Wightlink Ltd.

Lymington to Yarmouth Ferries: Mitigation and Monitoring (2020)

Five-year update and 10th Report for the Environment Management Panel

December 2020

Innovative Thinking - Sustainable Solutions

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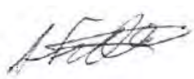
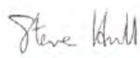
Colin Scott	Adam Fulford	Steve Hull
		

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ABPmer
Quayside Suite, Medina Chambers, Town Quay, Southampton, Hampshire SO14 2AQ
T: +44 (0) 2380 711844 W: http://www.abpmer.co.uk/

Contents

Appendix

Images

Figures

Tables

1 Introduction

1.1 Report background

This report reviews the status of Wightlink Ltd.'s saltmarsh enhancement and mitigation project at Lymington. This enhancement project was completed nearly eight years ago. It involved the use of maintenance dredge sediment from the Lymington marinas and harbour approaches to 'recharge' an eroding area of saltmarsh (Boiler Marsh) to the east of the Lymington River entrance (see Figure 1).

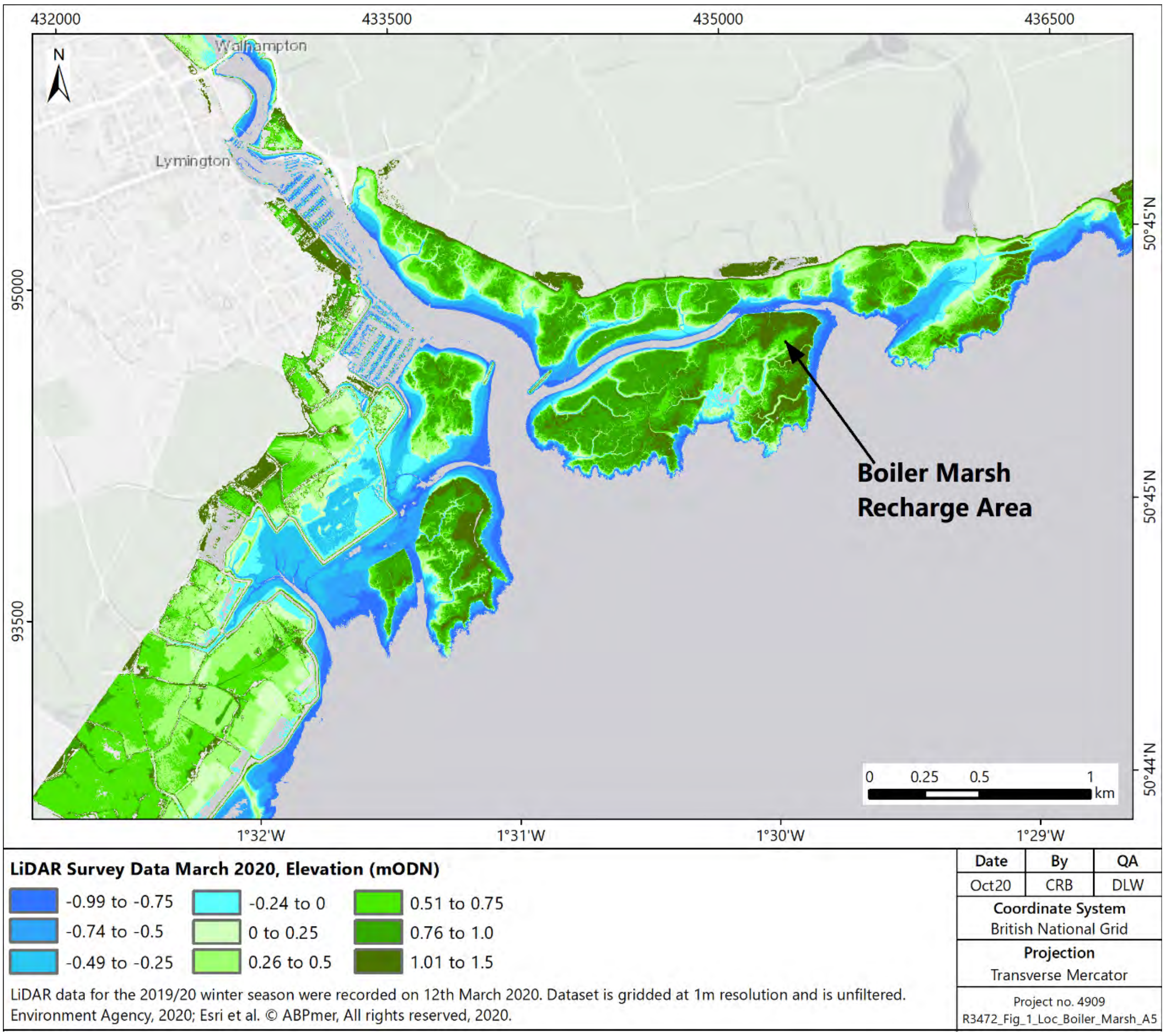


Figure 1. Location of the saltmarsh recharge area on Boiler Marsh.

This marsh recharge was carried over two winters in 2012 and 2013. The site was initially prepared by installing a series of polder and hay bale fences across a decaying section of Boiler Marsh. These were designed to help retain sediment in place. The sediment was then pumped into this area over the two winter campaigns.

