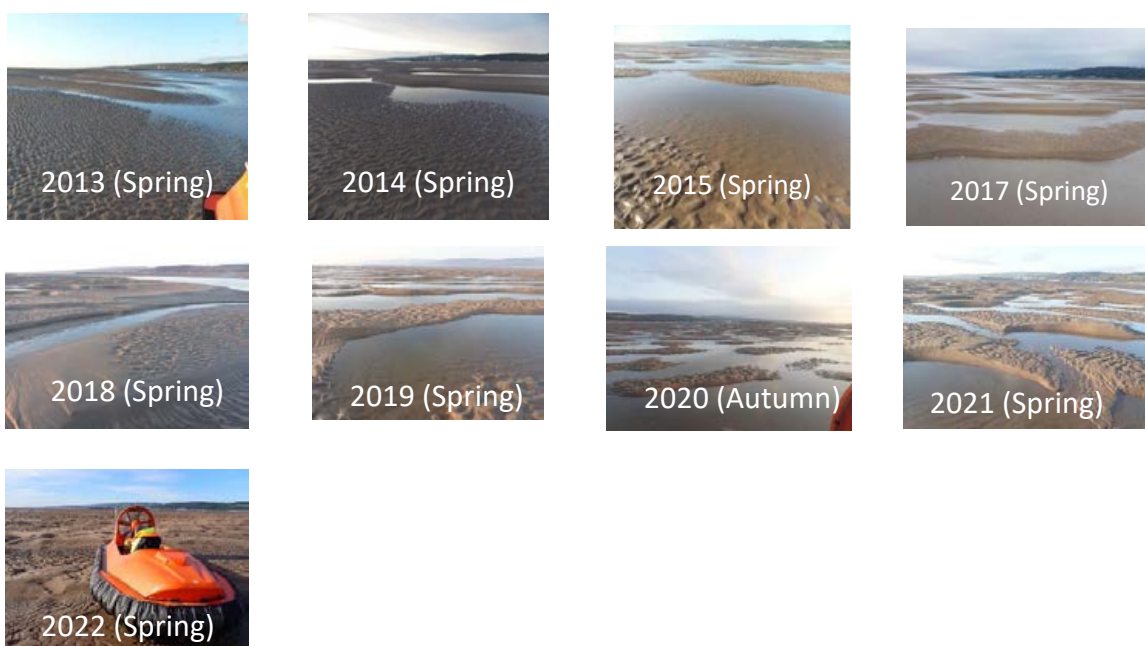
- **Years sampled:** 2005-2007, 2009-2013 (Spring and Autumn), 2014 (Spring), 2015 (Spring), 2017- 2019 (Spring), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores).
- **Silt level Spring 2022:** 43%
- **Silt range 2005 to 2022:** 0-54%



Summary: Throughout most of the monitoring period this area was characterised by rich muddy sand habitat (with some variation in sedimentary conditions recorded). In 2019, the station was located on a sandy bank edge shoal and in 2020 it was subtidal due to the westerly migration of the Mostyn Channel. In 2021 and 2022 it was located on a sandy slope on the channel margin.

A.3 Site A5

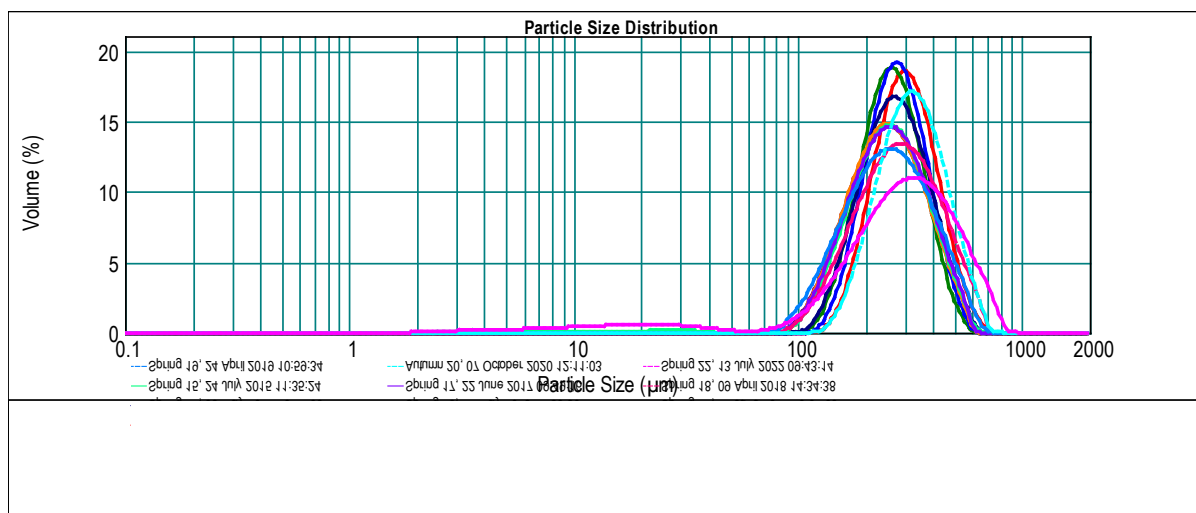
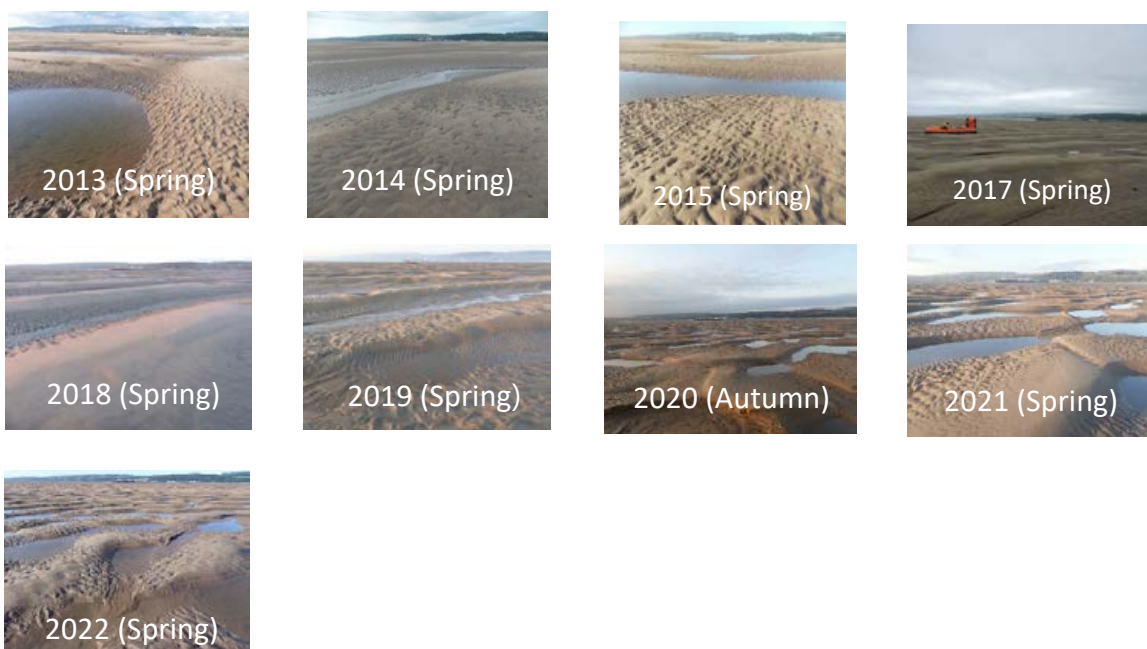
- **Years sampled:** 2005-2007, 2009-2015 (Spring), 2017-2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores)
- **Silt level Spring 2022:** 9%
- **Silt range 2005 to 2022:** 0-9%



Summary: The site has consistently been a mobile sand habitat with a species-poor macrofaunal assemblage. The topography of this area has been characterised by small sand waves, (typically with standing water in the troughs) throughout the monitoring period. Lugworm *A. marina* have occasionally been recorded at the site.

A.4 Site A6

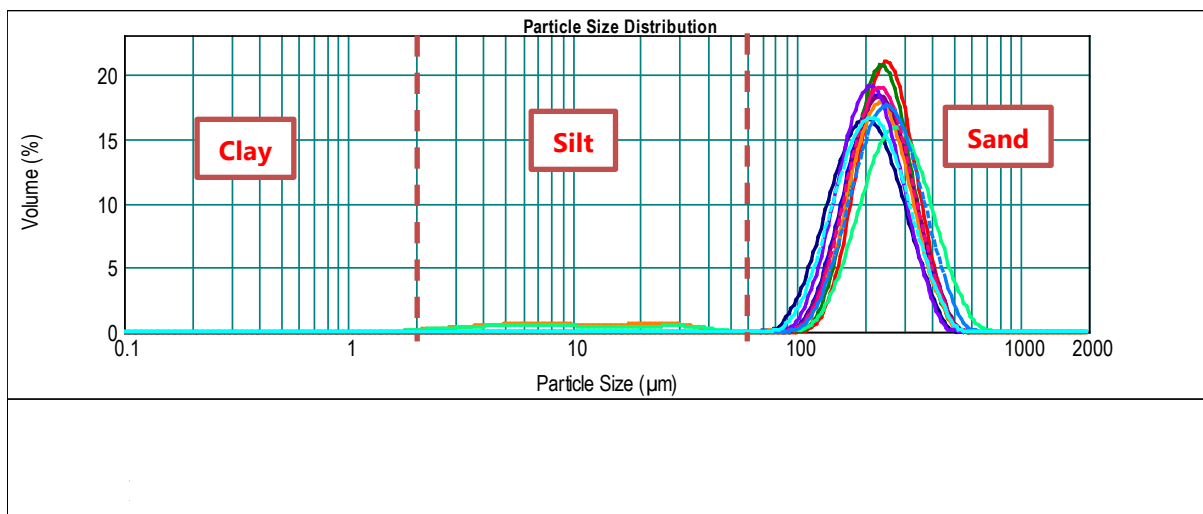
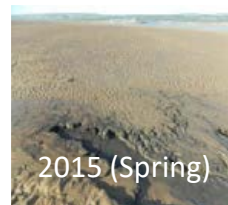
- **Years sampled:** 2005-2007, 2009-2015 (Spring), 2017- 2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores)
- **Silt level Spring 2022:** 7%
- **Silt range 2005 to 2022:** 0-7%



Summary: The site has consistently remained mobile sand habitat with a species-poor macroinfaunal assemblage. The topography of this area has been characterised by large sand waves (typically with standing water in the troughs and drier sand on the crests) throughout the monitoring period.

A.5 Site A7

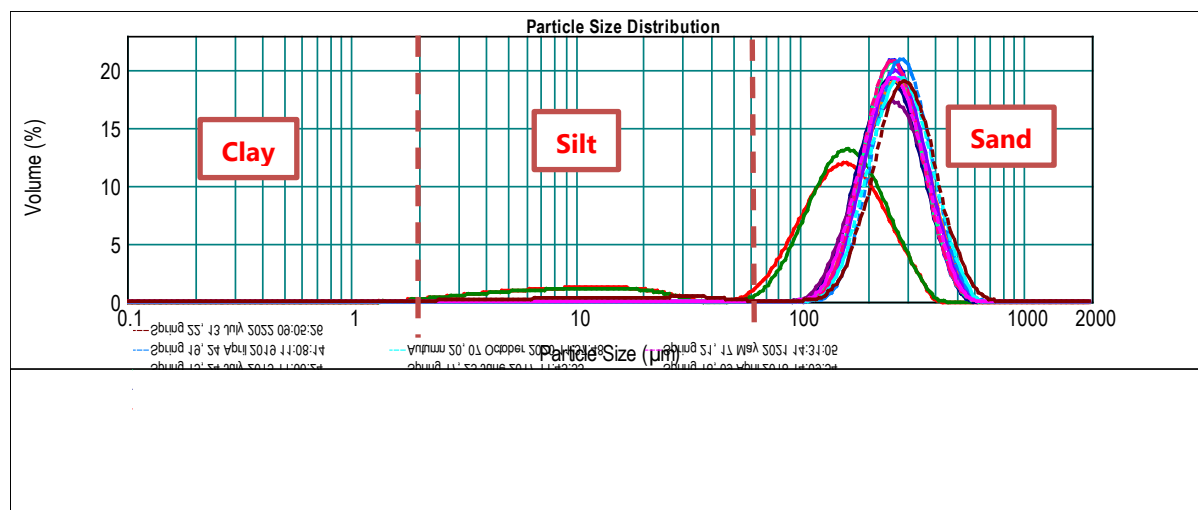
- **Years sampled:** 2005-2007, 2009-2015 (Spring), 2017 and 2018 (Spring), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores).
- **Silt level Spring 2022:** 0%
- **Silt range 2005 to 2022:** 0-9%



Summary: Throughout most of the monitoring period this site has comprised mobile sand habitat with a species-poor macroinfaunal assemblage. However, due to changes on the Salisbury Bank (where the Salisbury Channel is developing and migrating), Site A7 was subtidal in mid-channel during 2019 and again 2020. In 2021, the site was located on a low lying but exposed shoal in the channel and in 2022 approximately 80 m east of the channel.

A.6 Site A8

- **Years sampled:** 2005-2007, 2009-2015 (Spring), 2017- 2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** 2005-2007 LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores); 2009-2010 LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores). LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) since 2011
- **Silt level Spring 2022:** 4%
- **Silt range 2005 to 2022:** 0-17%



Summary: Between 2005 and 2007, the site was a mobile sand habitat with only a negligible amount of silt recorded. However, the habitat changed in 2009 and 2010 to muddy sand habitat (with a 15-17% silt fraction) with evidence of polychaetes, cockle *C. edule*, mudsnail *Peringia ulvae* and lugworm *A. marina* colonising the site. Since 2011, this site has returned to more impoverished mobile sand habitat.

A.7 Site Y3

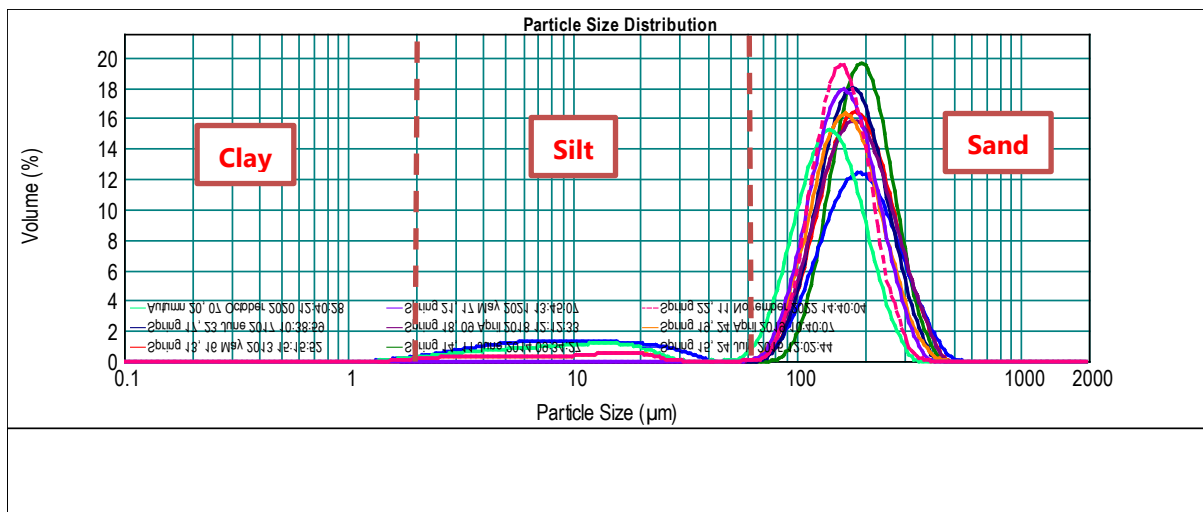
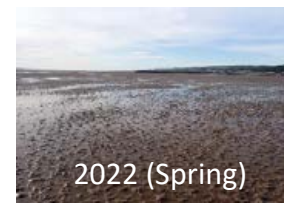
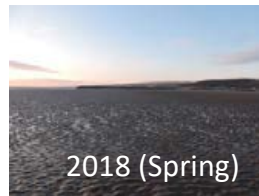
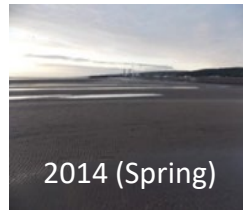
- **Years sampled:** 2009-2010 (Spring and Autumn), 2011-2015 (Spring), 2017 and 2018 (Spring)
- **Habitat type:** LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores).
- **Silt level Spring 2018:** 37%
- **Silt range 2009-2018:** 29-58%



Summary: Throughout most of the monitoring period this site has been a flat area of muddy fine sand habitat in the vicinity of a creek system. In 2019, 2020, 2021 and 2022 it was located subtidally within the channel due to the continued westerly migration of the Mostyn Channel.

A.8 Site Y4

- **Years sampled:** 2013 and 2015 (Spring), 2017- 2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) until 2019. LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) since 2020.
- **Silt level Spring 2022:** 6%
- **Silt range 2013-2022:** 0-19%



Summary: The site has been sampled since 2013. It is low in the tidal frame and has been underwater during the surveys. Prior to 2020 the habitat has been (when visible) a flat and poorly drained area of fine sand. In 2020, the site was slightly muddy sand. Species recorded in 2020 included common cockle *C. edule*, sand mason *L. conchilega* and lugworm *A. marina* along with a diatom film across the sediment surface. The site was sandier in 2021 and 2022 but with the species highlighted above still present.

A.9 Site Y5

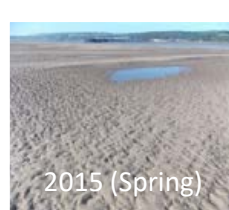
- **Years sampled:** 2010-2015 (Spring), 2017- 2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) 2010 to 2021. LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) since 2022.
-
- **Silt level Spring 2022:** 46%
- **Silt range 2010-2022:** 0-46%



2013 (Spring)



2014 (Spring)



2015 (Spring)



2017 (Spring)



2018 (Spring)



2019 (Spring)



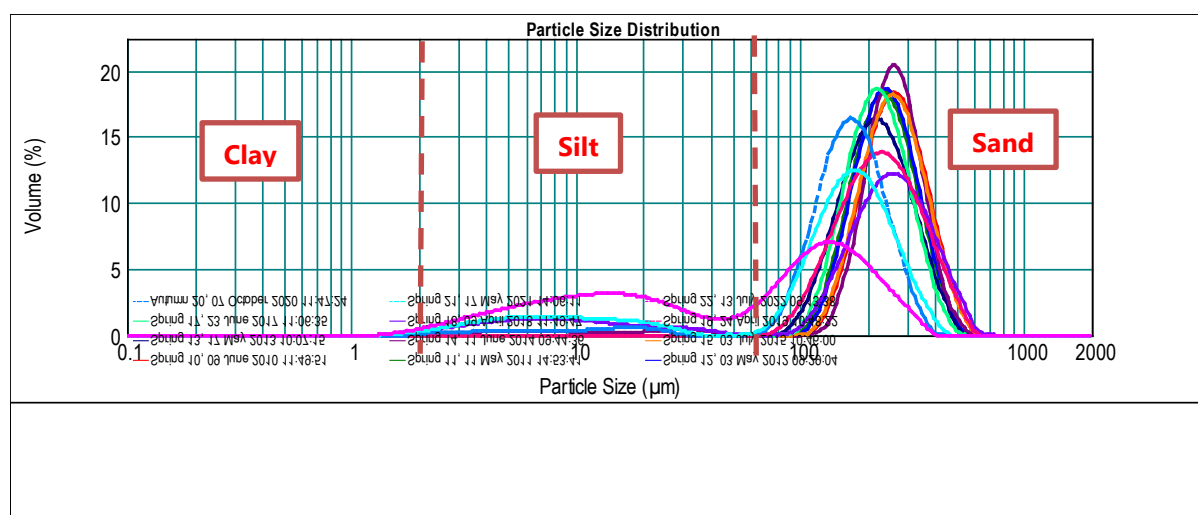
2020 (Autumn)



2021 (Spring)



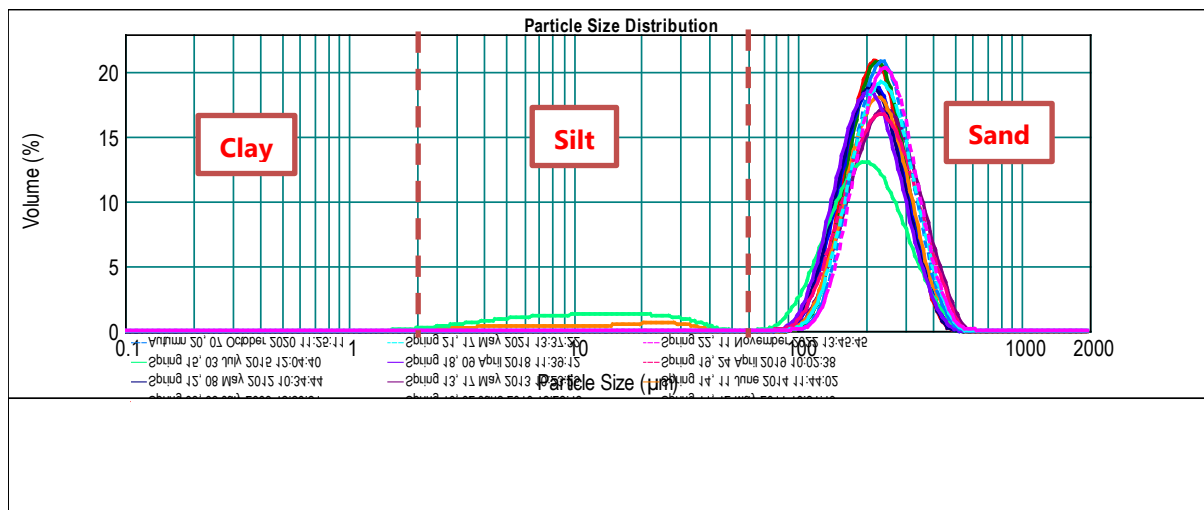
2022 (Spring)



Summary: The site has consistently remained mobile sand habitat, consisting of a species-poor macroinfaunal assemblage. This area had had large sand waves (with standing water in the troughs and drier sand on the crests) but has been flatter in topography since 2019. In 2022 the site was higher in elevation and had changed to muddier and more ecologically rich habitat with common cockle *C. edule*, sand mason *L. conchilega* and lugworm *A. marina* recorded.

A.10 Site Y6

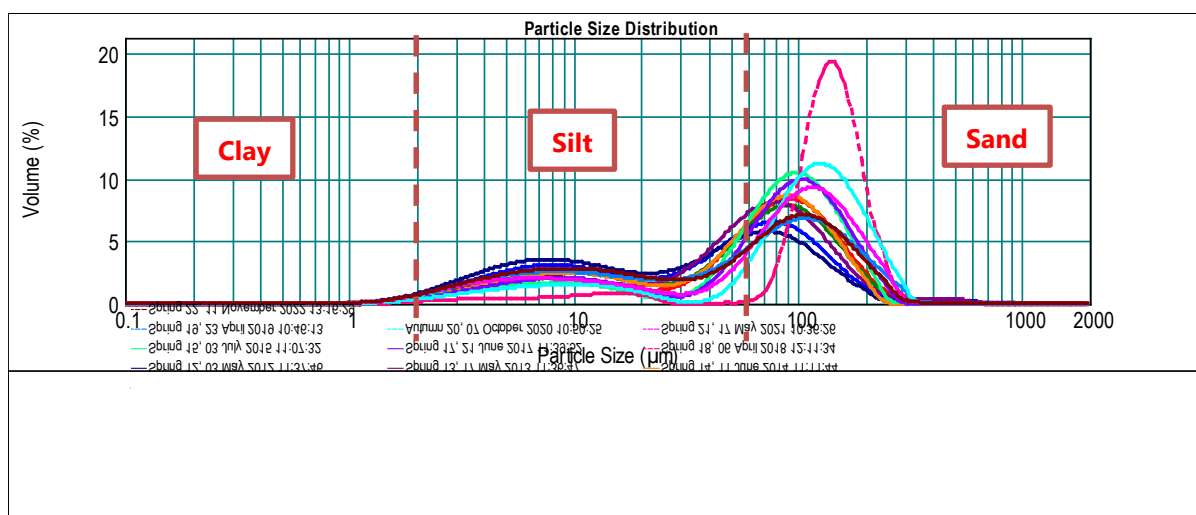
- **Years sampled:** 2009-2015 (Spring), Spring 2017 (sample retrieved but unfortunately lost although visual observations recorded fine sand habitat); Spring 2018-2019, Autumn 2020, 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores)
- **Silt level Spring 2022:** 0%
- **Silt range 2009 to 2022:** 0-17%



Summary: The site has consistently been a mobile sand habitat with a species poor macroinfaunal assemblage throughout most of the monitoring period. It is a flat area (with some small sandwaves present in some years) with firm and reasonably well-drained sand. Since 2017, the site has been on the edge of the channel (within 5-50 m) due to changes in the channel morphologies in this area.

A.11 Site B2

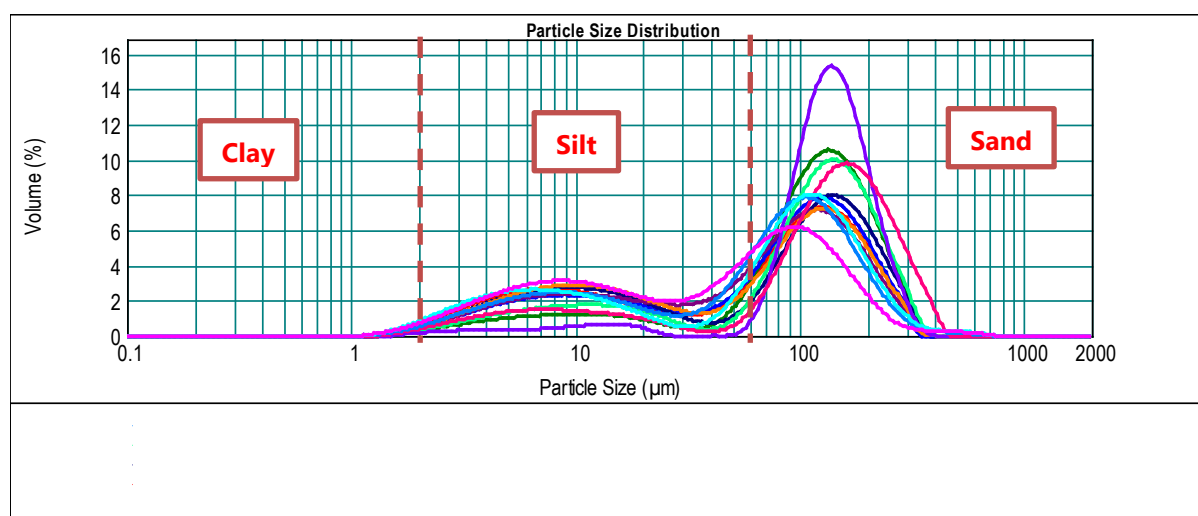
- **Years sampled:** 2005-2007, 2009-2015 (Spring), 2017-2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LMu.MEst (Polychaete/bivalve dominated mid estuarine mud shores) 2005 and 2012. LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) 2006-2011 and since 2013.
- **Silt level Spring 2022:** 50%
- **Silt range 2005 to 2022:** 8-67%



Summary: This site has been a stable mudflat habitat with associated macrofaunal (characterised by *Corophium volutator*., *P. ulvae* and the bivalve *M. balthica*) throughout almost all the monitoring period. It was covered in a thin veneer of sand in 2018 but typical surficial muddy sand conditions have been recorded since 2019. In 2022, due to the continued erosion of the Mostyn Bank the site was located near the bank edge.

A.12 Site B3

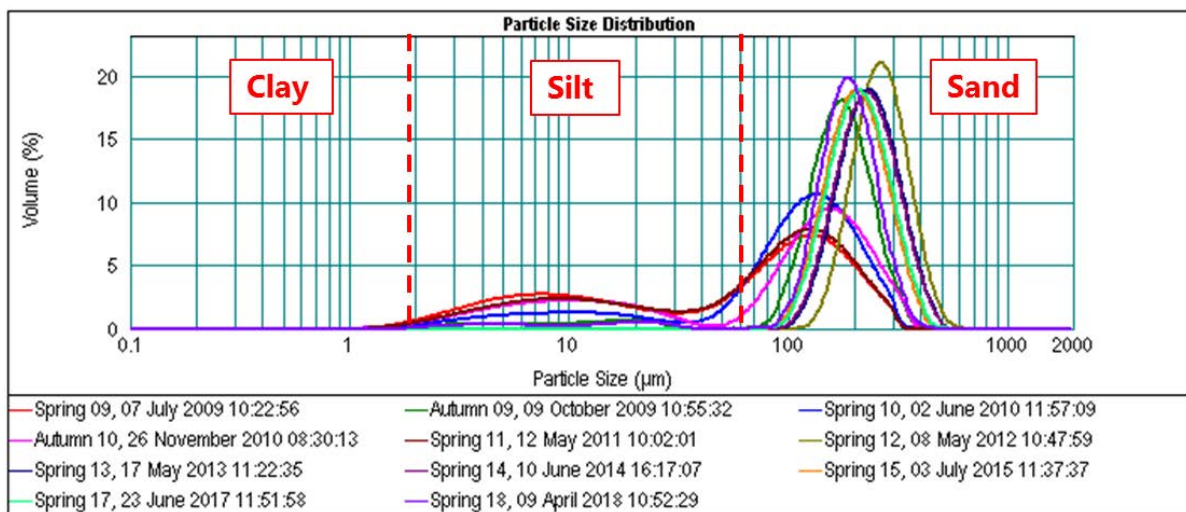
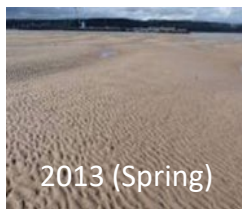
- **Years sampled:** 2005-2007, 2009-2015 (Spring), 2017 (Spring)-site submerged at low water, 2018-2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring).
- **Habitat type:** LS.LMu.MEst (Polychaete/bivalve dominated mid estuarine mud shores) 2005. LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) 2006 to 2015. LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) in 2018. LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) since 2020
- **Silt level Spring 2022:** 56%
- **Silt range 2005 to 2022:** 7-82%



Summary: During early years of the monitoring period this site was a stable and rich mudflat community (with some variability in silt levels) characterised by abundant mud shrimp *C. volutator*, Baltic tellin *M. balthica* and common cockle *C. edule*. The Mostyn Channel passed through this site in 2017. Since 2018 it has been located on the side margins of the Mostyn Approach Channel. From 2018 to 2022, the site has become more stable and ecologically rich with infauna including common cockle *C. edule*, peppery furrow shell *S. plana*, mud shrimp *Corophium* spp and sand masons *L. conchilega* present.

A.13 Site B5

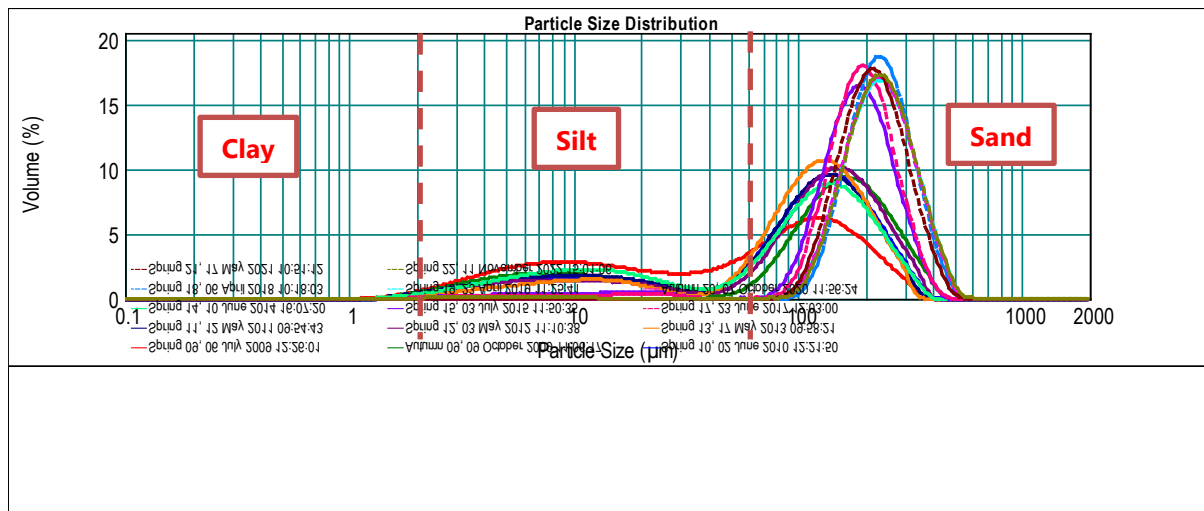
- **Years sampled:** 2005-2007; 2009-2013 (Spring and Autumn), Spring 2014, 2015, 2017 and 2018
- **Habitat type:** LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) 2005 to 2006 and 2009. LS.LMu.MEst (Polychaete/bivalve dominated mid estuarine mud shores) in 2007. LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) since 2010.
- **Silt level Spring 2018:** 5%.
- **Silt range 2005 to 2018:** 0-76%.



Summary: In previous years, the habitat at B5 showed a shift from mud or muddy sand (with varying degrees of deposited sand), to a tide-swept sand habitat. It has been influenced by morphological change as a result of the evolving Salisbury Channel in more recent years. In 2018, it was located on the margin of the Salisbury Channel, below an eroding clay edge, and in 2019, 2020, 2021 and 2022 was located in the channel.

A.14 Site B6

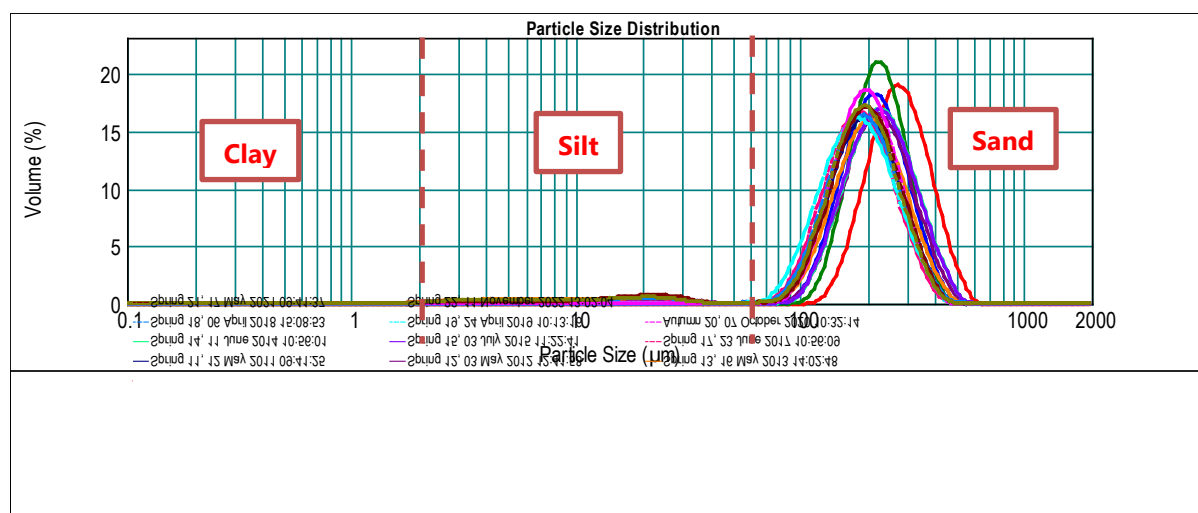
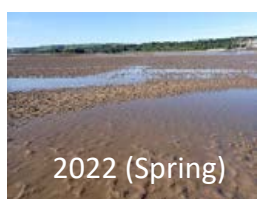
- **Years sampled:** 2005-2007, 2009 (Spring and Autumn), 2010-2015 (Spring), 2017- 2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LMu.MEst (Polychaete/bivalve dominated mid estuarine mud shores) in 2007. LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) between 2005-2006 and 2009-2015. LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) onwards from 2017.
- **Silt level Spring 2022:** 0%
- **Silt range 2005 to 2022:** 0-78%



Summary: This site has changed from mud habitat (observed between 2009 and 2015) to flat fine sand habitat (with no visible fauna evident) observed since 2017.

A.15 Site C1

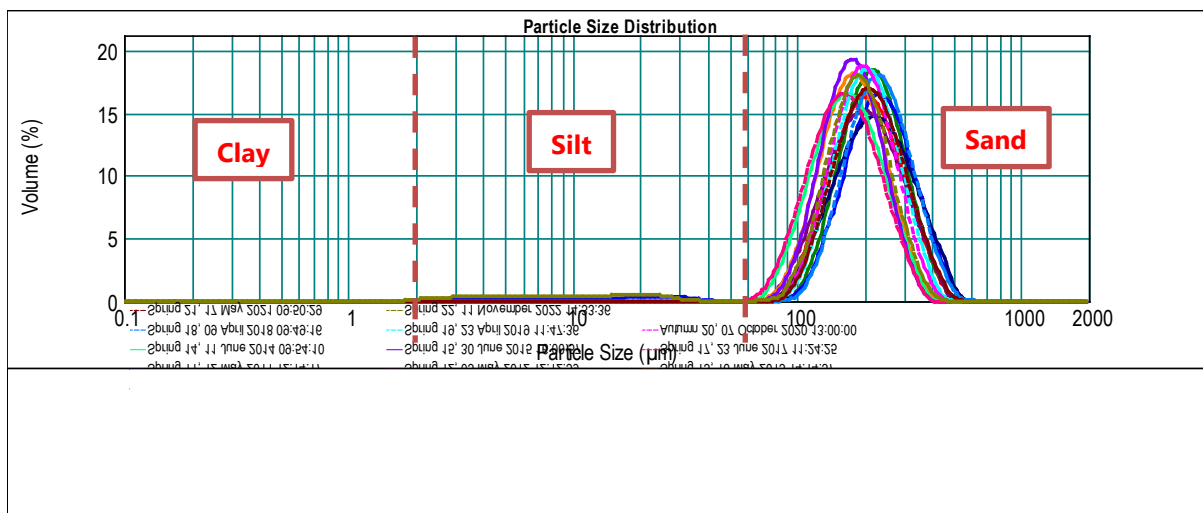
- **Years sampled:** 2005-2007, 2009 (Spring and Autumn), 2010-2015 (Spring), 2017-2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores)
- **Silt level Spring 2022:** 4%
- **Silt range 2005 to 2022:** 0-6%



Summary: Throughout the monitoring period, this site has been a mobile sand habitat with a species-poor macrofaunal assemblage. It is located in an area of megaripples (sandwaves) with poorly drained sand in the troughs. The site was flatter in 2018 and 2019 than observed in previous years. Sandwaves were recorded again in 2020 with the site flatter in 2021 and 2022.

A.16 Site C2

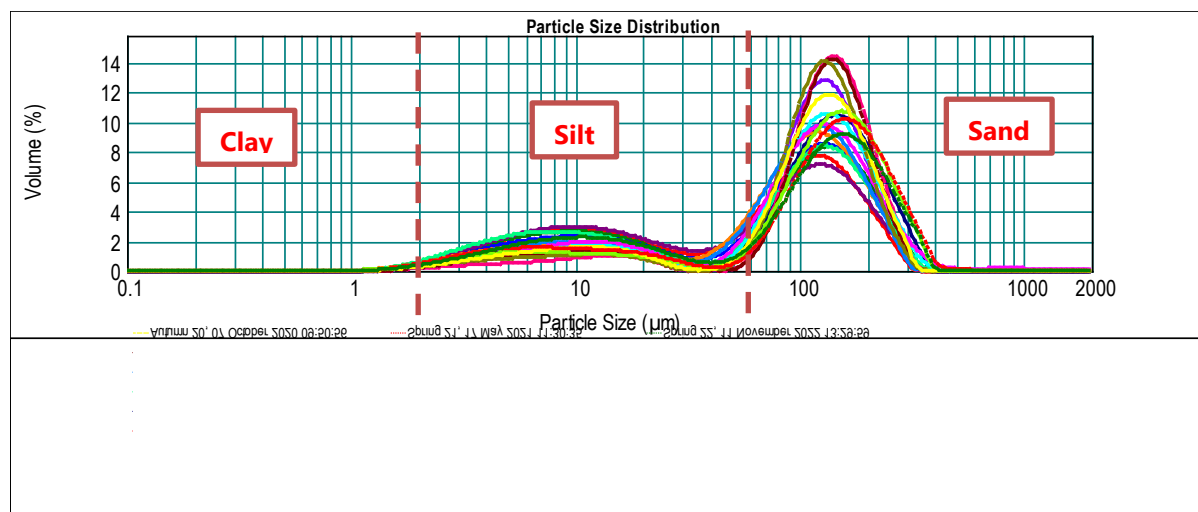
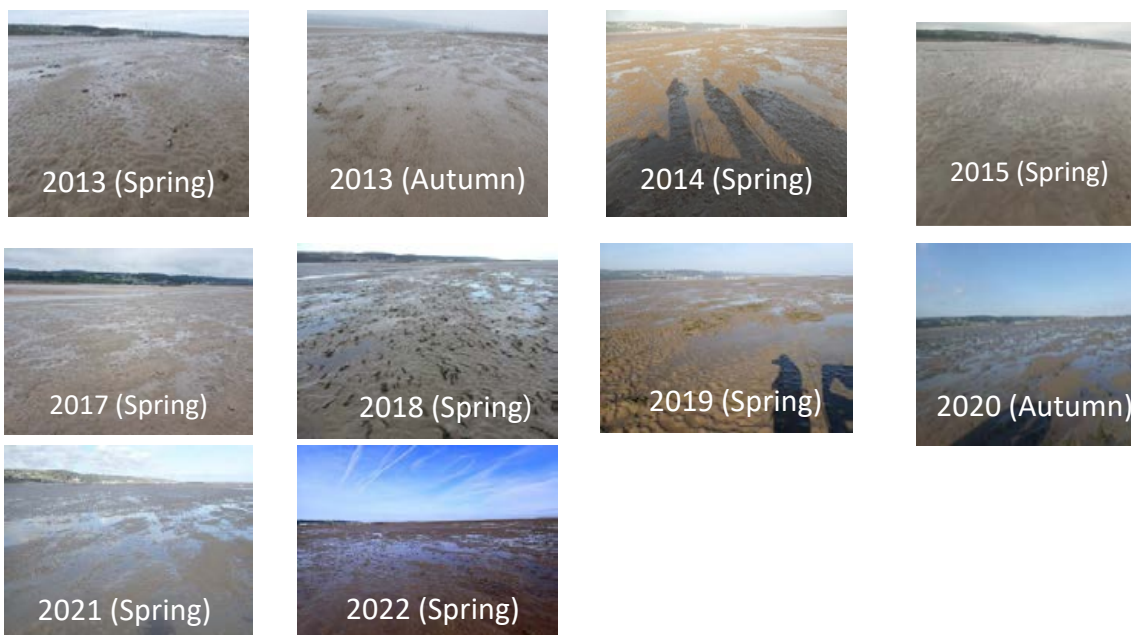
- **Years sampled:** 2005-2007; 2009 (Spring and Autumn), 2010-2015 (Spring), 2017- 2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores)
- **Silt level Spring 2022** 6%
- **Silt range 2005-2022:** 0-6%



Summary: Throughout the monitoring period the site has consistently been a mobile sand habitat with a species-poor macrofaunal assemblage characterised by low numbers of amphipods and errant polychaetes. The site is located in an area of gently sloping megaripples. No change was observed in 2022.

A.17 Site C3

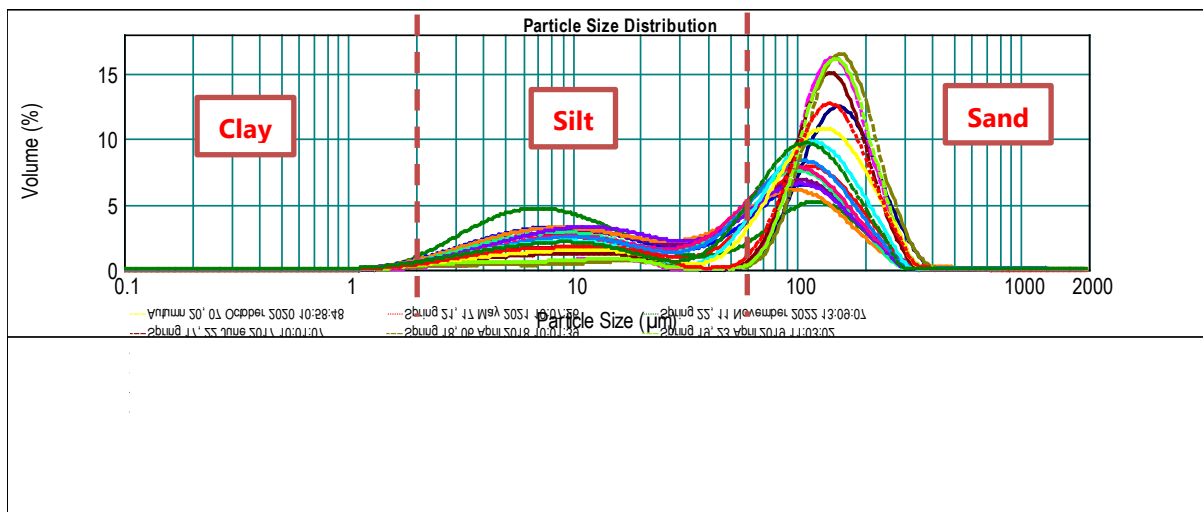
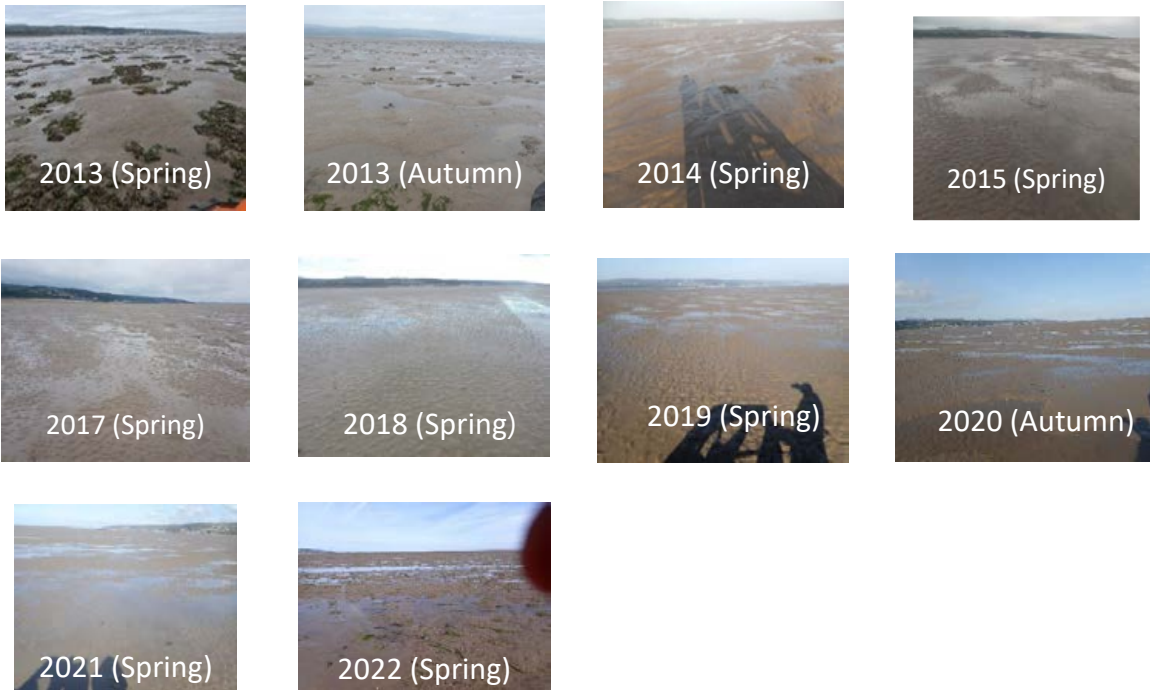
- **Years sampled:** 2005-2007; 2009-2013 (Spring and Autumn), Spring 2015, 2017- 2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) in 2005 and 2006. LS.LMu.MEst (Polychaete/bivalve dominated mid estuarine mud shores) in 2007. LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) since 2009.
- **Silt level Spring 2022:** 30%
- **Silt range 2005 to 2022:** 0-75%



Summary: The habitat in this area changed from mobile sand to muddy sand between 2005 and 2007, with a general trend towards enrichment of the benthos following the closure of the Salisbury Bank cross-channel. Since 2009, ecological characteristics have remained relatively stable, with a rich infaunal assemblage (characterised by mudsnail *H. ulvae* and abundant bivalves, including Baltic tellin *M. balthica*, peppery furrow shell *S. plana* and common cockle *C. edule*) recorded in all years. No change was observed in 2022.