Figure 2 provides an outline description of this marsh enhancement project. It shows the location of the fences and the positions where the sediment was discharged in each of the two campaigns.

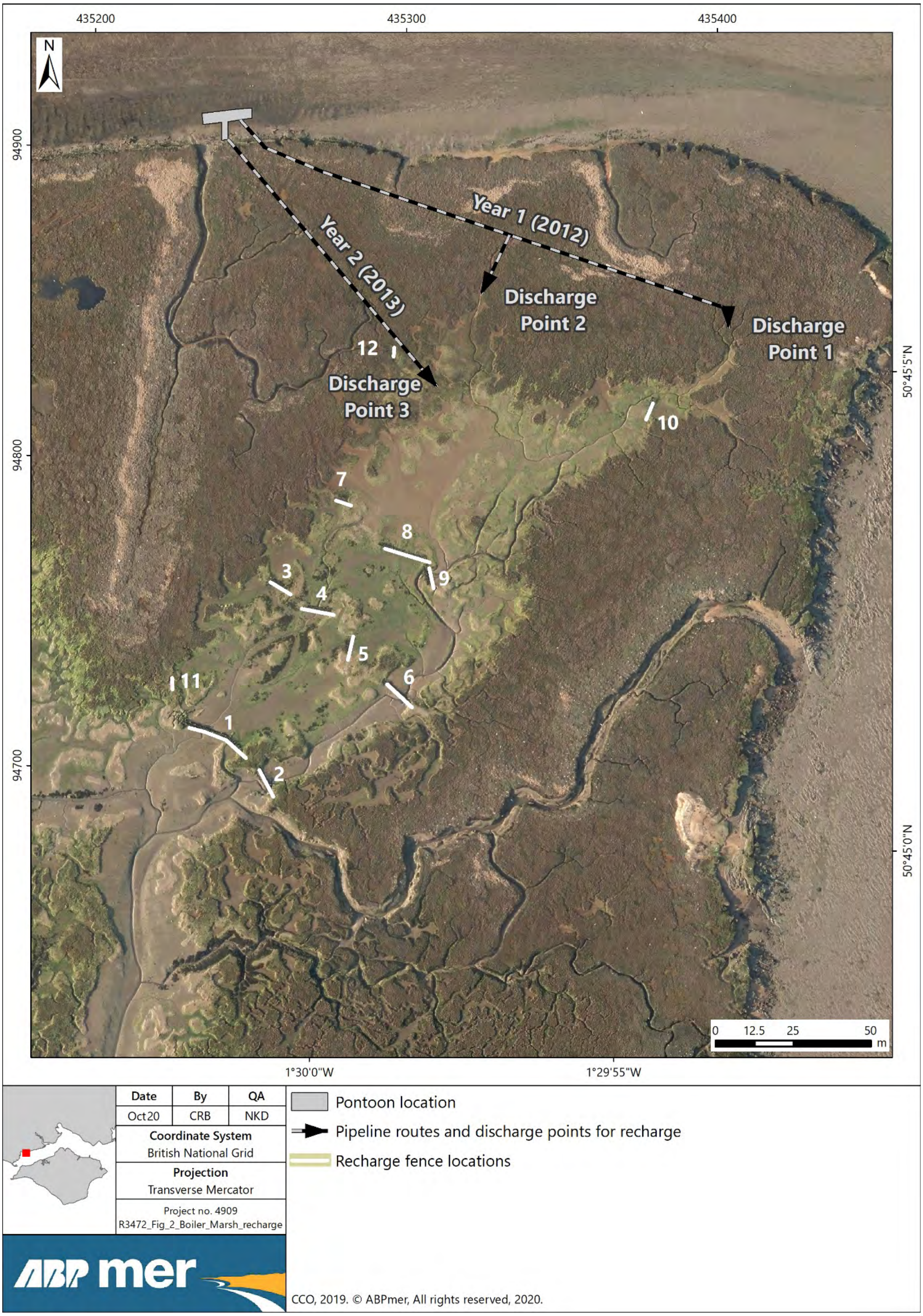


Figure 2. Location of pontoon, fences and pipelines for the Boiler Marsh recharge work

1.2 Adaptive mitigation

This work was carried out as mitigation for potential ecological effects that might arise from the operation of Wightlink's cross-Solent ferry service (operating between Lymington and Yarmouth). It was implemented to ensure there would be no adverse effect on the integrity of the Solent European Marine Site (EMS) with reference to the relevant EMS Conservation Objectives.

The sediment placement was designed to slow a process of erosion that was occurring within Boiler Marsh and, particularly, to delay the progression of a creek that was threatening to fracture this marsh section. This fracturing would have further exacerbated and accelerated erosion of the marshes and the surrounding intertidal areas.

In reducing the rate of intertidal loss in this manner, this mitigation was designed to offset any accelerated mudflat erosion that may occur from ferries operating within the estuary. The mitigation measures were also designed to be adaptable. If needed, the scale and frequency of the recharge could be altered (i.e. increased) as needed in response to the results of the separate ferry impact monitoring (ABPmer, 2010).

In addition, if needed, ferry speeds could also be changed for this adaptive mitigation programme. There was also a further option that the UK Government could impose a Special Nature Conservation Order (SNCO) (as a provision in the UK Habitat Regulations) to stop damaging activities. This flexibility and adaptability in the mitigation process provided full reassurances that the integrity of the EMS would not be affected.

1.3 EMP oversight

The adaptive mitigation process is being overseen by an Environment Management Panel (EMP). The EMP was set up as a condition of a 'Section 106' (S106) agreement which accompanied permissions for Wightlink's Lymington to Yarmouth ferry service. The tasks for the EMP include: evaluating the effects of the ferries; reviewing the success of the saltmarsh recharge works; and, if needed, advising on adaptations to the recharge works to ensure project objectives are achieved.

The panel's advice is informed by regular surveys and the monitoring reports provided by Wightlink Ltd.[1]. The results are then used by the EMP to determine whether there are any environmental effects arising from the operation of the Lymington/Yarmouth ferry service (potentially on the low-shore mudflat habitat of the Lymington Channel) and to assess the performance of intertidal habitat restoration measures that were carried out to mitigate for any such effects, should they occur.

In total nine monitoring reports were produced for the EMP between February 2012 and November 2015. There were also 18 other survey reports produced between July 2009 and December 2014 which reviewed the possible ferry effects within the Lymington Channel. These, in turn, were preceded by a range of other impact assessment and mitigation proposal reports, which accompanied the planning and marine licensing applications for this project (ERM and ABPmer, 2010).

For the first few years, during and after the saltmarsh recharge work, the EMP met on an annual basis to review the survey findings. The last EMP meeting was held five years ago on 19 November 2015 at which time the results and report from the 2015 surveys were reviewed (ABPmer 2015a). At that meeting, the panel advised that further time was required to be assured that the project was effective

[1] These reports were prepared and presented to the EMP by ABPmer on behalf of Wightlink Ltd and a list of these is shown in the references section at the end of this report.

(i.e. that there was no adverse effect on the integrity of the Solent EMS). Therefore, a five-year gap until the next meeting was proposed.

After that meeting a final ‘case summary’ report was prepared for the EMP (ABPmer 2015b). This summary reviewed and audited the work completed to-date in advance of the 5-year gap in the programme. It outlined the project’s consenting history as well as details about where key documents, including the S106 agreement., could be found[2]. This was done so that the context and status of the project could be readily understood by all EMP participants (including any new or replacement representatives) after the five-year gap.

This report now provides an updated review for the EMP following this five-year gap. It provides information needed for this panel to consider the performance and effectiveness of the mitigation measures. Section 2 outlines work undertaken for this review, which includes a review of estuary bathymetric data and a survey of the recharge site. The results of the survey and analysis work are then presented in Section 3 and in Appendix A, which includes fixed point photographs from all phases of the recharge survey programme. The conclusions are then set out in Section 4.

1.4 Other recent initiatives

In addition to the specific survey and analytical work undertaken for this review, it is worth noting some details about a few other projects and monitoring initiatives which have been pursued in the Lymington Estuary over the last few years. These are noted briefly here to provide a context for this review.

Firstly, the Lymington Harbour Commissioners (LHC) carried out a sequence of maintenance dredge campaigns along the margins of the main approach channel. There were five campaigns from 2009 to 2018. These were each undertaken over the winter months (between October and February). Details of the locations and timing of this dredging work were provided by LHC (as illustrated in Image 1).

Image 1. Location and timing of LHC lower river maintenance dredging campaigns

[2] These key documents are available on a password-protected online ftp account at https://ftp.abpmer.net/login.html.

In recent years, the LHC has also started a new campaign of sediment recharge work at the mouth of Lymington Estuary. For this work, dredged material (silt) is firstly loaded into barges (using a back-hoe dredge) at the channel and mooring dredge areas in the Lymington Estuary. The barges then move to a newly licensed disposal ground, which lies within the small embayment on the central and southern part of Boiler Marsh. The sediment is then discharged at this site by opening the hopper doors in the bottom of the barge, before then returning to the dredging site(s) to collect more sediment.

The LHC started this 'bottom-placement' recharge as a series of three annual trials from 2014 to 2016. It is now being carried out more formally under a new Marine Management Organisation (MMO) Marine Licence. This licence allows LHC to place 10,000 tonnes of sediment (approximately 7,700 m^3) at this site each winter.

This is as an alternative to placing it at a licensed subtidal disposal ground at 'Hurst Fort' (Ref. WI080) where much of the dredged sediment is placed. This alternative or 'beneficial use' activity is scheduled to occur annually from 2017/18 until 2023/24. Table 1 summarises the campaigns undertaken between 2014 and 2018.

Table 1. Intertidal Bottom Placement Campaigns at Lymington from 2014 to 2018

Years	Quantity (Wet Tonnes)	Quantity (m^3)[3]	Notes	MMO Licence Reference
2014 (Nov/Dec)	2,287	1,759	Year 1 Trial	L/2014/00084/6
2015 (Nov/Dec)	6,883	5,295	Year 2 Trial	
2016 (Oct to Dec)	9,942	7,648	Year 3 Trial	
2017/18 (Nov to Jan)	9,286	7,143	Year 4 Main Licence	L/2014/00396/2
2018 (Nov/Dec)	6,446	4,958	Year 5 Main Licence	

The intention of this work is to help protect the marsh and slow its erosion in an area where the Boiler Marsh is at its narrowest and, potentially, weakest. Delaying erosion in this location could therefore prolong the life expectancy of the marsh and the duration of the wave sheltering function it provides to the harbour.