A.18 Site C4

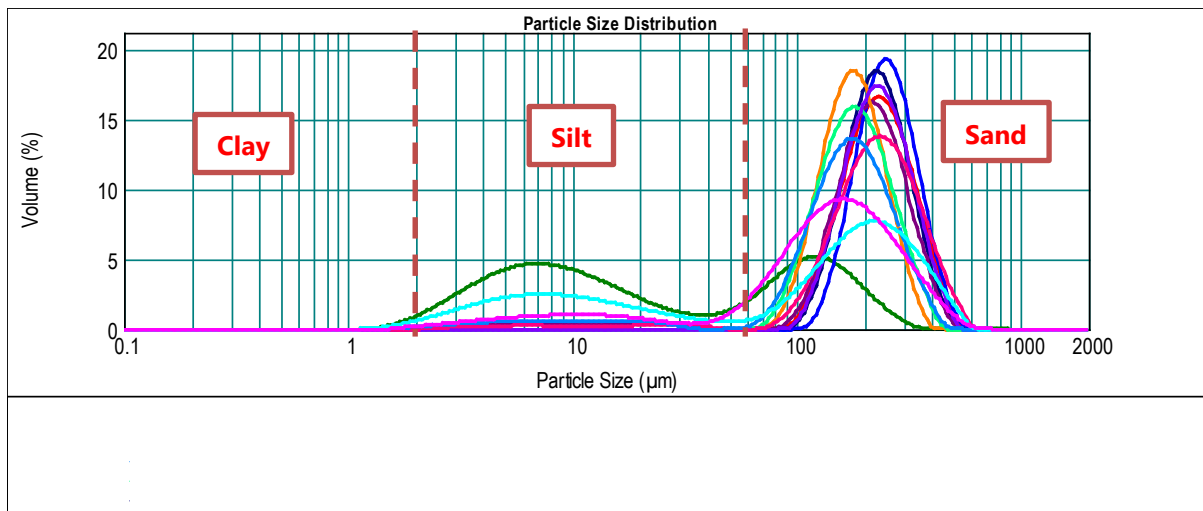
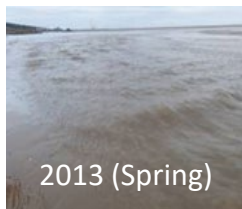
- **Years sampled:** 2005-2007; 2009-2013 (Spring and Autumn), Spring 2015, 2017- 2019, 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) in 2005. LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) since 2006.
- **Silt level Spring 2022:** 34%
- **Silt range 2005 to 2022:** 0-61%



Summary: The habitat in this area changed from mobile sand to muddy sand between 2005 and 2006, with a general trend towards enrichment of the benthos following the closure of the Salisbury Bank cross-channel. Since 2007, ecological characteristics have remained relatively stable with a rich infaunal assemblage recorded including cockles, sandmasons *L. conchilega*, peppery furrow shell *S. plana* and lugworms *A. marina*. No change was observed in 2022.

A.19 Site D1

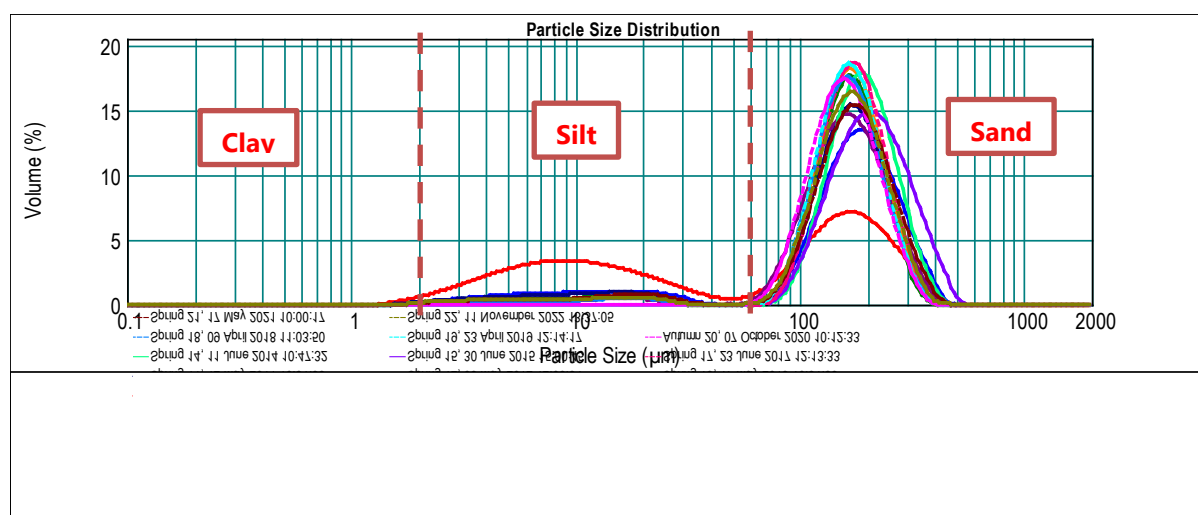
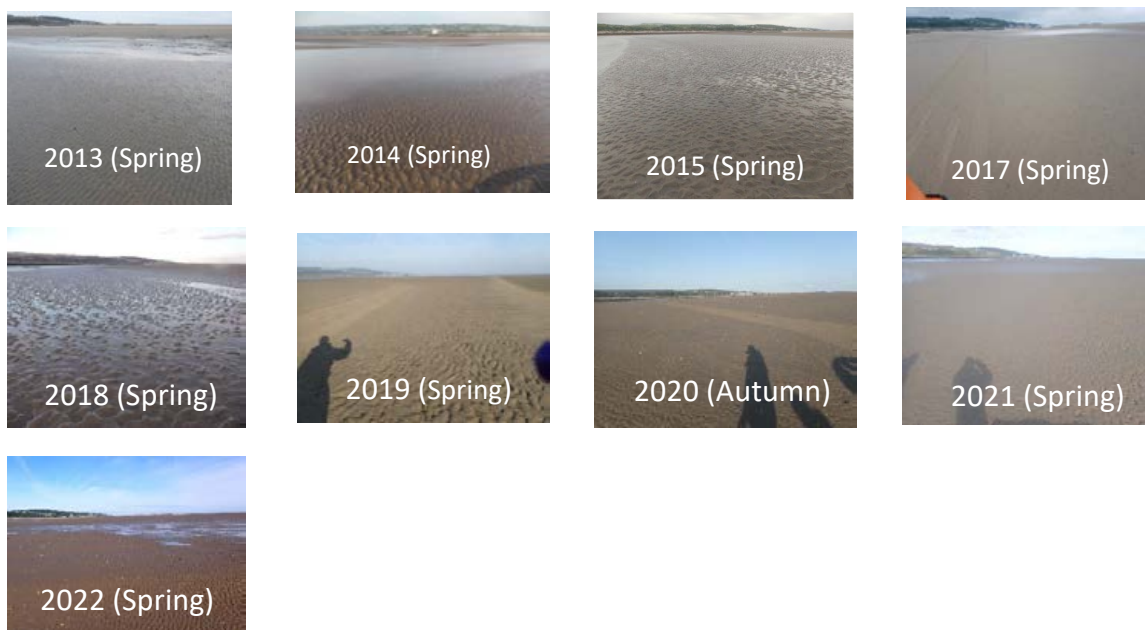
- **Years sampled:** 2005-2007, 2009 (Spring and Autumn), 2010-2015 (Spring), 2017- 2019 (Spring), 2021 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores).
- **Silt level Spring 2021:** 17%
- **Silt range 2005 to 2021:** 0-35%



Summary: The low elevation site has consistently been a mobile sand habitat with a species-poor macrofaunal community. The site has been located in an area of megaripples with poorly drained sand in the troughs. In 2019, localised mud accretion had occurred with abundant sand masons recorded. It had been altered by accretion of fine sediments with observations suggesting this was a localised event rather than a sign of broader morphological change. In 2020, it was located subtidally in the channel with conditions similar to 2019 observed in 2021. In 2022 the site was again located subtidally in the channel.

A.20 Site D2

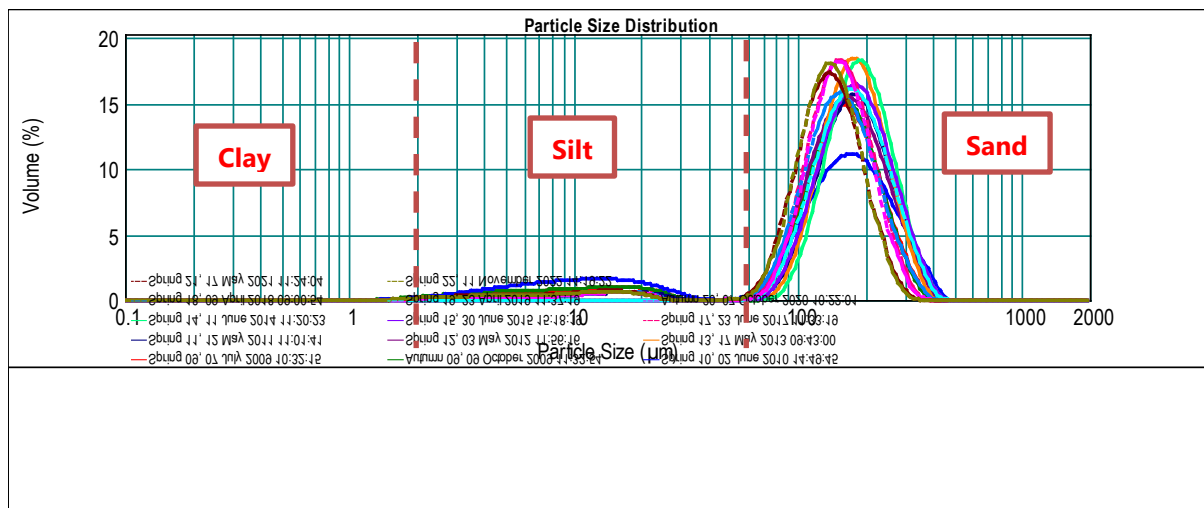
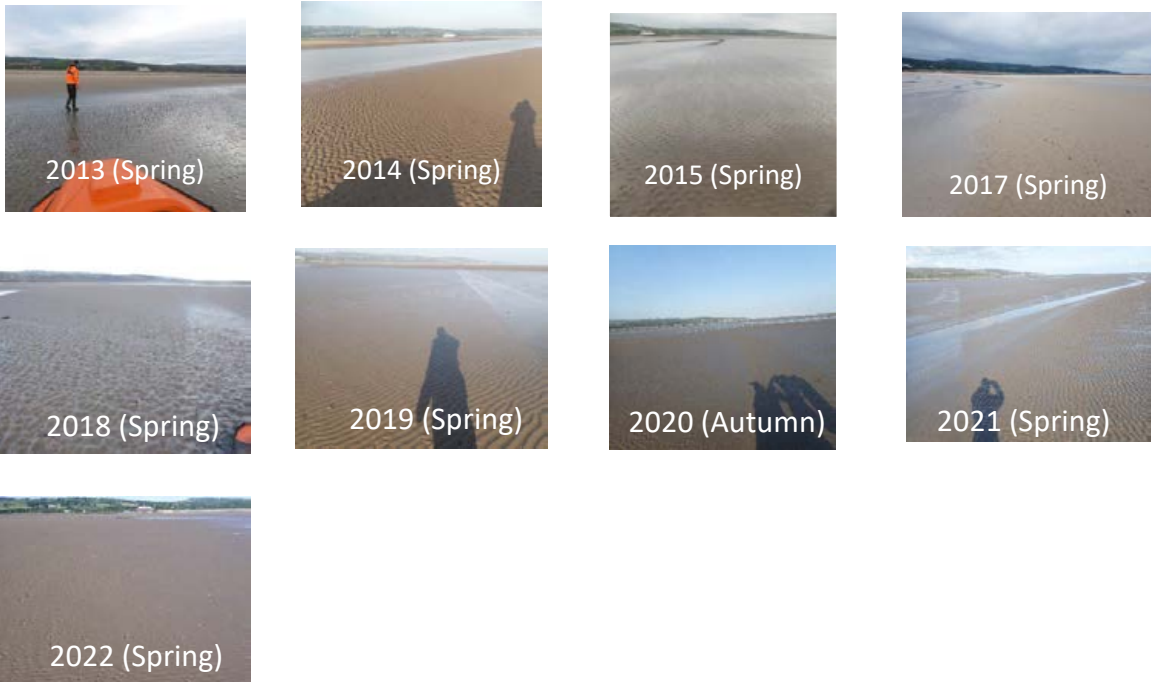
- **Years sampled:** 2005-2007, 2009 (Spring and Autumn), 2010-2015 (Spring), 2017- 2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) 2005-2007. LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) 2009-2011. LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) since 2012.
- **Silt level Spring 2022:** 6%
- **Silt range 2005 to 2022:** 0-46%



Summary: The habitat at this site changed from sand in 2005 and 2006 to muddy sand with increasing silt content in 2007 and then 2009. Between 2009 and 2011, the area consisted of highly mixed sedimentary conditions with fine sand and bands of organic-rich sediments and mud collecting in troughs at the surface. Since 2012, the habitat has consisted of flat sand. No change was observed in 2022.

A.21 Site D3

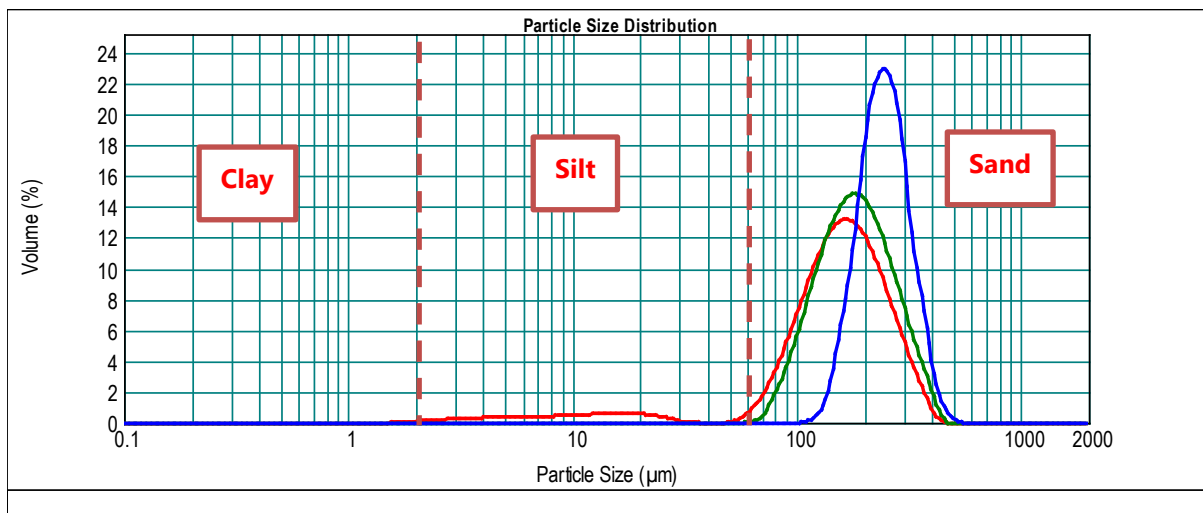
- **Years sampled:** 2005-2007, 2009 (Spring and Autumn), 2010-2015 (Spring), 2017- 2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) 2005. LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) 2006 to 2009. LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) since 2010.
- **Silt level Spring 2022:** 6%
- **Silt range 2005 to 2022:** 0-64%



Summary: The habitat at this site changed from exclusively sand in 2005 to muddy sand in 2006, 2007 and 2009. Since 2010, the habitat has consisted of flat sand. No change was observed in 2022.

A.22 Site W1

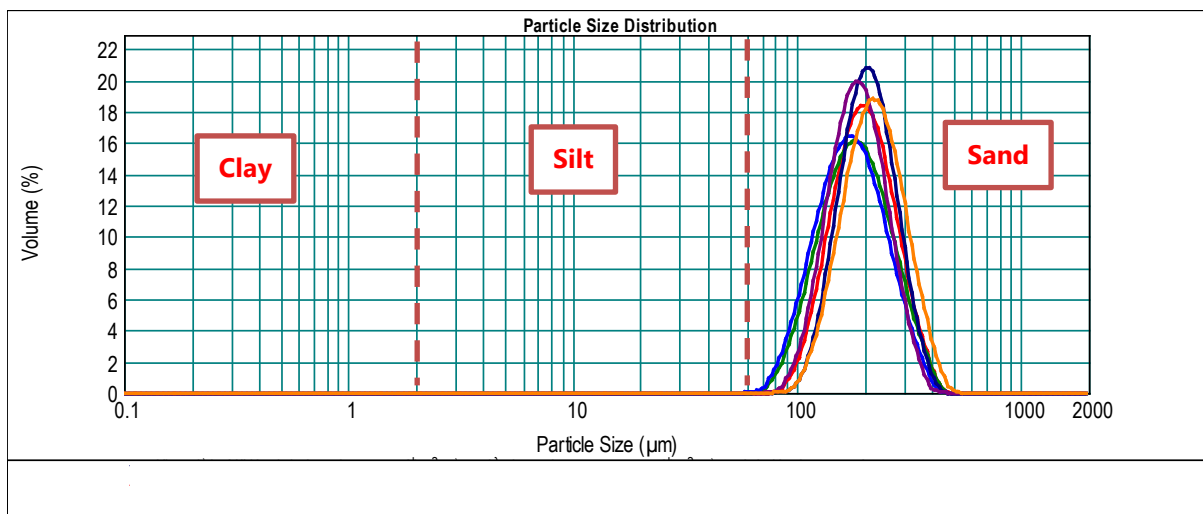
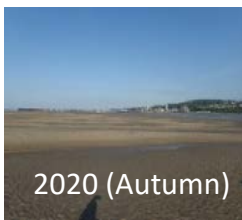
- **Years sampled:** 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores)
- **Silt level Spring 2022:** 0%
- **Silt range 2020 to 2022:** 0-7%



Summary: This site has only been sampled in 2020 and 2021, because it was located underwater in the channel in previous years. The site consisted of low elevation, poorly drained sand habitat located on the channel margin in both years. The site was higher in elevation and located further from the channel in 2022.

A.23 Site W2

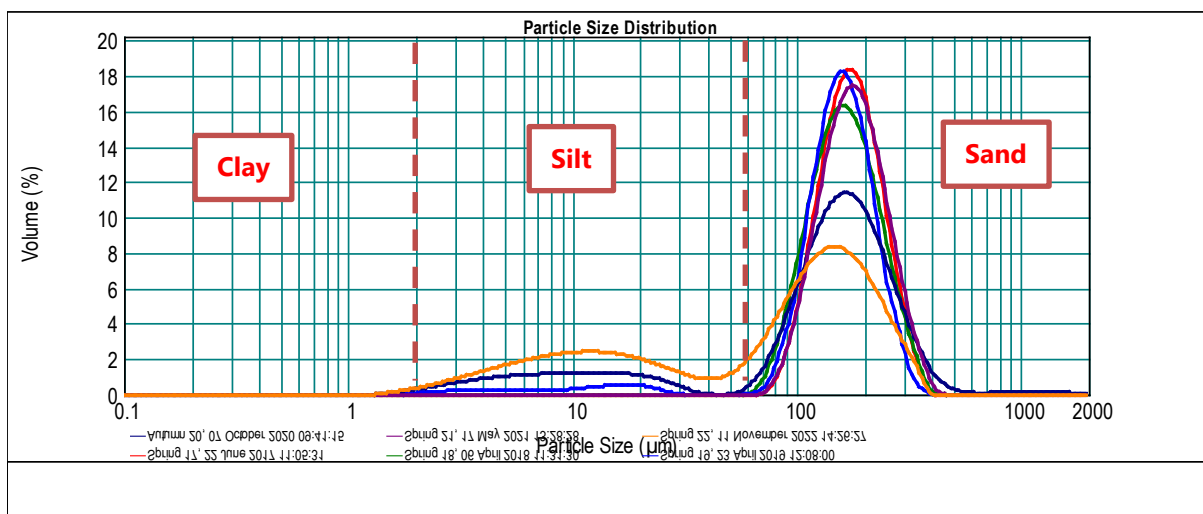
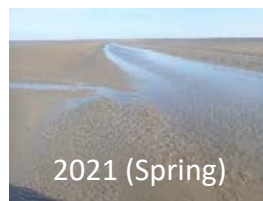
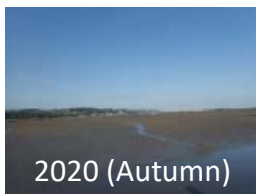
- **Years sampled:** 2017- 2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores)
- **Silt level Spring 2022:** 0%
- **Silt range 2017 to 2022:** 0%



Summary: This recently-sampled site comprises a mobile sand habitat and is located in an area of with poorly drained sand. No change was observed in 2022.

A.24 Site W3

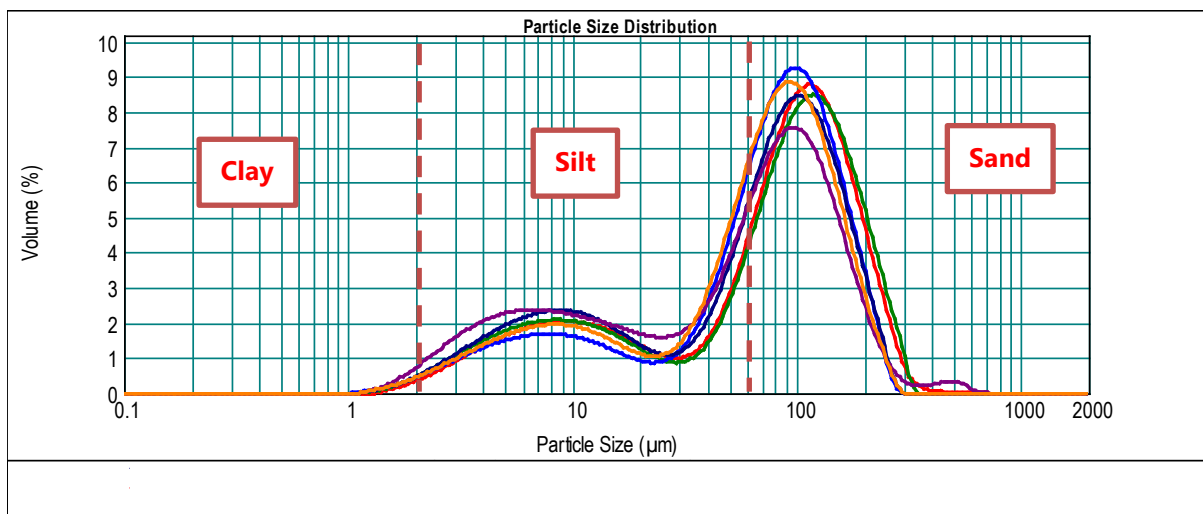
- **Years sampled:** 2017- 2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) 2017-2019, LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) since 2020.
- **Silt level Spring 2022:** 36%
- **Silt range 2017 to 2022:** 0-36%



Summary: The habitat at this location consisted of fine sand from 2017-2019. In 2020, an increase in silt was recorded and the site appeared to be more ecologically rich, with lugworms *A. marina* and common cockles *C. edule* present. However, in 2021 there appeared to be a return to more impoverished conditions with sandier conditions returning and limited fauna recorded (consisting of very occasional lugworms *A. marina* casts). In 2022, muddier conditions were again observed common cockles *C. edule* and *Corophium* spp recorded.

A.25 Site W4

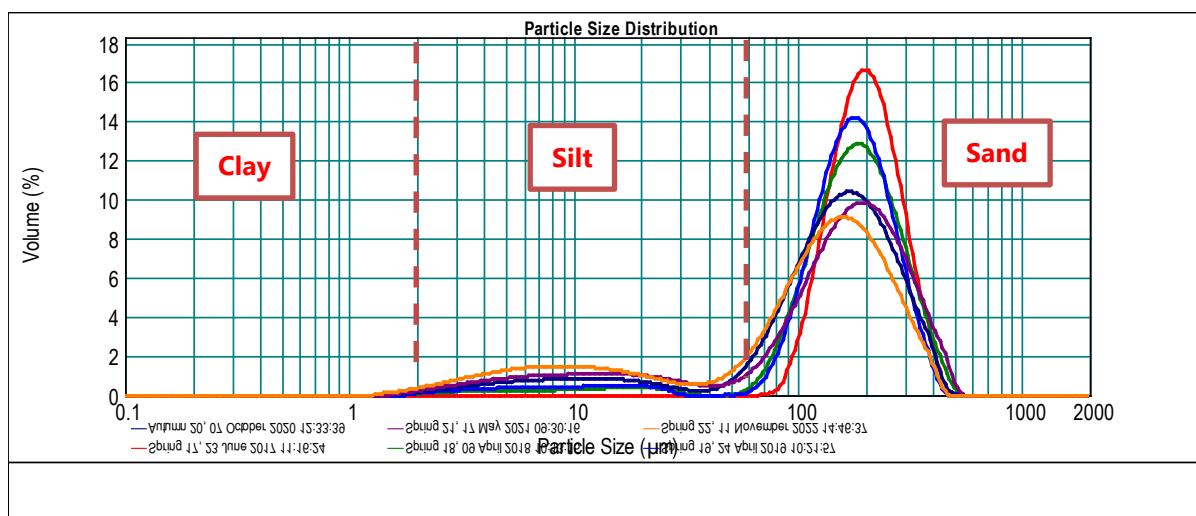
- **Years sampled:** 2017-2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores)
- **Silt level Spring 2022:** 43%
- **Silt range 2017 to 2022:** 36-49%



Summary: This site comprises a flat area of firm muddy sand. Abundant mudsnail *P. ulvae*, lugworm *A. marina* and common cockle *C. edule*. Patches of sand mason *L. conchilega* present as well as hummocky areas covered in strands of *Enteromorpha*. In 2022, peppery furrow shell *S. plana* and mudsnail *Peringia ulvae* were abundant and common cockles *C. edule* present in clumps on the surface.

A.26 Site W5

- **Years sampled:** 2017- 2019 (Spring), 2020 (Autumn), 2021 (Spring), 2022 (Spring)
- **Habitat type:** LS.LSa.MoSa (Barren or amphipod-dominated mobile sand shores) 2017-2019. LS.LSa.MuSa (Polychaete/bivalve dominated muddy sand shores) since 2020.
- **Silt level Spring 2022:** 24%
- **Silt range 2017 to 2022:** 0-24%



Summary: The habitat at this location consisted of a fine sand from 2017-2019. In 2020, an increase in silt was recorded and the site appeared to be more ecologically rich with lugworms *A. marina*, common cockles *C. edule*, sandmason *L. conchilega*, mudsnail *Peringia ulvae* and Baltic tellin *M. balthica* recorded. Similar conditions were also recorded in 2022.

B PSA Methods and Results

B.1 Particle Size Analysis Analytical Approach

Once sediment samples were returned from the field, they were processed straight away or frozen in a deep freeze at -20°C until needed for further analysis. The sample was initially assessed in appearance for use of the appropriate analysis. Mud samples were only run through the analysette, whilst any mixed samples (where present) containing sand, gravel or boulders were oven dried if large particles ($>2\text{ mm}$) were present. If the sample was only slightly coarse it was sieved on a 1.4 mm sieve bucket using a wash bottle of tap water. If material was retained then the whole sample was oven dried, and if all passed through the sieve then the sample was put through the analysette.

If appropriate, sub-samples were taken from samples that had been homogenised in the bag using a spatula, or the whole sample was used. A sample to be dried was added to pre-weighed dish then dried overnight in an oven at 110°C . The dish was re-weighed with the dried contents and once the sample had been carefully broken up, it was dry sieved using standard sieves mounted on a sieve shaker. Each sieve was gently brushed to remove retained particles into a tared dish and then weighed accumulatively starting with the largest sized sieve.

Material retained in the base pan was then transferred to a 500 ml conical flask via a funnel. The flask was filled up to 500 ml with tap water and a 15 ml phial was lowered into the conical flask on a piece of string. The flask was then stoppered and fully inverted several times, ensuring that the suspension was totally mixed. The phial was removed from the flask and the contents were run through the analysette. For mud samples, the sub-sample was treated the same way but broken up with water and a fine sieve when added to the flask.

The Malvern Mastersizer 2000 laser analysette measures diameters ranging from 0.02 to $2000\text{ }\mu\text{m}$ using laser diffraction. The machine, built to ISO 13320-1:1999⁶ specifications, was cleaned and aligned before taking all measurements. Measuring samples was controlled by the use of a Standard Operating Procedure (SOP) set up by ABP Marine Environmental Research Ltd (ABPmer). The SOP has built-in alarms for alignment, cleanliness and obscuration to control the measuring environment. Details of a sample were entered into the software then a background and five repeat measurements were taken to generate an average result. The data was processed in the Malvern software and the output saved digitally as a Portable Document Format (PDF).

If none of sample was dry sieved, then the Mastersizer output was considered to be a representative sub-sample of the whole population and was used as the final result. However, if dry sieving was undertaken then the two size populations (analysette and sieved) were merged using the dry weight data. The results were added to a Microsoft Excel spreadsheet, which combines the two populations together using percentage weight. The results were presented graphically in Excel and saved in a PDF format.

⁶ BS ISO 13320-1:1999, Particle size analysis. Laser diffraction methods. General principles. British Standards Institution, ISBN 0 580 34263 8, (Superseded in 2009).

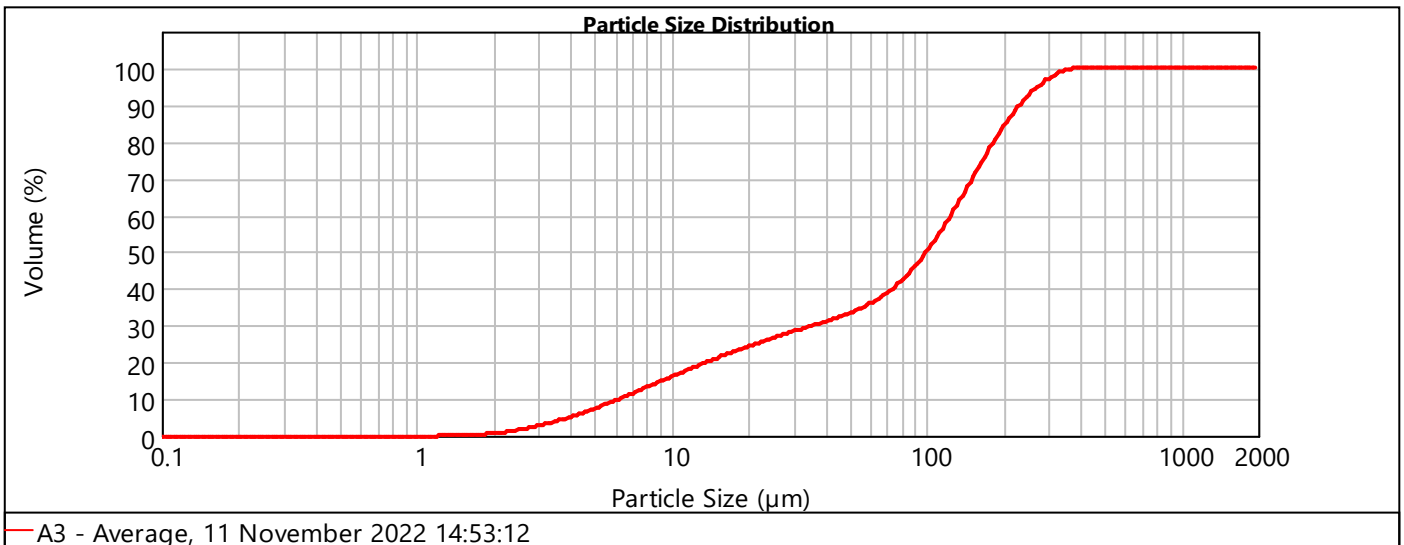
B.2 PSA Results

Particle Size Analysis Report

Sample Name: A3 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 11.04 %
 Sample Collected: June 2022 Weighted Residual: 0.464 %

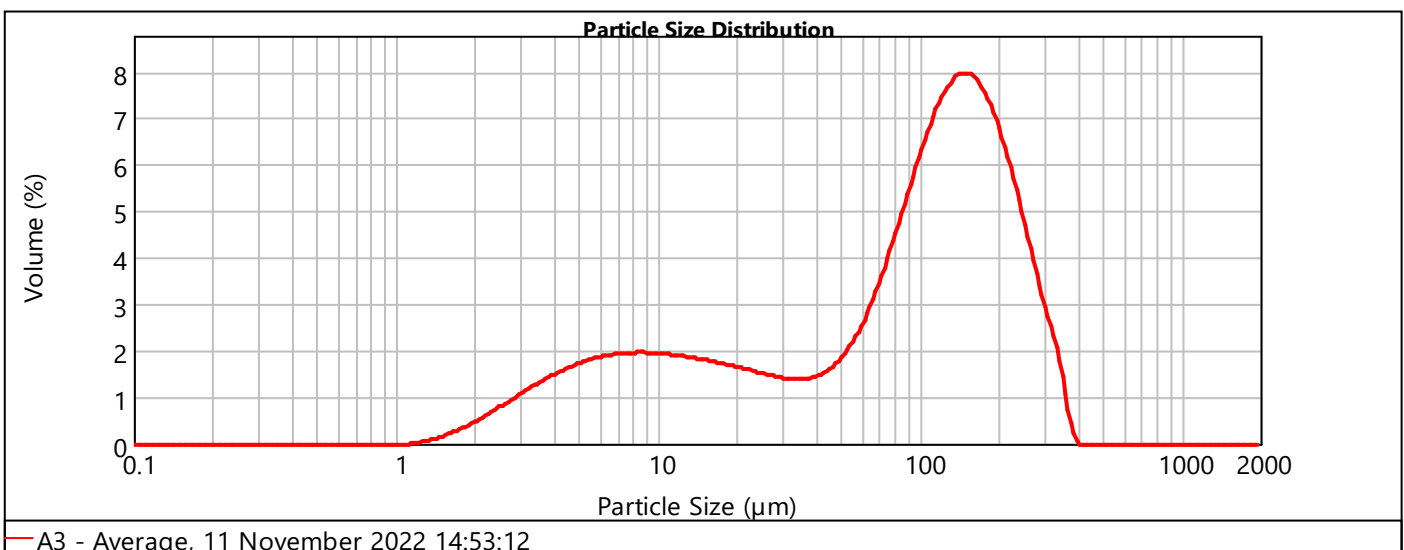
d(0.1): 6.170 μm d(0.5): 99.609 μm d(0.9): 231.844 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
1 %	9 %	15 %	12 %	48 %	16 %	0 %

Frequency Curve

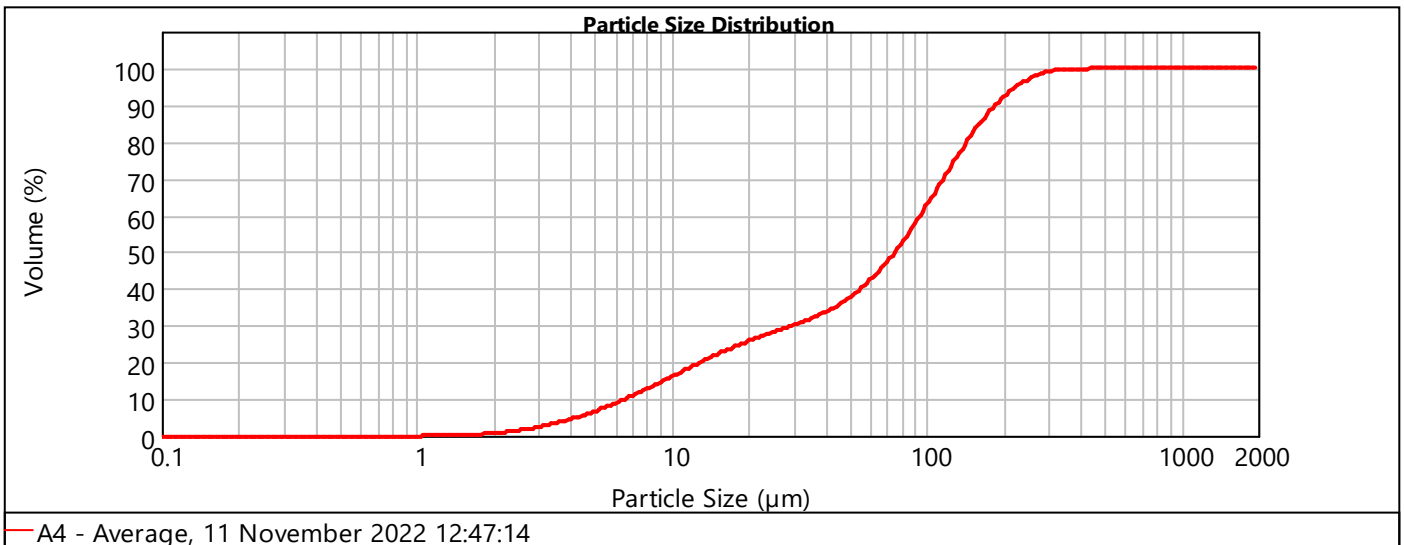


Particle Size Analysis Report

Sample Name: A4 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 10.13 %
 Sample Collected: June 2022 Weighted Residual: 0.351 %

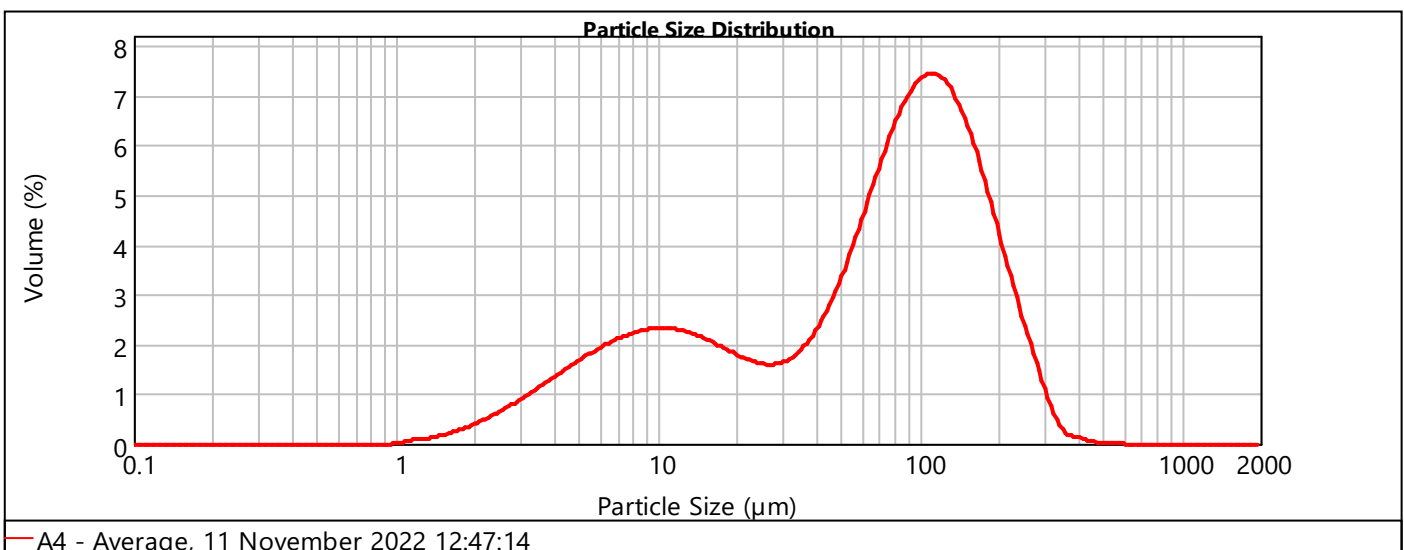
d(0.1): 6.555 μm d(0.5): 74.988 μm d(0.9): 186.337 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
1 %	8 %	17 %	17 %	50 %	8 %	0 %

Frequency Curve

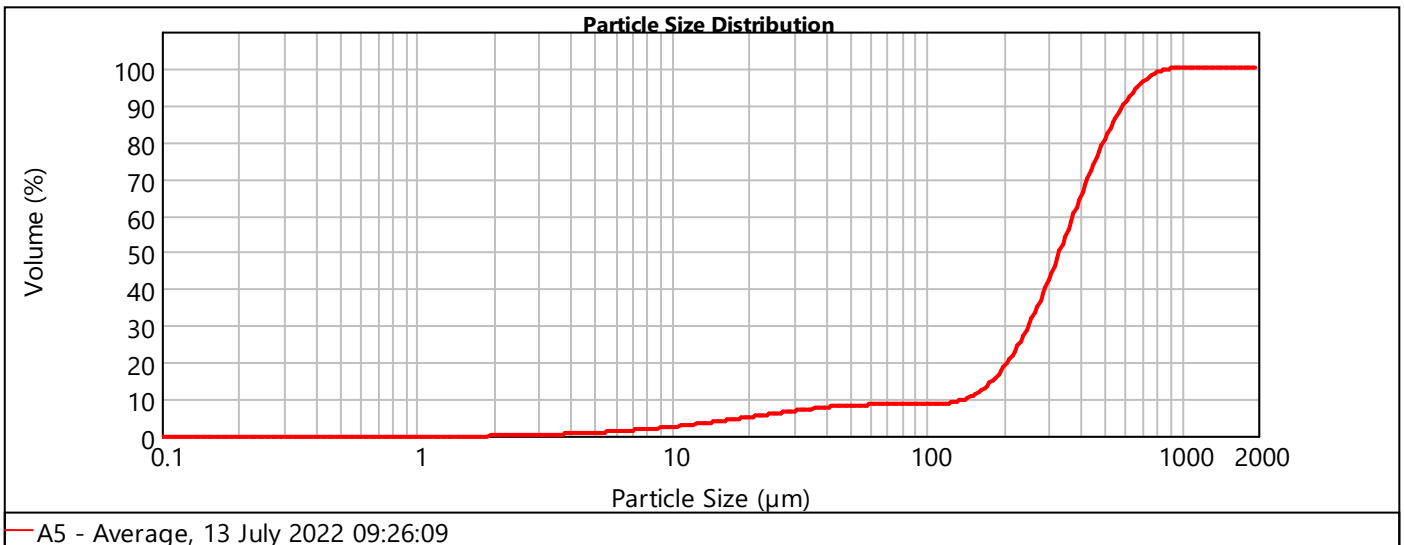


Particle Size Analysis Report

Sample Name: A5 - Average Measured by: AFulford on 13 July 2022 09:26:09
 Sample Source: Mostyn Obscuration: 11.34 %
 Sample Collected: June2022 Weighted Residual: 2.753 %