From surveys of these deposits it is apparent that much of the deposited material is relatively persistent (Black and Veatch, 2016 and 2017; ABPmer 2019). Depending on the composition of the deposited material, it can remain *in situ* for several months after the winter recharge campaigns are completed. Therefore, the deposits are evidently helping to maintain a temporary raised bed, which will be acting as a 'sacrificial bund' protecting the marsh at this location. To date, there has been no clear/detectable change to the marshes behind the deposit location. However, benefits to these areas from erosion reduction and/or improved bed accretion may become apparent (i.e. detectable by bathymetry and Light Detection and Ranging (LiDAR) survey techniques) over time.

The continued regular/annual placement of sediment at this site is therefore expected to further help maintain (and potentially build up) this feature. However, the size and persistence of this feature will always be influenced by factors such as sediment consolidation and the occurrence and nature of storm events (ABPmer 2019).

Over the last three years, the Solent Forum has been strategically reviewing opportunities for carrying out more, and larger-scale, saltmarsh restoration work using dredged sediment in the Solent. This work is being conducted in phases. Phase 1 reviewed the whole Solent (ABPmer 2018) and Phase 2 focused

3 The volumes quoted for the LHC bottom placements are in tonnes. Therefore a 1.3 conversion factor for 'soft silt mud' (HELCOM, 2015) is used here to provide an estimate in cubic meters.

on examining the rationale, approach and value of different recharge techniques used along the Lymington to Hurst Spit shoreline. This Phase 2 review included the detailed review of the rates of erosion of the marshes between Lymington and Hurst (ABPmer 2020). Full details about this 'Beneficial Use of Dredging in The Solent Project (BUDS)' project can be found on the Solent Forum website[4].

In addition, LHC has carried out further work to consider the options and timelines for pursuing the next phase of work of the breakwater construction at the mouth of the estuary (Black and Veatch, 2020). Phase 1 and 2 were completed in 2010 and 2014 and it is anticipated that the breakwaters will be constructed, in a total of six phases, over 35 years. The latest study was underpinned by a review of available data describing the rates of marsh erosion. This included consideration of the marsh erosion analysis that was carried out for the Solent Forum BUDS project.

Figure 3 and Figure 4 illustrate many of these issues and activities. They describe the net change in sea bed elevation across the mouth of the estuary based on available Environment Agency LiDAR data from 2008 to 2020. In each figure, red indicates a clear net lowering of the sea bed elevations while blue indicates a net increase in bed levels. Figure 3 shows the changes from 2008 to 2020 while Figure 4 shows the changes just over the last six years.