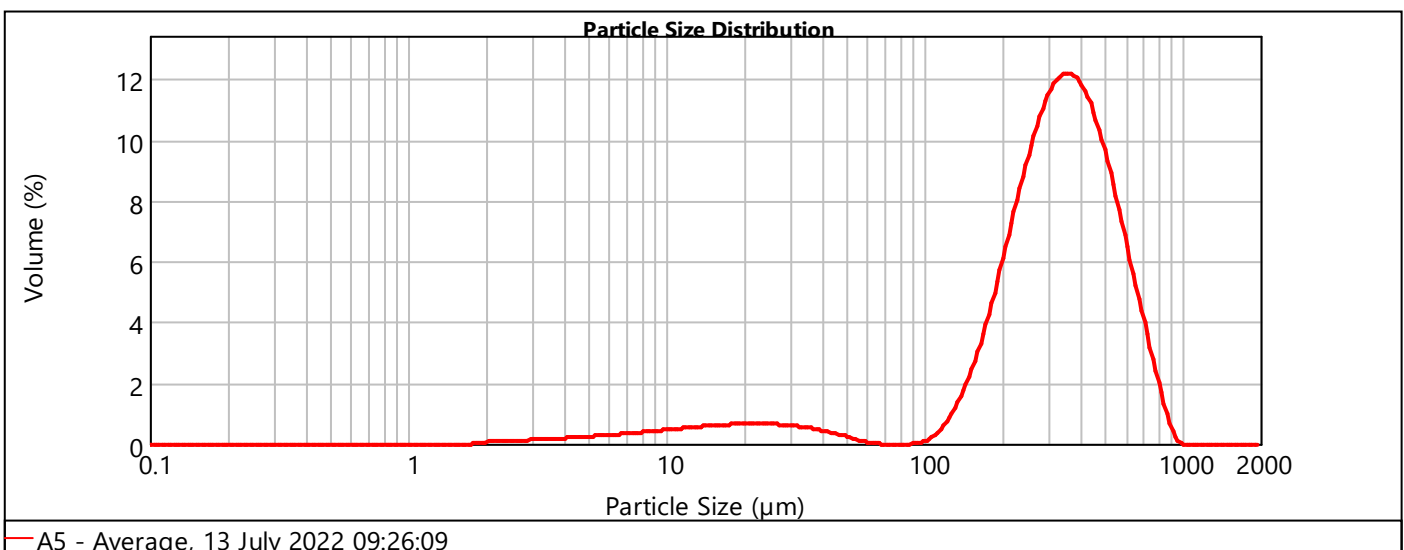
d(0.1): 140.871 μm d(0.5): 332.335 μm d(0.9): 591.792 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	1 %	4 %	3 %	10 %	72 %	9 %

Frequency Curve

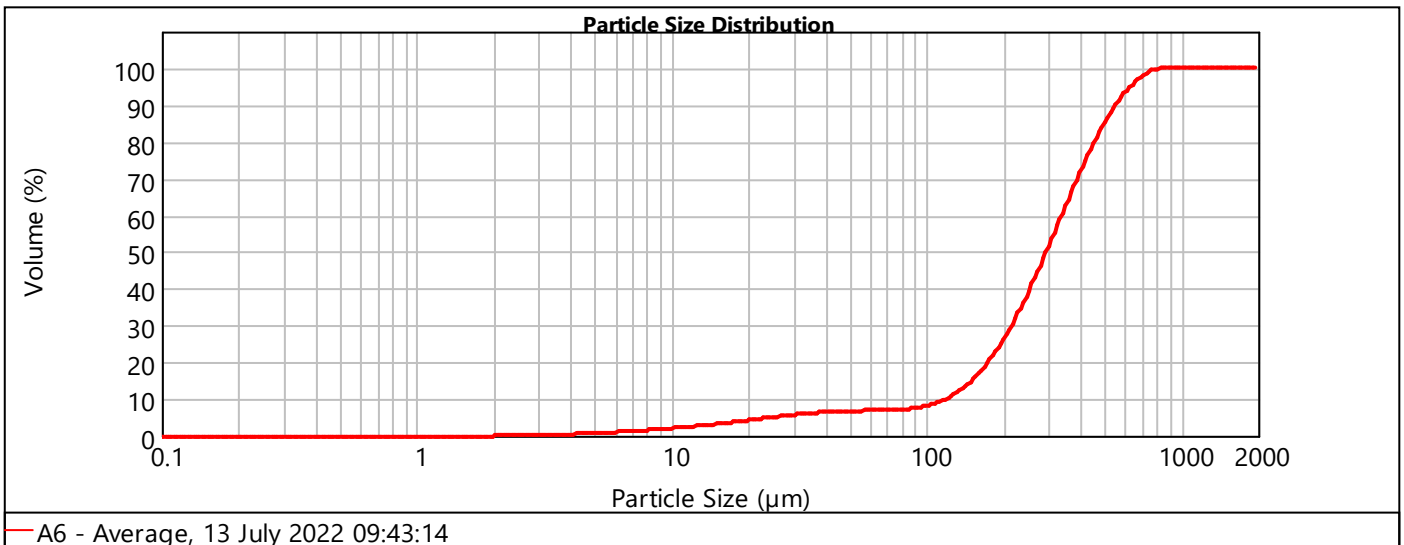


Particle Size Analysis Report

Sample Name: A6 - Average Measured by: AFulford on 13 July 2022 09:43:14
 Sample Source: Mostyn Obscuration: 11.24 %
 Sample Collected: June2022 Weighted Residual: 3.501 %

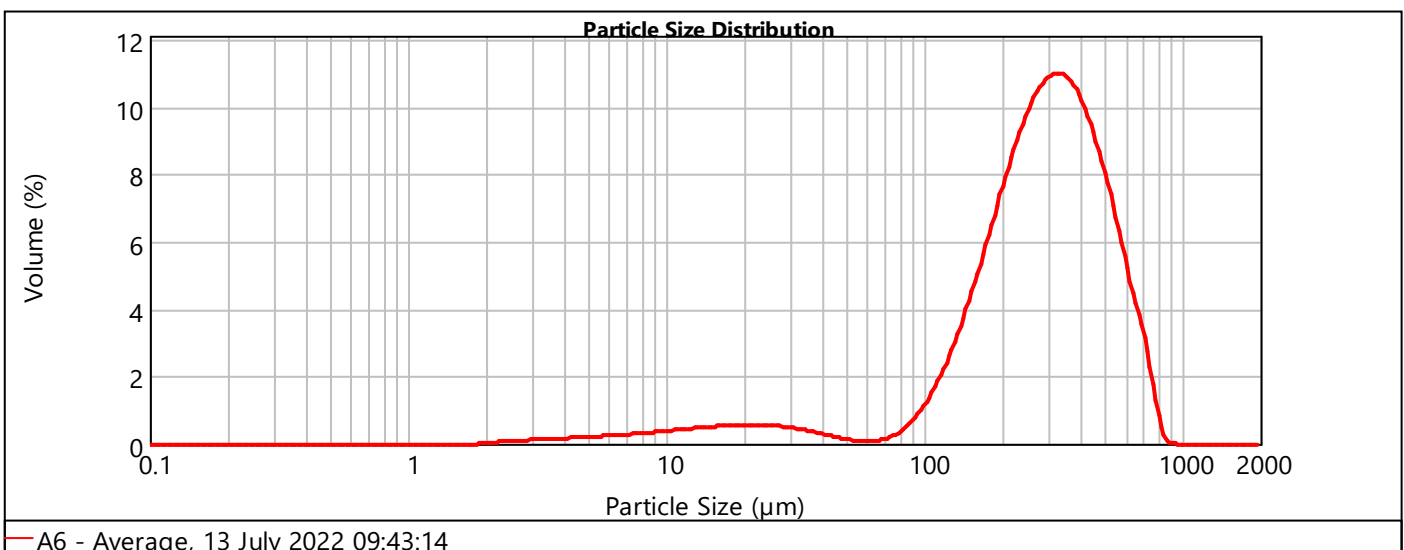
d(0.1): 118.363 μm d(0.5): 294.265 μm d(0.9): 550.277 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	1 %	3 %	3 %	19 %	67 %	7 %

Frequency Curve

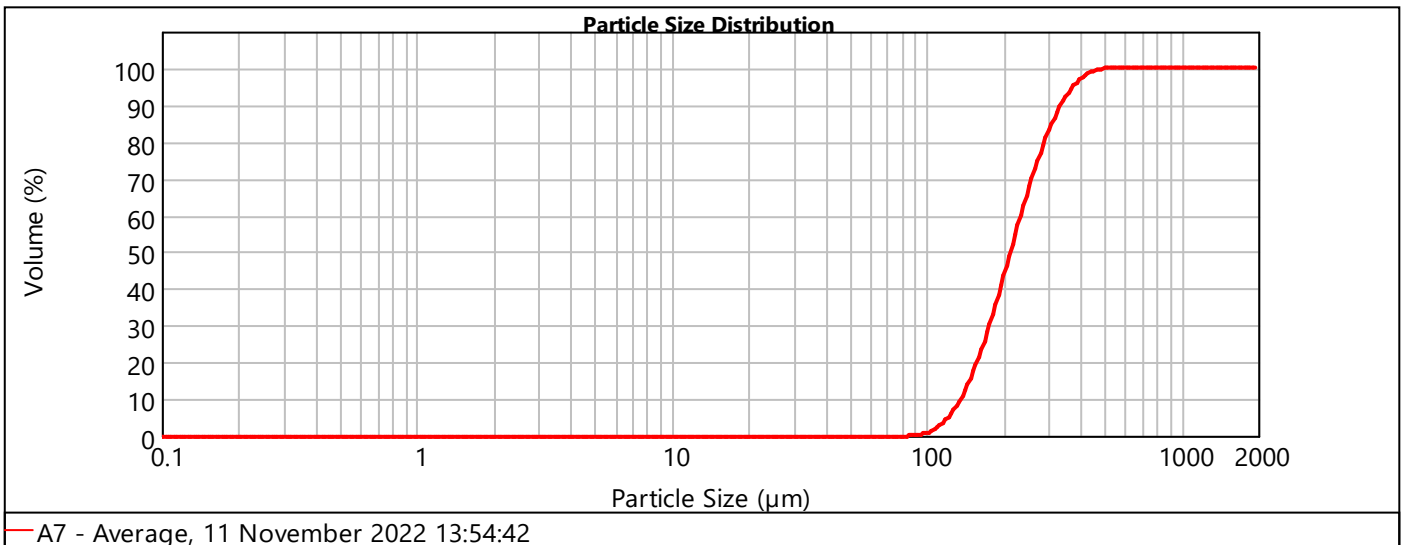


Particle Size Analysis Report

Sample Name: A7 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 9.13 %
 Sample Collected: June 2022 Weighted Residual: 0.842 %

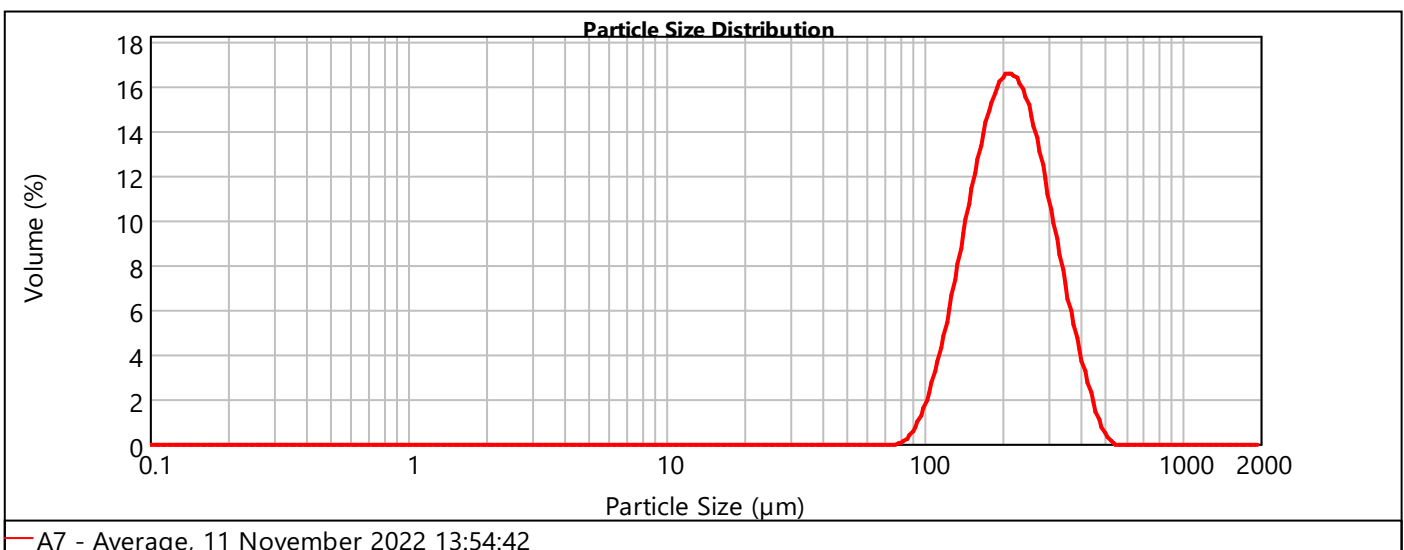
d(0.1): 135.805 μm d(0.5): 213.460 μm d(0.9): 335.643 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	0 %	0 %	0 %	43 %	57 %	0 %

Frequency Curve



Particle Size Analysis Report

Sample Name: A8 - Average

Measured by: AFulford on 13 July 2022 09:05:26

Sample Source: Mostyn

Obscuration: 10.24 %

Sample Collected: June2022

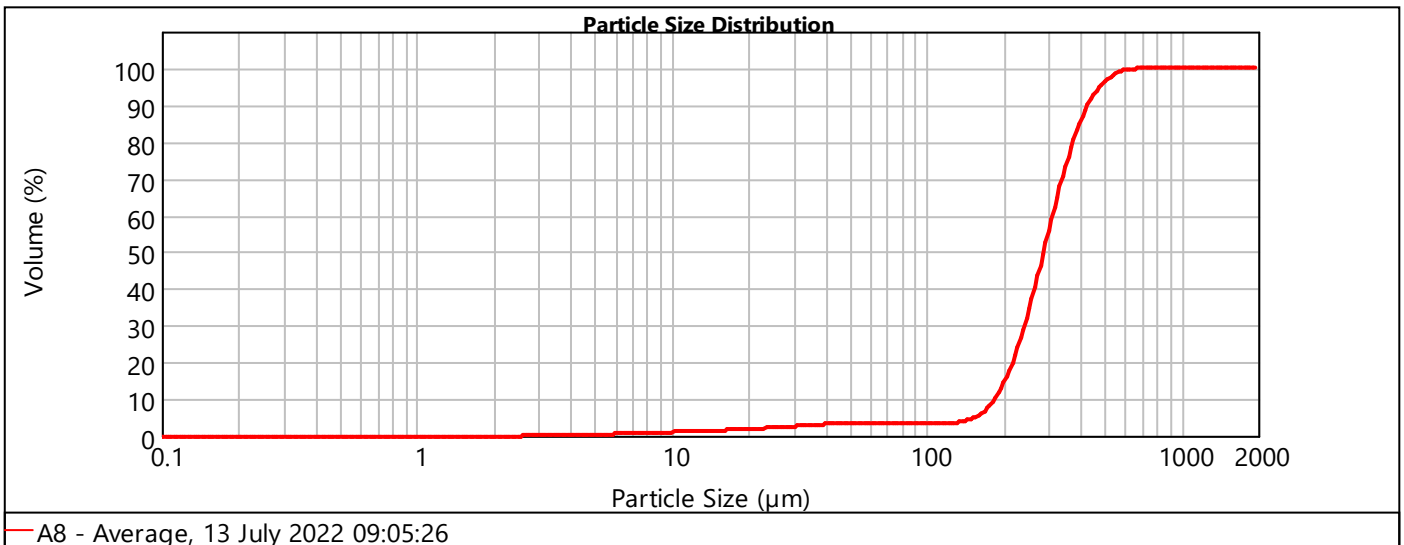
Weighted Residual: 2.203 %

d(0.1): 184.567 μm

d(0.5): 287.589 μm

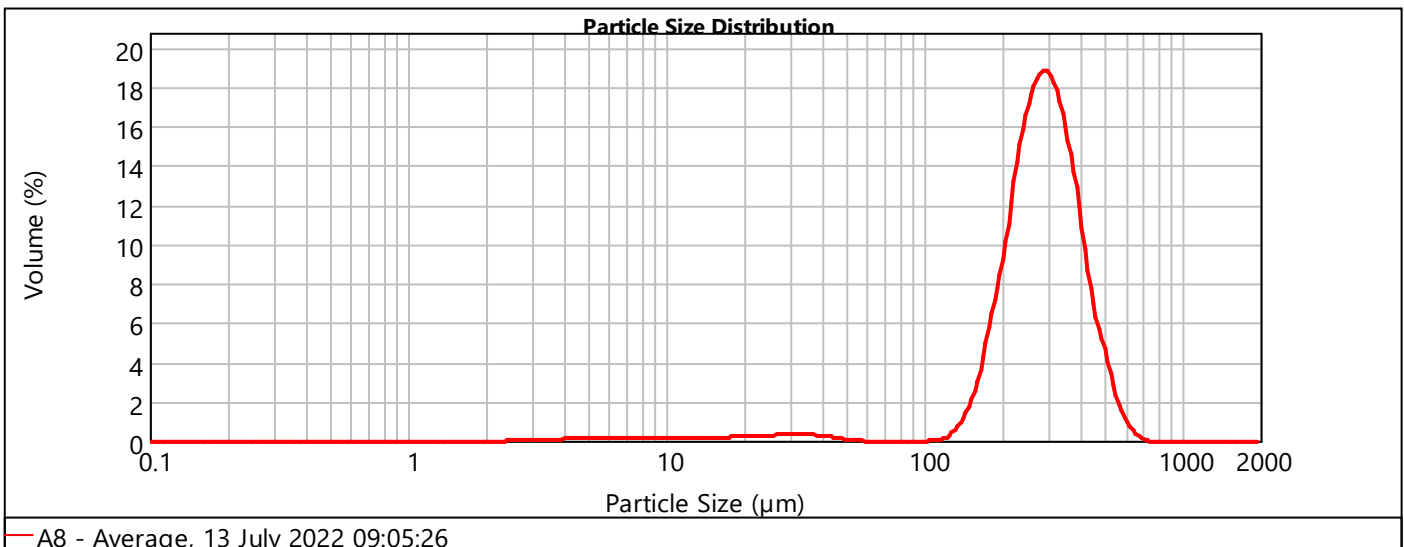
d(0.9): 427.390 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	1 %	1 %	2 %	11 %	85 %	0 %

Frequency Curve

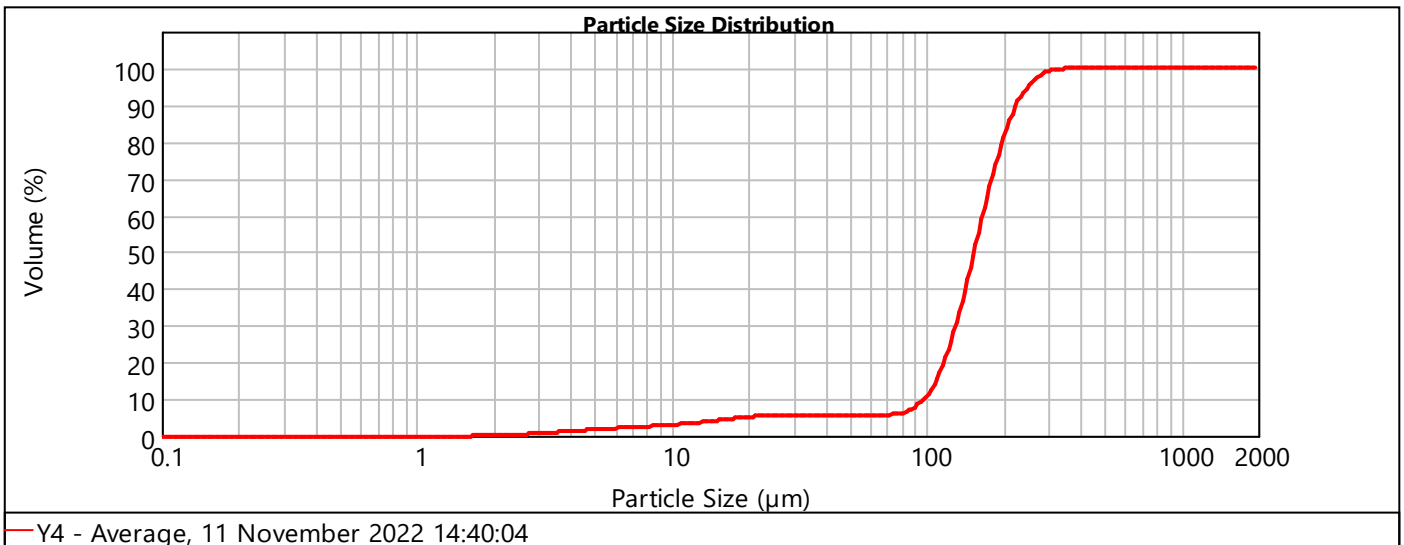


Particle Size Analysis Report

Sample Name: Y4 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 10.80 %
 Sample Collected: June 2022 Weighted Residual: 0.316 %

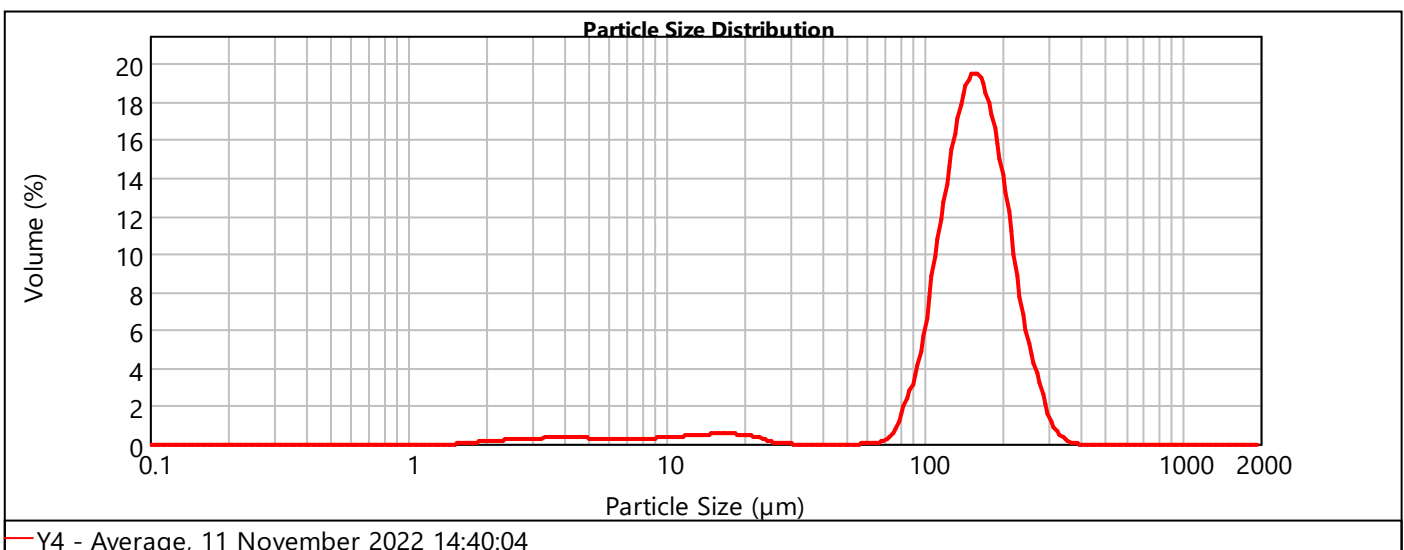
d(0.1): 97.781 μm d(0.5): 153.734 μm d(0.9): 224.466 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	2 %	3 %	1 %	75 %	19 %	0 %

Frequency Curve

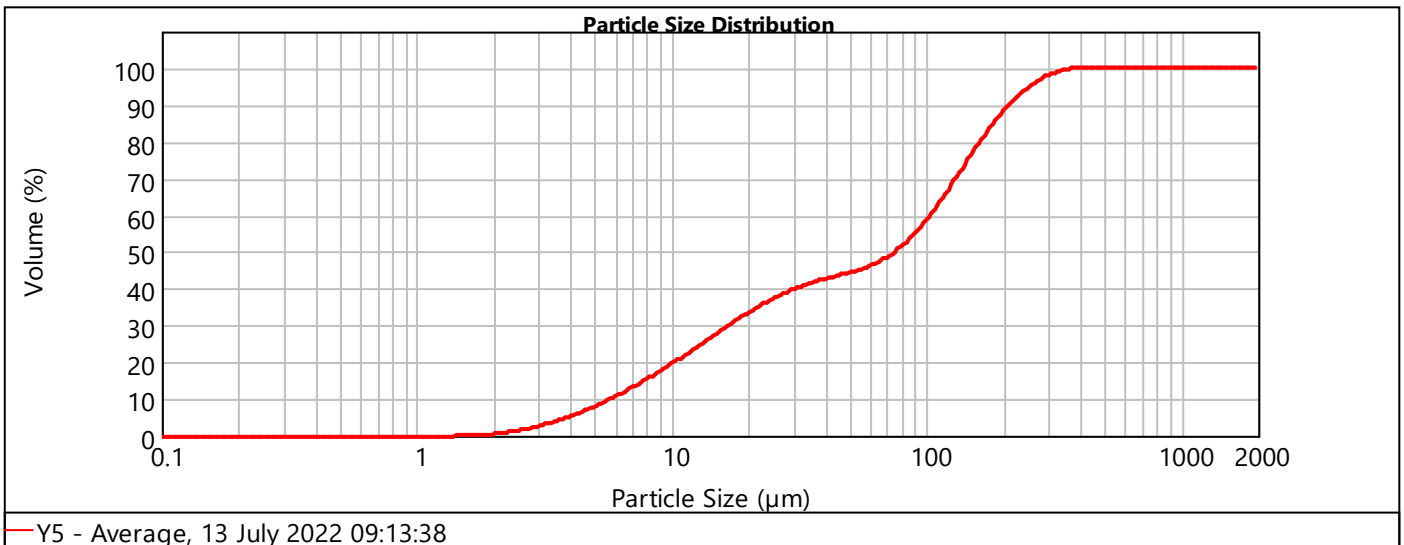


Particle Size Analysis Report

Sample Name: Y5 - Average Measured by: AFulford on 13 July 2022 09:13:38
 Sample Source: Mostyn Obscuration: 11.00 %
 Sample Collected: June2022 Weighted Residual: 1.081 %

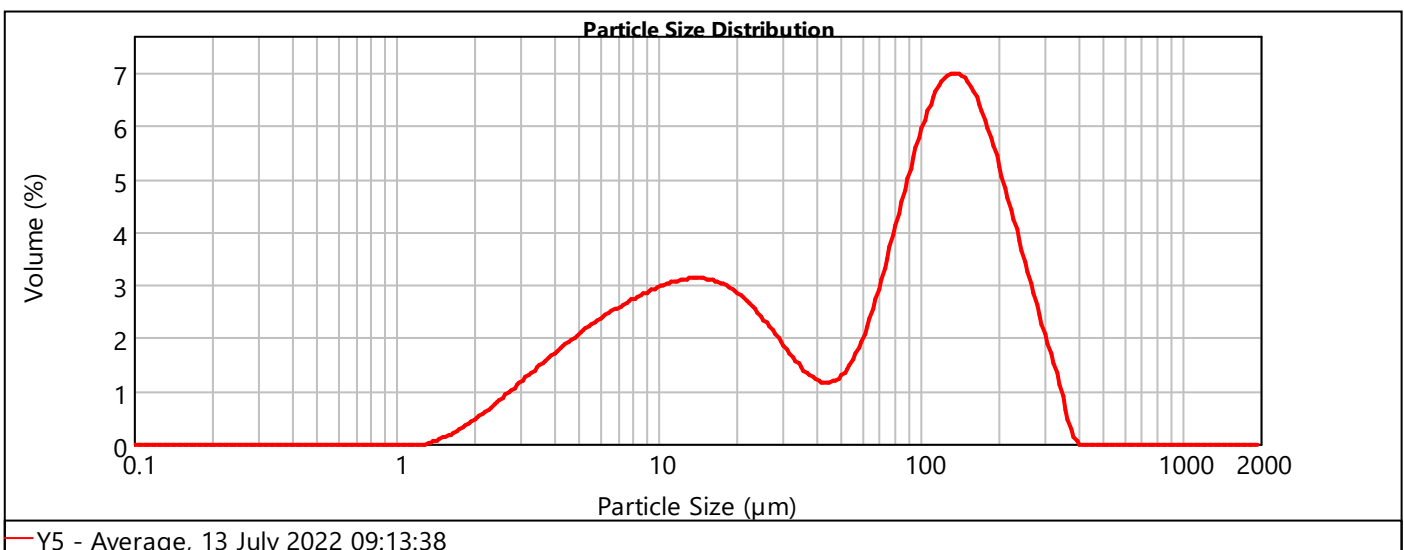
d(0.1): 5.715 μm d(0.5): 74.510 μm d(0.9): 209.817 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
1 %	10 %	23 %	13 %	42 %	12 %	0 %

Frequency Curve

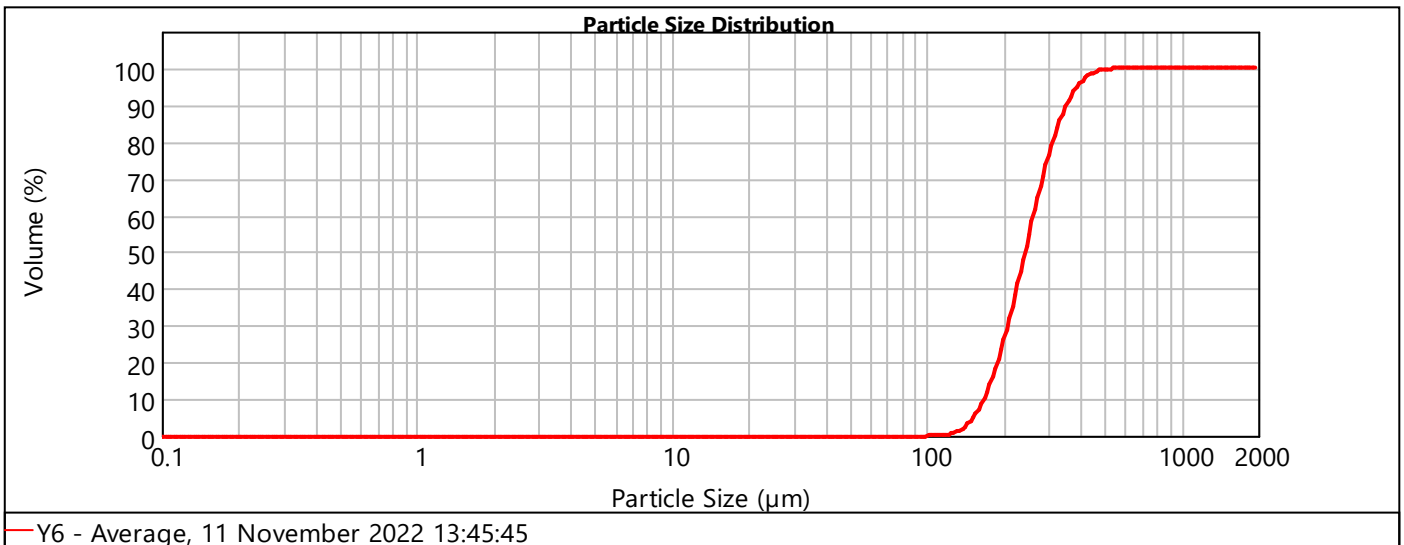


Particle Size Analysis Report

Sample Name: Y6 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 10.06 %
 Sample Collected: June 2022 Weighted Residual: 0.883 %

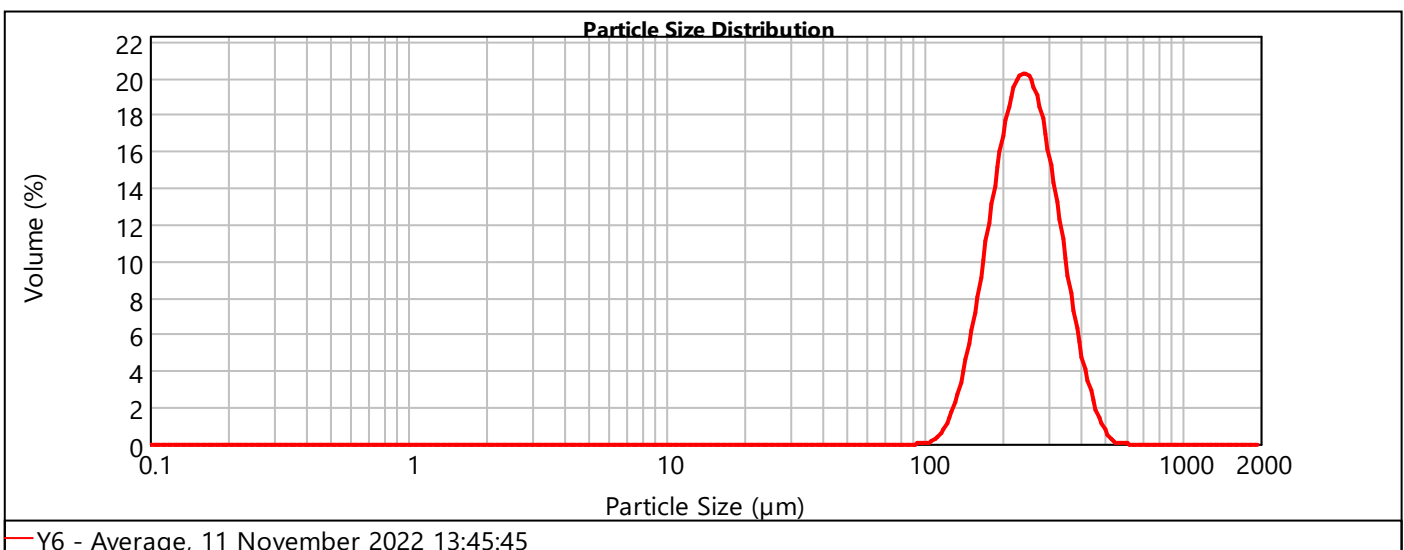
d(0.1): 167.860 μm d(0.5): 243.626 μm d(0.9): 353.584 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	0 %	0 %	0 %	25 %	75 %	0 %

Frequency Curve

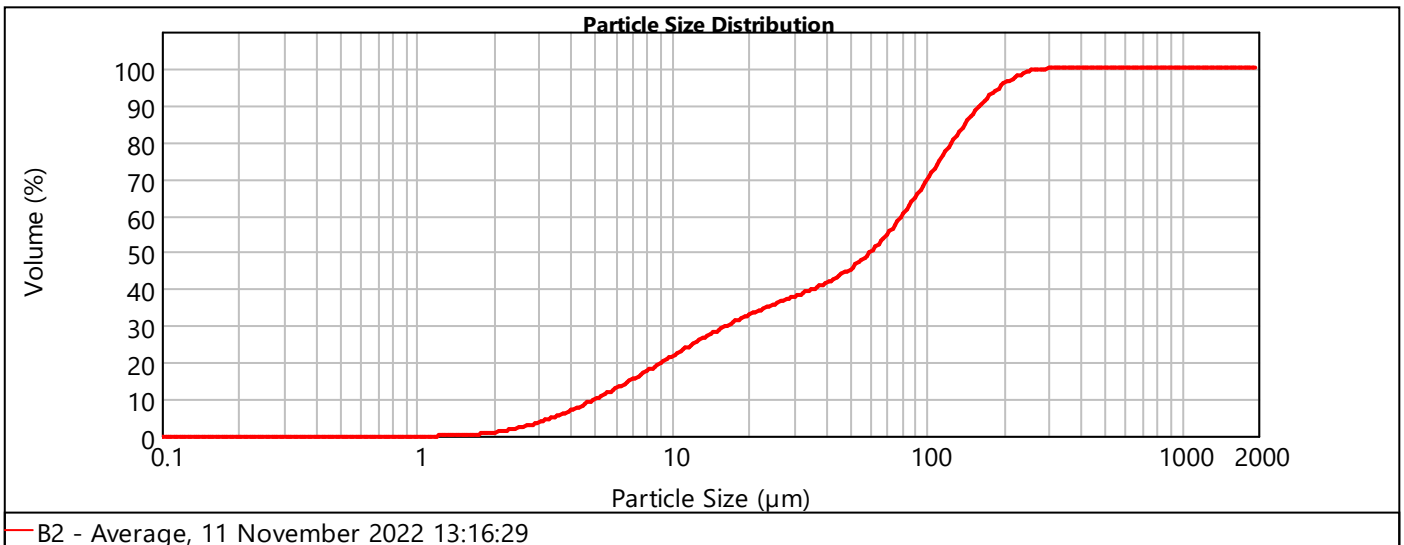


Particle Size Analysis Report

Sample Name: B2 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 11.03 %
 Sample Collected: June 2022 Weighted Residual: 0.429 %

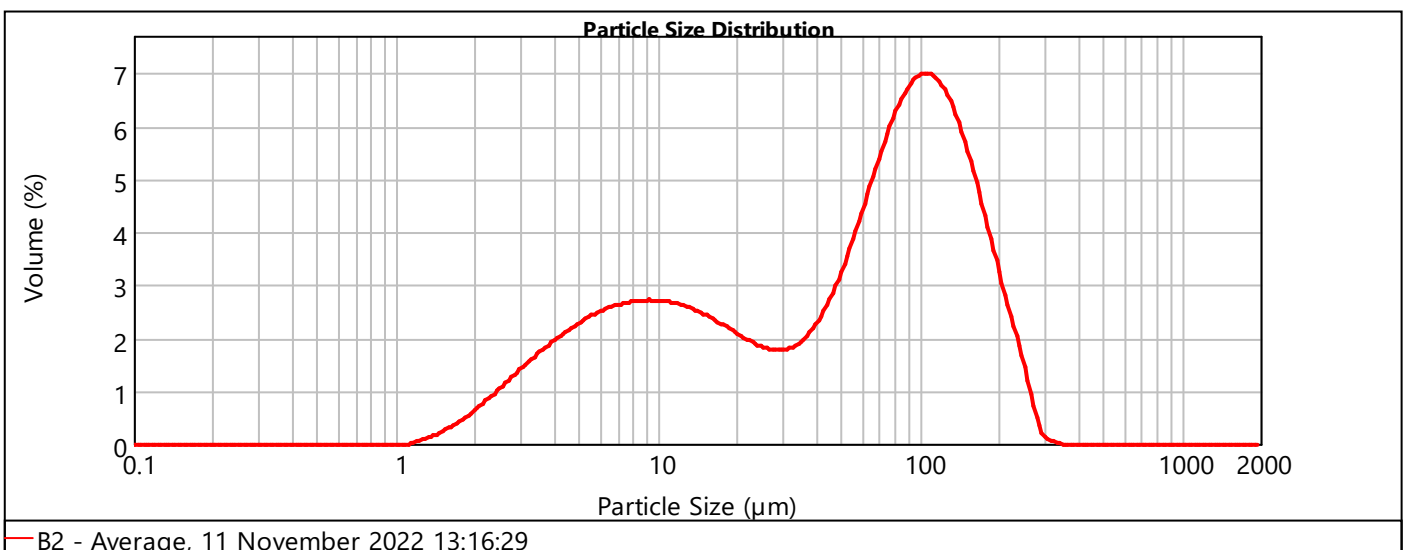
d(0.1): 5.025 μm d(0.5): 60.341 μm d(0.9): 162.758 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
1 %	12 %	20 %	17 %	46 %	4 %	0 %

Frequency Curve

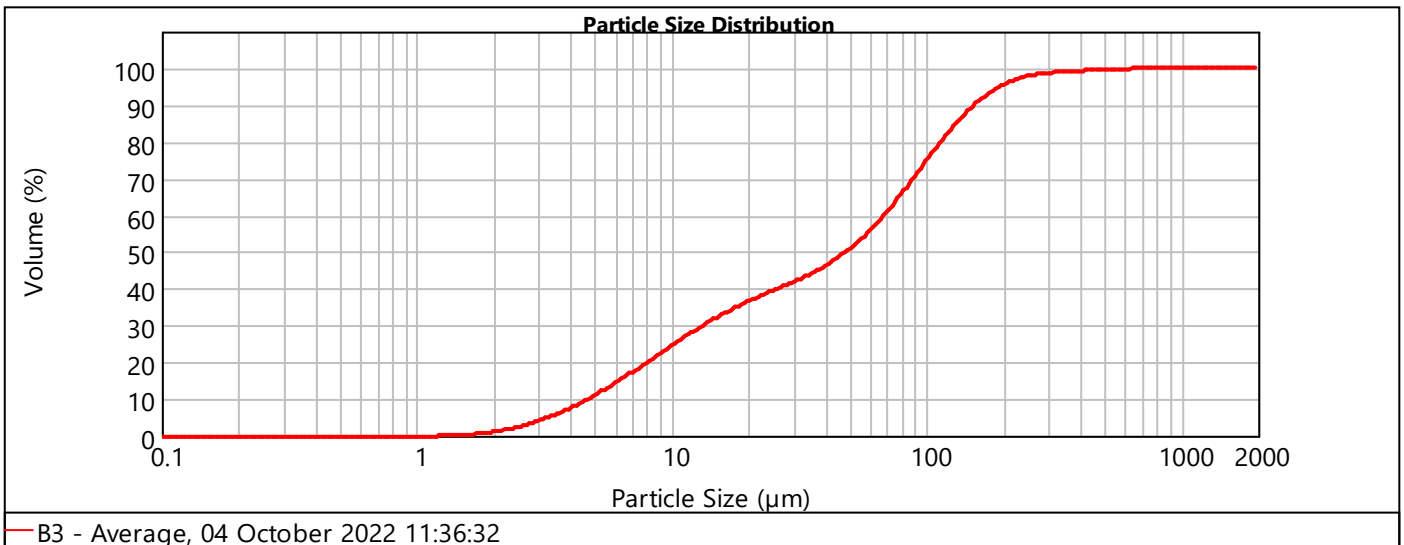


Particle Size Analysis Report

Sample Name: B3 - Average Measured by: AFulford on 04 October 2022
 Sample Source: Mostyn Obscuration: 10.58 %
 Sample Collected: Weighted Residual: 1.318 %

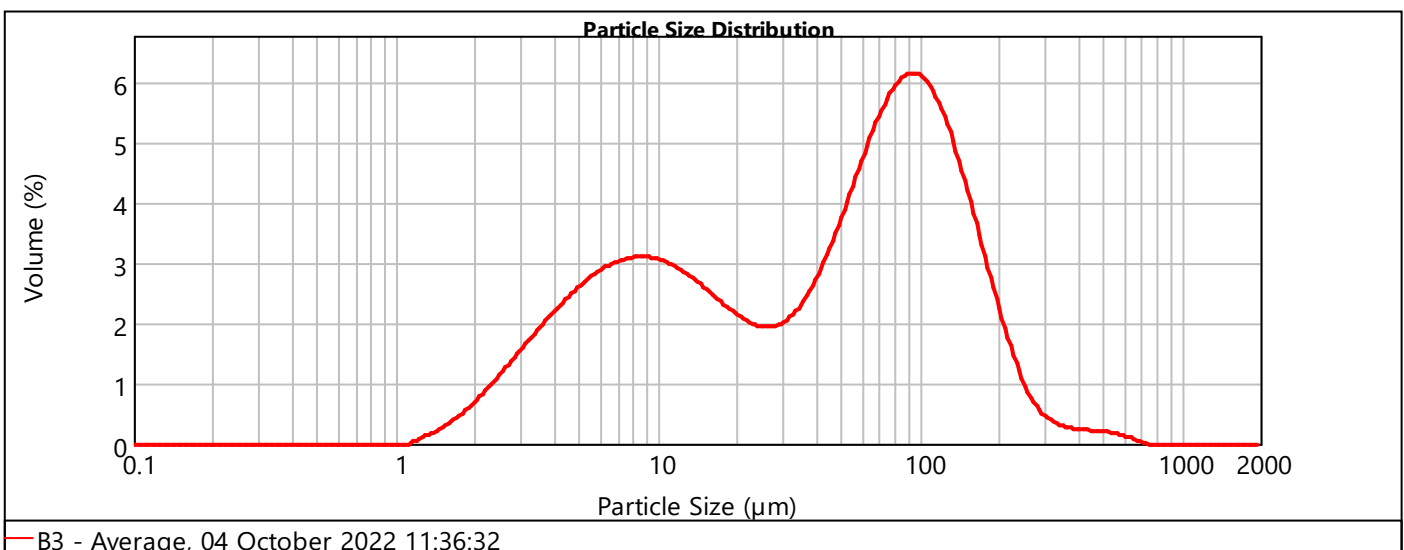
d(0.1): 4.680 μm d(0.5): 48.108 μm d(0.9): 153.215 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
1 %	13 %	22 %	19 %	40 %	4 %	0 %

Frequency Curve

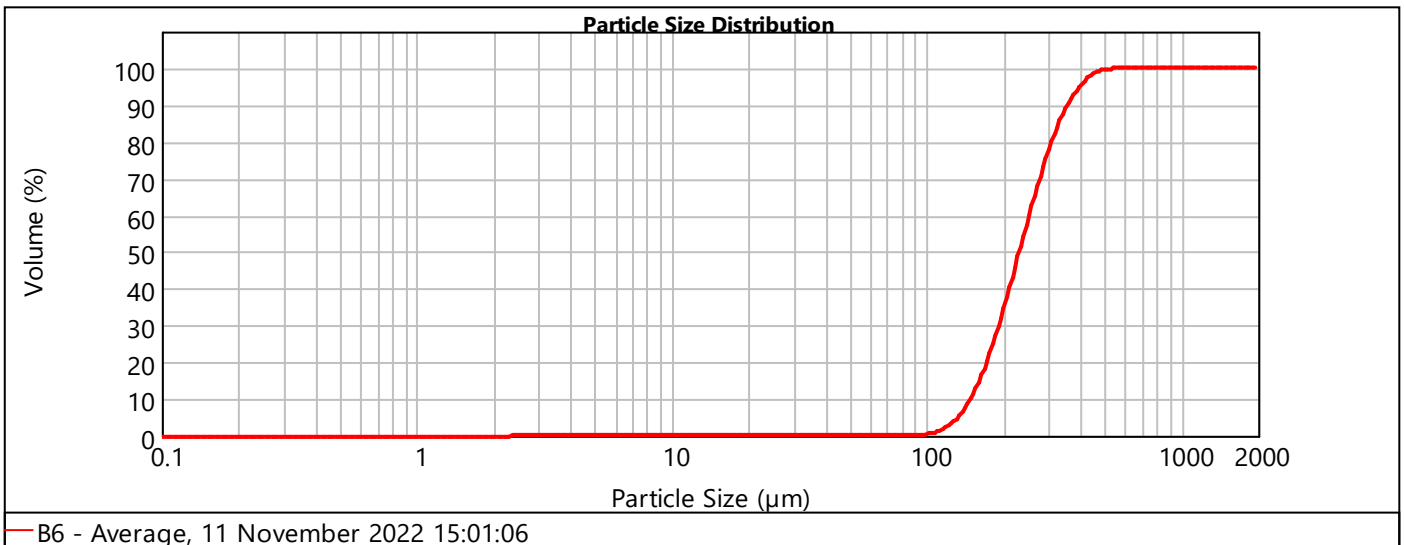


Particle Size Analysis Report

Sample Name: B6 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 10.54 %
 Sample Collected: June 2022 Weighted Residual: 1.054 %

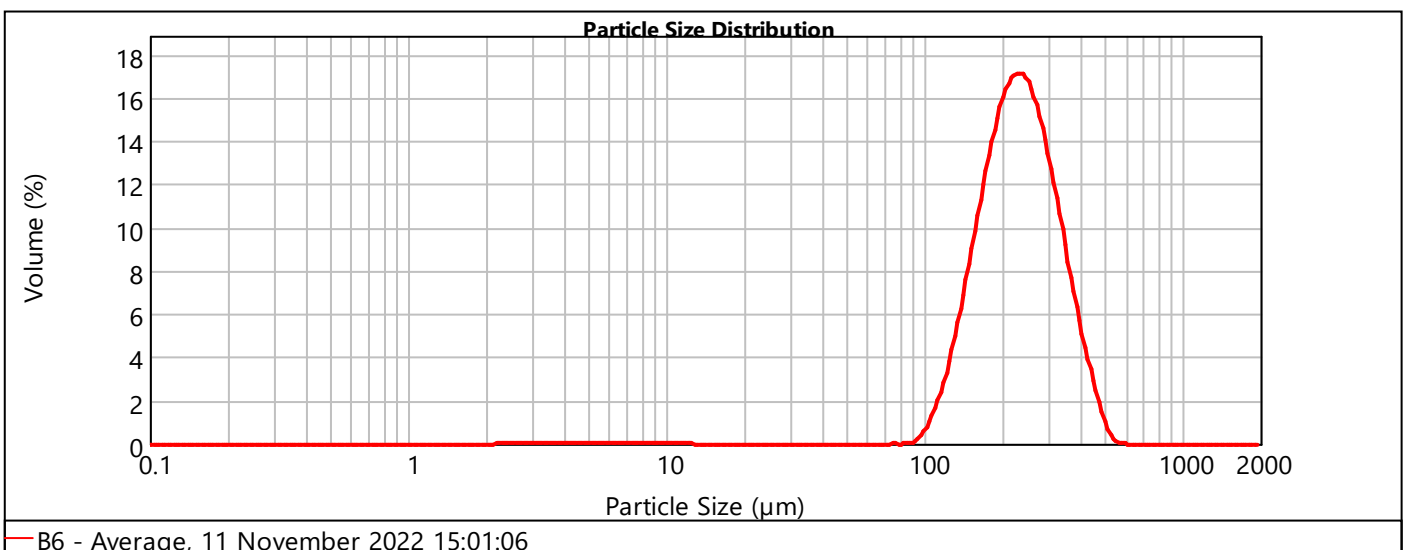
d(0.1): 148.547 μm d(0.5): 230.964 μm d(0.9): 356.849 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	0 %	0 %	0 %	34 %	66 %	0 %

Frequency Curve

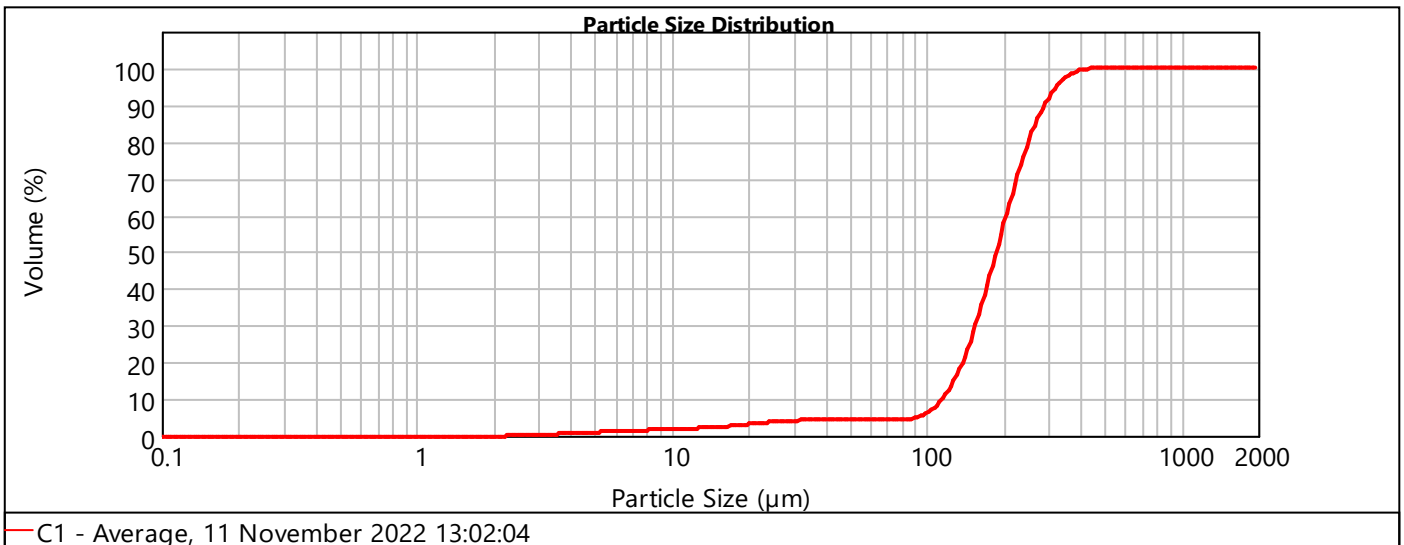


Particle Size Analysis Report

Sample Name: C1 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 9.94 %
 Sample Collected: June 2022 Weighted Residual: 0.359 %

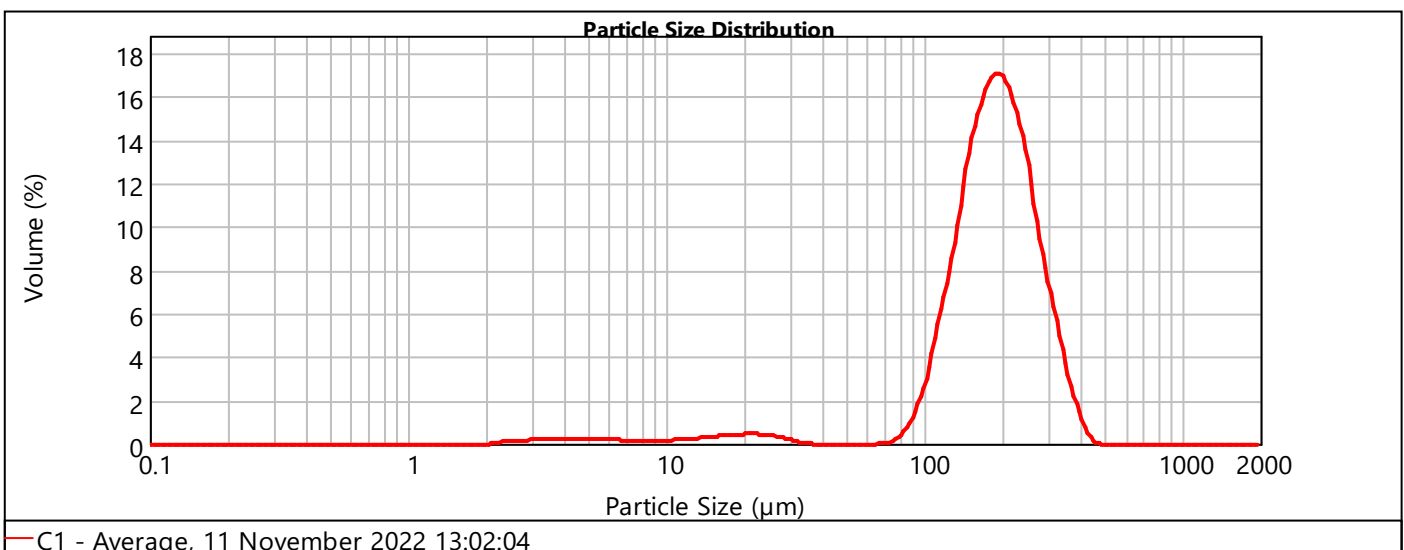
d(0.1): 115.093 μm d(0.5): 188.050 μm d(0.9): 290.668 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	1 %	2 %	1 %	53 %	43 %	0 %

Frequency Curve

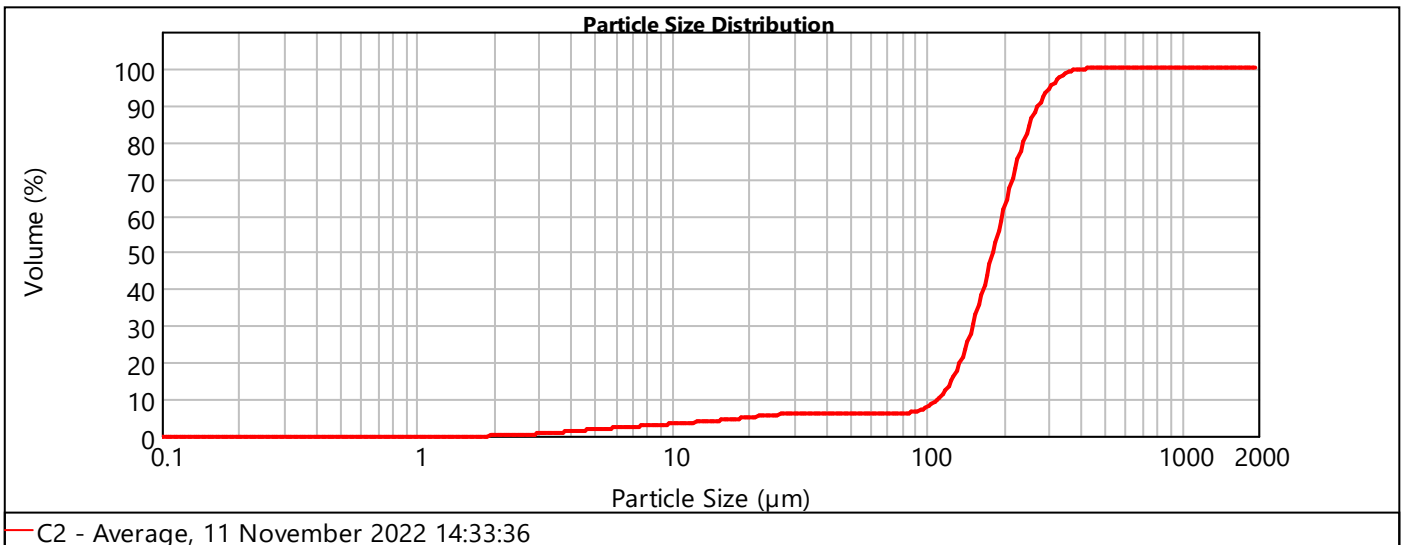


Particle Size Analysis Report

Sample Name: C2 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 10.30 %
 Sample Collected: June 2022 Weighted Residual: 0.264 %

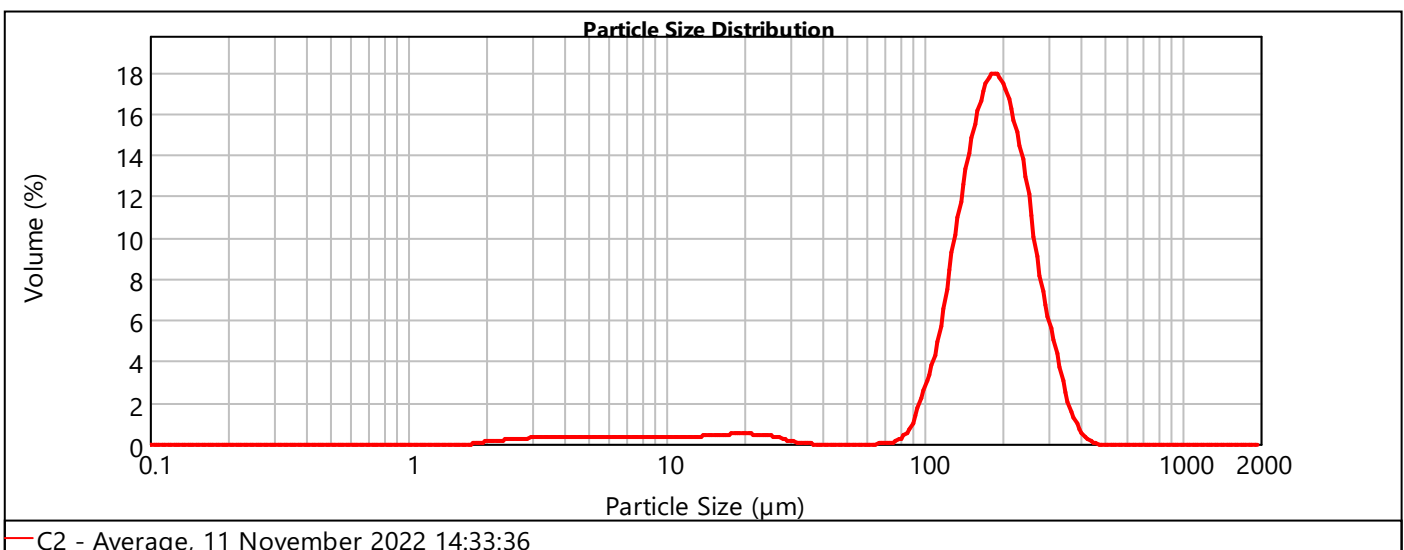
d(0.1): 110.340 μm d(0.5): 182.399 μm d(0.9): 274.559 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	2 %	3 %	1 %	55 %	39 %	0 %

Frequency Curve

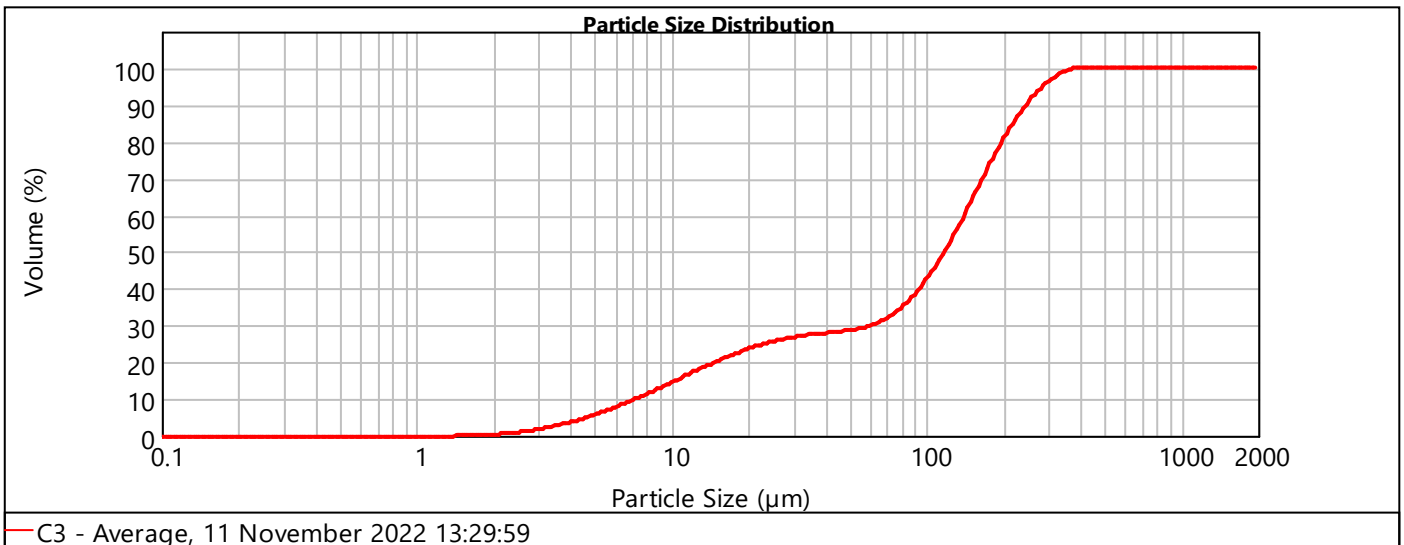


Particle Size Analysis Report

Sample Name: C3 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 10.55 %
 Sample Collected: June 2022 Weighted Residual: 0.517 %

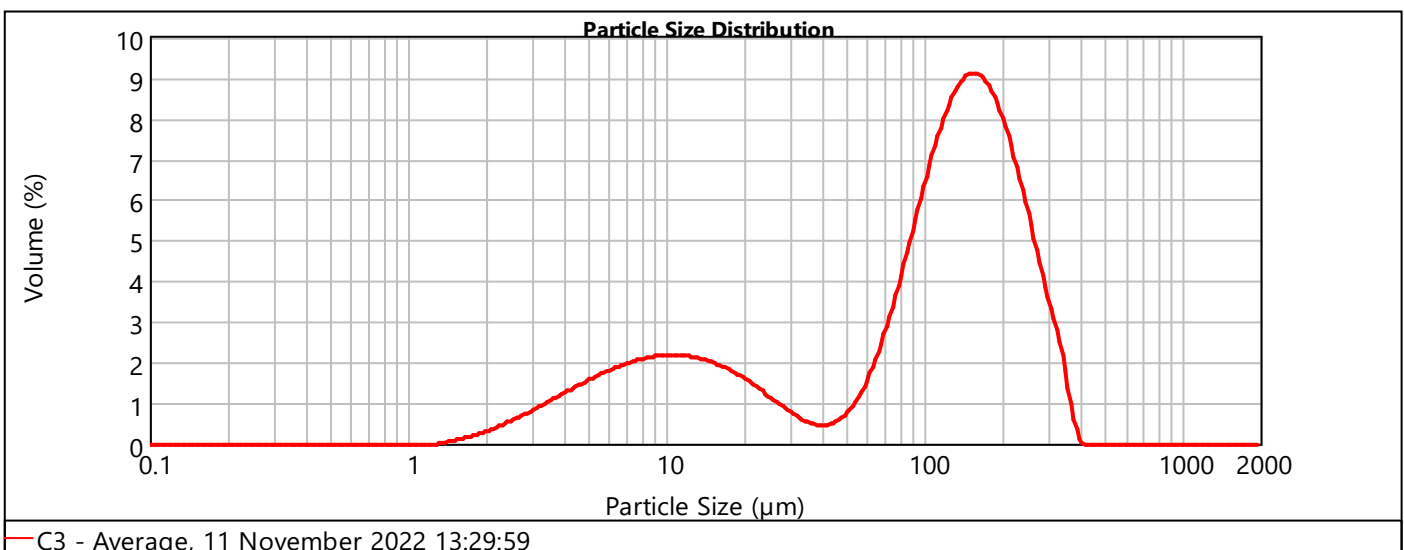
d(0.1): 7.162 μm d(0.5): 116.973 μm d(0.9): 244.301 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	7 %	16 %	6 %	51 %	19 %	0 %

Frequency Curve

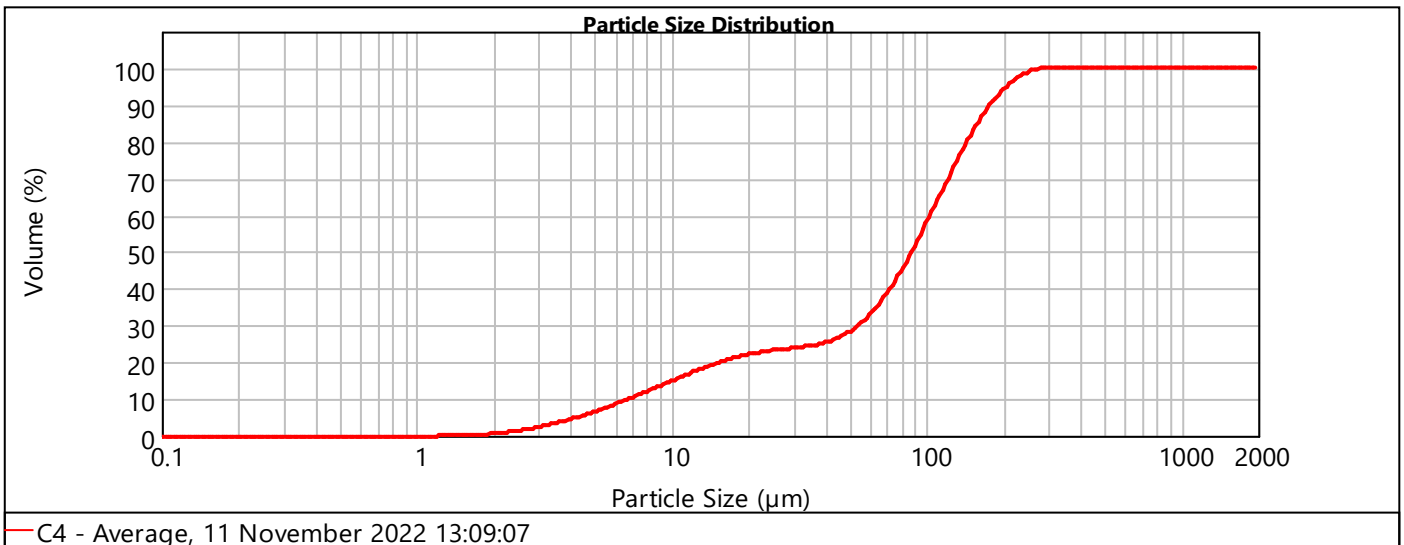


Particle Size Analysis Report

Sample Name: C4 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 11.05 %
 Sample Collected: June 2022 Weighted Residual: 0.493 %

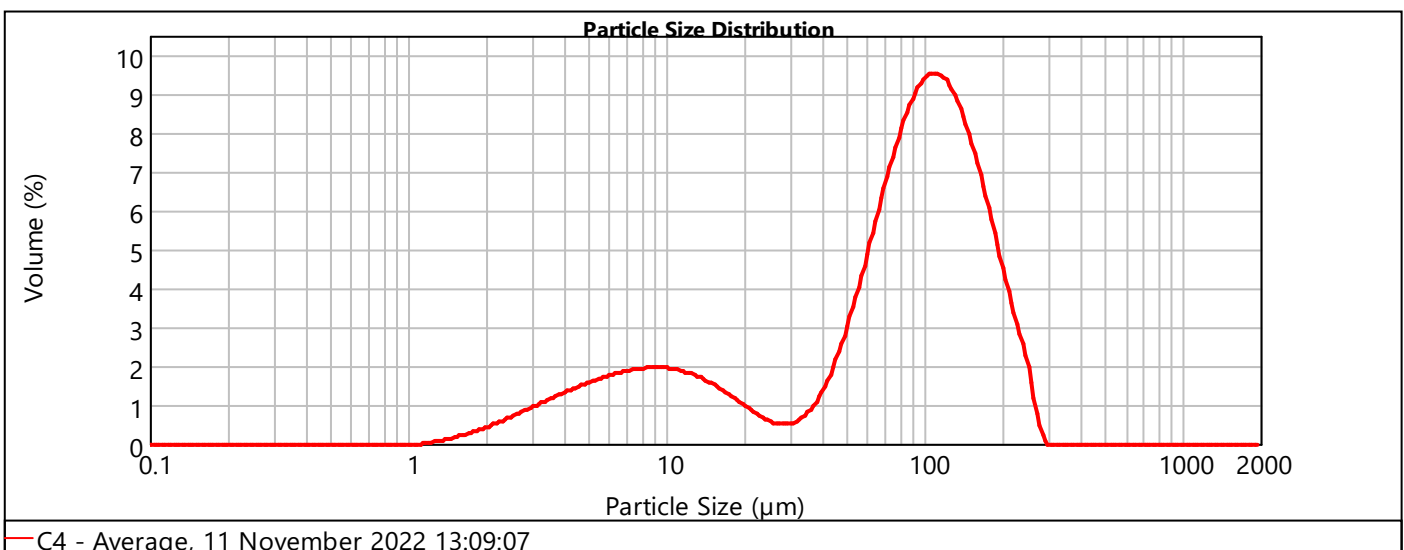
d(0.1): 6.735 μm d(0.5): 87.271 μm d(0.9): 177.314 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
1 %	8 %	14 %	11 %	61 %	6 %	0 %

Frequency Curve

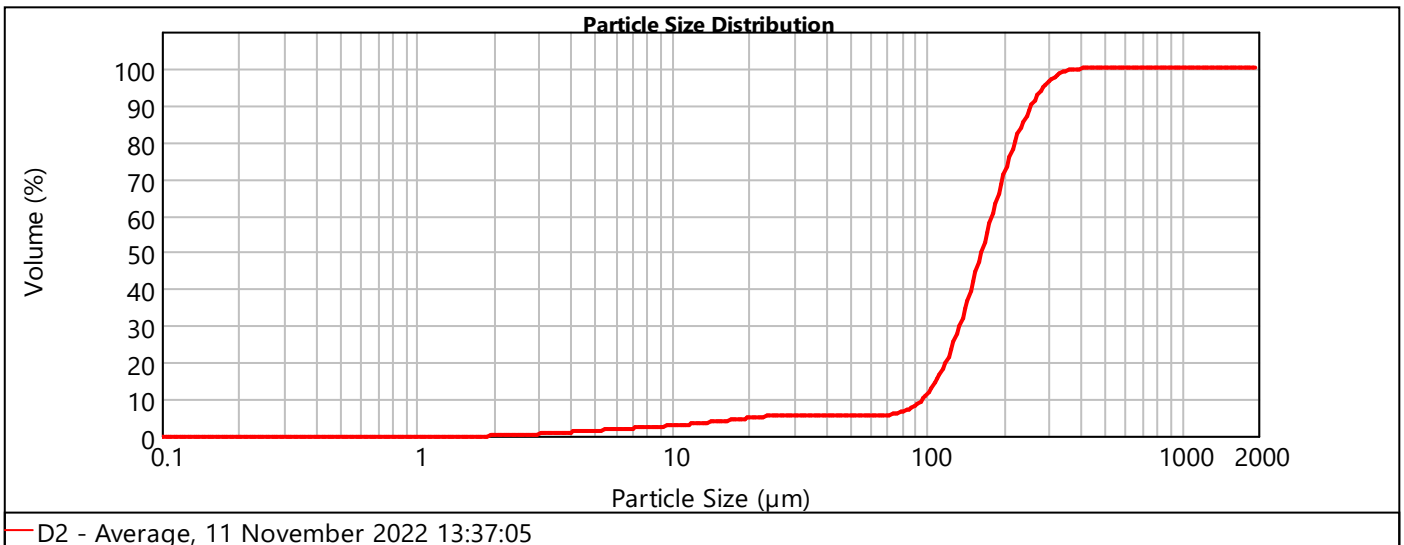


Particle Size Analysis Report

Sample Name: D2 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 10.41 %
 Sample Collected: June 2022 Weighted Residual: 0.285 %

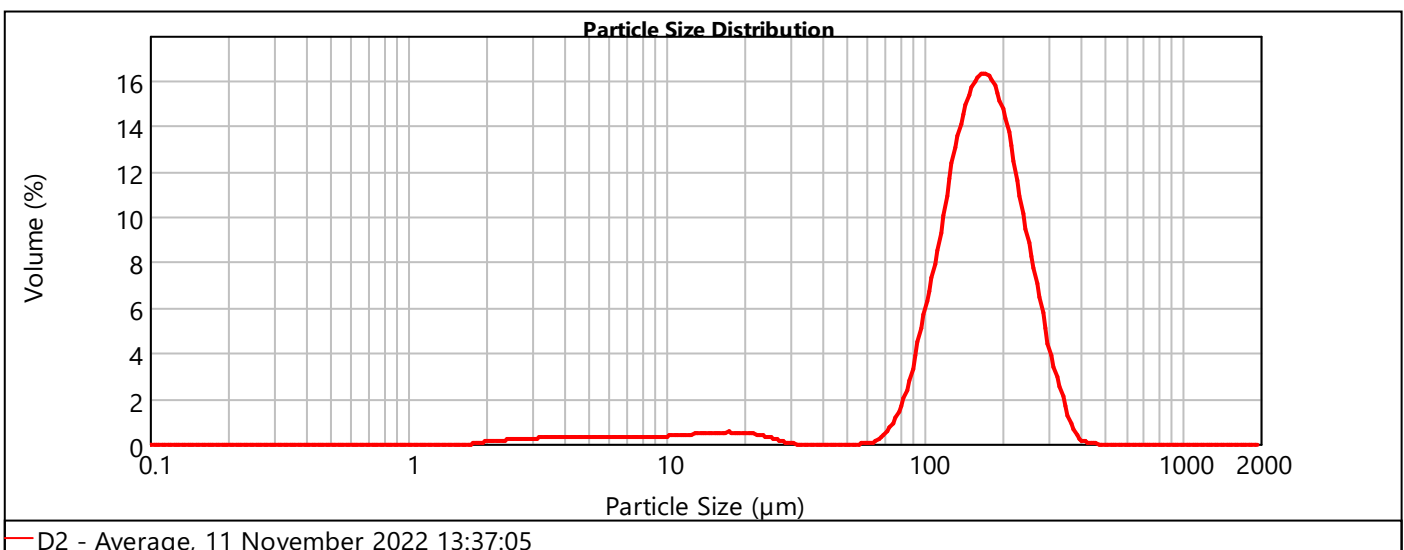
d(0.1): 96.298 μm d(0.5): 164.576 μm d(0.9): 258.530 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	2 %	3 %	1 %	65 %	30 %	0 %

Frequency Curve

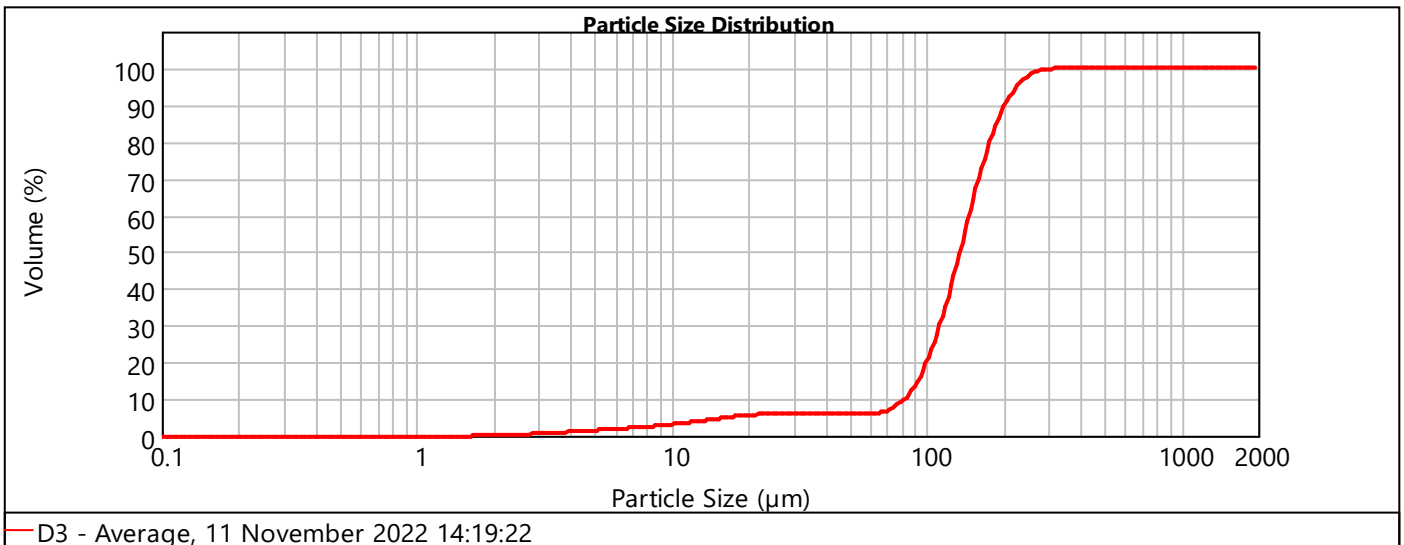


Particle Size Analysis Report

Sample Name: D3 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 11.18 %
 Sample Collected: June 2022 Weighted Residual: 0.355 %

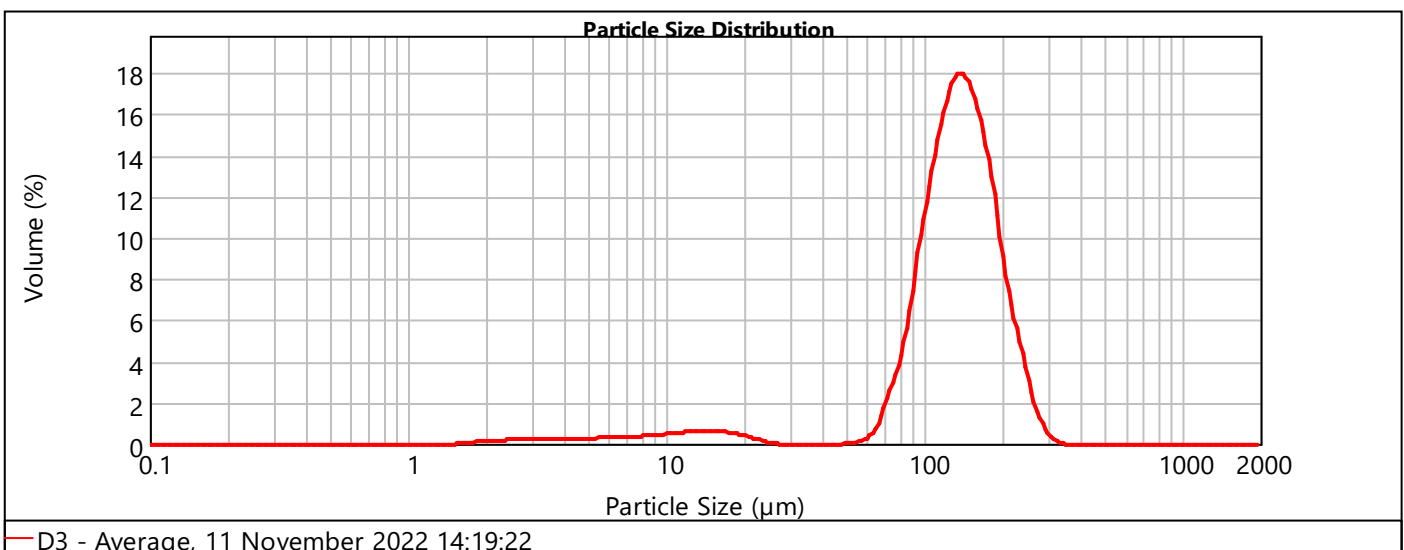
d(0.1): 81.746 μm d(0.5): 134.853 μm d(0.9): 202.698 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	2 %	4 %	0 %	83 %	11 %	0 %

Frequency Curve

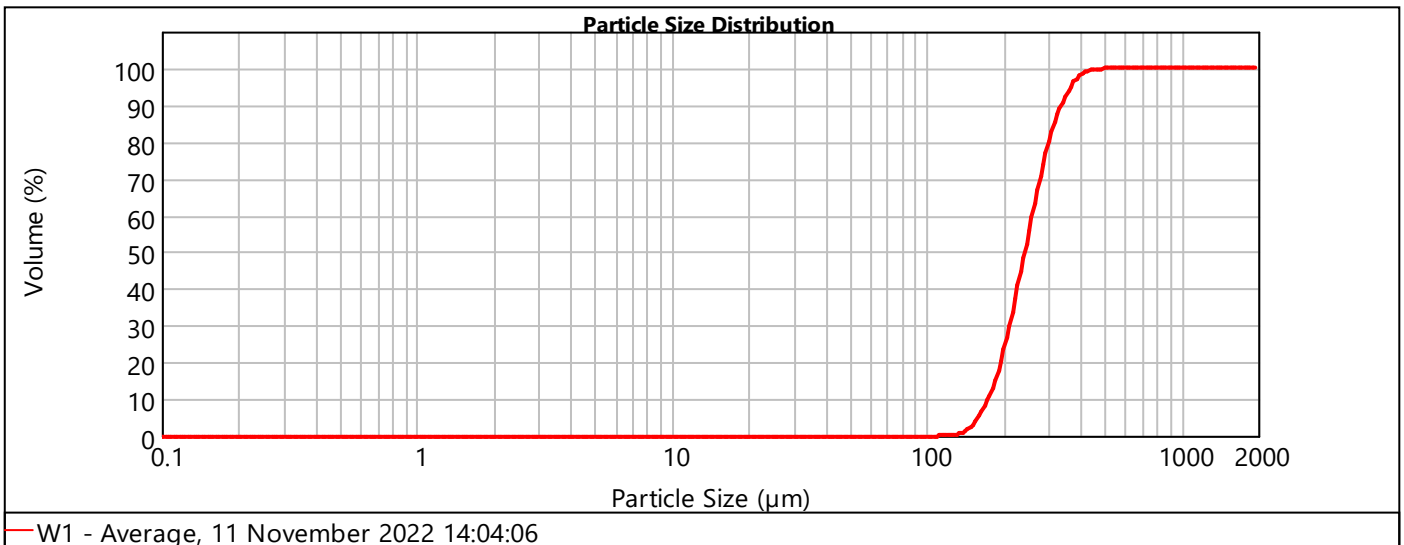


Particle Size Analysis Report

Sample Name: W1 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 10.64 %
 Sample Collected: June 2022 Weighted Residual: 0.417 %

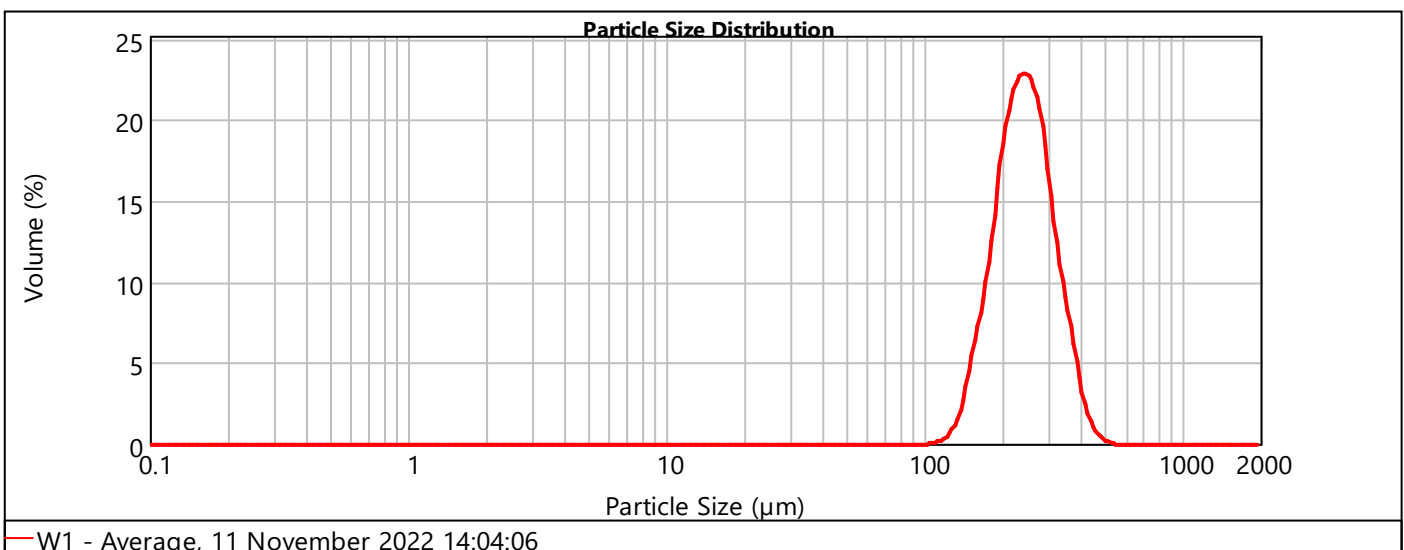
d(0.1): 174.382 μm d(0.5): 242.874 μm d(0.9): 337.981 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	0 %	0 %	0 %	23 %	77 %	0 %

Frequency Curve



Particle Size Analysis Report

Sample Name: W2 - Average

Measured by: MERshed on 11 November 2022

Sample Source: Mostyn

Obscuration: 10.14 %

Sample Collected: June 2022

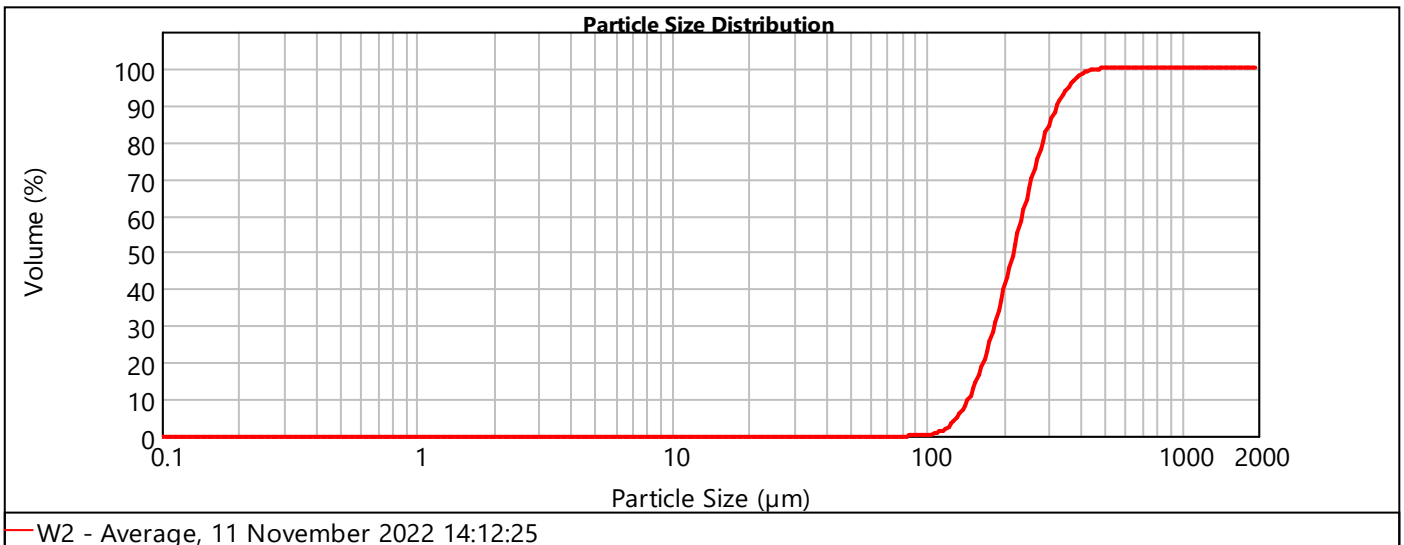
Weighted Residual: 0.674 %

d(0.1): 146.099 μm

d(0.5): 218.790 μm

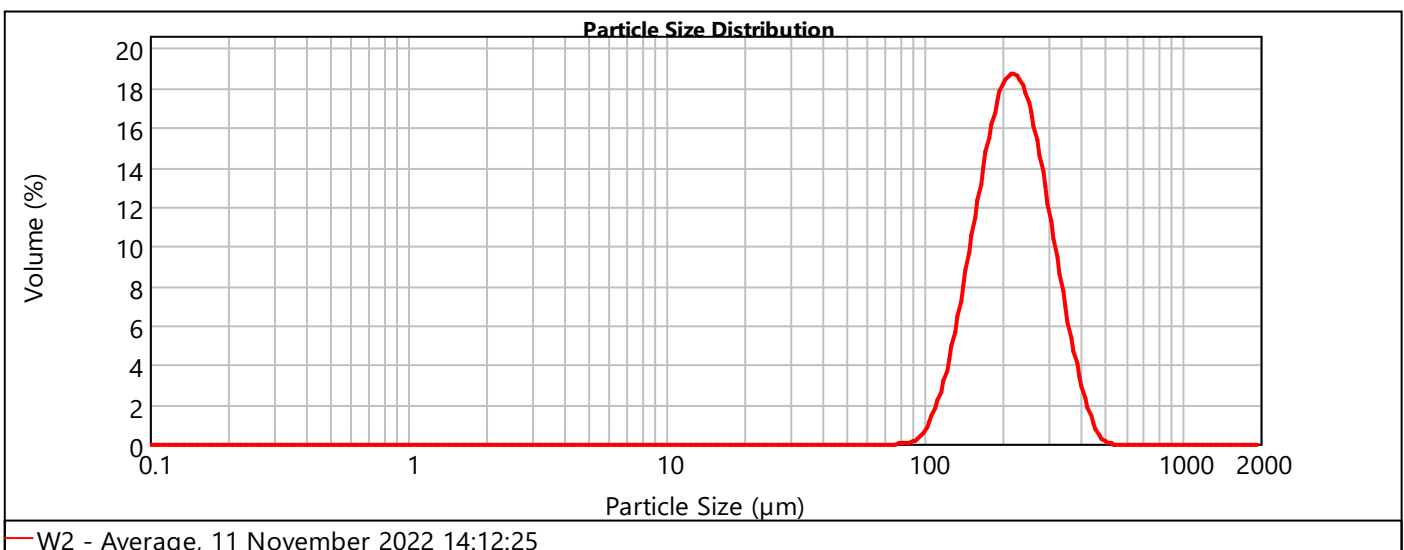
d(0.9): 325.573 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	0 %	0 %	0 %	39 %	61 %	0 %

Frequency Curve

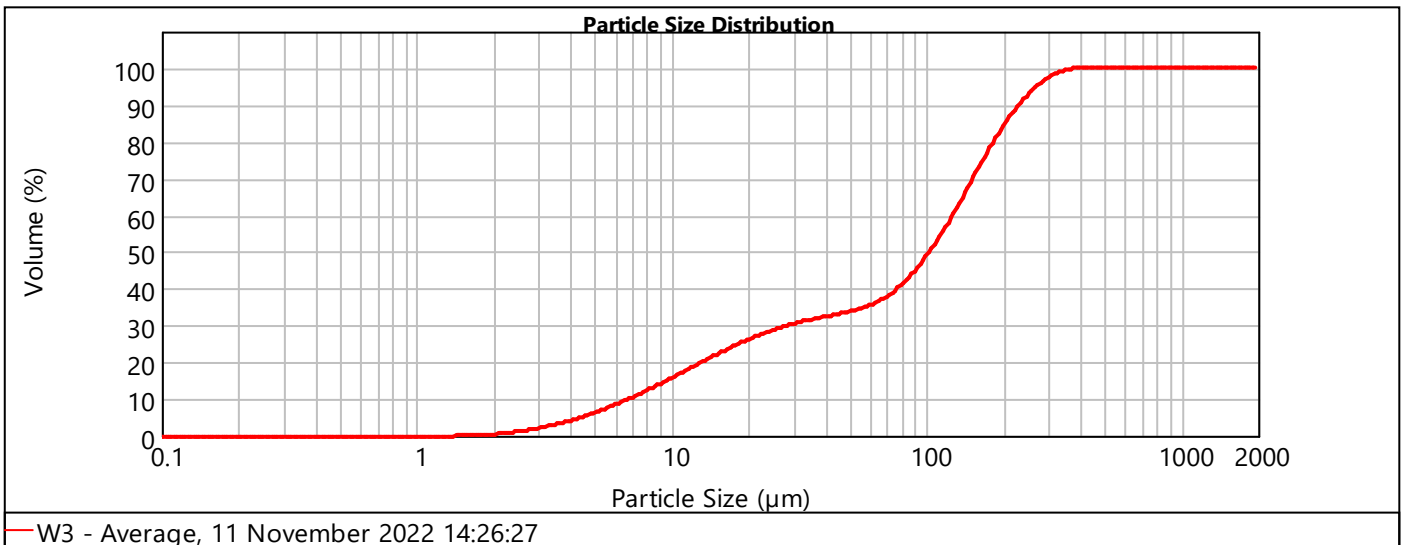


Particle Size Analysis Report

Sample Name: W3 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 10.29 %
 Sample Collected: June 2022 Weighted Residual: 0.507 %