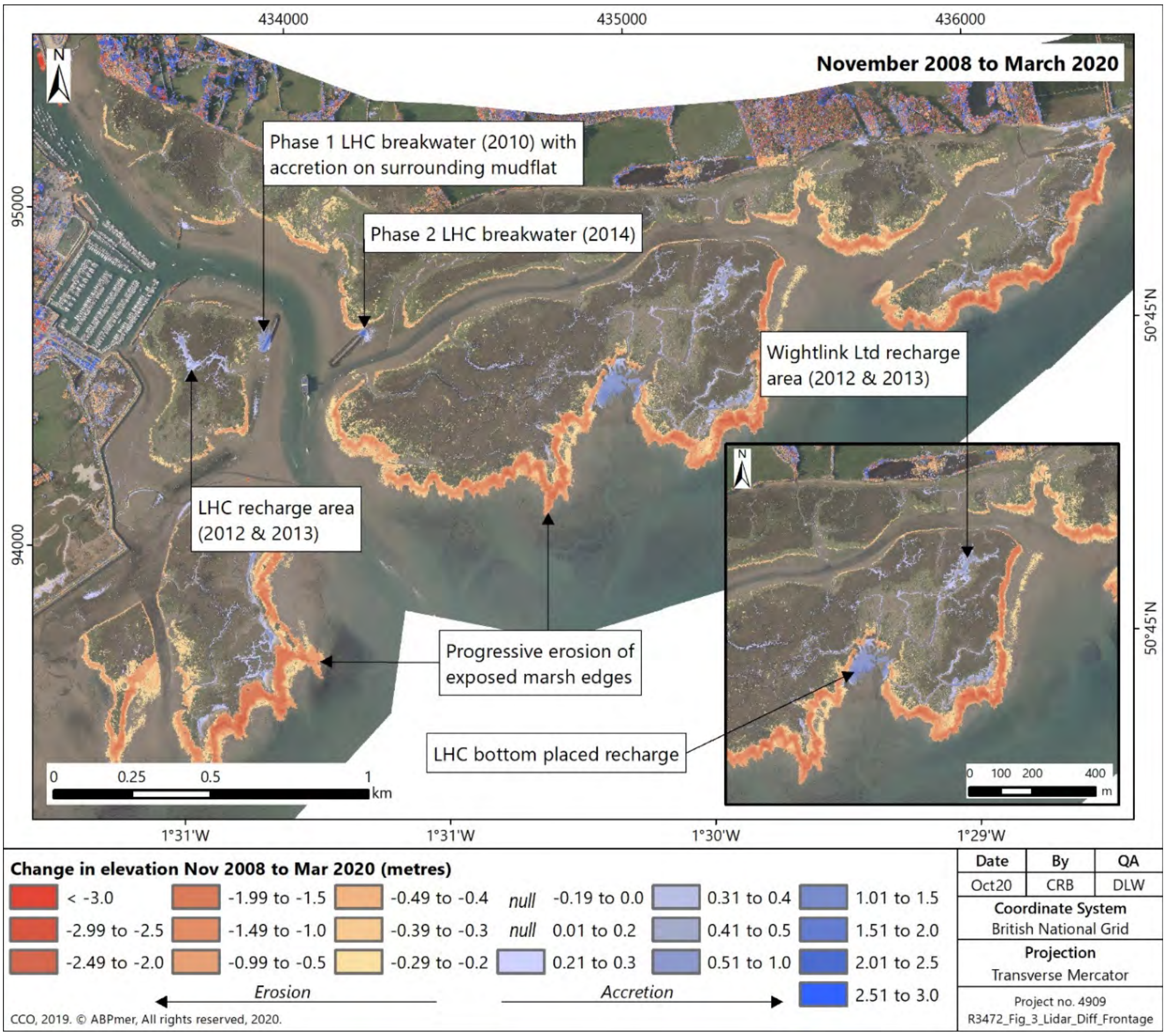


Figure 3. Habitat elevation change over Lymington frontage (LiDAR data 2008 to 2020)

4 http://www.solentforum.org/services/Current_Projects/buds/

As Figure 3 covers a 12-year period, it describes: the location of the LHC and Wightlink Ltd. recharge campaigns; the position of the LHC Phase 1 and Phase 2 rock armour breakwaters as well as the spatial patterns of ongoing marsh edge erosion are all illustrated. It also shows accretion taking place around the Phase 1 and Phase 2 breakwaters. Figure 4, which covers just the last 6 years only really shows the new LHC bottom placement work at Boiler Marsh as well as the ongoing marsh edge erosion.