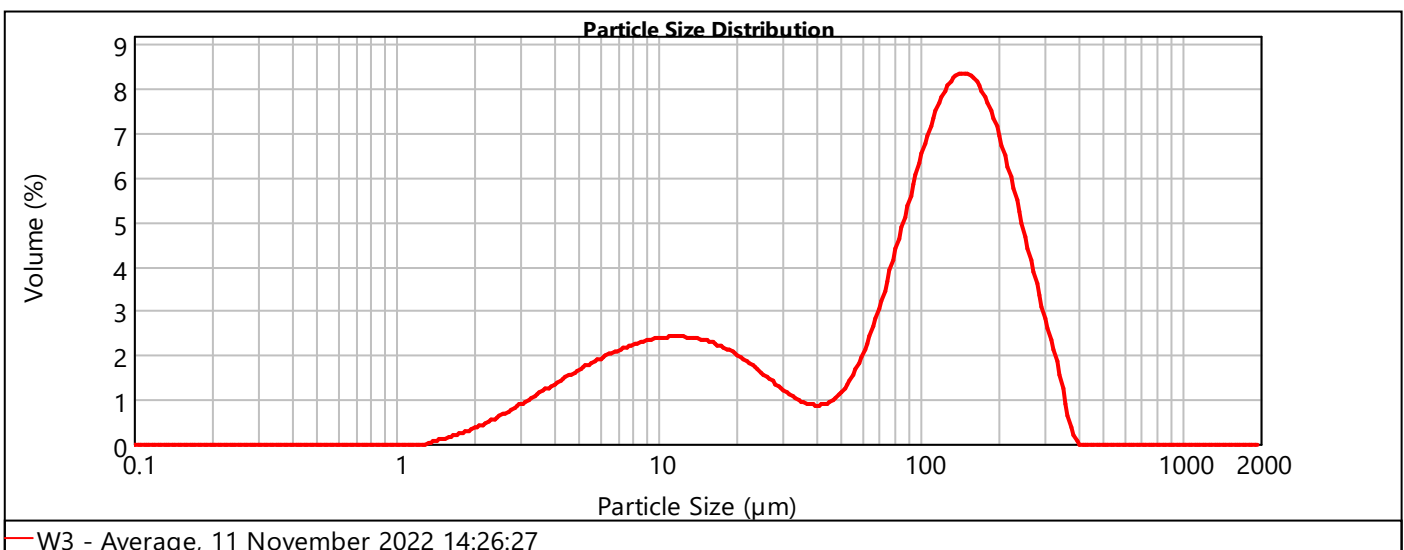
d(0.1): 6.745 μm d(0.5): 102.416 μm d(0.9): 229.637 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	8 %	18 %	9 %	49 %	16 %	0 %

Frequency Curve

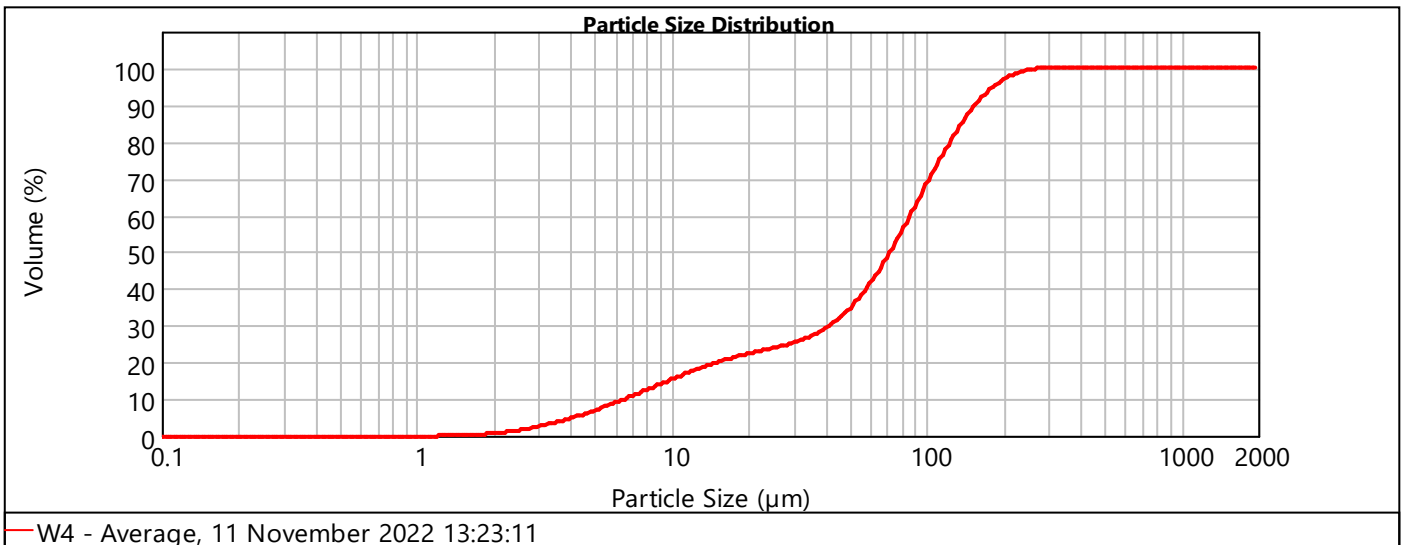


Particle Size Analysis Report

Sample Name: W4 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 10.33 %
 Sample Collected: June 2022 Weighted Residual: 0.413 %

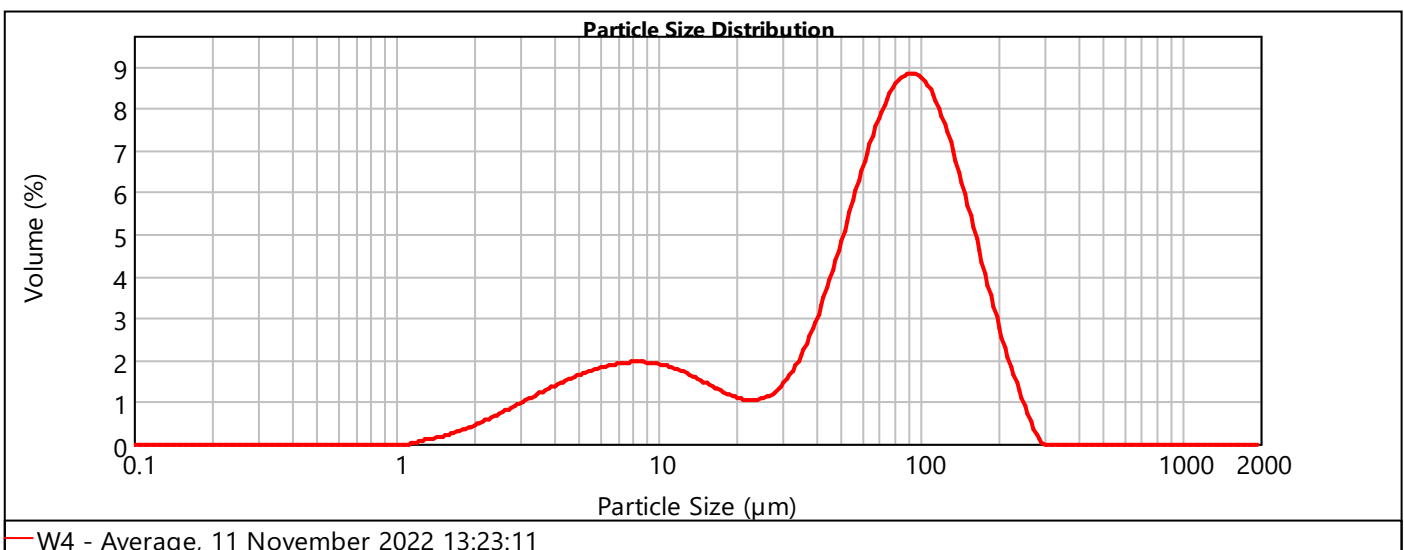
d(0.1): 6.505 μm d(0.5): 71.853 μm d(0.9): 154.986 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
1 %	8 %	13 %	19 %	55 %	3 %	0 %

Frequency Curve

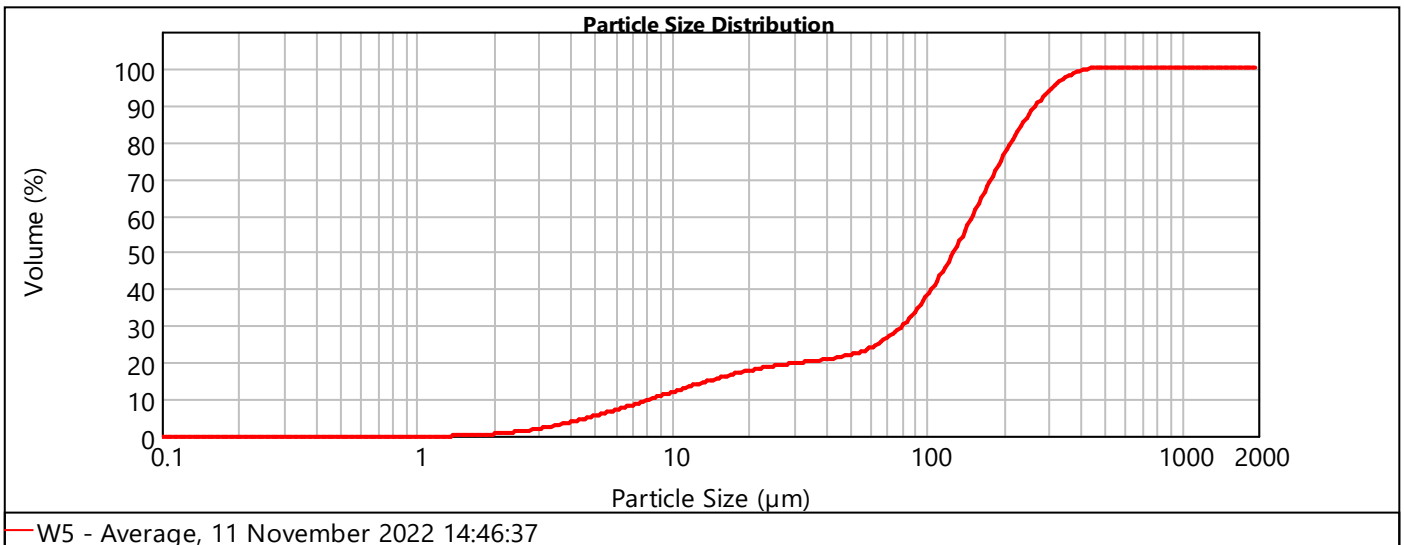


Particle Size Analysis Report

Sample Name: W5 - Average Measured by: MERshed on 11 November 2022
 Sample Source: Mostyn Obscuration: 10.87 %
 Sample Collected: June 2022 Weighted Residual: 0.351 %

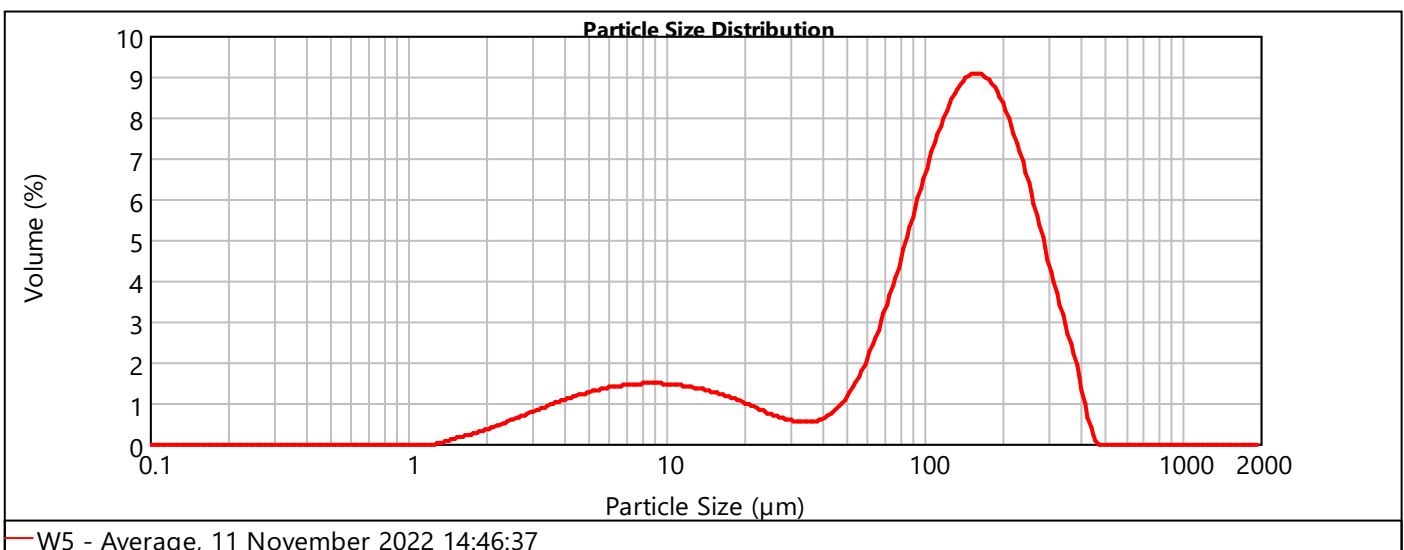
d(0.1): 8.260 μm d(0.5): 127.707 μm d(0.9): 269.211 μm

Cumulative Frequency Plot



Clay	Silt			Sand		
	Fine	Medium	Coarse	Fine	Medium	Coarse
0 %	6 %	11 %	6 %	52 %	24 %	0 %

Frequency Curve



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G Review of Bird Disturbance Monitoring (ABPmer, 2015)



Gwynt y Môr Offshore Wind Farm Ltd

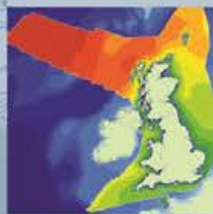
Bird Disturbance Monitoring of the 'RWE Pontoon' at the Port of Mostyn

Review of Two Year Monitoring Programme (2013 to 2015)

Report R.2320

August 2015

Creating sustainable solutions for the marine environment



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Gwynt y Môr Offshore Wind Farm Ltd

Bird Disturbance Monitoring of the 'RWE Pontoon' at the Port of Mostyn

Review of Two Year Monitoring Programme (2013 to 2015)




Date: August 2015

Project Ref: R/4187/02

Report No: R.2320

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Summary

Report Background

On behalf of Gwynt y Môr (GyM) Offshore Wind Farm Ltd., ABP Marine Environmental Research Ltd. (ABPmer) has monitored the levels of bird disturbance that occur on the intertidal habitats adjacent to the new RWE pontoon at the Port of Mostyn on the Dee Estuary. This pontoon facility was constructed to provide berthing for operations and maintenance vessels supporting the development of RWE Innogy UK's offshore windfarms in Liverpool Bay. As part of the marine licence consent conditions for this pontoon monitoring of bird disturbance was required for the first two years of its operation.

This bird disturbance monitoring was needed particularly to understand how birds within the Dee Estuary Special Protection Area (SPA) responded to this new facility. The survey work involved monthly bird counts from October 2013 to March 2014 and then from July 2014 to March 2015. The results from the first year of monitoring were reviewed in April 2014 (ABPmer, 2014) and this report now describes the results from the full period up to March 2015.

Project Implementation (Including Extra Survey Work)

The required consent for the pontoon (referred to here as the 'RWE Pontoon') was provided on the 5 March 2013 by the Marine Consents Unit (MCU) (now part of Natural Resources Wales (NRW)). Construction of the pontoon then began in April 2013 and it was completed by July 2013. The pontoon then became operational in September 2013.

During the first year of its operation the landward side of the pontoon and its connecting link-span needed to include visual screening (within opaque netting) during bird passage and over-wintering periods. This was also a marine licence consent condition and was required to mitigate for any bird disturbance effects occurring from activities on the pontoon structure. However, in November 2014 NRW approved the removal of this screening because it was causing logistical and health and safety concerns. This was replaced by a berthing plan whereby vessels were moored up in a sequence so that the vessels themselves provided the visual screening. The decision to alter the disturbance mitigation process was informed by the results of the first year of bird monitoring. This evidence was also further supplemented by extra survey work and fixed-point camera analysis that RWE/GyM commissioned ABPmer to undertake during the June and July 2014 period.

Survey Methods

The bird surveys were undertaken once a month and were focussed on describing bird behaviour within a relatively small (3.5ha) area of intertidal habitat which lies closest to the pontoon during operation. This intertidal area was divided into the following two discrete surveying zones:

- Count Sectors C (covering the lower shore; 1.9ha); and
- Count Sectors G (covering the upper shore; 1.6ha)¹.

The RWE Pontoon is located around 25m from the low-shore boundary of Sector C and approximately 75m from the middle of this sector. The boundary of Sector G is approximately 120m from the centre of the pontoon although the edges of Sector G are around 60-70m from the ends of the pontoon. The monthly bird surveys involved hourly bird counts taken throughout the tidal cycle in these areas to understand the distribution, abundance and behaviour of both roosting and feeding waterbirds.

The nearby foreshore area fronting Warwick Chemicals (known as Count Sector D which is 12ha in size) to the south east (upstream) was also counted as a control site at high water and low water. This area is separated physically and visually from Count Sectors C and G by a rocky promontory fronting the Warwick Chemicals site.

The monitoring approach adhered to the requirements of the Marine Licence consent conditions and involved the application of 'disturbance threshold criteria' to help describe the level of disturbance to birds and provide an objective analysis of the effects caused by different quayside activities. For these criteria, disturbance levels were ranked from Level 1 (no reaction) to Level 4 (a large event in which birds are disturbed up to and beyond 300m from their original location and then leave the area).

Monthly reports were produced which summarised the results of each survey and used threshold exceedance and alert levels based on the reactions observed to provide a clear interpretation of the findings and ensure that, if there were any issues, they were identified as soon as possible (with 'Green' representing no or very low overall disturbance, 'Amber' more moderate disturbance and 'Red' higher disturbance levels). Noise levels were also recorded during each survey count period from the November 2013 survey onwards using a 'Lutron SL-4013' sound level meter (0.1dB resolution).

In addition, a static time-lapse camera was voluntarily introduced for the period 11 August to 2 October 2014. The purpose of the camera was to provide further evidence about bird behaviour in the lower part of the foreshore in response to activities on the pontoon. The camera took photos of the foreshore every 20 seconds throughout daylight hours. These images were then stitched together to create videos for each weekly period which were then analysed and notable events recorded (such as disturbance responses and large bird flocks). In total, over 150 hours of additional data was collected using the static time-lapse camera.

This project and preceding Environmental Impact Assessment (EIA) has also greatly benefited from the fact that the Port of Mostyn has been separately engaged in a long-term bird monitoring programme since 2009. These surveys describe the baseline waterbird abundances over a full calendar year, making it possible to compare the RWE Pontoon Monitoring data against past results from the rest of the Port of Mostyn estate.

¹ These area labels (i.e. C and G) were derived from established count sectors as used for separate monitoring of the wider Port of Mostyn area (this separate survey work has been carried out monthly by ABPmer since November 2009 and is continuing).

Results

The analysis of the results has focused primarily on Redshank, the most common species recorded in the count sectors and also the species considered most susceptible to the effects of disturbance (due to being relatively 'skittish' and also requiring more feeding time to offset the energetic costs of feeding than other waterbirds)². The effects on other waterbirds (including especially SPA bird species) in the area are also discussed. The results of this work are summarised below under the following categories:

- The general abundance of waterbirds across the adjacent intertidal area;
- The activities observed on the pontoon and across the wider area;
- The frequency of bird disturbance events (i.e. clear reactions by birds);
- The nature of activities causing disturbance events; and
- The character of bird reactions/movement.

General Waterbird Abundance

The abundance of waterbirds during the survey period was inherently variable between surveys but clear changes were observed over seasonal and tidal cycles. In general, the abundance of most waterbirds species using the area was typically highest during winter periods although numbers of Redshank were larger in passage periods, particularly in autumn months.

The area being surveyed is mainly used as a sheltered high water roost site (Sector G) for Redshank and Oystercatcher especially, but also a number of other species. Birds from this area then typically feed on the mudflats of Salisbury Middle and the lower shore habitat found in Sector C.

Redshank was consistently the most abundant species present in both Sectors G and C (there was typically flocks of >100 birds and regular peaks >200). Low numbers of Oystercatcher were generally recorded throughout the first year of monitoring although regular flocks of 200-400 were recorded during the second year. Large numbers of Knot and Dunlin were also recorded during some periods with moderate numbers of Turnstone also being observed. Other species present were generally observed in low numbers (i.e. as just a few individuals).

Activities on the Pontoon and the Wider Area

A large number of activities were observed on the pontoon during the monitoring period which had the potential to cause bird disturbance. Regular activities on the pontoon facility, such as vessel movements and equipment deliveries, were recorded in approximately half of the counts. Periods of highest vessel activity generally occurred outside of low water periods (when water levels become suitable to navigate through the Inner Channel). The number of vessels using the pontoon was typically one to three vessels with up to nine vessels during the busiest periods.

² This need for more feeding time arises because Redshank select particularly small prey in relation to body size compared with other waders (Dwyer *et al.*, 2010; Wright *et al.*, 2013; IECS (2009a).

Also activities unrelated to the pontoon facility were regularly recorded during the counts. These 'background noise sources' included those created by nearby construction, a helicopter overflight and dredging vessel movements.

Frequency of Bird Disturbance Events (i.e. Clear Reactions by Birds)

Throughout the majority of counts, no or very little reaction from birds was observed even though there were activities on the pontoon and elsewhere during the majority (>90%) of the counts. Of the 119 hourly counts undertaken, disturbance events (i.e. a reaction to an activity) by any bird species whether they are an SPA interest feature species or not were observed on 28 occasions as follows:

- Twenty disturbance events were Level 2 (small disturbance with mild behavioural reaction/birds disturbed to within 100m of original location);
- Three disturbance events were Level 3 (moderate disturbance with birds disturbed up to 300m from original location); and
- Five disturbance events were Level 4 (large disturbance with birds disturbed up to and beyond 300m from their original location and then leave the area).

Of these 28 disturbance events discussed above, the majority (24 events) included reactions by SPA species (largely Redshank but also Oystercatcher, Dunlin and Curlew) with non-SPA species disturbed consisting of Black-headed Gull, Herring Gull and Great-crested Grebe. For Redshank specifically, reactions were observed during 19 of the 119 survey counts as follows:

- Fourteen disturbance events were Level 2;
- One disturbance event was Level 3; and
- Four disturbance events were Level 4.

Activities Causing Reactions by Birds

Of the 28 disturbance reactions observed by all bird species, the majority (22) were due to activities on the pontoon and associated vessel movements in the vicinity. Of these events the majority (18) were Level 2 reactions (i.e. a small behaviour change), one was Level 3 and three were Level 4. Two of these Level 4 disturbance events occurred in the very first month of the surveys and the third event occurred in winter 2014/15. The Level 3 event occurred in the first winter (2013/14).

The other disturbance reactions (by all birds) were from activities unrelated to the pontoon activities and included: background construction related noise (one Level 2, one Level 3 and one Level 4), noise from the delivery of a skip (Level 2), army attack helicopters flying overhead (Level 3) and a gas release from the nearby chemical works (Level 4).

On the 19 occasions when Redshank were seen to react, the disturbance event was mainly (14 times) in response to vessel/pontoon activity while on five occasions it was a response to other activities (skip delivery or distant background noise).

Bird Reactions and Movements

Bird movements when disturbed varied throughout the monitoring period. However, as indicated above, most disturbance reactions were typically minor, with birds stopping feeding and either flying up or walking away up the shoreline to resettle/resume feeding within 100m (Level 2). The rare larger disturbance events (Level 3 and 4) would cause birds to move further distances. Generally birds would fly towards either Sector D, the sandbanks in the middle estuary or to the north-west towards the breakwater.

Also when a reaction occurred it was often only a proportion of the birds present that exhibited a response. Typically flocks of less than 30 birds (mainly Redshank) were disturbed. The largest event involved a flock of 200 Redshank being disturbed by a gas release at the nearby chemical plant. Again, most disturbance events involved Redshank stopping feeding and either flying up or walking away up the shoreline to resettle and resume feeding within 100m (Level 2).

During the survey period, Redshank also exhibited a new behavioural preference for roosting on the rocks beneath the wooden fencing located along the quayside, rather than the more exposed rocks to the east of Sector G. This potentially relates to the sheltering effect of the new fencing that was introduced at this location.

Alerts for SPA Species

As noted above, each monthly summary report summarised the results of each survey and used threshold exceedance and alert levels to describe the severity of the reaction being observed. Further action was only considered necessary such as a modification of operational procedures if the 'Red' alert level was exceeded.

In total, only six of the 17 monthly surveys exceeded the Green threshold. All alerts exceeding the Green threshold were amber with no red alerts for SPA features issued. Therefore, no further direction such as to alter behaviour on the pontoon was considered necessary.

Changes in Redshank Abundance

In addition to considering bird reactions it is important to also understand whether the presence of the pontoon altered the degree of bird usage on the adjacent intertidal. To understand, specifically, the numbers of Redshank using the areas adjacent to the pontoon before and after the commencement of GyM operations, the average numbers at high water and low water in winter and in spring passage and autumn passage were plotted (using data collected by the Port and by GyM).

The findings indicate that the numbers of Redshank using the foreshore adjacent to the pontoon are generally similar before and after the pontoon became operational for the following periods: spring passage high water, spring passage low water, autumn high water and winter high water. In contrast, during autumn passage period at low water, around half the number of Redshank were recorded using the foreshore area in the two years after the pontoon was put in place when compared with the three years previous. However, there was also a large (greater than 50%) reduction in the average bird

numbers using the adjacent 'control' area (Sector D) during this period. Therefore, a broader decline in Redshank numbers is indicated by this data rather than a direct cause-effect link to the pontoon.

From these results, however, there appears to have been lower numbers of Redshank using the foreshore adjacent to the RWE pontoon during winter low-water periods since the pontoon became operational. The numbers are lower by around a half in the two years post pontoon operation. At the same time the numbers of Redshank in the control Area D were unchanged so, in contrast to the comparable 50% reduction observed for the autumn low water period, a potential link to pontoon activities cannot be excluded on this seasonal evidence alone (although such a reduction was not observed during other seasons).

Conclusions

In summary the key findings from this detail set of surveys is as follows:

- The area adjacent to the RWE Pontoon continues to function well as both a roost site (with new roosting area developing since the pontoon was installed) and as a low shore feeding area;
- Disturbance events in the area occurred relatively infrequently. When disturbance was observed, events were generally low reaction with birds typically showing mild behavioural changes (such as increased vigilance, avoidance walking and short flights) before rapidly resettling and resuming feeding;
- Large disturbance events which caused a stronger reaction in birds (i.e. a flying out of the area) were only recorded occasionally, mainly due to noise elsewhere in the area or atypical movements or thruster noises when vessels were docked into the inner berths (closest to the mudflats) during the first monthly survey;
- There is no consistent evidence of changes (reductions) in waterbird abundance which can be linked to the pontoon. In particular, it is surprising that there is no clear effect during the passage period when it might be expected that the transitory birds would be less likely to be habituated to pontoon activities;
- The results of the monitoring programme lend support to many of the predictions made in the original ES (GoBe Consultants Ltd., 2011), especially that:
 - The majority of disturbance events observed were due to vessel movements on the pontoon and in the immediate vicinity;
 - Birds in the area appear to be habituated to existing activities such that Redshank are tolerant of disturbance pressures well within a precautionary ('unhabituated') distance of 250m.
- The ES also concluded that Area C (the most vulnerable area closest to the pontoon) would be moderately affected by visual disturbance events from the pontoon without mitigation. The actual effects have been closer to minor/negligible (from noise and visual effects) due to a combination of bird tolerance/habituation and the adoption of appropriate and required working methods on the pontoon itself.



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Abbreviations

ABP	Associated British Ports
ABPmer	ABP Marine Environmental Research Ltd
CCW	Countryside Council for Wales
dB	Decibels
EA	Environment Agency
EIA	Environmental Impact Assessment
ES	Environmental Statement
GIS	Global Information System
GoBe	GoBe Consultants Ltd.
GyM	Gwynt y Môr Offshore Wind Farm Ltd.
HRA	Habitats Regulation Assessment
HW	High Water
IECS	Institute of Estuarine and Coastal Sciences
JCB	J.C. Bamford Excavators Limited
LiDAR	Light Detection And Ranging
LW	Low Water
MEP	Mostyn Energy Park
MCU	Marine Consents Unit
NE	Natural England
NRW	Natural Resources Wales
O&M	Operations and Maintenance
ODN	Ordnance Datum Newlyn
OS	Ordnance Survey
PoM	Port of Mostyn
Ramsar	Ramsar Convention on Wetlands of International Importance
RHIB	Rigid-hulled Inflatable Boat
SAC	Special Area of Conservation
SPA	Special Protection Area
UK	United Kingdom
UKD	UK Dredging
WeBS	Wetland Bird Survey

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Bird Disturbance Monitoring of the 'RWE Pontoon' at the Port of Mostyn

Review of Two Year Monitoring Programme (2013 to 2015)

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1. Introduction

1.1 Report Background

On behalf of Gwynt y Môr (GyM) Offshore Wind Farm Ltd., ABP Marine Environmental Research Ltd. (ABPmer) has monitored levels of bird disturbance on intertidal areas adjacent the new pontoon facility at the Port of Mostyn on the Dee Estuary. This monitoring work extended over a 'two year' period between October 2013 and March 2014 and June 2014 and March 2015. These surveys were undertaken in fulfilment of the conditions of a marine licensing consent (Ref 11/76/ML) for the operation of this pontoon (referred to here as the 'RWE Pontoon').

An interim report presenting a summary of the results of the first year of monitoring up to March 2014 was produced in May 2014 (ABPmer, 2014) and this report now describes the full dataset up to March 2015.

1.2 Project Background

In 2010, an agreement was reached with RWE Innogy UK for the lease of a major part of the Port of Mostyn's infrastructure to fulfil the 25-year operations and maintenance (O&M) requirements for their three wind farms off the North Wales coast (North Hoyle, Rhyl Flats and Gwynt-y-Môr). As part of this agreement, a pontoon facility was required to provide berthing for O&M vessels. The Environmental Statement (ES) associated with this development (GoBe Consultants Ltd., 2011) was submitted to the Marine Consents Unit (MCU), which is now part of Natural Resources Wales (NRW), in December 2011.

Following formal consultation, consent for the pontoon facility was approved by the MCU on the 5 March 2013. Construction of the pontoon began in April 2013 and was completed by July 2013. The pontoon became operational in September 2013.

As part of the Marine Licence for the pontoon, a number of conditions relating to operational monitoring were required. In particular, monitoring of waterbird populations adjacent to the pontoon was required for the first two years of operation as noted above. These were required to validate the predictions made in the ES (GoBe Consultants Ltd, 2011) with regard to the response of the key passage and overwintering bird populations on the intertidal area which lies closest to the pontoon during operation.

The measures identified in the marine licensing consent formed the basis of an Ornithological Monitoring Strategy (IECS, 2013). This monitoring strategy and ABPmer's site-specific knowledge and experience of the Port of Mostyn area, formed the basis of the monitoring methodology. ABPmer has undertaken separate (and ongoing) ornithological monitoring on behalf of the Port of Mostyn since 2009. These Port of Mostyn surveys describe the baseline waterbird abundances around the Port estate over a full calendar year and to date cover a period of six years. The data from these surveys were also used to inform the Environmental Impact Assessment (EIA) for the pontoon proposal (GoBe Consultants Ltd, 2011).

An additional requirement of the Marine Licence was that the landward side of the link-span and pontoon was screened at all times during passage and over wintering periods of operation. This was required to visually shield activities on the pontoon from birds using the foreshore. In October 2013 RWE Innogy UK requested that the pontoon screening be removed (but the link-span screening retained). This request was made because the pontoon screening was causing logistical problems on site and posing a health and safety concern. It was also motivated by the fact that the vessels themselves were considered to provide a more effective screening function. In addition, on those intermittent occasions when birds react to activities on the pontoon they do so mainly in response to vessel movements on the inside of the pontoon. The screening was therefore considered to be of limited value.

As part of this process a pontoon berthing plan was submitted to NRW which included details of the vessel 'self-screening' approach to mitigate the potential disturbance effects of personnel and equipment moving along the pontoon. NRW were satisfied with the measures outlined in the plan and confirmed that the screens of the pontoon could be removed in November 2014. The RWE application and NRW decision regarding this change in mitigation practice was informed by extra survey work and fixed-point camera analysis that RWE/GyM commissioned ABPmer to undertake during the June and July 2014 period.

In summary, therefore, the key dates over the monitoring period include:

- **November 2009:** Port of Mostyn monthly bird surveys begin;
- **April 2013 to July 2013:** RWE Pontoon construction;
- **September 2013:** RWE Pontoon became operational;
- **October 2013:** RWE/GyM monthly bird monitoring at the pontoon begins;
- **June 2014:** Extra surveys and fixed point camera studies undertaken by ABPmer for RWE/GyM to inform application for mitigation/screening change;
- **November 2014:** Screening removed and vessel berthing plan introduced; and
- **March 2015:** RWE/GyM monthly bird monitoring ends.

Further details of the methodology used for the RWE Pontoon bird surveys can be seen below in Section 2. Section 3 provides an overview of the separate long-term Port of Mostyn ornithological monitoring (as undertaken between 2009 and currently ongoing). The results of the RWE Pontoon monitoring work are presented in Section 4, with Section 4.1 describing the abundance and distribution of waterbirds recorded at each count sector and Section 4.2 providing a summary of disturbance events recorded during the monitoring. Finally, the main conclusions from the report are presented in Section 5.

1.3 Study Area

The Port of Mostyn is located on the southern (Welsh) shore of the outer Dee Estuary which lies between north Wales and the Wirral Peninsula in England (Figure 1). The Dee is of a high nature conservation value for birds and qualifies as a Special Protection Area (SPA) and Ramsar Site supporting passage and wintering bird populations of European and International importance (CCW and NE, 2010).

The location and extent of these designated sites within the estuary are shown in Figure 1. Summary information on the abundances of bird qualifying species within the SPA and Ramsar citations are presented in Table 1. The location of the RWE Pontoon is shown in Figure 2.

Table 1. Qualifying Bird Species in the Dee Estuary SPA and Ramsar Citations (1994/95 to 1998/99)

Internationally Important Populations of Regularly Occurring Annex 1 Species		
Breeding Population (5 year peak mean 1995-1999)	Little Tern	69 pairs (2.9% of British population)
	Common Tern	392 pairs (3.2% of British population)
Wintering Population (5 year peak mean 1994/95-1998/99)	Bar-tailed Godwit	1,150 individual birds (2.2% of the British population)*
Passage Population (5 year peak mean 1995-1999)	Sandwich Tern	957 (2.3% of the British population)
Internationally Important Populations of Regularly Occurring Migratory Species		
Wintering Population (5 year peak mean 1994/95-1998/99)	Northern Pintail	5,407 individual birds (9% of the population)*
	Eurasian Teal	5,251 individual birds (1.3% of the population)*
	Dunlin	27,769 individual birds (2% of the population)*
	Knot	12,394 individual birds (3.5% of the population)*
	Oystercatcher	22,677 individual birds (2.5% of the population)*
	Black-tailed Godwit	1,747 individual birds (2.5% of the population)*
	Curlew	3,899 individual birds (1.5% of the population)*
	Grey Plover	1,643 individual birds (1.5% of the population)*
	Common Shelduck	7,725 individual birds (2.6% of the population)*
Passage Population (5 year peak mean 1994/95-1998/99)	Redshank	5,293 individual birds (3.5% of the population)*
	Redshank	8,795 individual birds (5.9% of the population)*
Internationally Important Assemblage of Waterfowl (Also Ramsar Criterion 5)		
Wintering Population (5 year peak mean 1994/95-1998/99)	Wintering assemblage	120,726 individual birds (21,401 wildfowl, 29,960 waders) ** Including Great-crested Grebe, Cormorant, Shelduck, Oystercatcher, Black-tailed Godwit, Bar-tailed Godwit, Teal, Pintail, Grey Plover, Curlew, Redshank, Knot, Lapwing, Sanderling, Dunlin and Wigeon (of these 94,955 are SPA overwintering species based on the sum of the peaks quoted for these species in this table)***.
* Also Ramsar Criterion 6 ** Also Ramsar Criterion 5 *** The 2001 SPA Review of the Dee Estuary (Stroud <i>et al.</i> , 2001) SPA also considered Mallard should form part of the Internationally Important Assemblage.		

2. Methodology

2.1 Bird Survey Methods

The GyM bird surveys were undertaken, as required, once a month from October 2013 to March 2014 (Year 1 surveys) and then from June 2014 to March 2015 (Year 2 surveys) covering the intertidal area which lies closest to the pontoon during operation. In addition to these core requirements of the marine licence consents, GyM commissioned ABPmer to undertake two extra surveys during June and July 2013.

This intertidal area covered by the surveys was divided into two discrete surveying zones which are referred to as Count Sectors C (covering the lower shore; an area of 1.9ha) and G (covering the upper shore; an area of 1.6ha). These count sectors cover the following areas:

- **Count Section C:** the lower Mostyn Dock foreshore³ (i.e. the area in front of the dock and between the Mostyn breakwater and the Warwick Chemicals Promontory) including the rock armour facing of the Mostyn Quay. The RWE Pontoon is located around 25m from the low-shore boundary of Sector C and approximately 75m from the middle of this sector (Figure 2); and
- **Count Section G:** the upper shore high tide roost area along the Mostyn Dock foreshore area (including the present roost on the northwest side of the Warwick Chemicals promontory and the upper rock armour facing of Mostyn Quayside). The lower boundary of Sector G is approximately 120m from the centre of the pontoon, although the edges of Sector G are around 60/70m from the ends of the pontoon.

In addition, the nearby Warwick Chemicals foreshore area (known as **Count Sector D**; 12ha in size) to the south east (upstream) of the Warwick Chemicals promontory was also counted as a control site at high water and low water.

These count sectors and the survey methods applied are the same as those covered by ongoing, year-round and monthly ornithological surveys of the Port of Mostyn estate since 2009 (as noted above and described in more detail in Section 3). It was an important consideration for the work that these surveys follow such a consistent methodology in order to ensure that there is compatibility across the datasets. The location and description of these count sectors are presented in Figure 3.

The surveys in Sector C and G involved hourly bird counts taken throughout the tidal cycle to understand the distribution, abundance and behaviour of both roosting and feeding waterbirds. Seven hourly counts were taken throughout the tidal cycle. Where possible, surveys were timed to coincide with spring tides (e.g. within approximately a 5-day period of the largest tide each month).

³ The low shore Sector C generally remains inundated for the first three hours after high water so that birds can essentially only use the area when it is exposed for the last four hours of the survey on an ebbing tide (and first four hours of flooding tide survey).

During the surveys, the location of any vessel movement was recorded to provide an indication of pontoon usage; in particular individual berth usage and whether vessels moored on the inner or outer side of the pontoon was noted. In March 2014 a definitive berth plan of the pontoon was provided by GyM and this was used to identify and describe the locations of mooring vessels. This plan is presented in Figure 4. Prior to this, the berth location of each vessel was noted by the bird surveyor based on visual observations. Measurements of noise levels were also recorded during each survey count period from the November 2013 survey onwards using a Lutron SL-4013 sound level meter (0.1dB resolution).

Surveys of Count Sector D were not possible in December 2013, due to a severe storm surge on 5 and 6 December 2013 that washed some of the sea defences and access road to Sector D away. However, a high water observation of Sector D was carried out from the pontoon walkway on this occasion.

In addition to the bird counts, GyM commissioned ABPmer to install a static time-lapse camera taking photos of the foreshore every 20 seconds throughout daylight hours. This was implemented to provide further evidence (alongside the extra surveys in June and July 2013) about the behaviour of birds in the lower part of the foreshore in response to activities on the pontoon outside the survey periods. It was also used to inform judgements about the mitigation screening. The camera was put in place between the 11 August 2014 and the 2 October 2014. The analysis involved stitching together the images to create videos for each weekly period. These videos were then analysed and notable events such as disturbances, large flocks of waterbirds and bird behaviour recorded. In total, over 150 hours of additional data was collected using the static time-lapse camera.

2.2 Disturbance Criteria

The monitoring approach used threshold criteria levels to help describe the level of disturbance to birds within the Port and to provide an objective analysis of the effects caused by different quayside activities. Throughout this report and the preceding monthly reports the terms 'activities' and 'disturbance events' are used when discussing the reaction of birds to operations on the pontoon and in the surrounding area. For clarity, we define these terms in the context of effects on birds within the Port area as the following, based on that proposed by Nisbet (2000):

- **'Activities'** are defined as any activity and associated visual or noise stimuli that have the potential to change the immediate behaviour of one or more individual birds within the survey area. This may include human activities (e.g. movement of people/boats, construction noise) or natural occurrences (e.g. presence of raptors or other predators); and
- **'Disturbance events'** are defined as the reaction of birds to such activities; demonstrated by a clear change in contemporaneous behaviour in response to any ambient activities.

The disturbance levels used to categorise bird responses during surveys are presented below:

- **Level 1 no reaction:** No reaction by birds in the survey area;
- **Level 2 disturbance:** A small disturbance event in which birds show mild behavioural response to disturbance (such as stopping foraging for a short period of time) and/or disturbed within 100m of their original location before resettling rapidly within or near their original area after the disturbance passed/ended;
- **Level 3 disturbance:** A moderate disturbance event in which birds are disturbed up to 300m from their original location and then resettle rapidly within or near their original area after the disturbance passed/ended; and
- **Level 4 disturbance:** A large event in which birds are disturbed up to and beyond 300m from their original location and then leave the area.

The following threshold exceedance levels have then been applied as part of each monthly report to help provide a clear interpretation of the findings:

- **Green:** There is either no disturbance (Level 1) or Level 2 disturbances are occurring one or two times during any given six-hour survey period;
- **Amber:** Level 2 disturbances are occurring regularly (three or more times) during any given six-hour survey period or Level 3 disturbances occurring one or two times during any given six-hour survey period or one Level 4 disturbance during any given six-hour survey period; and
- **Red:** Level 4 disturbances are occurring two or more times during any given six-hour survey period.

Further action was considered necessary such as a modification of operational procedures or disturbance mitigation if the Red alert level was exceeded.

This approach was developed based on methods that have previously been identified to accompany the proposal to extend the Mostyn quay along the breakwater (ABPmer, 2010) and also for the monitoring of Port activities at Immingham Outer Harbour on the Humber Estuary (ABPmer, 2004). These criteria are also provisionally planned to be used as part of the monitoring of the proposed Mostyn Energy Park development which is subject to ongoing planning application consultation as informed by the accompanying Environmental Impact Assessment (EIA) and Habitats Regulations Appraisal (HRA).

This approach provides an objective mechanism for disseminating the results and helps to discriminate between the effects of the operation of the pontoon and effects from natural and unrelated anthropogenic disturbances.

3. Port of Mostyn Ornithological Monitoring (2009 to 2015)

The data collected as part of ABPmer's ongoing ornithological monitoring of the whole Port of Mostyn area (as noted in Section 2.1) provides a very useful background context to help better understand the results of the pontoon monitoring in terms of bird numbers and trends in general around the port estate throughout recent years.

This wider contextual data is provided below prior to the more detailed analysis of the GyM specific survey data (see Section 4.1). For this separate programme, commissioned by the Port of Mostyn, monthly surveys have been carried out year-round since 2009 and have been grouped seasonally as follows:

- **Winter:** November to February;
- **Spring Passage:** March to May;
- **Summer:** June to July; and
- **Autumn Passage:** August to October.

As these surveys have been undertaken through the tidal cycle it has been possible to analyse the data focusing on both high water and low water counts to understand the distribution and abundance of both roosting and feeding waterbirds around the Port of Mostyn.

Information on bird movements across the wider Port estate based on the Port of Mostyn Ornithological Monitoring data is initially described in Section 3.1 with Section 3.2 focusing specifically on bird movements and abundance in Sectors G, C and D.

3.1 Overview of Bird Movements Around the Port

A conceptual overview of the relationship between bird roosting and foraging areas was produced within the ES for the proposed Mostyn Energy Park (Port of Mostyn, 2013). This overview was based on information and annotated maps produced by the surveyors which provide details on bird movement, distribution and typical peak abundances for each hourly phase of the tide. Summary maps for the Port of Mostyn area are presented in Figures 5 and 6 for the ebb and flood phases of the tide respectively.

The ornithological surveys have shown that the majority of waterbirds using the area around the Port of Mostyn tend to roost on the foreshore below Warwick Chemicals (Count Sector 'D') or along the upper foreshore of the Mostyn Bank. On the Mostyn Bank they predominantly roost on an area consisting of deposited cockle shell between Mostyn and Ffynnongroyw (Count Sector 'H', see Figure 3) and in the southern corner of the bank, near the sea wall (Count Sector 'E', see Figure 3).

The foraging behaviour of most waterbirds around the Port of Mostyn tends to be dictated by their preference for each of these broad roosting areas (i.e. Mostyn Bank or Warwick Chemicals foreshore). Waterbirds roosting on the Mostyn Bank tend to follow the water's edge down the bank on the ebbing tide, often moving into the gutters to feed before following the water back up the bank on a flooding tide. Waterbirds using the Warwick Chemicals foreshore

mainly tend to undertake short flights to the sandbanks on and around Salisbury Middle as they become exposed during low water.

Waterbirds roosting on Mostyn Bank generally include a mix of waders (such as Redshank, Oystercatcher, Black-tailed Godwit, Knot and Curlew) and wildfowl (such as Shelduck and Mallard). While all these species show a similar broad feeding pattern through the tidal cycle as described above, individual species do exhibit different foraging behaviour and habitat preferences.

The dominant species is Oystercatcher often show highest levels of foraging activity at low water and typically disappear into gullies out of sight to feed. Some flocks loaf on Mostyn Bank throughout the entire tidal phase with limited foraging, while Redshank and other species generally spend a much higher proportion of the time foraging than Oystercatcher, although they will still loaf for several hours of the tidal cycle. Curlew appear to spread out in looser flocks on the Mostyn Bank than the smaller waders (Redshank, Knot and Dunlin). Mallard prefer to use the cross-mudflat channel running out from the Ffynnongroyw footbridge with Shelduck preferring to spread out along the shoreline on the Mostyn Bank.

Few waterbirds use the hard substratum habitat above Mostyn Bank, although small numbers of Turnstone are generally seen feeding in the rocky intertidal areas and very low numbers of Oystercatcher are recorded feeding around the breakwater. During passage periods around 200–600 Oystercatcher and similar numbers of Redshank have been recorded roosting along the rock ledge on the north west of the breakwater at mid-high water. The general bird usage of the areas east of the breakwater, including the Warwick Chemicals foreshore (Sector D) and Sectors G and C, is reviewed in more detail in Section 3.2 below.

When disturbed, waterbirds tend to move from one roosting site to another such as from Count Sector D on the Warwick Chemicals foreshore around to Roosts H or E on the western side. Oystercatcher, also, sometimes fly to one of the nearby sand banks if exposed once disturbed. For the majority of the time most species stay local to the Port of Mostyn although Black-tailed Godwits are more likely to move up and down the estuary.

3.2 Bird Numbers and Spatial Movements in Sectors G, C and D

To describe the waterbird abundance in Sectors G, C and D (i.e. in the vicinity of the RWE Pontoon) the survey data collected between 2009 and 2015 was obtained and reviewed. Figures 7a-c presents the average low water and high water counts between winter 2009/10 and spring 2015 for Sector G (Figure 7a), Sector C (Figure 7b) and Sector D (Figure 7c).

To then describe the value of the site in a national and regional context, Tables A1 and A2 in Appendix A summarise the winter and passage peak means for low and high water respectively and also compares the winter 6-year peak counts of key species against national 'importance thresholds'⁴. The high water counts are also compared against previously

⁴ A wetland in Britain is considered nationally important if it holds 1% or more of the estimated British population of one species or subspecies of waterbird and the threshold numbers are based on this 1% value (Holt *et al.*, 2015).

recorded estuary-wide abundance Wetland Bird Survey (WeBS) Core Counts for the most recently available five years between 2009/10 and 2013/14 (Holt *et al.*, 2015). Low water counts are compared against the latest available WeBS Low Tide Counts from the 2008/9 winter.

3.2.1 Count Sectors G and C

The section of the Mostyn Dock foreshore that is covered by Count Sectors C and G is primarily used by Oystercatcher and Redshank. These species typically use the pebble beaches and boulder areas at the top of the intertidal (Sector G) to roost at high water and use the lower foreshore as a feeding and loafing area (Sector C). Birds will generally follow the tide down from Sector G to Sector C. It should be noted however, that the feeding habitat in Sector C is probably not large enough to support all birds that roost in Sector G and typically many of these roosting birds fly out to feed on Salisbury Middle at low tide when it is exposed.

Redshank has been the most abundant species recorded in both Sector G and C throughout the survey period (Image 1). This species had a 6-year peak mean winter abundance of around 100 birds in each sector at low water (150 in Sector G and 118 in Sector C). This represents 1-2% of the estuary-wide abundance recorded during the most recent WeBS low water survey (from 2008/09).



Image 1. Redshank feeding and loafing on the Mostyn Dock foreshore, 2 October 2014 (Count Sector C) captured using the static time-lapse camera

During high-water the 6-year peak mean abundance of Redshank was 323 in Sector G and 14 in Sector C. This represents 3% and <1% respectively of the total abundance recorded in the Dee Estuary (when compared to 5-year estuary-wide peak mean counts from the 2009/10-2013/14 WeBS Core Count).

Numbers of Redshank have generally been larger in passage periods in both sectors, particularly in autumn months (6-year autumn peak mean abundance of 922 birds at high water in G and 750 birds in C at low water).

Sector C consists of intertidal area, the majority of which is inundated at high water. Some areas around the boundary of the site however remain exposed and are used by some birds intermittently as a roost site, generally in lower numbers than Sector G. Peak numbers of roosting birds in winter periods have shown a high degree of variability in Sector G with numbers between approximately 100 and 800 birds recorded.

Flocks of several hundred Oystercatcher have been recorded in Sector G roosting at high water and feeding at low water with generally small numbers recorded in Sector G at low water. Dunlin, Curlew and Turnstone have also been present throughout the monitoring period, although their numbers show more variability.

3.2.2 Count Sector D

The upper shore area of Warwick Chemicals Foreshore (Image 2) consists of a pebble beach with areas of shingle with large fences at the top of the foreshore. The larger Sector D consistently supports higher bird numbers than G and C. This is primarily due to the area being used as a roost by large numbers of Oystercatcher (which usually feed on the cockle beds found on the Salisbury Middle before moving to the Warwick Chemicals Foreshore during mid to high water).



Image 2. Oystercatcher on Warwick Chemicals foreshore roost, 17 March 2010 (Count Sector D)

The 6-year peak mean abundance for Oystercatcher in Sector D was 3,500 birds at high water (representing 14% of 5-year estuary-wide peak mean 2009/10 to 13/14) count. At low water a 5-year peak mean abundance of over 3,992 Oystercatcher was recorded (equivalent to 12% of the estuary-wide abundance based on the 2008/09 WeBS low water survey).

In addition, the site is regularly used by roosting Redshank. Overwintering numbers have remained relatively consistent over the survey period with the exception of winter 2013/14 when double the amount observed in previous winters was recorded (peak of 750 birds). Other species such as Turnstone occasionally recorded at the site. The site can be popular with sea anglers (fishing off the foreshore directly in front of the roost) who intermittently cause disturbance to roosting birds.

4. Results of the RWE Pontoon Monitoring

4.1 Introduction

This section provides a summary of the waterbird numbers and disturbance events recorded during the monthly surveys from October 2013 to March 2014 and June 2014 to March 2015 in Count Sector G, Count Sector C and Count Sector D respectively. Over this period a total of seventeen monthly surveys were carried out, each covering a period of seven hours through the tidal cycle (119 hourly counts were therefore undertaken in total).

The analysis of the results has focused primarily on Redshank, the most common species recorded in the count sectors and also the species considered most susceptible to the effects of disturbance (due to being relatively 'skittish' and also requiring more feeding time to offset the energetic costs of feeding than other waterbirds)⁵.

The results are presented in Figure 8 and 9. Figure 8 presents the average abundance of the Dee Estuary SPA species and Turnstone⁶ in Count Sector G, C and D for each monthly survey. Figure 8a presents the average abundances at high water and Figure 8b presents the abundances at low water. Figure 9 shows the number of Redshank and the proportion disturbed in Count Sectors G and C during each of the 119 hourly counts. Table 2 provides a summary of the species present and peak bird numbers recorded.

4.2 Waterbird Numbers Recorded

A total of 12 species were recorded using Sectors C, G and D during the monitoring. These species included⁷:

- Black-headed Gull *Chroicocephalus ridibundus*;
- Cormorant *Phalacrocorax carbo*;
- Shag *Phalacrocorax aristotelis*;
- Knot *Calidris canutus*;
- Curlew *Numenius arquata*;

⁵ Redshank are generally considered less tolerant to disturbance stimuli than other waterbirds frequently recorded along the Mostyn foreshore (such as Turnstone and Oystercatcher) but not as sensitive as some species such as Curlew (Dwyer *et al.*, 2010; IECS, 2009a). However, Redshank are regarded as being more vulnerable to the long-term effects of disturbance and extreme weather than other waterbirds, due to requiring more feeding time to offset the energetic costs of foraging (Wright *et al.*, 2013). This need for more feeding time arises because Redshank select particularly small prey in relation to body size compared with other waders (Dwyer *et al.*, 2010; IECS (2009a).

⁶ While the Turnstone is no longer listed as a qualifying species of the Dee Estuary Ramsar following a reassessment in 2009, the species has been included in this review due to this inclusion in the original Ramsar citation and also because the species is specifically mentioned in the Regulation 35 advice as occurring in substantial numbers within the Dee Estuary SPA (CCW and NE, 2010).

⁷ The species that are interest features of the Dee Estuary SPA are highlighted in **bold**.

- **Dunlin** *Calidris alpina*;
- Grey Heron *Ardea cinerea*;
- Herring Gull *Larus argentatus*;
- **Oystercatcher** *Haematopus ostralegus*;
- **Redshank** *Tringa totanus*;
- **Shelduck** *Tadorna tadorna*; and
- Turnstone *Arenaria interpres*.

4.2.1 Count Sectors G and C

Redshank was usually the most abundant waterbird species present in both Sectors G and C (typically flocks of up to several hundred birds) throughout the monitoring programme. An average over the survey period of approximately 250 Redshank was recorded roosting in Sector G at high water (Figure 8a) with a peak of 981 birds recorded in September 2014 (Table 2).

At low water an average over the survey period of approximately 105 Redshank were recorded in Sector G (Figure 8b) and a peak of 350 birds in October 2014. Fewer Redshank were recorded during low water feeding and loafing on the mudflat habitat in Sector C with an overall average of approximately 10 birds (Figure 8b) and a peak of 107 birds in October 2014 (Table 2).

Oystercatcher were also abundant throughout the surveys with an average of 129 birds recorded roosting in Sector G and a peak of 575 birds in January 2015. On average no more than 2 Oystercatcher were recorded feeding and loafing in Sector C with a peak of 10 Oystercatcher recorded in March 2015.

Small numbers of Dunlin and Turnstone (occasional flocks of approximately 20-30 birds) were also recorded. Other species present such as Curlew and Shelduck were generally observed in low numbers of just a few individuals (Table 2 and Figure 8a and 8b). This is consistent with the findings of the Port of Mostyn ornithological monitoring (Section 3).

In general, birds will leave their roosting sites at low water to feed elsewhere before returning, after which they are often observed loafing and roosting on the exposed sand at low water. The time spent feeding at low water varies between species, with Oystercatcher only spending a short time feeding before returning and Redshank feeding for usually one or two hours (P. Milner, pers. comm., April 2014). Further details of the spatial movements of birds in the study area can be seen in Figure 10 and discussed further in Section 3.1.

Throughout the monitoring period Sector C consistently supported fewer birds than Sector G. As highlighted in Section 3, this is due to the use of Sector G primarily as a roost site, becoming more important towards high water as birds return from their low tide foraging grounds. Numbers in this sector were consistently highest at high water. Sector C is intertidal and hence used during low water, when birds were observed to follow the tide to forage on the exposed sands, although some birds may move off to foraging grounds in the middle estuary.

Table 2. Bird Numbers Recorded in Count Sectors G and C During the RWE Pontoon Monitoring

Survey	Count Sector G Overview	Count Sector C Overview
October 2013	Moderate numbers of Redshank were observed roosting and feeding in Sector G (peak of 158 roosting), while low numbers (< 20 individuals) of Herring Gull, Oystercatcher, Dunlin, Turnstone, Shelduck, Curlew and Black-headed Gull were also observed roosting and feeding.	Bird counts recorded low numbers of Herring Gull (peak of 21) and Black-headed Gull (peak of 23) roosting and feeding, while Redshank (peak of 28) and a few individual Oystercatcher, Shelduck and Curlew were also observed feeding in the area.
November 2013	Moderate numbers of Redshank and Dunlin were observed roosting in Sector G (peak of 231 and 105 birds respectively), while low numbers of Turnstone (peak of 25 birds) and single individuals of Shelduck, Curlew, Herring Gull and Black-headed Gull were also observed roosting and feeding.	Bird counts recorded low numbers of Redshank feeding (peak of 11 birds) and Black-headed Gull (peak of 10 birds) and a few individual Oystercatcher, Shelduck and Curlew were also observed feeding in the area.
December 2013	Moderate/low numbers of Redshank and Turnstone were observed roosting in Sector G (peak of 96 and 53 birds respectively), while low numbers of roosting Black-headed Gull, Oystercatcher, Herring Gull and feeding Curlew were also observed. Low numbers of individual Redshank were also observed feeding.	Bird counts recorded low numbers of feeding and roosting Redshank (peak of 22 roosting) and roosting Herring Gull (peak of 15) and Black-headed Gull (peak of 19). A few individual Oystercatcher and Curlew were also observed feeding in the area.
January 2014	Bird numbers were highest in Sector G during the January 2014 survey at counts coinciding with high water. During the first hourly count, 40 roosting Redshank were observed in Sector G. Moderate/low numbers of Redshank, Dunlin and Turnstone were observed roosting in Sector G (peaks of 137, 46 and 21 birds respectively) during the second hourly count. Few individuals (<10) of Redshank, Dunlin, Turnstone, Black-headed Gull, Oystercatcher, Herring Gull, Curlew and Shelduck were also observed roosting and feeding in Sector G throughout the rest of the survey period.	Bird counts during the January 2014 survey consistently recorded few individuals (<10) of Redshank, Oystercatcher, Herring Gull, Shelduck and Black-headed Gull feeding and roosting in Sector C throughout the survey period.
February 2014	Bird numbers were highest in Sector G during the February 2014 survey at counts coinciding with high water. A total of 203 roosting Redshank were observed in the first hourly count in Sector G and 206 were recorded in the second count, with numbers then falling to 109 roosting and feeding in the third hourly count as the tide dropped and remaining low (< 10) thereafter. Moderate/low numbers of Dunlin, Turnstone and Herring Gull also were observed roosting in Sector G (peaks of 35, 15 and 34 birds respectively) throughout the ebbing tide. A few individuals (<10) of Oystercatcher and Curlew were also observed roosting and feeding in Sector G throughout the survey period.	Bird counts during the February 2014 survey consistently recorded only a few individuals (<10) of Redshank, Oystercatcher, Dunlin, Herring Gull and Black-headed Gull feeding and roosting in Sector C throughout the survey period.

Survey	Count Sector G Overview	Count Sector C Overview
March 2014	<p>Bird numbers remained relatively high in Sector G throughout the March 2014 survey due to the numbers of Redshank present. A total of 165 and 183 roosting Redshank were observed in the first and second hourly counts in Sector G respectively, coinciding with high water. As the tide dropped the number of Redshank observed feeding increased, with 190 roosting and 8 feeding in the third hourly count, followed by 160 feeding in the fourth hour. Redshank numbers dropped slightly in the fifth and sixth count to 89 and 79 roosting and feeding respectively as birds moved down the shore as the tide dropped into Sector C to feed, before increasing again to 137 roosting and 8 feeding in the seventh hourly count.</p> <p>Low numbers (<15) of Turnstone, Herring Gull and Oystercatcher were also observed roosting and/or feeding in Sector G (peaks of 13, 7 and 4 birds respectively) throughout the ebbing tide. A single Curlew was also observed feeding and roosting during the second half of the survey.</p>	<p>Bird counts in Sector C during the March 2014 survey recorded low numbers of Black-Headed Gull (peak of 19 roosting) and few individuals of feeding and roosting Herring Gull and Oystercatcher (peaks of 5 and 4 respectively). Moderate numbers of Redshank were observed feeding and roosting in Sector C from the fourth count onwards as birds moved down the shore from Sector G to feed, although numbers decreased in Sector C thereafter as birds finished feeding and returned to Sector G. A peak of 85 individuals were observed feeding in the fourth hourly count, dropping to 44 feeding and 18 roosting in the fifth count. Redshank numbers then dropped further to 18 feeding and 10 roosting in the sixth count and only 8 feeding in the seventh count.</p>
June 2014	<p>Bird numbers remained low in Sector G throughout the survey on 16 June 2014. Low numbers (<5 individuals) of Oystercatcher, Shelduck and Herring Gull were observed loafing and feeding in Sector G throughout the tidal cycle. A single Heron was also observed feeding in Sector G during counts four and five.</p>	<p>Bird counts in Sector C on 16 June 2014 also recorded low numbers (≤ 5 individuals) of birds throughout the seven hourly counts. A few individual Herring Gulls were present in Sector C throughout the survey, dropping to a single bird in the final (high water) hourly count. A single Shelduck was observed loafing in the area at low water during the first hourly count. One feeding and four loafing Oystercatcher were also present at low water during the first and second hourly counts respectively.</p>
July 2014 (1)	<p>Bird numbers were moderate/high in Sector G throughout the survey on 14 July 2014. Low numbers (<20 individuals) of Oystercatcher, Turnstone and Herring Gull were observed loafing and feeding in Sector G throughout the tidal cycle. Numbers of Black-headed Gulls increased throughout the survey from 15 individuals in the first hourly count before peaking at 230 roosting birds in the fifth hourly count and dropping off to 117 roosting birds in the seventh hourly count. No Redshank were present in Sector G during low water and through the first four hourly counts, although 186 birds were observed roosting in the area at high water in the fifth hourly count and this increased to 215 roosting birds in the seventh hourly count.</p>	<p>Bird counts in Sector C on 14 July 2014 recorded low/moderate numbers of birds feeding and loafing in the area throughout the tidal cycle. Low (< 10 birds) numbers of Herring Gull and Black-headed Gull were observed in Sector C throughout the majority of the survey, with a peak of 28 feeding and loafing Black-headed Gulls in the fourth hourly count. A single Oystercatcher was observed feeding in the area during the third hourly count.</p>

Survey	Count Sector G Overview	Count Sector C Overview
July 2014 (2)	<p>Bird numbers were moderate/high in Sector G throughout the survey on 28 July 2014. Low numbers (<10 individuals) of Oystercatcher, Turnstone, Herring Gull and Curlew were observed loafing and feeding in Sector G throughout the tidal cycle. Bird numbers peaked in Sector G at high water as birds came in to roost in the area. Numbers of Black-headed Gulls increased throughout the survey from 9 individuals in the first hourly count before peaking at 250 roosting birds in the fifth hourly count and dropping off to 215 roosting birds in the seventh hourly count. Low numbers (< 15) of Redshank were present in Sector G during low water and through the first three hourly counts, although this increased to 43 birds loafing and feeding in the area in the fourth hourly count, 53 roosting in the fifth hourly count and 106 and 102 roosting Redshank at high water in the sixth and seventh hourly counts respectively.</p>	<p>Bird counts in Sector C on 28 July 2014 recorded low/moderate numbers of birds feeding and loafing in the area throughout the tidal cycle. Low (< 10 birds) numbers of Redshank, Oystercatcher, Herring Gull and Black-headed Gull were observed in Sector C throughout the majority of the survey, with peaks of 34 loafing Redshank in the third hour and 40 feeding and loafing Black-headed Gulls in the fourth hourly count. A single Curlew was observed feeding in the area during the second and fourth hourly counts. No birds were observed in Sector C in hours six and seven at high water, when the area becomes inundated by the tide.</p>
August 2014	<p>Bird numbers were moderate/high in Sector G throughout the survey on 18 August 2014. Bird numbers peaked in Sector G at high water as birds came in to roost in the area. High numbers (> 200) of Redshank were present in Sector G during low water and through the first three hourly counts, although numbers of Redshank increased throughout the survey as birds came in to roost, reaching 399 birds in the fifth hourly count, 423 in the sixth hour and 420 birds loafing and feeding in the area in the seventh hourly count.</p> <p>Numbers of Black-headed Gulls increased throughout the survey from two individuals in the first hourly count before peaking at 74 roosting birds in the fifth hourly count and dropping off to 59 roosting birds in the seventh hourly count. Low numbers (<10 individuals) of Oystercatcher, Turnstone, Herring Gull and Dunlin were observed loafing and feeding in Sector G throughout the tidal cycle. A single Curlew was observed feeding in the area during the second hourly count.</p>	<p>Bird counts in Sector C on 18 August 2014 recorded low numbers of birds feeding and loafing in the area throughout the tidal cycle. Low numbers of Redshank (peak of 12) and a single Oystercatcher were observed in Sector C during the first four hourly counts. Low numbers (< 10) of Herring Gull were present throughout counts 1-6, and Black-headed Gull numbers increased throughout the survey, from 3 individuals in the first count to a peak of 39 in the sixth hourly count. A single Curlew was observed feeding in the area during the third hourly count. No birds were observed in Sector C in hour seven at high water, when the area becomes inundated by the tide.</p>
September 2014	<p>Bird numbers were high in Sector G throughout much of the survey on 11 September 2014. Bird numbers peaked in Sector G at high water as birds came in to roost in the area. Low numbers of birds were present in Sector G during low water (22 birds) although numbers of Redshank increased throughout the survey as birds came in to roost reaching 925 birds in the fifth hourly count, 780 in the sixth hour and 981 birds in the area in the seventh hourly count.</p>	<p>Bird counts in Sector C on 11 September 2014 generally recorded low numbers of waterbirds feeding and loafing in the area throughout the tidal cycle. However, moderate numbers of Black-headed Gull were recorded (counts of 97 and 140 birds in the fourth and seventh counts respectively). Low numbers of Redshank (peak of 37), three Oystercatchers and a single Shelduck were also observed in Sector C during the first four hourly counts. Low numbers (< 10) of Herring Gull were present throughout many of the counts.</p>

Survey	Count Sector G Overview	Count Sector C Overview
	<p>Moderate numbers of Oystercatcher were also observed, peaking at 185 birds in the sixth hourly count and dropping off to 120 roosting birds in the seventh hourly count. In addition, moderate numbers of Black-headed Gull (peak of 80 birds in the fifth hourly count) and small numbers of (<17 individuals) of Turnstone and Herring Gull were observed loafing and feeding in Sector G throughout the tidal cycle. A single Shelduck was also observed roosting in the area during the fifth, sixth and seventh hourly counts.</p>	
<p>October 2014</p>	<p>Redshank numbers on 6 October 2014 survey peaked at high water as birds roosted in the area (776 birds). Numbers then gradually declined throughout the survey as birds dispersed to feed (from 522 birds in the second hourly count to 8 birds in the seventh hourly count).</p> <p>Small numbers of Oystercatcher were also observed, peaking at 28 roosting birds in the third hourly count and dropping off to 2 feeding birds in the seventh hourly count. In addition, moderate numbers of Turnstone (peak of 45 birds in the third hourly count) and small numbers (<17 individuals) of Dunlin, Black-headed Gull, Cormorant and Herring Gull were observed loafing and feeding in Sector G throughout the tidal cycle. A single Heron was also observed roosting in the area during the fifth, sixth and seventh hourly counts.</p>	<p>Bird counts in Sector C on 6 October 2014 generally recorded low numbers of waterbirds feeding and loafing in the area throughout the tidal cycle. However, moderate numbers of Redshank were recorded at low water (counts of 79 and 107 birds in the fourth and seventh counts respectively).</p> <p>Black-headed Gull were recorded in the third hourly count (peak of 30 birds). Low numbers (< 10) of Herring Gull and Cormorant (1-2 individuals) were present throughout many of the counts. In addition a single Heron was recorded in the second hourly count and a single Curlew in the seventh hourly count.</p>
<p>November 2014</p>	<p>Redshank numbers on 10 November 2014 survey increased towards high water as birds as birds flew in from the surrounding area to roost (from 12 in the first hourly count to 435 birds in the sixth hourly count). Numbers remained high in the seventh hourly count (395 birds).</p> <p>Large numbers of Oystercatcher were also observed, peaking at 270 roosting birds in the seventh hourly count. In addition, moderate numbers of Turnstone (peak of 52 birds in the fourth hourly count) and small numbers (<30 individuals) of Dunlin, Black-headed Gull, Curlew, and Herring Gull were observed loafing and feeding in Sector G throughout the tidal cycle.</p>	<p>Bird counts in Sector C on 10 November 2014 generally recorded low numbers of waterbirds feeding and loafing in the area throughout the tidal cycle. Three Redshank were recorded in the third hourly count and one in the fourth hourly count. One Oystercatcher was also recorded in the first hourly count.</p> <p>Low numbers (<10) of Herring Gull and Black-headed Gull were present throughout many of the counts. In addition a single Cormorant was recorded in the seventh hourly count.</p>

Survey	Count Sector G Overview	Count Sector C Overview
December 2014	<p>Redshank numbers on 13 December 2014 survey increased towards high water as birds flew in from the surrounding area to roost (from 11 birds in the first hourly count to 108 birds in the seventh hourly count).</p> <p>Large numbers of Oystercatcher were also observed, peaking at 437 roosting birds in the seventh hourly count. Moderate numbers of Turnstone (peak of 51 birds in the fifth hourly count) and Dunlin were also recorded (peak of 49 birds in the fifth hourly count). In addition, small numbers (<10 individuals) of Curlew, Shag and Herring Gull were observed loafing and feeding in Sector G throughout the tidal cycle.</p>	<p>Bird counts in Sector C on 13 December 2014 generally recorded low numbers of waterbirds feeding and loafing in the area throughout the tidal cycle. Small numbers of Redshank and Oystercatcher were recorded in the first five counts (with a peak of six Redshank and nine Oystercatcher in the fourth hourly count).</p> <p>Low numbers (<30) of Herring Gull, Dunlin and Shag were also present throughout many of the counts.</p>
January 2015	<p>In this upper shore area, there were good numbers of several species using the site as a high water roost particularly. Redshank numbers on 19 January 2015 survey were highest (72) at high water as bird roosted on the top of foreshore. Their abundance then decreased towards low water (from 72 birds in the first hourly count to 10 birds in the seventh hourly count).</p> <p>Large numbers of Oystercatcher were also observed, peaking at 575 roosting birds in the first hourly count. In addition, large numbers of Dunlin and Turnstone (peaking at 135 and 69 birds respectively in the second hourly count) were also recorded. Moderate numbers of Herring Gull (peak of 55 birds in the first hourly count) and small numbers (<10 individuals) of Curlew and Shag were observed loafing and feeding in Sector G throughout the tidal cycle.</p>	<p>Bird counts in Sector C on 19 January 2015 generally recorded low numbers of waterbirds feeding and loafing in the area throughout the tidal cycle. Small numbers of Redshank and Dunlin were recorded in the first five counts (with a peak of 12 Redshank and 10 Dunlin in the first and fourth hourly counts respectively). Low numbers (<15) of Herring Gull, Oystercatcher and Shag were also present throughout many of the counts.</p>
February 2015	<p>Redshank numbers on 13 December 2014 survey generally increased towards high water as birds flew in from the surrounding area to roost (from 3 birds in the first hourly count to 235 birds in the seventh hourly count).</p> <p>Large numbers of Oystercatcher were also observed, peaking at 365 roosting birds in the sixth hourly count. Moderate numbers of Herring Gull (peak of 36 birds in the sixth hourly count) and small numbers (<20 individuals) of Dunlin, Curlew, Shelduck, Turnstone and Black-headed Gull were observed loafing and feeding in Sector G throughout the tidal cycle.</p>	<p>Bird counts in Sector C on 26 February 2014 generally recorded low numbers of waterbirds feeding and loafing in the area throughout the tidal cycle. Small numbers of Redshank and Oystercatcher were recorded in the first four counts (with a peak of six Redshank in the fourth hourly count and nine Oystercatcher in the third hourly count).</p> <p>Low numbers (<20) of Herring Gull, Black-headed Gull and Dunlin were also present throughout many of the counts.</p>



Survey	Count Sector G Overview	Count Sector C Overview
March 2015	<p>Moderate numbers of loafing and feeding Redshank were present (50 birds) at the start of the survey on 12 March 2015 survey. Their abundance then generally increased towards high water as birds flew in from the surrounding area to roost (124 birds in the seventh hourly count).</p> <p>Large numbers of Oystercatcher were also observed, peaking at 430 roosting birds in the sixth and seventh hourly count. Moderate numbers of Turnstone (peak of 29 birds in the fourth hourly count) and small numbers (<20 individuals) of Dunlin, Curlew, Shelduck, Herring Gull, Ringed Plover, and Black-headed Gull were observed loafing and feeding in Sector G throughout the tidal cycle.</p>	<p>In Sector C on the 12 March 2015 generally low numbers of waterbirds were recorded feeding and loafing in the area throughout the tidal cycle. Small numbers of Redshank and Oystercatcher were recorded in the first four counts (with a peak of four Redshank in the second hourly count and 10 Oystercatcher in the fourth hourly count).</p> <p>Low numbers (<10 individuals) of Herring Gull were also present throughout many of the counts.</p>

4.2.2 Count Sector D

Bird numbers observed in Sector D at high water and low water were also variable throughout the survey period, with an average of approximately 300 Oystercatcher and 125 Redshank recorded. As is usual, Oystercatcher was consistently the most abundant species present in Sector D. Peak numbers in Sector D were observed in January 2014, when numbers were dominated by a flock of 1,800 Oystercatcher at high water. Bird numbers in Sector D were consistently highest at high water, indicating the particular importance of the area as a roost site, particularly for Oystercatcher.

4.3 Disturbance Monitoring

4.3.1 Activities and Noise Levels

A large number of activities were observed on the pontoon during the monitoring period which had the potential to cause bird disturbance. Regular activities on the pontoon facility, such as vessel movements and equipment deliveries, were recorded in approximately half of the counts. Periods of highest vessel activity generally occurred outside of low water (when water levels become suitable to navigate through the Inner Channel). The number of vessels using the pontoon was typically one to three vessels with up to nine vessels during the busiest periods.

Also activities unrelated to the pontoon facility were regularly recorded during the counts. These 'background noise sources' included those created by nearby construction, a helicopter overflight, raptor presence (a female Merlin flew overhead during the October survey) and dredging vessel movements.

A summary of the activities and disturbance levels observed in Count Sectors G and C is presented in Table 3.

Associated noise levels recorded with each activity generally did not exceed 70dB, with the exception of several helicopters flying overhead (71-77dB), electric truck and crew movements on the pontoon during the March and December 2014 surveys (77dB and 79dB respectively) and the prolonged release of gas from the Warwick Chemicals plant close to Area G (75dB). A very small proportion of vessel movements also exceeded 70dB although the vast majority were between 57 and 65dB. IECS (2009a) state that bird reactions to noise disturbance are generally low to moderate below 70dB and moderate to high above this level. However, very few of these activities caused disturbance to any birds present (see Table 3). In addition, no pattern was evident which suggested louder vessels arriving at the pontoon caused increased disturbance. In this respect noise levels measured in periods of vessel related disturbance was in the range recorded more generally for vessels during the entire monitoring programme.

4.3.2 Disturbance Events (All Species)

Throughout the 17 monthly surveys, a total of 119 hourly counts were undertaken (i.e. seven hourly counts per survey). Of these 119 hourly counts, disturbance events were observed on 28 occasions (i.e. there was a reaction to an activity by any bird species whether they are an SPA interest feature species or not).



Image 3. Support vessel leaving the pontoon on the 19 September 2014 with several hundred Redshank on lower shore (captured using the static time-lapse camera)

The majority (18) of the 28 disturbance events were Level 2 reactions (small disturbance with mild behavioural reaction/birds disturbed to within 100m of original location), three Level 3 (moderate disturbance with birds disturbed up to 300m from original location) and five were Level 4 (large disturbance with birds disturbed up to and beyond 300m from their original location and then leave the area).

Of the 28 disturbance reactions observed throughout the monitoring, 22 were due to activities on the pontoon and associated vessel movements in the vicinity of the pontoon and inner channel. Disturbance events appeared to be mainly due to the vessel docking into the inner berths near the mudflats which often caused more erratic movements and louder thruster noise (associated with manoeuvring) compared to other more general vessel movements.

These findings are consistent with previous research which has found that vessels approaching birds at faster speeds and which approach closely to bird aggregations cause much higher disturbance than the regular presence of vessels in boat channels (Chatwin *et al.*, 2013; Rodgers and Schwikert, 2002; Bellefleur *et al.*, 2009; Burger, 1998). Other research has also indicated that in general, birds appear to habituate to continual noises (such as engine noise) as long as there is no large amplitude 'startling' component (Hockin *et al.*, 1992; IECS, 2009a; IECS, 2009b).

The other disturbance events were due to background construction related noise (one Level 2, one Level 3 and one Level 4), noise from the delivery of a skip (Level 2), army attack helicopters flying overhead (Level 3) and a gas release from the nearby chemical works (Level 4). None of these activities were associated with the pontoon.

Typically flocks of less than 30 birds (mainly Redshank) were disturbed, with a flock of 200 Redshank being the largest number recorded as disturbed in any one event (due to a gas release at the nearby chemical plant).

4.3.3 Disturbance Events (Redshank)

For Redshank in particular, disturbance reactions were observed on 19 occasions. Fourteen of the 19 disturbance events were Level 2 reactions, one was Level 3 and four were Level 4. On 14 occasions this was in response to vessel/pontoon activity and in response to other activities (skip delivery or distant background noise) on five occasions.

As described above, on the vast majority of occasions no reaction by Redshank was observed even though there were activities on the pontoon and elsewhere during the majority (>90%) of the counts. Very few disturbance events were also observed during the analysis of the camera time-lapse footage (Image 3 and Table 4). Furthermore, only a small numbers of Redshank have been disturbed (on average 20 birds) with only one disturbance event when over 200 birds were disturbed (approximately 50% of the total number of Redshank in the sector at that time).

During the survey period, Redshank also exhibited a new behavioural preference for roosting on the rocks beneath the wooden fencing located along the quayside, rather than the more exposed rocks to the east of Sector G (P. Milner, pers. comm., May 2014). This potentially relates to the sheltering effect of the new fencing that was introduced at this location. The number of Redshank occurring in Sectors G and C and the proportion disturbed is presented in Figure 8.

4.3.4 Disturbance Events (Monthly Alert Response of SPA Species)

The monthly alert levels (see Section 2.2) based on the number and magnitude of disturbance events observed each month (ranked from low to high as Green, Amber and Red) are presented in Table 3. The alerts are designed to understand the effects specifically on SPA features and ensure that, if there were any issues, they were identified as soon as possible. Further action was only considered necessary such as a modification of operational procedures if the 'Red' alert level was exceeded.

In total, only six of the 17 monthly surveys exceeded the Green threshold. All alerts exceeding the Green threshold were amber with no red alerts for SPA features issued. Therefore, no further direction such as to alter behaviour on the pontoon was considered necessary.

Although detailed disturbance observations were not carried out for Sector D, some unquantified disturbance was observed during the October, November, December and February surveys due to construction work being carried out by Network Rail on the sea defences damaged in the December storm surge. Additionally, two fishermen were observed in Sector D in January that caused some (unquantified) disturbance.

4.3.5 Disturbance Events (Bird Movements)

Bird movements when disturbed varied throughout the monitoring period. Most disturbance events were Level 2 and reactions by birds were typically minor, with birds stopping feeding and either flying up or walking away up the shoreline to resettle/resume feeding within 100m. The rare larger disturbance events (Level 3 and 4) would cause birds to move further distances. Generally birds would fly towards either Sector D, the sandbanks in the middle estuary or to the north-west towards the breakwater. A conceptual overview of bird movements within the survey area is presented in Figure 10.

Whether a bird relocated within the Port area when disturbed or to further afield often depends on the species affected. Oystercatcher were more likely to fly more than a mile away towards Salisbury Middle, while disturbed Redshank were likely move to another area within the Port estate, generally within a mile of Sectors G and C (P. Milner, pers. comm., April 2014).

4.3.6 Effects on Waterbird Numbers (Especially Redshank)

The preceding sections have described the extent to which a detectable reaction was observed by the birds using the intertidal adjacent to the pontoon as well as the nature of those reactions. In addition to considering bird reactions it is important to also understand whether the presence of the pontoon altered the degree of bird usage on the adjacent intertidal.

To understand, specifically, the numbers of Redshank using the areas adjacent to the pontoon before and after the commencement of GyM operations, the average numbers at high water and low water in winter and in spring passage and autumn passage were plotted (using data collected by the Port and by GyM)⁸. These plots are shown in Figure 11a-c and encompass the four years before and the two years after the RWE pontoon became operational (using data collected by the Port and by GyM). The figures show the average Redshank at high water and low water in Count Sectors G, C and D during winter periods (Figure 11a), spring passage periods (Figure 11b) and autumn passage periods (Figure 11c).

⁸ This use of seasonal averages at high and low water was advised by NRW (as part of the separate Mostyn Energy Park Application (MEP) application) as the most appropriate analysis to understand bird numbers before and after pontoon operation.

While the temporary and spatial variability of bird distributions does complicate the analysis, there are a number of general characteristics of Redshank use in the area that can be highlighted. In particular, the abundance of Redshank is much higher in the area during the autumn passage period. Typically around 2000 Redshank were recorded in the area during these autumn migratory periods although numbers were somewhat lower at around 1500 during the most recently surveyed autumn period (in 2014). During the overwintering periods and during the spring passage months Redshank numbers range between around 200 and 500 across the Port estate

At high-water these Redshank are distributed across five or six different roost sites immediately upstream and downstream of the Port. Typically the roost area near to the RWE pontoon (Survey Area G) is used by between 20-45% of the Redshank present in the Port of Mostyn area. When the low water is exposed then the majority of Redshank that are roosting in the area will also forage and loaf locally. At low water the foreshore area that lies close to the RWE pontoon (Survey Areas G and C) has been used by anywhere between just a few Redshank (<10 as in the 2009/10 winter) to around or over 500 birds (as during the peak autumn passage periods of 2010 to 2012).

These findings indicate that the numbers of Redshank using the foreshore adjacent to the pontoon are very similar before and after the pontoon became operational for the following periods: spring passage high water, spring passage low water, autumn high water and winter high water. In making these comparisons the average values are used and in cases where there is what appears to be a uniquely high baseline value in the Port and GyM data (i.e. the winter high water value of 342 Redshank in Area G during the 2011/12 winter) then this is ignored in favour of understanding the values that are more typical over the survey periods.

In contrast, during autumn passage period at low water, around half the number of Redshank were recorded using the foreshore area in the two years after the pontoon was put in place when compared with the three years previous. However, there was also a large (greater than 50%) reduction in the average bird numbers using the adjacent 'control' area (Sector D) during this period. Therefore, a broader decline in Redshank numbers is indicated by this data rather than a direct cause-effect link to the pontoon.

Over the winter low-water periods there appears to have been a decline in the numbers of Redshank using the foreshore (Survey Areas G and C) adjacent to the RWE pontoon since the pontoon became operational. The numbers are lower by around a half in the two years post pontoon operation (with the particular high values from the winter 2012/13 period excluded from the approximation of the baseline levels). At the same time the numbers of Redshank in the control Area D were unchanged so, in contrast to the comparable 50% reduction observed for the autumn low water period, a potential link to pontoon activities cannot be excluded on this seasonal evidence.

Previous research has shown that waterbirds may reduce the effects associated with human disturbance by leaving an area or feeding in supplementary feeding grounds (Velasquez and Hockey 1992; Carless, 2005; Dwyer 2010; Navedo and Herrera, 2012). Given the proximity of nearby higher quality feeding and roosting grounds, a temporary re-distribution of Redshank to

other feeding areas in the vicinity of the Port could have occurred over the winter periods following pontoon operation. However, it is surprising that there is no clear effect during the passage period when it might be expected that the transitory birds would be less likely to be habituated to pontoon activities.

Furthermore, the estuary-wide abundance of Redshank based on WeBS Core Count data for the year the pontoon became operational (2013/14) was 7,190 birds. This value is approximately 20-35% lower than the abundances recorded in the previous 5 years (between approximately 9,200 and 11,200 birds) for the Dee Estuary (Holt *et al.*, 2015). The observed reduction could therefore be part of wider biogeographic trends linked to changes in the overall flyway population or in response to various environmental factors.

In addition, the average numbers of winter birds recorded on this foreshore at low water have on one occasion been much lower prior to the pontoon being in place (i.e. during the 2009/10 winter) than in the two winters since.

Instead of leaving an area birds might also change the timings of their feeding routine or extend their feeding period (Urfi *et al.*, 1996). Pontoon activity only occurred during suitable tidal and weather windows, allowing large periods of feeding time when there was no activity on the pontoon. In addition, the pontoon is primarily only used during daylight hours. Waterbirds regularly feed nocturnally and have been shown to use this as a mechanism to avoid disturbance (Goss-Custard and Verboven 1993; Gill *et al.*, 2001; Lourenço *et al.*, 2013). It is therefore possible that wintering Redshank were continuing to use this area but shifted to a more nocturnal regime.