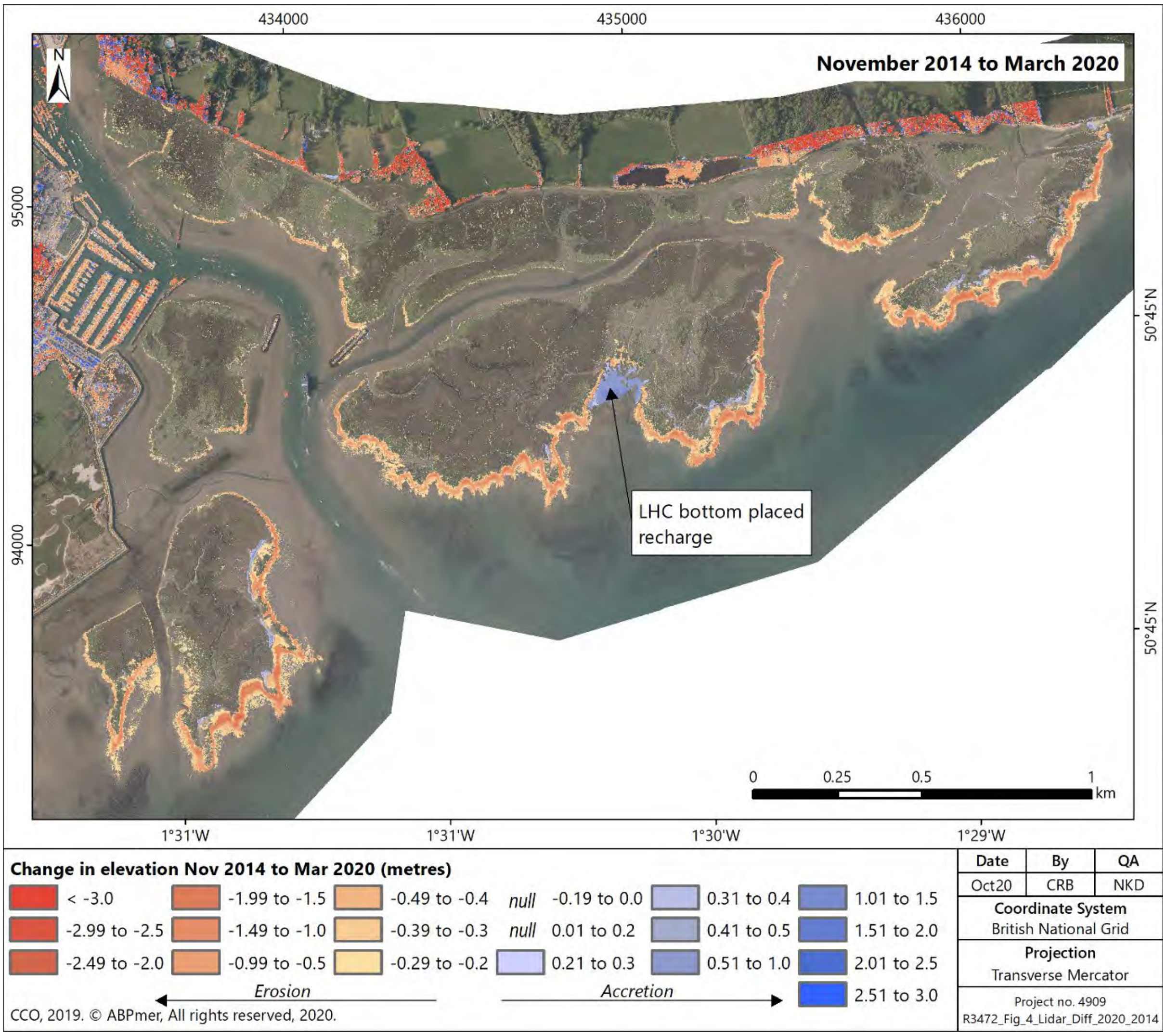


Figure 4. Habitat elevation change over Lymington frontage (LiDAR data 2014 to 2020)

2 Methods

2.1 Introduction

The methods employed for this review were, essentially, the same as those pursued in previous studies for the EMP. Firstly, the condition of the recharge area was reviewed by examining available remote-sensing data and by conducting a site visit and a field survey. This work is summarised in Section 2.2.

Secondly, to determine whether any ferry effects could be detected, a desk-based review of available remote-sensing and bathymetry data was conducted. The results were used to describe morphological changes in the estuary and to understand whether any observed changes could be linked to the operation of the Wightlink Ferry service. This work is outlined in Section 2.3.

2.2 Recharge area

To describe the condition of the recharge, and assess its performance over the last five years, Wightlink Ltd. and ABPmer visited the mitigation area on 12 August 2020. ABPmer then surveyed the site in more detail on 9 September 2020. As in previous years the field survey involved a walkover of the site to describe the sediment elevations in the recharge area and the characteristics of the marsh habitat surrounding it. The sampling locations for this September survey were the same as in previous years (see Figure 5). The survey included:

- Measuring sediment heights at several 'graduated stakes' (labelled GradA to GradO) that were deployed within and adjacent to the recharge to describe changes in bed elevation from accretion, compactions or erosion;
- Taking fixed-point photographs at nine boundary posts (labelled BP1 to BP9) around the internal edge of the recharge area to visually describe the habitat development over time; and
- Analysis of marsh plant species at ten quadrat sampling sites (labelled Q1 to Q11[5]) within and around the recharge area to determine whether this habitat changes over time.

At each of the saltmarsh quadrat sites (Q1 to Q11), plant species were analysed using both 0.25 m^2 and 4 m^2 quadrats. For this latest survey, the small wooden stakes that used to precisely mark the quadrat location markers were no longer present. On this occasion, therefore, the quadrat positions were relocated with slightly less accuracy (±1-2 m) using GPS. This means that there will be some inherent differences in the recorded plant assemblages when comparing the 2020 survey results and those from previous surveys (up to 2015).

Many of the graduated stakes (GradA to GradO) were also covered in macroalgae (mainly *Fucus spiralis*) and so bed elevation readings could not be taken from them. This was true particularly for stakes located at the lower elevations of the site. However, in addition to taking readings from these stakes, the latest Environment Agency LiDAR data describing bed levels across this marsh area were obtained and analysed (as shown also in Figure 3 and Figure 4). The visible graduated stakes and the LiDAR data together appear to provide a clear and consistent description of the morphology of marsh and, especially, the sediment/bed elevations within and around the recharge[6].

5 As in previous years, Quadrat No. 2 could not be sampled because a migrating channel creek eroded across the site between the 2012 and 2013 surveys. Therefore, Quadrat No. 11 (on the recharge area) was added to the survey regime after the completion of the second recharge work in 2013.

6 Before and after the recharge work, the Channel Coastal Observatory (CCO) also carried out separate laser-scan surveys of the recharge area to provide information of sediment/bed levels. No new CCO laser-scanning surveys have since been carried out on this site (Stuart McVey, CCO per comm).

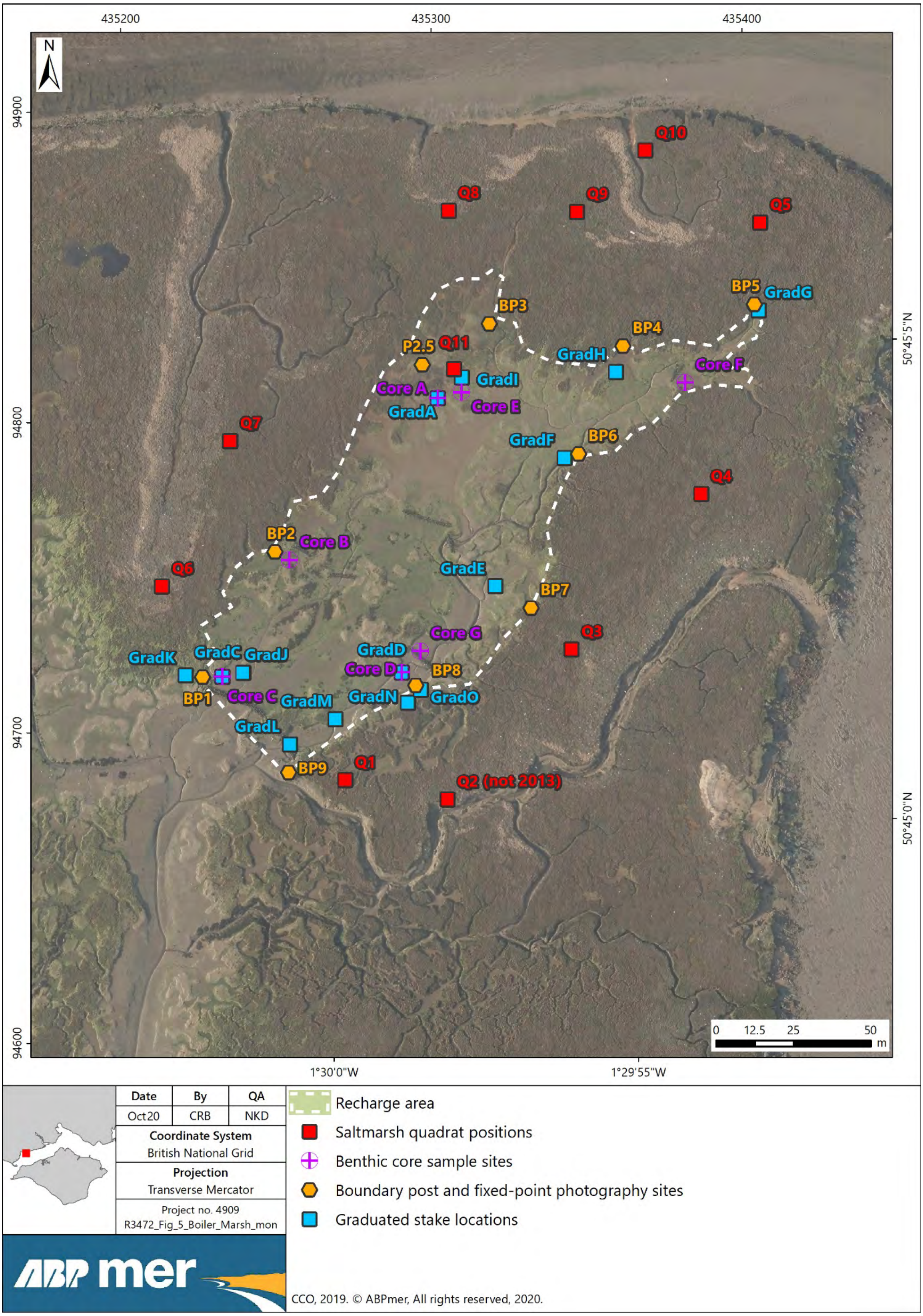


Figure 5. **Location of monitoring sites at the Boiler Marsh recharge site**

2.3 Estuary morphology

To describe the morphology of the estuary and identify changes that have occurred in recent years, the latest bathymetric data was provided by Lymington Harbour Commissioners (LHC). The LHC regularly carries out bathymetric surveys to inform their maintenance of the navigable approaches and to assess the effectiveness of dredging campaigns. Four such surveys have been conducted since the last EMP report was produced. These were carried out in May 2016, June 2017, January 2018 and September 2019 (see Image 2).

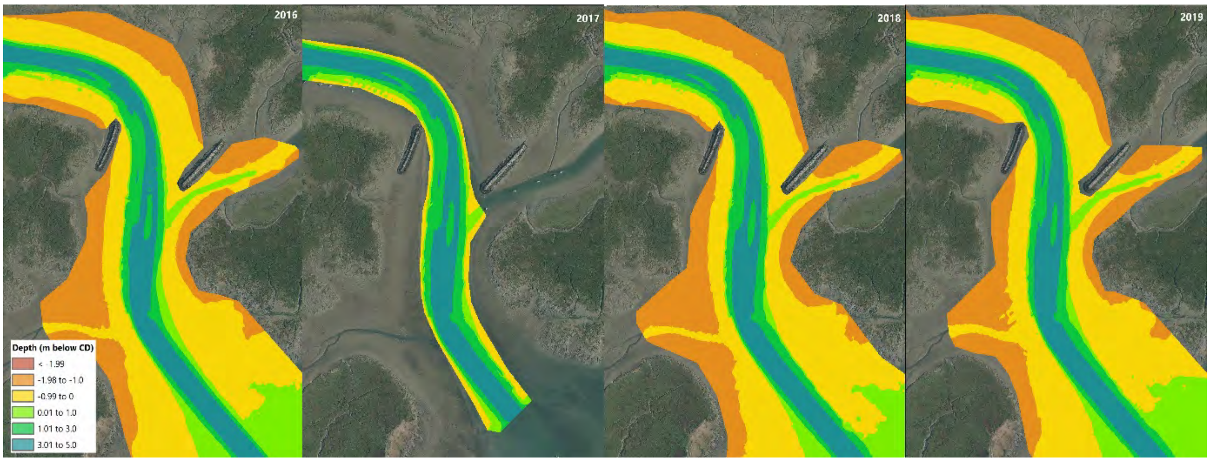


Image 2. Overview of bathymetric surveys carried out by LHC (2016 to 2019)

In addition, to describe the intertidal elevations of mudflats and marshes around the Lymington Estuary, the latest Environment Agency LiDAR was also obtained and analysed. The Environment Agency has carried out three such surveys since the previous EMP report. These were in January/February 2016, February 2018, and March 2020.