Table 3. Overview of Activities and Disturbance Events Recorded in Count Sectors G and C From October 2013 to March 2014

Season	Survey	Activities	Count Sector G Overview	SPA Species Threshold	Count Sector C Overview	SPA Species Threshold
Autumn	October 2013	<ul style="list-style-type: none"> Support vessels arriving/departing pontoon Skip delivery noise Distant drilling/construction noise Female Merlin flying low over Sectors G and C 	Two small (Level 2) disturbance events were recorded; one due to a support vessel departing from the pontoon and one due to the noise of a skip delivery. One large (Level 4) disturbance event occurred due to distant drilling/construction noise. During all disturbance events Redshank were the only species disturbed	Amber (Redshank)	One small (Level 2) disturbance event was recorded due to a support vessel arriving at the pontoon, disturbing low numbers of Black-headed Gull and Herring Gull, and two large (Level 4) disturbance events occurred for the same reason, one disturbing 24 Redshank and one disturbing 8 Black-headed Gulls.	Amber (Redshank)
Winter	November 2013	<ul style="list-style-type: none"> Generator noise (55dB) Support vessel departing Berth 4 (60dB) Helicopter flying overhead (71dB) Support vessel arriving at Berth 4 (58dB) RHIB arrive/departing Berth 3 (58dB) 	No disturbance events were observed in Sector G (Level 1).	Green	One small (Level 2) disturbance event was recorded due to a support vessel departing from Berth Four. This event disturbed low numbers of Redshank and Dunlin.	Green
	December 2013	<ul style="list-style-type: none"> Generator noise (53dB) Distant heavy plant movements (58dB) Support vessel departing Berth 8 (58dB) Support vessel movements at Berths 7 and 8 (67dB) Heavy support vessel arrived at quayside (69dB) 	No disturbance events were observed in Sector G (Level 1).	Green	One small (Level 2) disturbance event was recorded due to the heavy support vessel arriving at the quayside that stayed for an extended period. This disturbed 3 Herring Gull and 1 Great-crested Grebe.	Green
	January 2014	<ul style="list-style-type: none"> Background noise from chemical works (54dB) Support vessel arriving at Berth 4 (59dB) Support vessels arriving at buoy off pontoon (62dB) Support vessel movements on Berths 4 and Berth 6 (60dB) Engineering works on support vessel at Berth 4 (60dB) 	No disturbance events were observed in Sector G (Level 1).	Green	Two small (Level 2) disturbance events were recorded during the January 2014 survey; one due to support vessels arriving at a buoy off the pontoon and one due to engineering works on a support vessel at Berth 4. The vessel arriving at the buoy off the pontoon disturbed 6 Black-headed Gulls which moved off the mud and onto the shoreline <100m away. The engineering works on a support vessel at Berth 4 disturbed 8 Redshank that stopped foraging and moved <100m.	Green
	February 2014	<ul style="list-style-type: none"> Dredger UKD Orca departing quayside (60dB) Dredger UKD Orca present in channel with engines running (59dB) Background noise (51dB) Electric truck and crew arriving on pontoon walkway (60dB) Support vessel motoring onto buoy (62dB) Two cockle fishermen on inflatable RHIB motoring under pontoon walkway (61dB) Support vessel 'Victory' arriving at Berth 4 (55dB) Support vessel 'Penrhyn Bay' arriving at Berth 6 (60dB) 	One small (Level 2) disturbance event was observed, caused by a support vessel motoring onto a buoy. This disturbed 5 of the 9 Redshank present at the time that stopped foraging and moved 100m away.	Green	Two disturbance events were recorded during the February 2014 survey; one Level 2 due to a survey vessel motoring to a buoy off the pontoon and one Level 3 due to the arrival of an electric truck with trailers and 6 crew onto the pontoon to deliver equipment to a support vessel. The survey vessel motoring to the buoy off the pontoon disturbed all 6 Redshank present which stopped foraging and moved 100m away. The delivery of equipment to the support vessel disturbed the 2 Oystercatcher and 1 of the 2 Curlews present that stopped feeding. These birds were feeding almost directly beneath the pontoon when the truck and its crew arrived which is partially see-through due to its structure. The 2 Oystercatcher retreated to the shoreline while the Curlew flew off towards the sandbanks in the middle estuary.	Amber (Redshank, Oystercatcher, Curlew)

Season	Survey	Activities	Count Sector G Overview	SPA Species Threshold	Count Sector C Overview	SPA Species Threshold
Spring	March 2014	<ul style="list-style-type: none"> Electric truck and crew movements (77dB) Support vessel Cwynnan Bay departing its berth (63dB) Small RHIB motored past pontoon area (64dB) Support vessel Cwynnan Bay returning to its berth (63dB) Support vessel Discovery arriving at outer berth on pontoon (62dB) Background construction noise (58dB) 	No disturbance events were observed in Sector G (Level 1).	Green	No disturbance events were observed in Sector C (Level 1).	Green
Summer	June 2014	<ul style="list-style-type: none"> Operational noise from Seajack Frederica on the quayside (55dB) Service vessels Inceni Defiant (59dB), Aberdaron Bay (59dB) and Caernarfon Bay (60dB) all departed inner berths of the pontoon Operational noise from Seajack Frederica on the quayside (55dB); Peregrine Falcon flew through Sectors G and C and perched on quayside Survey vessel Norse 1050 motored past the pontoon (61dB); Peregrine Falcon perched on quayside RIB departed from inner berth of the pontoon (58dB) Operational noise from Seajack Frederica on the quayside (55dB) 	No disturbance events were observed in Sector G (Level 1).	Green	No disturbance events were observed in Sector C (Level 1).	Green
Summer	July 2014 (1)	<ul style="list-style-type: none"> Sea Jack Frederica quayside operations (56dB) Electric truck and crew movements on walkway (64dB) Support vessel Buzzard left from inner berth (67dB) Support vessel CWIND Adventure left inner berth (60dB) Support vessel Captain P left inner berth (74dB) Support vessel Defiant left inner berth (59dB) Support vessel CWIND Challenger left inner berth (69dB) Support vessel Guardian 14 left outer berth (60dB) Support vessel Gaillon left inner berth (61dB) Support vessel Guardian 2 left inner berth (59dB) Support vessel Penrhyn Bay left outer berth (59dB) Support vessel NSL Discovery left from inner berth (60dB); Support vessel Caernarfon Bay arrived at outer berth (55dB) Sea Jack Frederica quayside operations (56dB) Support vessel Kitty Petra left outer berth (61dB) Support vessel Caernarfon Bay left from outer berth (60dB), returned (59dB) and left (58dB) Sea Jack Frederica quayside operations (56dB) Support vessel Caernarfon Bay returned to outer berth (59dB) and left again (58dB). Sea Jack Frederica quayside operations (56dB) 	No disturbance events were observed in Sector G (Level 1).	Green	Two disturbance events (Level 2 events) were observed during the July 2014 survey in Sector C. The first disturbance event was caused by the departure of the support vessel Buzzard from an inner berth on the pontoon during the second hourly count, which disturbed three Black-headed Gulls which stopped foraging and moved up the shore from Sector C to Sector G. The departure of the CWIND Challenger vessel from an inner berth of the pontoon during the third hourly count disturbed the single feeding Oystercatcher in Sector C which also stopped foraging and moved up the shore to Sector G. All other activities recorded during the survey did not result in a disturbance event.	Green
Summer	July 2014 (2)	<ul style="list-style-type: none"> Support vessel Captain P left inner berth (63dB) Support vessel Buzzard left outer berth (61dB) Support vessel Maldon left outer berth (59dB) Support vessel Inceni Defiant moved from storm buoy to outer berth and left after 5mins (54dB) Support vessel Aberdaron Bay moved from storm buoy to outer berth and left after 15 minutes (54dB) Support vessel Caernarfon Bay moved from storm buoy to outer berth and left after 5 minutes 	No disturbance events were observed in Sector G (Level 1).	Green	Two disturbance events (Level 2 events) were observed during the second July 2014 survey in Sector C. The first disturbance event was caused by the departure of the support vessel Captain P from an inner berth on the pontoon (noise level recorded as 63dB) during the second hourly count, disturbing three Redshank around 30m from the pontoon which stopped foraging and flew from Sector C to Sector D.	Green

Season	Survey	Activities	Count Sector G Overview	SPA Species Threshold	Count Sector C Overview	SPA Species Threshold
		<ul style="list-style-type: none"> Support vessel Endurance left storm buoy (55dB) Support vessel Gaillion left inner berth (59dB) Support vessel Gardian 14 left outer berth (57dB) Support vessel Gardian 2 left inner berth (58dB) Support vessel Cwind Challenger left inner berth (71dB) Support vessel Icen Victory left outer berth (55dB) Support vessel Cwind Resolution left inner berth (70dB) Support vessel Penrhos Bay left inner berth (56dB) Support vessel Kinmel Bay left inner berth (56dB) Support vessel Norse 1050 left from storm buoy (59dB) Support vessel Patricia motored past pontoon several times (60dB) 			The departure of the support vessel Gaillion from an inner berth of the pontoon (noise level recorded as 59dB) during the third hourly count disturbed two Turnstone and 25 Redshank around 50m from the pontoon in Sector C, which flew 30m and resettled. All other activities recorded during the survey did not result in a disturbance event.	
Autumn	August 2014	<ul style="list-style-type: none"> Low-level background shore-side construction noise (52dB) Loud JCB operations noise at shore-side construction site (64dB) Low-level background shore-side construction noise (52dB) RHIB motored past pontoon towards the south east (54dB) Support vessel Festnet Skua motored past pontoon onto storm buoy near Area D (62dB) Support vessel Festnet Tern motored past pontoon onto storm buoy near Area D (70dB) RHIB motored past pontoon towards the north west (65dB) Low-level background shore-side construction noise (52dB) Support vessel Windcat 3 left from storm buoy near Area D, travelling north westerly (65dB) RHIB motored past pontoon towards the south east (64dB) Support vessel CWind Challenger arrived at inner berth (65dB) Low-level background shore-side construction noise (52dB) Support vessel Channel Chieftain VII arrived at quayside (68dB) Support vessel CWind Resolution arrived at outer berth (65dB) Low-level background shore-side construction noise (52dB) Support vessel Discovery arrived at inner berth (63dB) Loud JCB operations noise at shore-side construction site (64dB) 	<p>Two disturbance events were observed during the August 2014 survey in Sector G, one Level 3 event and one Level 2 event. The Level 3 event occurred in the second hourly count and was caused by noise from loud JCB operations in the shore-side construction site on the quayside to the west of Sector G (64dB), disturbing 25 Redshank (9.5% of Redshank present) and 2 Black-headed Gull that were foraging in the area and took flight from the mud in the west of the area to the rocks on the south east side of Sector G between Sectors G and D.</p> <p>The second disturbance event occurred in the sixth hourly count during high water and was again due to noise from JCB operations in the construction site (64dB), disturbing 3 Redshank (0.71% of Redshank present) that also left rocks on the west of the area and took flight, resettling on the rocks to the south east.</p>	Amber (Redshank)	No disturbance events were observed in Sector C (Level 1).	Green
Autumn	September 2014	<ul style="list-style-type: none"> Support vessel Guardian 14 left from pontoon outer berth (65dB) Support vessel Icen Defiant returned to outer berth on pontoon (57dB) Support vessel Icen Defiant left from inner berth on pontoon (58dB) Prolonged release of gas from the Warwick Chemicals plant close to Area G (75dB). Support vessel Endurance left from storm buoy off Area D travelling in north westerly direction (59dB) Support vessel Aberdaron Bay left from outer berth on pontoon Rib/tender motored past pontoon travelling in south easterly towards storm buoys in Area D (58dB) 	<p>Two disturbance events were observed in Sector G, one Level 4 event and one Level 2 event. The Level 4 event occurred in the fifth hourly count and was caused by the prolonged release of gas from the Warwick Chemicals plant close to Area G (75dB). This event disturbed 200 Redshank (22% of Redshank present) along with 80 Black-headed Gull and 20 Oystercatcher that were roosting in the area. These birds took flight from the mud in the North West direction with a small number of birds returning after the noise subsided.</p>	Amber (Redshank and Oystercatcher)	Only one minor (Level 2) disturbance event was observed in during the September 2014 survey, despite a number of activities being recorded on the RWE pontoon and the quayside during the survey. The disturbance event was caused by the support vessel Caernarfon Bay leaving from the outer berth on pontoon whilst other vessels were crewing up and loading equipment (62dB). This event caused 2 Redshank (50% of Redshank present) to take flight but these birds then rapidly resettled to forage 100m away from original location within one minute.	Green

Season	Survey	Activities	Count Sector G Overview	SPA Species Threshold	Count Sector C Overview	SPA Species Threshold
		<ul style="list-style-type: none"> Support vessel Fastnet Tern left from storm buoy in Area D (68dB). Two Electric truck and trailer movements along pontoon walkway. (64dB) Support vessel Caernarfon Bay moved from quayside to outer berth on pontoon (59dB) Rib/tender motored past pontoon travelling in south easterly towards storm buoys off Area D (58dB) Electric truck and trailer movements along pontoon walkway (69dB) Support vessel Aberdaron Bay moved from quayside to outer berth on pontoon (62dB) Support vessel Xplorer left from storm buoy off Area D travelling in north westerly direction (67dB) 	The other disturbance event occurred in the third hourly count during high water and was caused as the support vessel Caernarfon Bay left from outer berth on pontoon whilst other vessels were crewing up and loading equipment. This event disturbed 50 Redshank (21% of the Redshank present) and 30 Great-black Backed Gull. The birds flew in a North West direction before quickly resettling 100m away (within 1 minute).			
Autumn	October 2014	<ul style="list-style-type: none"> Support vessel Gaillion left from inner berth on pontoon(57dB) Support vessel Gardian 2 left from inner berth on pontoon(59dB) Support vessel Caernafon Bay returned to inner berth on pontoon (62dB) Support vessel Cwind Adventure returned to inner berth on pontoon (60dB) Support vessel Windcat 3 left from storm buoy off Area D travelling in north westerly direction (58dB) Support vessel Caernafon Bay left from inner berth on pontoon (61dB) Support vessel Cwind Adventure left from inner berth on pontoon (62dB); Airbus wing barge Afon Dyfrdwy motored past pontoon towards Mostyn main slipway (58dB) Rib/tender motored past pontoon travelling south easterly towards storm buoys in Area D (59dB) Rib/tender motored past pontoon travelling north westerly away from storm buoys in Area D (59dB) Support vessel Norse 1050 left from storm buoy in Area D travelling south east (57dB) Support vessel NSL Discovery left from pontoon outer berth(59dB) Support vessel Fastnet Puffin left from storm buoy in Area D(62dB) Support vessel Iceni Victory left from pontoon outer berth (58dB) Support vessel Iceni Defiant left from pontoon outer berth (57dB). 4 Rib/tenders motored past pontoon travelling from south east towards north west 964 (dB) 	<p>Two disturbance events were observed in Sector G, both of which were Level 2 events. The first Level 2 event occurred in the second hourly count and was caused when the support vessel Windcat 3 left in a north westerly direction from the storm buoy off Area D (58dB). This disturbed 30 Redshank (6% of Redshank present). The birds flew in a South West direction before quickly resettling 100m away (within 1 minute).</p> <p>The other Level 2 disturbance event was also in the second hour and was caused by electric truck and trailer movements along the pontoon. This event disturbed 60 Redshank (11% of the Redshank present). The birds flew in a South West direction before quickly resettling 100m away (within 1 minute).</p>	Green	No disturbance events were observed in Sector C (Level 1).	Green
Winter	November 2014	<ul style="list-style-type: none"> 2 Electric truck/trailer and crew movements along pontoon walkway (64dB) Support vessel NSL Discovery left from outer berth on pontoon (62dB) Support vessel Iceni Victory left from outer berth on pontoon (62dB) Support vessel Iceni Defiant left from pontoon inner berth (58dB) 	Two disturbance events were observed in Sector G, both of which were Level 2 events. The first Level 2 event occurred in the second hourly count and was caused when the support vessel Cwind Adventure moved onto the inner berth of the pontoon (62dB). This disturbed 3 Oystercatcher (100% of the Oystercatcher present). The birds flew in a		Two disturbance events were observed in Sector C, one of which was a Level 2 event and the other a Level 4 event. Both disturbance events occurred in the second hourly count. The Level 2 event was caused when the support vessel Cwind Adventure left from inner berth of the pontoon (58dB). This disturbed 3 Herring Gull which took flight and flew in a South West direction before quickly resettling 100m away (within 1 min).	Amber (Redshank)

Season	Survey	Activities	Count Sector G Overview	SPA Species Threshold	Count Sector C Overview	SPA Species Threshold
		<ul style="list-style-type: none"> Support vessel Caernafon Bay left from inner berth on pontoon (56dB) Support vessel Cwind Adventure moved onto inner berth on pontoon (62dB) Support vessel Cwind Resolution left from outer berth on pontoon (63dB) Support vessel Colwyn Bay left from inner berth on pontoon (59dB) Support vessel Gardian 14 left from inner berth on pontoon (61dB) Support vessel Windcat 3 left from inner berth on pontoon (60dB) Support vessel Cwind Adventure left from inner berth on pontoon (58dB) Support vessel Penrhos Bay left from inner berth on pontoon (60dB) Electric truck/trailer and crew movements along pontoon walkway (65db); Support vessel Gardian 2 came into inner berth on pontoon. (Note – Pontoon activity unusually high at the same time as this boat movement so the bird disturbance may not have been caused by this boat.) (59dB) Support vessel Endurance left from storm buoy in Area D (58dB) Support vessel Bayard 2 left from outer berth on pontoon (57dB) Support vessel Gaillion left from outer berth on pontoon (58dB) Support vessel Gardian 2 left from inner berth on pontoon (57dB) Support vessel Cwind Resolution manoeuvring just off quayside area (59dB) Support vessel Caernafon Bay moved from outer to inner berth on pontoon (57dB) 	<p>South East direction before quickly resettling 100m away (within 2 minutes).</p> <p>The other Level 2 disturbance event was in the fourth hourly count and was caused by electric truck and crew movements along pontoon walkway (64dB). This event disturbed 30 Redshank (39% of the Redshank present) and 30 Turnstone (58% of the Turnstone present). The birds took flight but quickly resettled in same location (within 1 min).</p>		<p>The Level 4 event was caused when the support vessel Gardian 2 came into inner berth of the pontoon (59dB). This caused six Redshank to take flight (40% of the Redshank present). These birds left the area towards the offshore sandbanks and did not return.</p>	
Winter	December 2014	<ul style="list-style-type: none"> Electric truck and trailer movements along pontoon walkway (79dB) Crew movements on pontoon (56dB) Small fishing vessel Little Wonder motored past pontoon travelling south easterly towards storm buoys in Area D (55dB) Small fishing vessel Jacqueline motored past pontoon travelling south easterly towards storm buoys in Area D (54dB) Crew movements on pontoon (59dB) Crew man running down pontoon walkway (65dB) 	No disturbance events were observed in Sector G (Level 1).	Green	One disturbance event (Level 2) was observed in Sector C during the survey. The event was caused when a crew member ran down the pontoon walkway (65dB). This caused two Redshank (67% of the Redshank present) to take flight from Sector C before quickly resettling in Sector G to resume foraging.	Green
Winter	January 2015	<ul style="list-style-type: none"> Background chemical works noise (53 dB) Survey vessel Norse 1050 motored past pontoon travelling south easterly towards storm buoy close to pontoon (55dB) 2 Army attack helicopters flew low over pontoon area going NW (78dB) Small rib motored past pontoon travelling from vessel Norse 1050 towards quayside (62dB) Support vessel NSL Discovery came onto pontoon outer berth to drop off crew men (61dB) 	Two disturbance events were observed in Sector G, one of which was a Level 2 event and the other a Level 3 event. The first Level 2 event occurred in the third hourly count and was caused as a small rib motored past the pontoon travelling from vessel Norse 1050 towards the quayside (62dB). This disturbed 20 Dunlin (59% of the Dunlin present) and six Redshank (21% of the Redshank present).	Amber (Redshank, Dunlin and Oystercatcher)	No disturbance events were observed in Sector C (Level 1).	Green

Season	Survey	Activities	Count Sector G Overview	SPA Species Threshold	Count Sector C Overview	SPA Species Threshold
		<ul style="list-style-type: none"> 3 Army attack helicopters flew low over pontoon area going NW (78dB) Vessel with no visible name/number markings motored past pontoon travelling south easterly towards storm buoys in Area D (64dB) Dredging vessel Eileen motored from storm buoys in Area D towards breakwater end of quayside (60dB) 	<p>The birds stopped foraging and flew around before resettling to feed.</p> <p>The Level 3 disturbance event also occurred in the third hourly count and was caused by two Army attack helicopters flying low over the pontoon in a North West direction. This event disturbed 5 Oystercatcher (1% of the Oystercatcher present). The birds took flight and resettled on spit between Area G and D.</p>			
Winter	February 2015	<ul style="list-style-type: none"> Background wind and chemical works noise (55 dB) Two crew men walked down pontoon to meet vessel Small vessel Hagar motored onto pontoon outer berth to pick up crew members before travelling south easterly towards storm buoys in Area D Dredging vessel Eileen motored from quayside past pontoon towards storm buoys in Area D Vessel Patricia motored past pontoon travelling north west towards quayside from storm buoys in Area D Small inflatable tender motored from quayside past pontoon towards storm buoys in Area D Two crew men with equipment walked down pontoon to vessel Icen Defiant. Small vessel Hagar motored from storm buoys in Area D past pontoon towards quayside Support vessel Icen Defiant motored from inner pontoon to outer pontoon berth 	No disturbance events were observed in Sector G (Level 1).	Green	No disturbance events were observed in Sector C (Level 1).	Green
Spring	March 2015	<ul style="list-style-type: none"> Background wind, sea and shore-side background noise including chemical works noise (57 to 64dB) Support vessel Icen Defiant left pontoon inner berth (60dB) Multiple crew movements up and down pontoon walkway to/from various support vessels (60dB) Support vessel Gaillion left pontoon inner berth (63dB) Support vessel Wind transfer of Barrow left pontoon outer berth (62dB) Support vessel Guardian left pontoon inner berth (62dB) Support vessel Guardian 10 left pontoon inner berth (61dB) Support vessel EMS Viking left pontoon outer berth (60dB) Support vessel Guardian 3 returned to pontoon inner berth (64dB) 	No disturbance events were observed in Sector G (Level 1).	Green	No disturbance events were observed in Sector C (Level 1).	Green

Table 4. Data Log for the Static Time Lapse Camera

Week Number	Data Week Ending	Notes/Observations
1	18/08/14	▪ Three main mud banks used by birds in area with deep gullies/channels in between
		▪ Freshly exposed (accreting?) mud at lower shore
		▪ Birds feed on banks as tide drops and move into gullies and lower shore at low water (see annotated photo)
		▪ Mainly Redshank and Gulls (difficult to identify)
		▪ Up to ~200 birds feeding across whole area at times, all banks
		▪ Video 1.1 – 1min07secs-Boat arrival at inner berth at low water
		▪ -15 birds feeding at lower shore show no reaction, possibly move a few metres to west
		▪ Video 1.2 – 6min30secs-Boat arrives at inner berth on dropping tide then leaves again few minutes after
2	26/08/14	▪ Few birds feeding on lower shore show no reaction
		▪ Movements between pontoon and outer estuary to buoys near Area D show little effect
		▪ Video 2.1 – 3min35secs-Boat arrival at inner berth, flock of gulls – potentially disturbed? No way of defining causality
		▪ Video 2.1 – 5min25secs-Boat departs inner berth
		▪ Video 2.1 – 5min55secs-Vessel arrival at storm buoys, small vessel motors from storm buoys. High bird numbers across mudflats apparently unaffected
		▪ Video 2.1 – 7min05secs-Large vessel arrives at outer berth. Birds feeding on lower shore.
		▪ Video 2.1 – 7min40secs-Vessel arrival at inner berth. People movements on boat and around pontoon
		▪ Video 2.1 – 7min55secs-Leading vessels depart inner berth. One vessel returns almost immediately
		▪ Video 2.1 – 9min15secs-Various vessel manoeuvres/arrivals at inner berths. Some birds feeding on mud banks. Higher numbers of birds seem to arrive (from middle estuary?)
		▪ Video 2.1 – 10min55secs onwards-Vessel movements around pontoon
		▪ Video 2.2 - 4min05secs-Two vessels depart then return to inner berths at low water. Low numbers of birds feeding on lower bank
		▪ Video 2.2 - 4min50secs-Two vessels arrive at inner berth, low bird numbers around
		▪ Video 2.2 - 6min40secs-Large vessel arrives at outer berth although few birds around and little effect
		▪ Video 2.2 - 6min40secs onwards – No vessel movements although large numbers of birds feeding across site at low water and within close proximity to pontoon
3	09/09/14	▪ Video 2.3 - 1min10secs-Boats return to inner berths.
		▪ Video 2.3 - 10min25secs onwards -Moderate/high numbers of birds feeding at water's edge within metres of pontoon, although no activity on pontoon.
		▪ Video 3.1-3min47secs-Boats arrive back at the inner berths with moderate numbers of birds feeding on lower shore.
		▪ Video 3.1-3min56secs-High numbers of birds feeding at water's edge relatively close to the pontoon. Boats moored and no activity on pontoon.
		▪ Video 3.1 4min0secs-The high numbers of birds on lower shore disperse at the same time as the arrival of a vessel at the inner berth.
		▪ Video 3.1 4min02secs-Moderate/high numbers of Redshank on lower shore when vessel arrived back at Pontoon.
		▪ Video 3.1 4min24secs-Moderate bird numbers on the lower shore with some activity on the Pontoon.
		▪ Video 3.1 9min14secs-Vessel arrives at inner berths with low numbers of birds on foreshore.
		▪ Video 3.2 No boats moored at pontoon at low water.
		▪ Video 3.3. 7min23 seconds-Vessel arrives at Pontoon but few birds present on the lower shore prior to arrival of the vessel.
4	19/09/14	▪ Video 3.3 13min3sec-Moderate/high numbers of birds on the lower shore but no activity on pontoon.
		▪ Video 4.1 3min1sec-Vessel arrives at inner berth. Low numbers of birds feeding before, within and after manoeuvres.
		▪ Video 4.1 3min30sec-High numbers of birds on the lower shore at the time a medium sized vessel arrives at inner berth to moor on the side of other boats and manoeuvres near mudflat. Birds either stay in same place or walk a bit further up the shore. This is a good example of a typical reaction to vessel (when such relations occur).
		▪ Video 4.1 7min44sec-Mid to low tide (ebbing) tide showing large numbers of Oystercatcher loafing on rocks and Shelduck/Redshank feeding on lower shore.
		▪ Video 4.1 11min2sec-Large numbers of Oystercatcher roosting on rocks directly below camera
		▪ Video 4.1 13min2sec- Boats arrive back at the inner berths. Most birds on the mid and upper part of mudflat in gutters and continue feeding.
		▪ Video 4.2 4min26sec-Vessels arriving in at the inner berth. Birds scattered on the lower shore and continue feeding
5	23/09/14	▪ Video 4.3 4min09sec-Vessel arriving at the inner berth at mid to high tide. Small area of mud exposed with lots of feeding birds. No evidence of disturbance.
		▪ Video 5.1 2min52sec-Vessel arrives in at inner berths but difficult to see birds on foreshore due to poor visibility.
6	2/10/14	▪ Video 5.1 7min15- Redshank feeding on mudflat below camera.
		▪ Video 6.1 1min36-Good numbers (200+) of Redshank feeding at low water.

5. Conclusions

In summary the key findings from this detail set of surveys is as follows:

- The area adjacent to the RWE Pontoon continues to function well as both a roost site (with new roosting area developing since the pontoon was installed) and as a low shore feeding area;
- Disturbance events in the area occurred relatively infrequently. When disturbance was observed, events were generally low reaction with birds typically showing mild behavioural changes (such as increased vigilance, avoidance walking and short flights) before rapidly resettling and resuming feeding;
- Large disturbance events which caused a stronger reaction in birds (i.e. a flying out of the area) were only recorded occasionally, mainly due to noise elsewhere in the area or atypical movements or thruster noises when vessels were docked into the inner berths (closest to the mudflats) during the first monthly survey;
- There is no consistent evidence of changes (reductions) in waterbird abundance which can be linked to the pontoon. In particular, it is surprising that there is no clear effect during the passage period when it might be expected that the transitory birds would be less likely to be habituated to pontoon activities;
- The results of the monitoring programme lend support to many of the predictions made in the original ES (GoBe Consultants Ltd., 2011), especially that:
 - The majority of disturbance events observed were due to vessel movements on the pontoon and in the immediate vicinity; and
 - Birds in the area appear to be habituated to existing activities such that Redshank are tolerant of disturbance pressures well within a precautionary ('unhabituated') distance of 250m.
- The ES also concluded that Area C (the most vulnerable area closest to the pontoon) would be moderately affected by visual disturbance events from the pontoon without mitigation. The actual effects have been closer to minor/negligible (from noise and visual effects) due to a combination of bird tolerance/habituation and the adoption of appropriate and required working methods on the pontoon itself.

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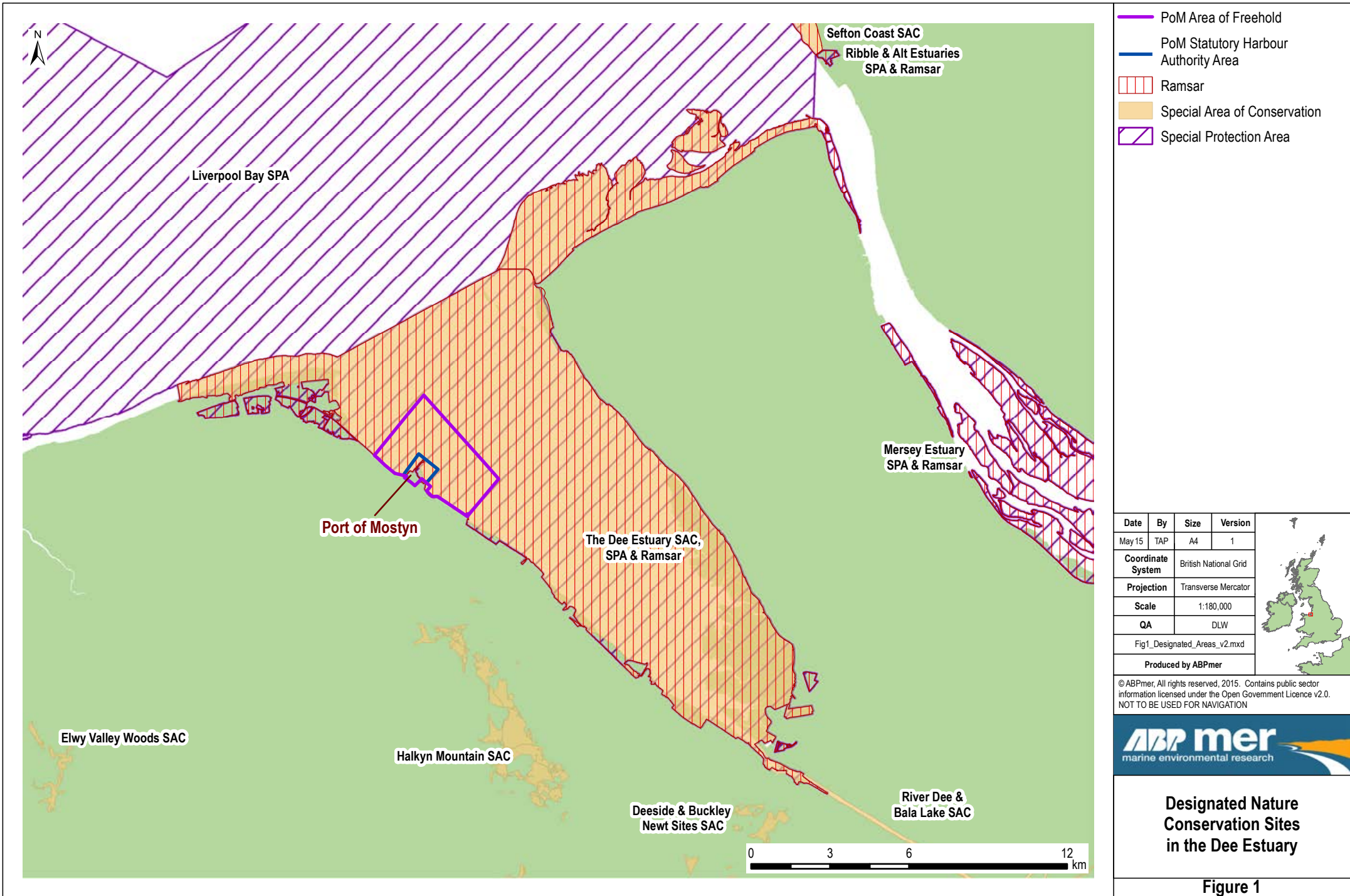
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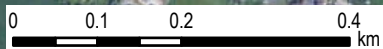
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Figures







Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

-  RWE Pontoon
-  Count Sector C
-  Count Sector D
-  Count Sector G

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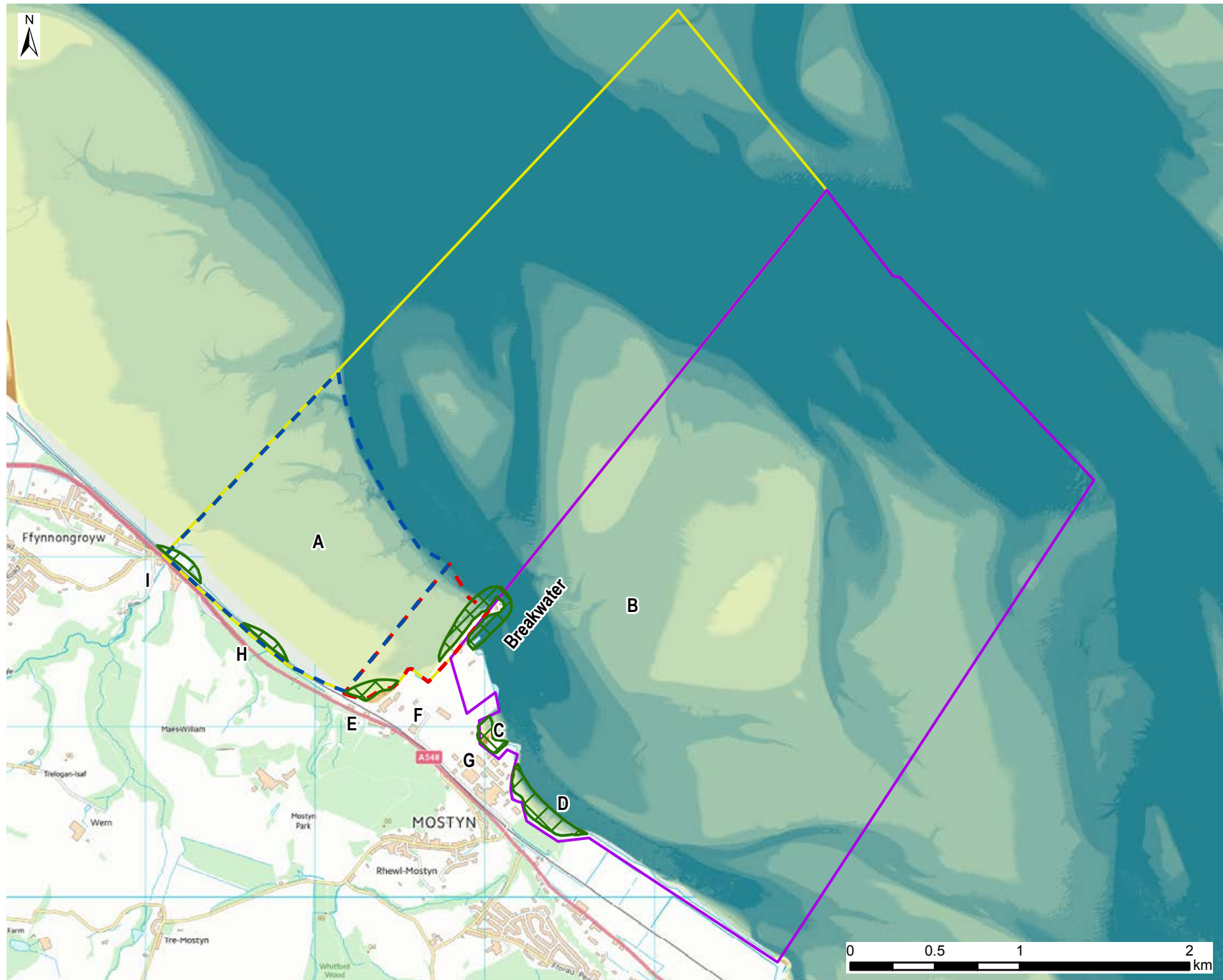










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









Location of the RWE Pontoon at the Port of Mostyn and Overview of Count Sectors Surveyed

Figure 2



-  Port Roost Count Sections
-  WeBS Area
-  Section A1
-  Section A2
-  WeBs Mostyn
-  Dock Shore (69453)
-  WeBS Ffynongroyw Bay
-  South Sector (96961)

2012 LiDAR data (mODN)

-  < -3
-  -3 - -2
-  -2 - -1
-  -1 - 0
-  0 - 1
-  1 - 2
-  2 - 3
-  3 - 4
-  4 - 5
-  5 - 6
-  6 - 7
-  7 - 8
-  8 - 9
-  9 - 10
-  >10

Date	By	Size	Version
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Produced by ABPmer			



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Port of Mostyn and the Main Bird Survey Count Sectors

Figure 3



- RWE Pontoon
- Berths
- Count Sector C
- Count Sector D
- Count Sector G

Date	By	Size	Version
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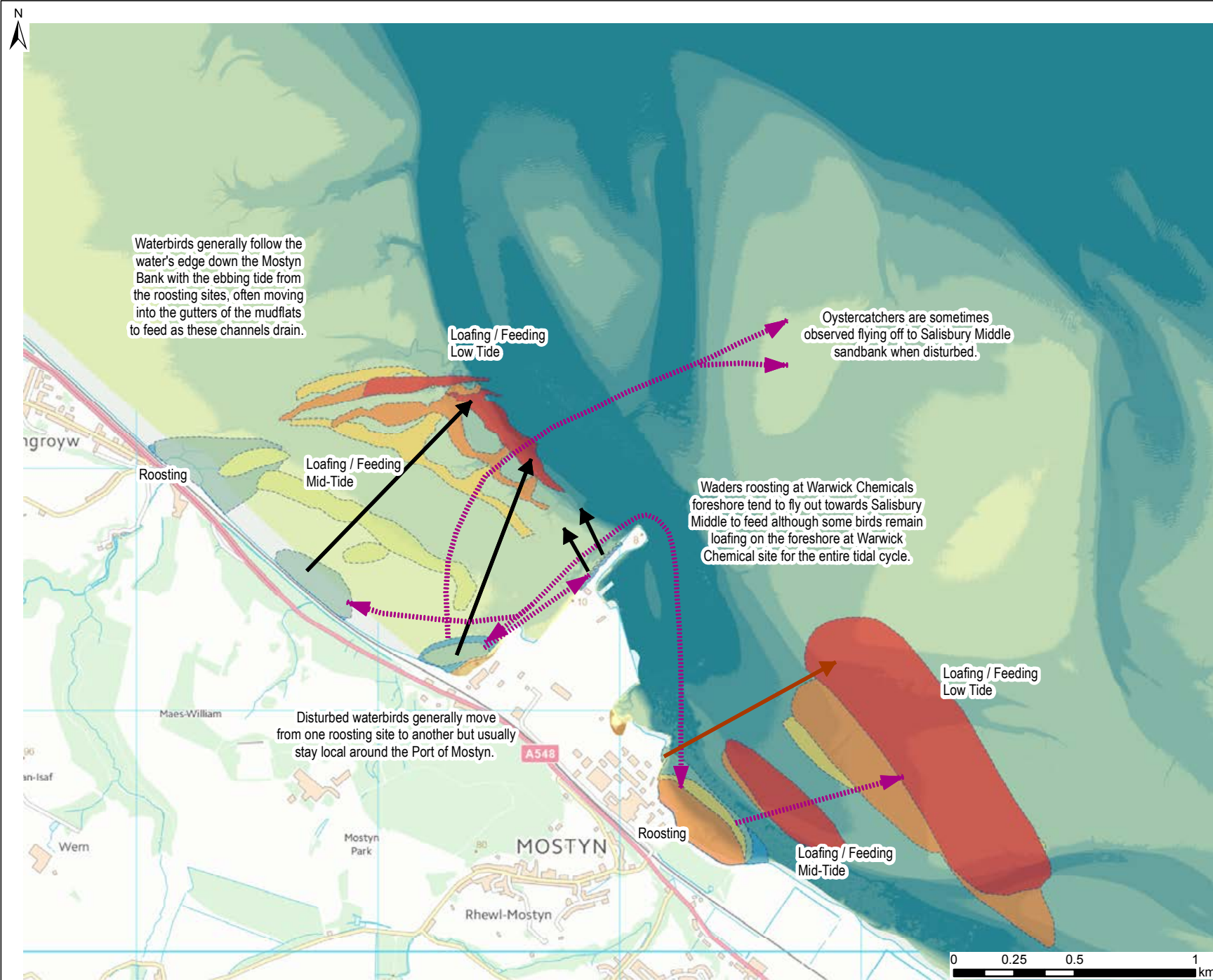
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**Layout of the RWE Pontoon
Indicating Berth Locations**

Figure 4

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



- Directions of Movement/Flight
- Waterbirds Walking (Following Tide)
 - Flight
 - Disturbance Flight
- Water Level
- HW
 - HW+1
 - HW+2
 - HW+3
 - HW+4
 - HW+5

Date	By	Size	Version
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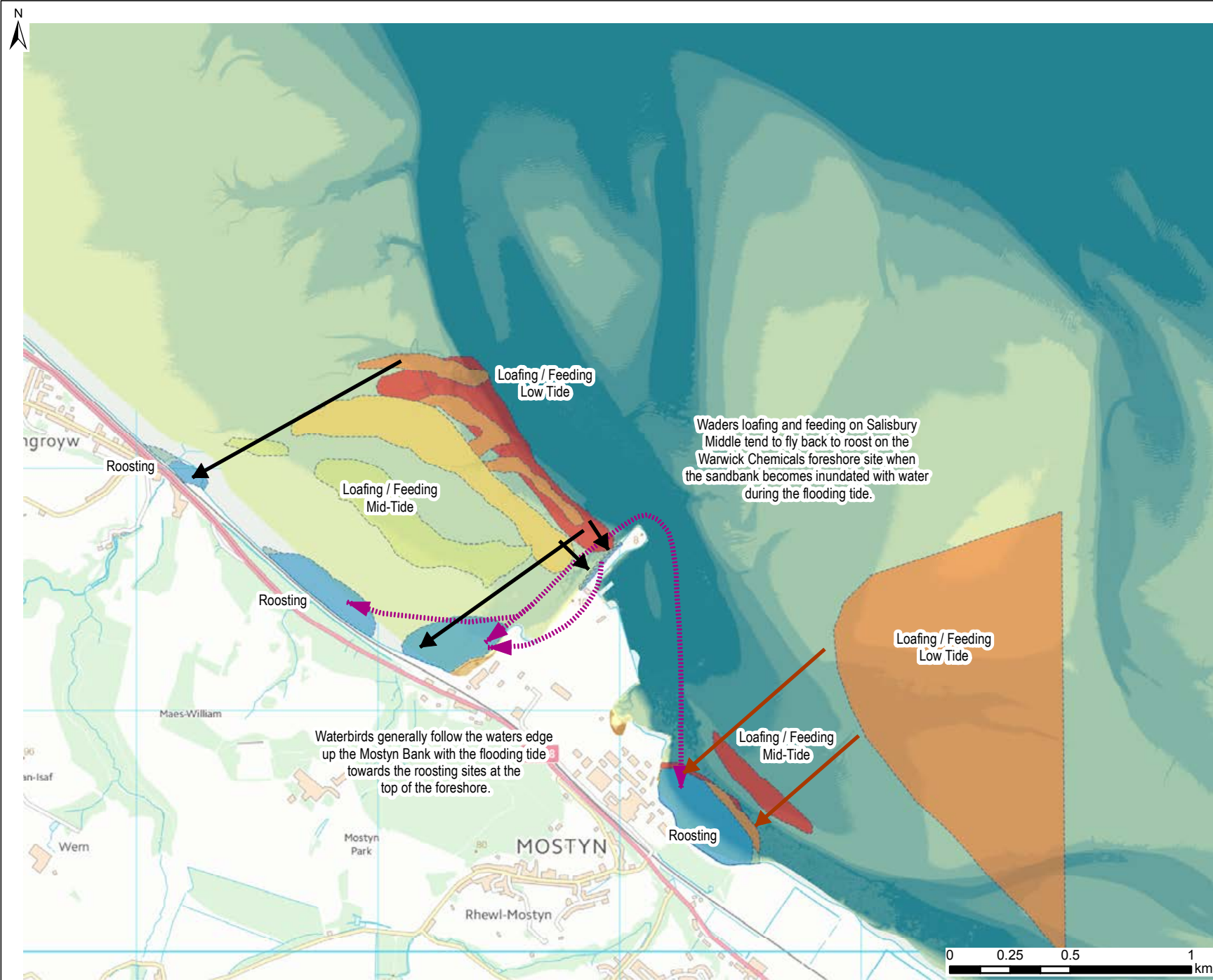


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Conceptual Overview of Bird Movements on a Falling (Ebb) Tide around the Port of Mostyn

Figure 5



- Directions of Movement/Flight
- Waterbirds Walking (Following Tide)
 - Flight
 - Disturbance Flight
- Water Level
- LW
 - LW+1
 - LW+2
 - LW+3
 - LW+4
 - LW+5

Waders loafing and feeding on Salisbury Middle tend to fly back to roost on the Warwick Chemicals foreshore site when the sandbank becomes inundated with water during the flooding tide.

Waterbirds generally follow the waters edge up the Mostyn Bank with the flooding tide towards the roosting sites at the top of the foreshore.

Date	By	Size	Version
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Scale		1:22,000	
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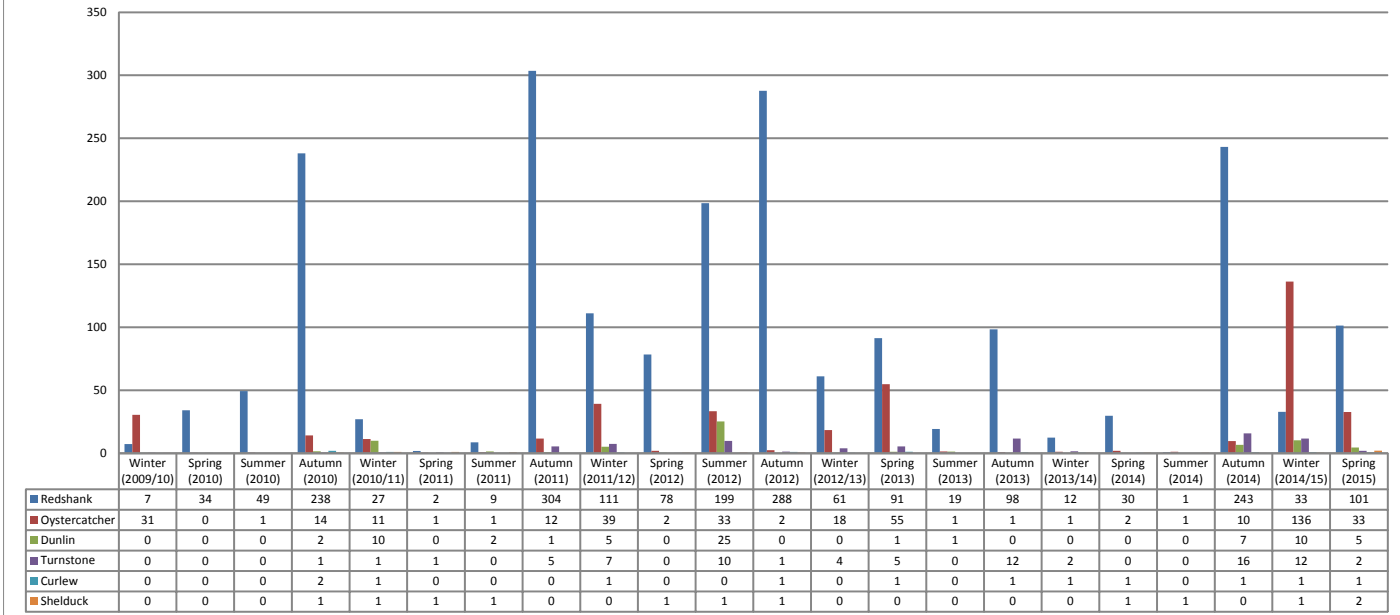
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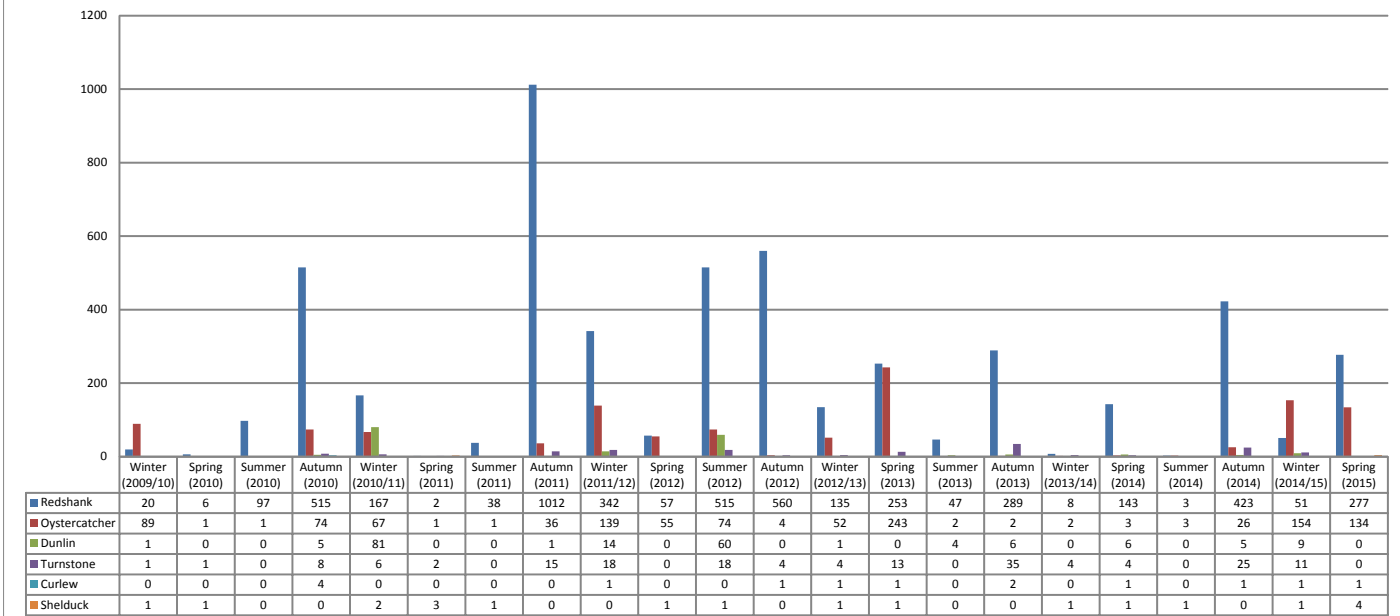
Conceptual Overview of Bird Movements on a Rising (Flood) Tide around the Port of Mostyn

Figure 6

Average Abundance of Key Species at Low Water (LW 1-4 and HW 3-7)



Average Abundance of Key Species at High Water (HW 1-2 and LW 6-7)



Date	By	Size	Version
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Scale		NA	
QA		DLW	
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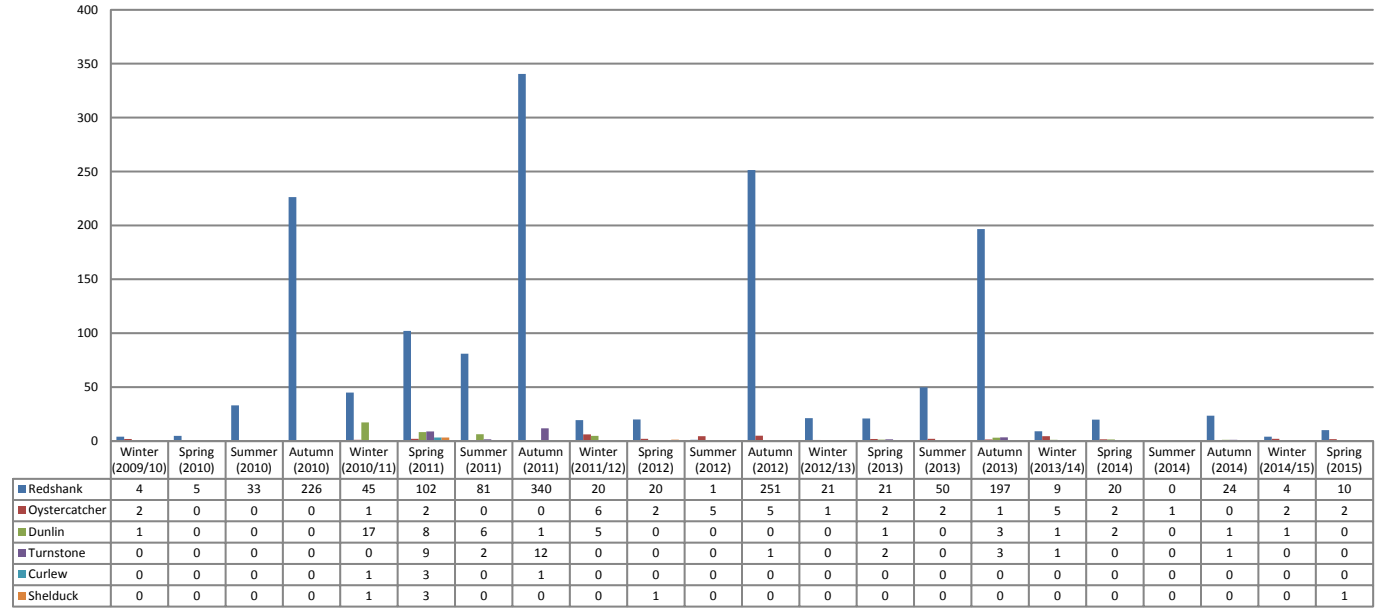
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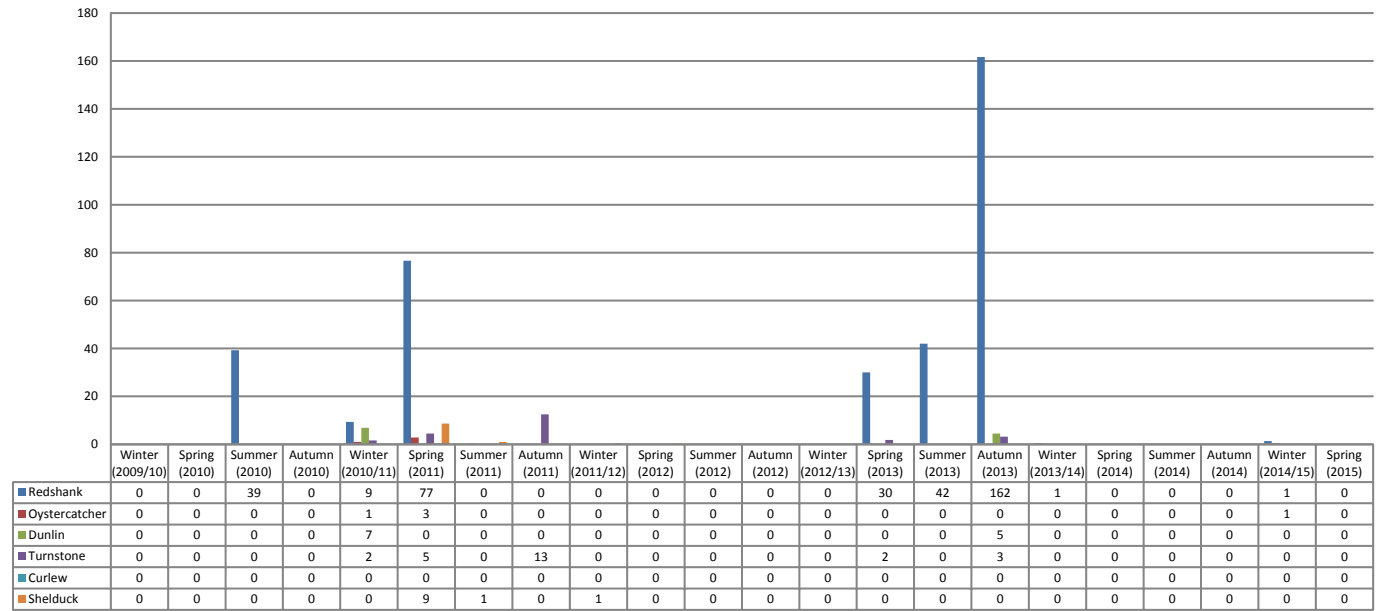
Average Low and High Water Counts in Sector G from 2009 to 2015

Figure 7a

Average Abundance of Key Species at Low Water (LW 1-4 and HW 3-7)



Average Abundance of Key Species at High Water (HW 1-2 and LW 6-7)



Date	By	Size	Version
May 15	TAP	A4	1
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Projection		NA	
Scale		NA	
QA		DLW	
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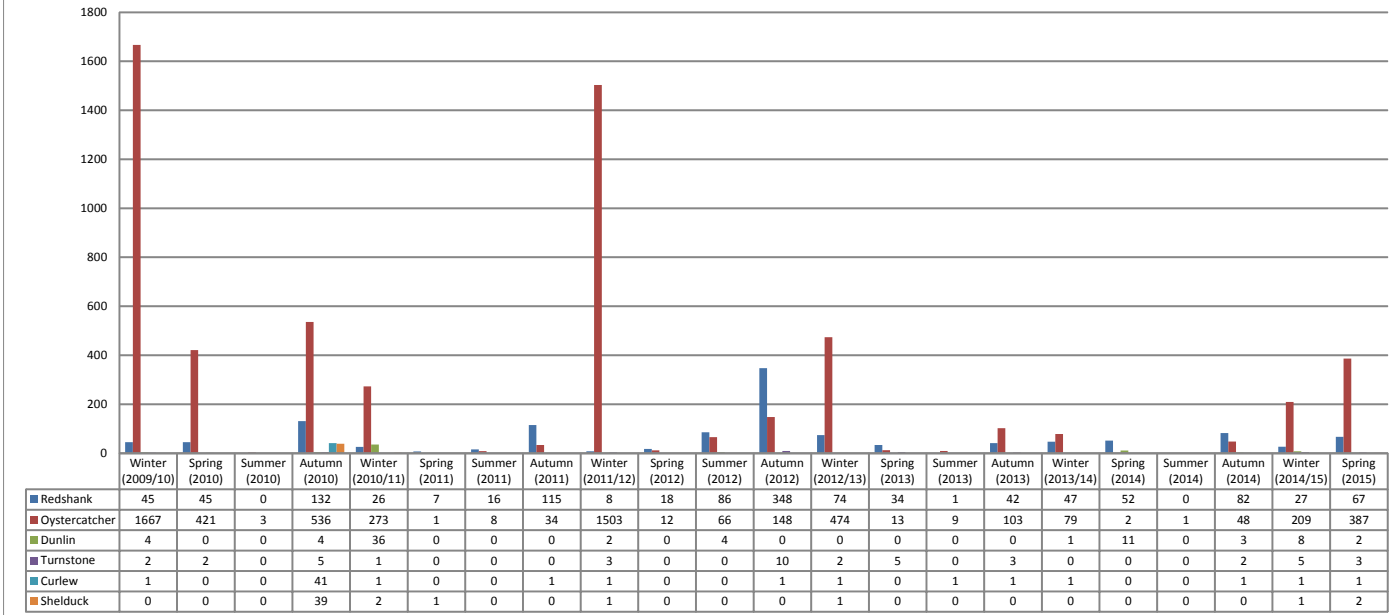
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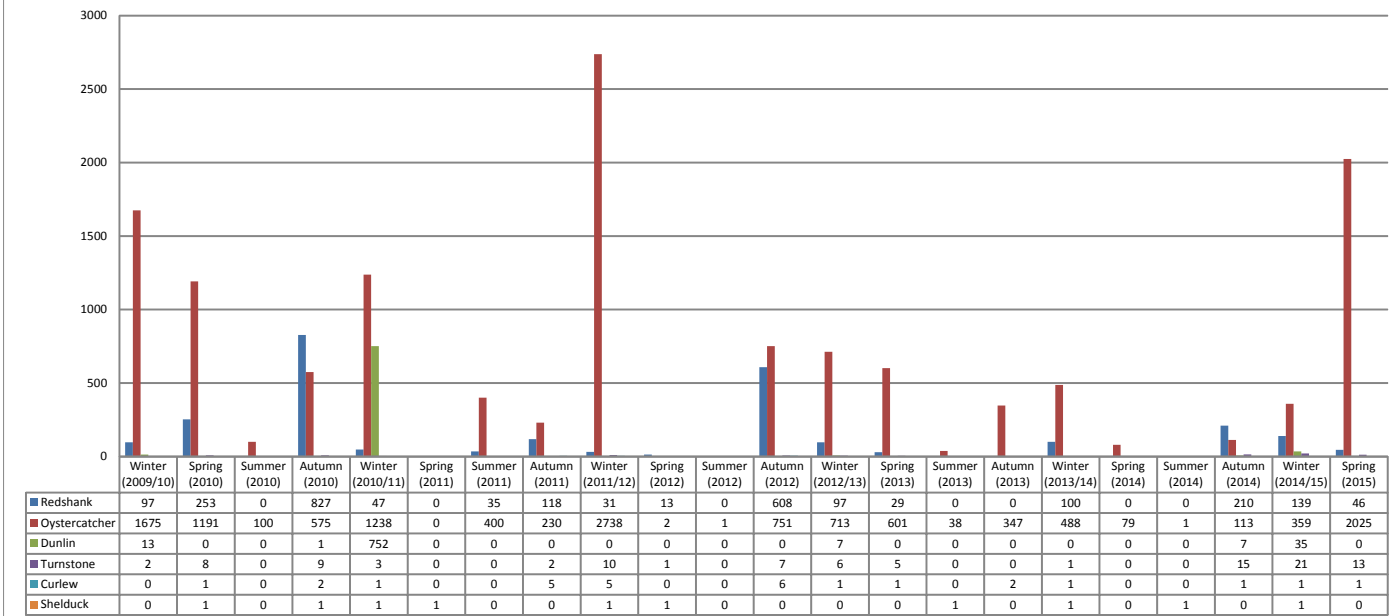
Average Low and High Water Counts in Sector C from 2009 to 2015

Figure 7b

Average Abundance of Key Species at Low Water (LW 1-4 and HW 3-7)



Average Abundance of Key Species at High Water (HW 1-2 and LW 6-7)



Date	By	Size	Version
May 15	TAP	A4	1
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Scale		NA	
QA		DLW	
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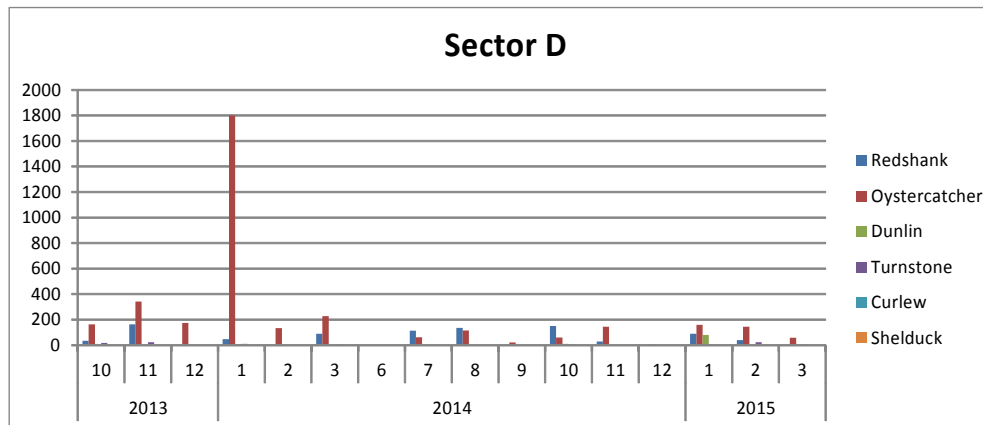
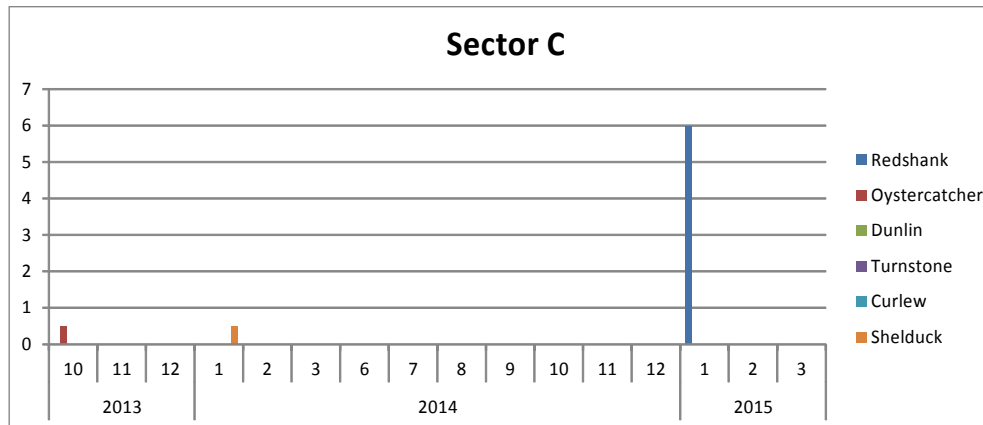
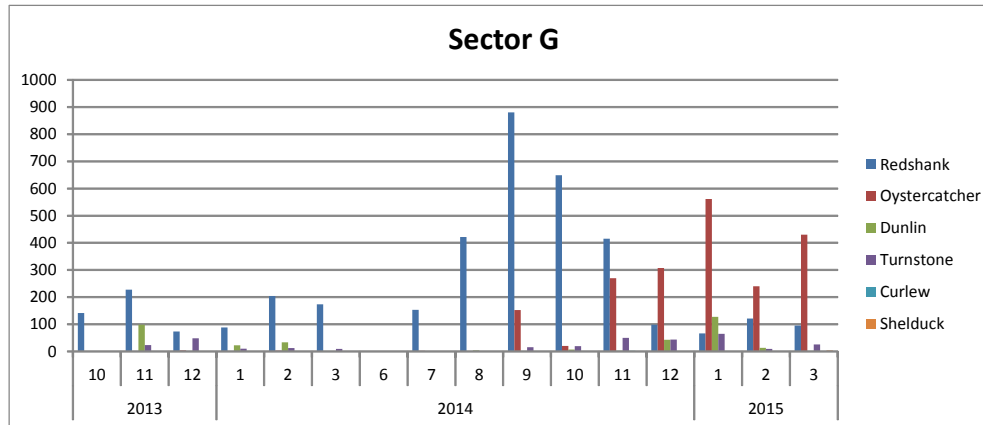


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Average Low and High Water Counts in Sector D from 2009 to 2015

Figure 7c



Date	By	Size	Version
Jul 15	TAP	A4	1
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Scale		NA	
QA		DLW	
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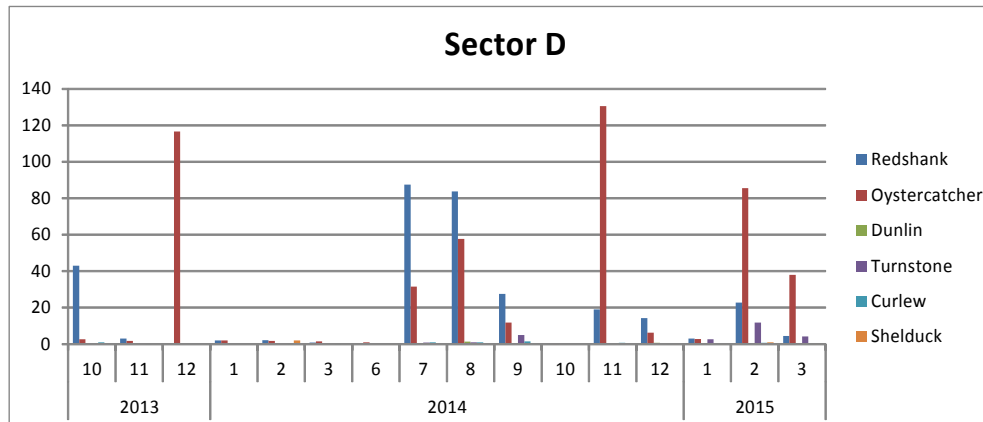
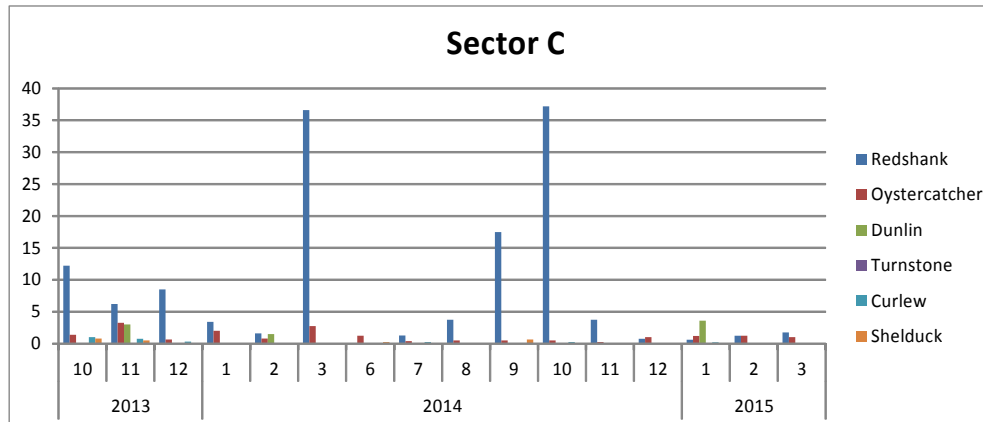
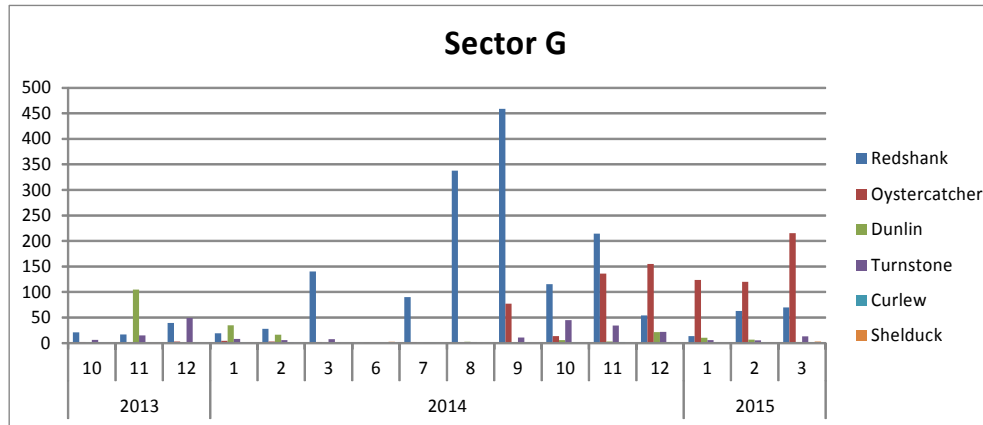


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Average High Water Abundance of the Main Species Observed in Count Sectors G, C and D during the Pontoon Monitoring (Oct 13 to Mar 14 & Jun 14 to Mar 15)

Figure 8a



Date	By	Size	Version
Jul 15	TAP	A4	1
Coordinate System		NA	
Projection		NA	
Scale		NA	
QA		DLW	
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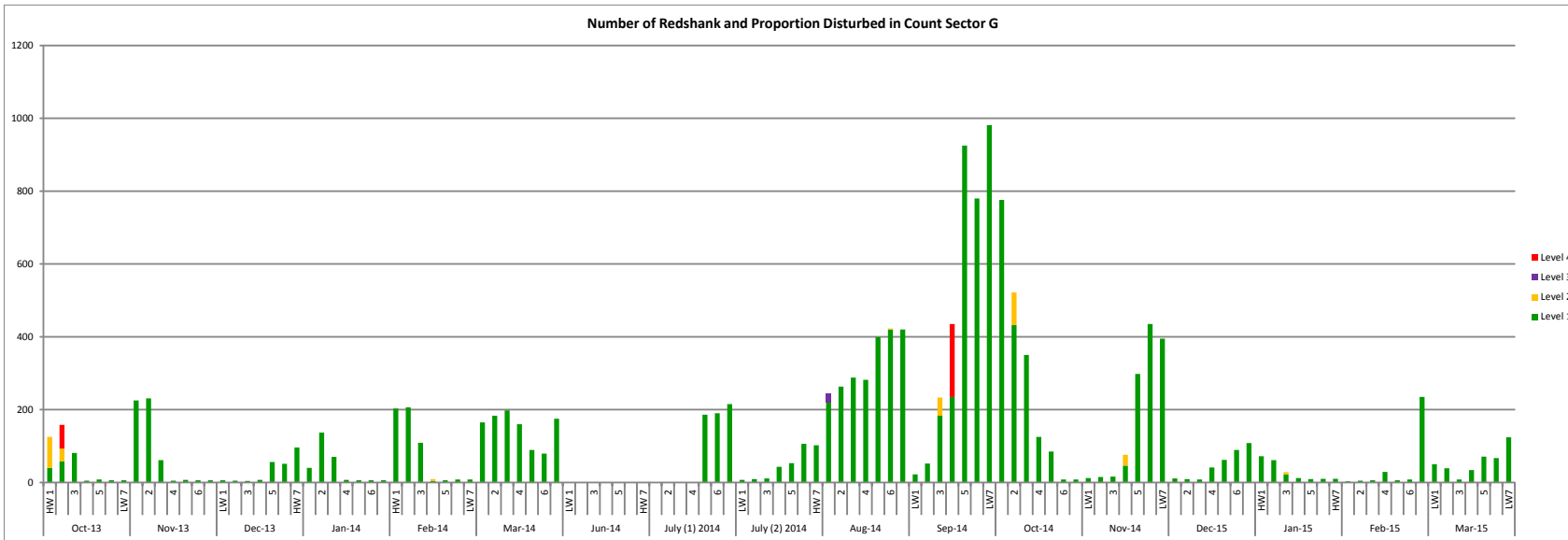
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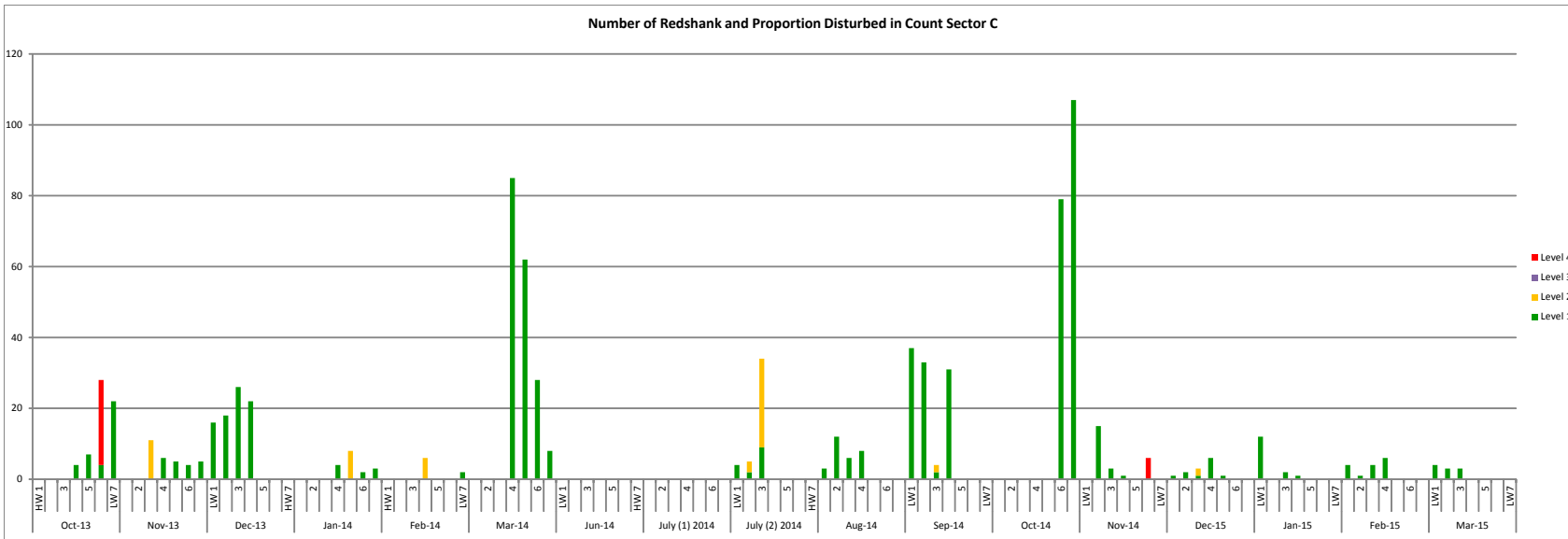
Average Low Water Abundance of the Main Species Observed in Count Sectors G, C and D during the Pontoon Monitoring (Oct 13 to Mar 14 & Jun 14 to Mar 15)

Figure 8b

Number of Redshank and Proportion Disturbed in Count Sector G



Number of Redshank and Proportion Disturbed in Count Sector C



Date	By	Size	Version
Jul 15	TAP	A4	1
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Projection		NA	
Scale		NA	
QA		DLW	
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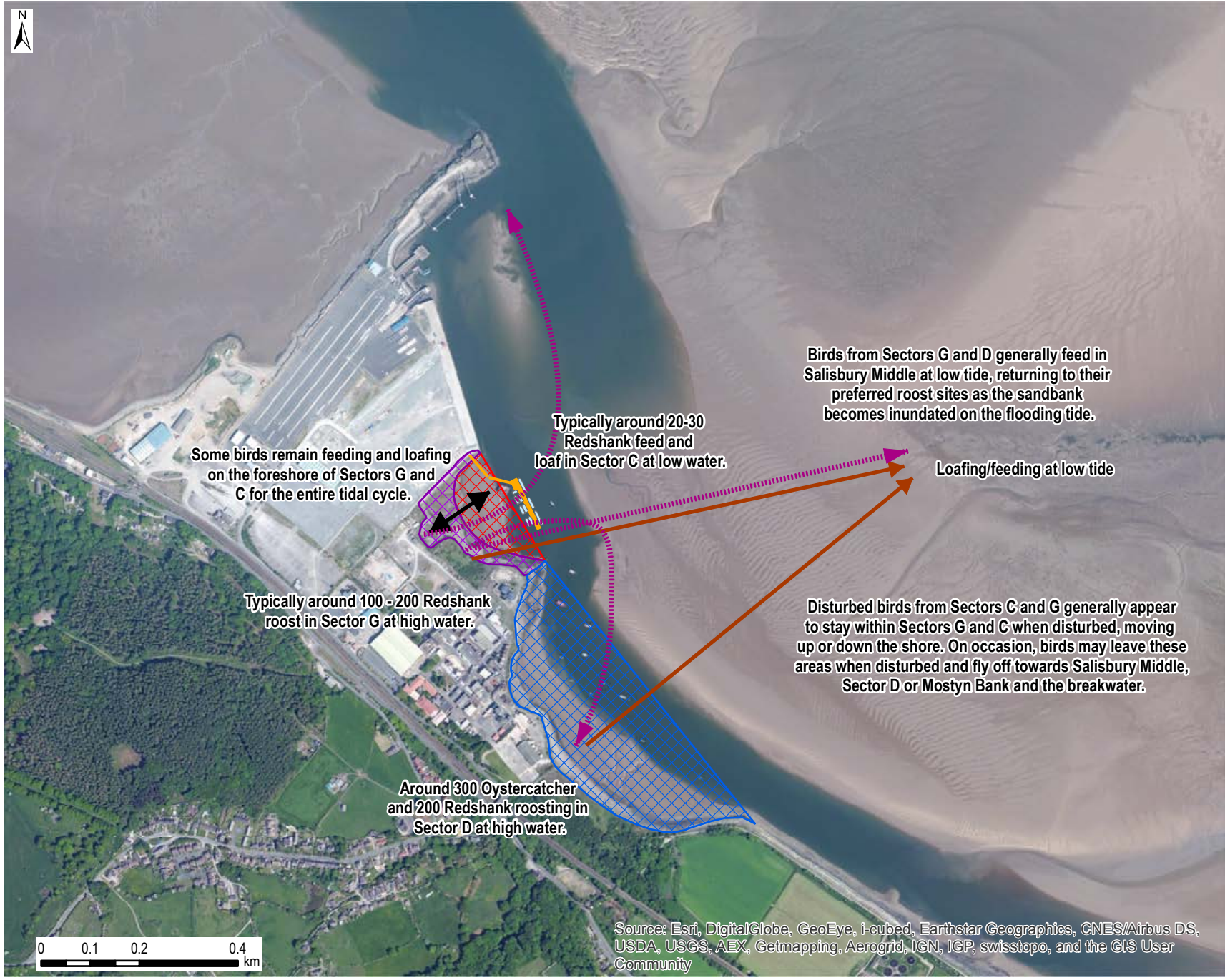


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Number of Redshank and the Proportion Disturbed in Count Sectors G and C during the Pontoon Monitoring (Oct 13 to Mar 14 & Jun 14 to Mar 15)

Figure 9



- RWE Pontoon
- Berths
- Count Sector C
- Count Sector D
- Count Sector G
- Bird Disturbance Movements
- Bird Walking Movements
- Bird Flight Movements

Date	By	Size	Version
May 15	TAP	A4	1
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Projection		Transverse Mercator	
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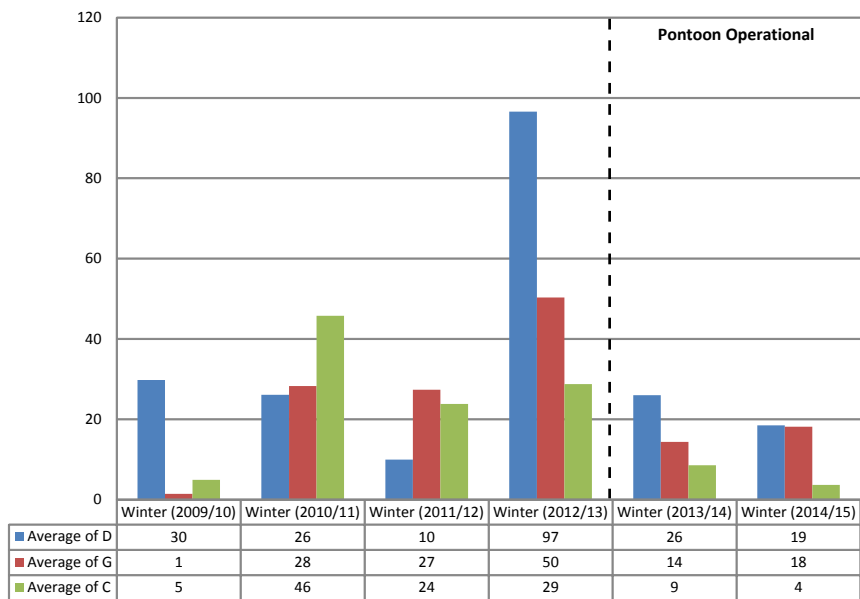


Conceptual Overview of Bird Movements around the Mostyn Dock and Warwick Chemicals Foreshore

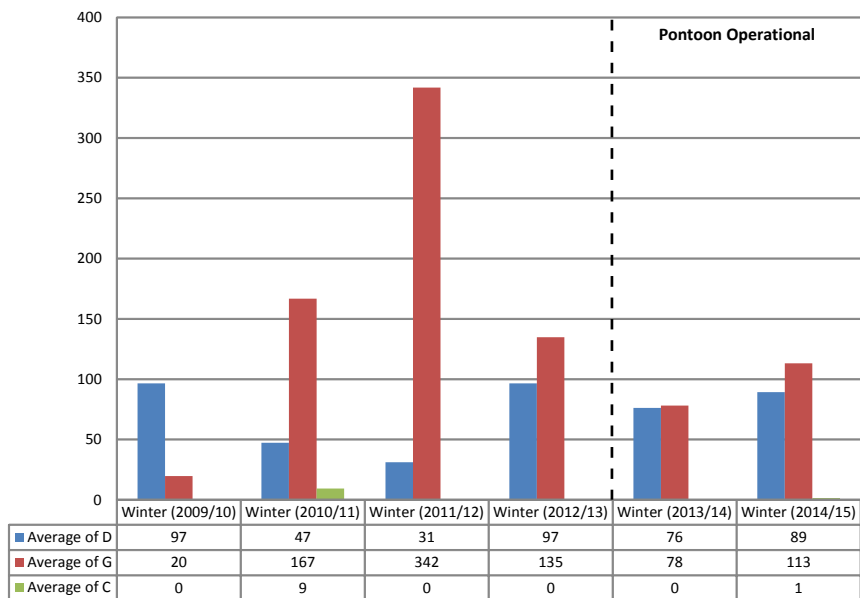
Figure 10

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Winter Average Low Water (LW 1-4 and HW 3-7)



Winter Average High Water (HW 1-2 and LW 6-7)



Date	By	Size	Version
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QA		DLW	
4187_Fig11a_Redshank_Winter.mxd			
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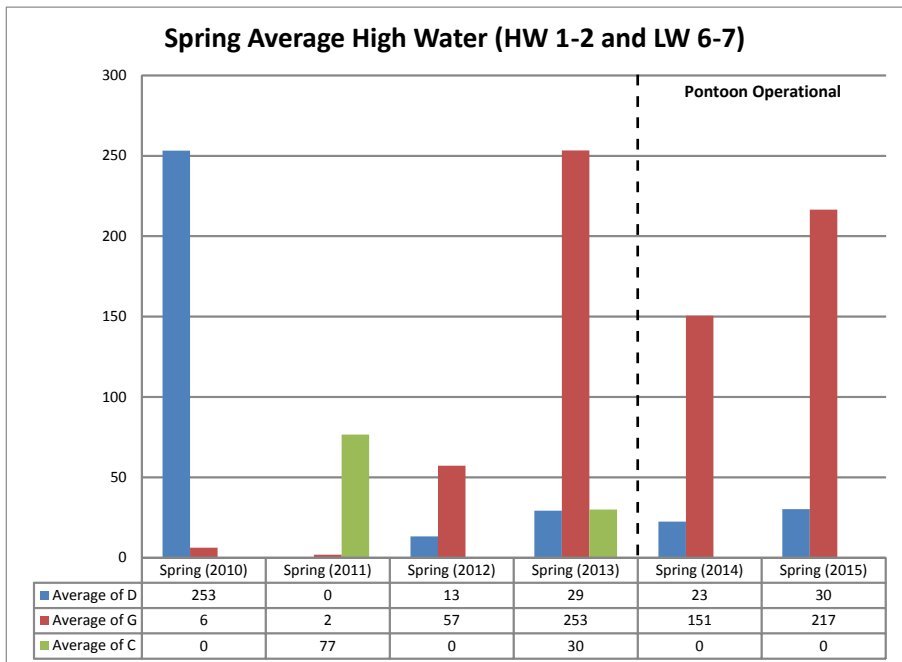
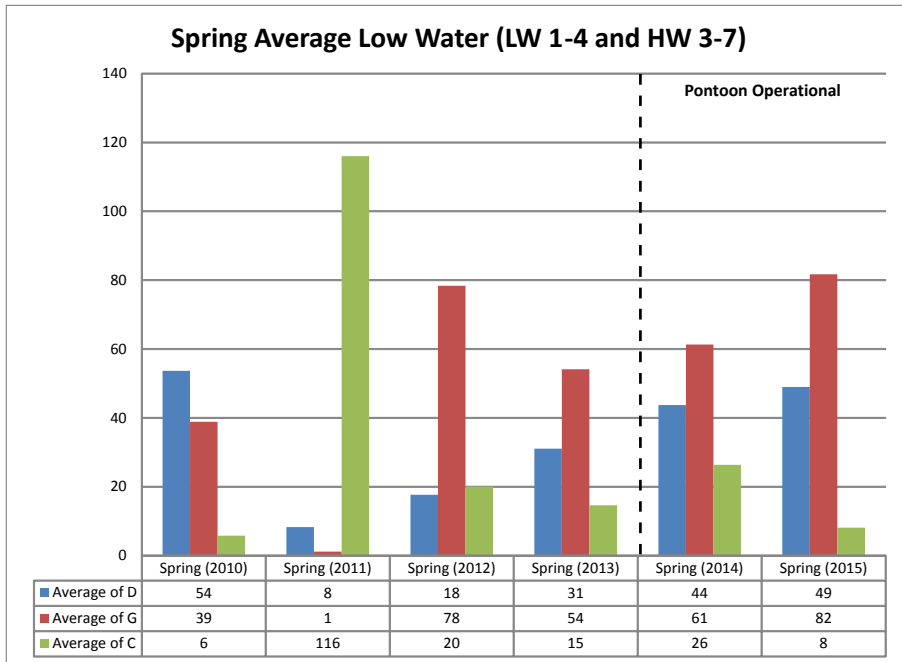


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Average Redshank at High Water and Low Water in Count Sectors G, C and D during Winter Periods (2009/10 - 2014/15)

Figure 11a



Date	By	Size	Version
May 15	TAP	A4	1
Coordinate System		NA	
Projection		NA	
Scale		NA	
QA		DLW	
4187_Fig11b_Redshank_Spring.mxd			
Produced by ABPmer			

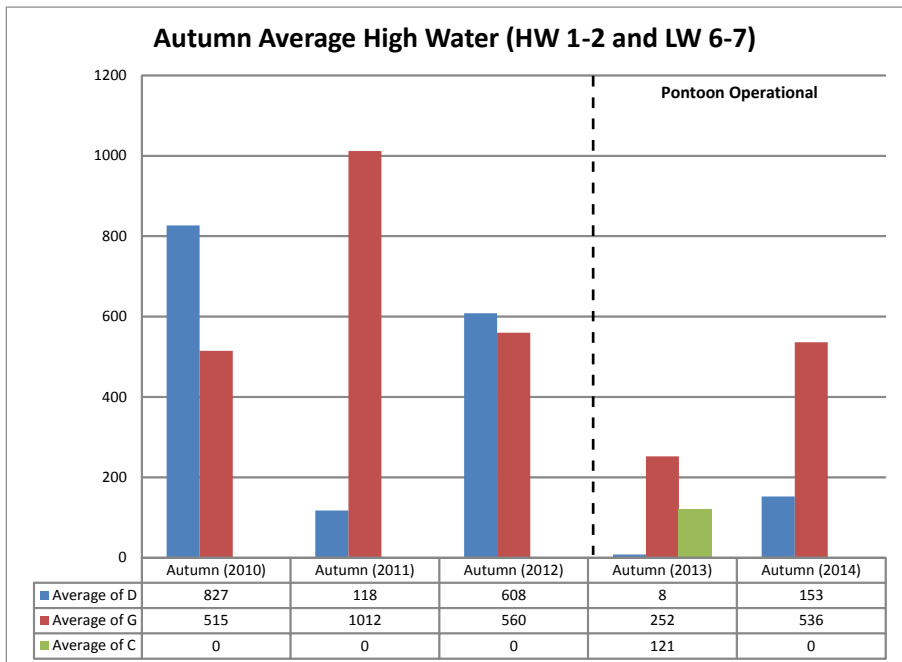
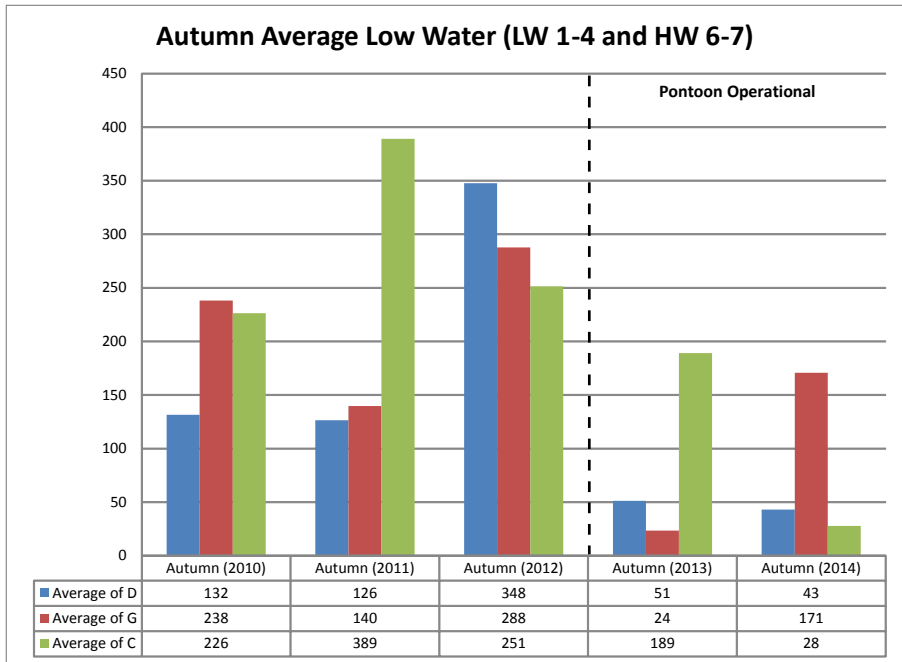


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Average Redshank at High Water and Low Water in Count Sectors G, C and D during Spring Passage Periods (2010 - 2015)

Figure 11b



Date	By	Size	Version
May 15	TAP	A4	1
Coordinate System		NA	
Projection		NA	
Scale		NA	
QA		DLW	
4187_Fig11c_Redshank_Autumn.mxd			
Produced by ABPmer			



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Average Redshank at High Water and Low Water in Count Sectors G, C and D during Autumn Passage Periods (2010 - 2014)

Figure 11c

Appendix A

Peak High and Low Water Counts in
Sectors G, C and D from 2009 to 2015



A. Peak High and Low Water Counts in Sectors G, C and D from 2009 to 2015

Table A1. Peak Low Water Counts in Sector G, C, D (2009-2015)

Species	Sector	5-Year Peak Mean (6-Year Peak Mean for Winter and Spring) (2009/10 to 2015)				Winter 6-Year Peak Mean (2009/10 to 14/15) As % of National Thresholds and 2008/9 WeBS Estuary-Wide Low Tide Count	
		Winter	Summer	Passage		% National Threshold	% Estuary- Wide WeBS Count
				Spring	Autumn		
Redshank	G	150	80	303	638	13%	2%
	C	118	99	196	750	10%	1%
	D	333	82	243	814	28%	3%
Oystercatcher	G	134	13	127	38	4%	<1%
	C	25	11	5	12	1%	<1%
	D	3992	76	481	996	125%	12%
Dunlin	G	45	11	7	18	1%	<1%
	C	29	5	27	11	1%	<1%
	D	132	4	15	10	4%	1%
Turnstone	G	19	5	3	13	4%	1%
	C	3	2	8	11	1%	0%
	D	24		8	27	5%	1%
Curlew	G	2	<1	2	3	<1%	<1%
	C	2	<1	7	2	<1%	<1%
	D	7	1	2	84	1%	0%
Shelduck	G	2	1	3	1	0%	0%
	C	2	1	6	<1	0%	0%
	D	5		3	50	1%	0%
Black-tailed Godwit	G	<1				<1%	<1%
	C	<1			3	<1%	<1%
	D				31	0%	0%
Bar-tailed Godwit	G	1			3	0%	0%
	C						
	D				2		
Knot	G	1		5		0%	0%
	C	1					
	D	109		11	1	3%	1%

NB While Turnstone has been included in the table (due to the inclusion in the original Ramsar citation), the Turnstone is no longer listed as a qualifying species of the Dee Estuary Ramsar following a review in 2009 and therefore has not been included in the total.

Table A2. Peak High Water Counts in Sector G, C and D (2009-2015)

Species	Sector	5-Year Peak Mean (6-Year Peak Mean for winter and spring) (2009/10 to 2015)				Winter 6-Year Peak Mean (2009/10 to 14/15) As % of National Thresholds and WeBS 5-Year Estuary-Wide Peak Mean (2009/10 to 2013/14)	
		Winter	Summer	Passage		% National Threshold	% Estuary- Wide WeBS Count
				Spring	Autumn		
Redshank	G	323	325	257	922	27%	3%
	C	14	48	63	100	1%	<1%
	D	370	14	224	788	31%	4%
Oystercatcher	G	444	35	213	63	14%	2%
	C	1	<1	2		<1%	<1%
	D	3500	226	1506	770	109%	14%
Dunlin	G	70	30	3	13	2%	1%
	C	9		<1	3	<1%	<1%
	D	1035		1	9	30%	8%
Turnstone	G	26	8	8	38	5%	10%
	C	2		4	6	<1%	1%
	D	28		11	21	6%	11%
Curlew	G	2		1	3	<1%	<1%
	C			<1	<1		
	D	8		1	6	1%	0%
Shelduck	G	2	2	4	1	<1%	<1%
	C	1		5		<1%	<1%
	D	2	1	1		<1%	<1%
Black-tailed Godwit	G						
	C						
	D	<1	1		40	<1%	<1%
Bar-tailed Godwit	G	1			1	<1%	<1%
	C						
	D	<1				<1%	<1%
Knot	G	56		3		2%	0%
	C					<1%	<1%
	D	34		25	1	1%	0%

NB While Turnstone has been included in the table (due to the inclusion in the original Ramsar citation), the Turnstone is no longer listed as a qualifying species of the Dee Estuary Ramsar following a review in 2009 and therefore has not been included in the total.



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