In previous years, the monitoring programme has also included field surveys of the intertidal mudflats alongside the Lymington Channel. A series of 'graduated stakes' were deployed in this mudflat habitat in June 2009 and these were regularly revisited in the years following (up to October 2014). These were valuable for describing quite small-scale erosion of accretion changes on this mudflat.

For this 2020 review though, it was judged unsafe to carry out a further survey of these stakes. This is especially because many of these stakes were covered in macroalgae and, therefore, it would have been necessary to access them on foot to clear them and take readings. Given these safety and technical considerations, as well as the amount of other bathymetric and topographic data that is available to describe the estuary morphology, these stakes were not revisited on this occasion.

Analysis of this bathymetry and LiDAR data was carried out in the same way as for previous studies. Further details about these analyses are presented in the preceding report. In summary, though, this work involved describing changes in the intertidal morphology by comparing the alignments of Mean Low Water (MLW) and Chart Datum (CD) along the length of the estuary over time. This was done using bathymetry data to define the CD and MLW alignments and LiDAR to define the MLW position.

In addition, to describe changes to the sub-tidal estuary channel shape, the bathymetry data was analysed at four pre-determined cross sections located near to navigation posts at Harpers Post South, Cocked Hat, Bag of Halfpence and Seymour's Post. When considering the analysis and presentation of these cross sections it was recognised that there can be errors if interpolated data is used. Therefore, to ensure maximum accuracy, only the *in-situ* field survey depth readings taken along these cross sections were extracted and plotted. This means that the position where the readings are taken along each transect is not consistent between years.

For these analyses, the bathymetry and LiDAR data collected since 2015 was added to the data previously collated and analysed for the period 1993 to 2015. This allows judgements to be made about the changes over time.

Some of the data collected during this period (especially in the late 1990s) is less accurate than the data obtained in recent years. These changes in survey accuracy over time, as well as the inherent vertical accuracy of all topographic and bathymetric readings, need to be borne in mind. For example, LiDAR data collected for the Environment Agency is required to have a vertical accuracy of less than ±15 cm. Greater accuracies than this are typically achieved however and in recent years the data has usually had accuracies of no more than ±5 cm.

The situation is similar for bathymetric data. The International Hydrographic Organization (IHO) hydrographic standard (as used ports and harbours) requires a vertical accuracy of ±25 cm. While the accuracy of bathymetric readings is dependent on several factors (including water depth) the final accuracy is often better than this at around ±5-10 cm. Shoreline surveys Ltd work to an accuracy of ±5 cm for the Lymington surveys.

3 Results

3.1 Introduction

The results from the latest surveys of the recharge area and the estuary are presented below. To firstly understand how the recharge/mitigation area has performed, the results from the survey work across this site are presented in Section 3.2. To then consider whether there are any signs of an effect arising from the operation of the ferry service, the estuary morphology changes are described Section 3.3.

3.2 Recharge area

3.2.1 Sediment elevation

Within the recharge area

The second phase of the recharge work was completed in early 2013. The last review of this work (as reported in late 2015) described conditions on the disposal site almost three years after its completion. The latest survey results, therefore, describe conditions nearly eight years after this work was completed.

To describe these latest conditions, the readings taken from some of the graduated stakes (i.e. those that were visible and not covered in macroalgae) are shown in Table 1. Figure 6 also shows the bed levels across of the site (as topographic cross sections) based on LiDAR data. This plot includes results from 12 LiDAR surveys undertaken between 2007 and 2020. These show changes before and after the recharge (seven surveys from 2007 to 2013) and then in the years since (five surveys from 2014 to 2020).

Based on both the *in-situ* observations and the data on sediment elevation in Table 1 and Figure 6, the site has remained quite stable. There has been some further compaction of the recharged dredge sediment, especially where it was more deeply deposited at the uppermost (northern) side of the site. There is also evidence of sediment movement within and around the site. Overall the amount of sediment in the recharge area is about the same in 2020 as it was in 2015.

As shown in Table 1, reductions in bed level occurred at most of the visible graduated stakes between 2015 and 2020. These stakes are mainly in the northern half of the recharge area where generally elevation has lowered by a further few centimetres since 2015. This is illustrated by Stake I and Stake A (as shown in Image 3 and Image 4 respectively).

Image 3. Stake I before and after 2012/13 recharge work (for site location see Figure 5)

Table 2. Sediment Elevation (cm) Changes from Baseline at the Graduated Stakes

Graduate Stake Ref	Stake Colour Codes	July 2010	September 2010 (cm change)	September 2012 (cm change)	September 2013 (cm change)	September 2014 (cm change)	September 2015 (cm change)	September 2020 (cm change)
Stake A		Installed	+2.0 *	Not Taken	+13.5	+13.5 (0.0[#])	+12.5 (-1.0[#])	+8.0 (-3.5[#])
Stake C		Installed	+1.5 *	+1.0 *	+1.5 *	-1.5 (-3.0[#])	-2.5 (-1.0[#])	-5.5 (-3.0[#])
Stake D		Installed	Not Visible**	+7.4	+8.7 *	+11.9 (+3.2[#])	Not visible***	+1.0 (n/a)
Stake E				Installed	+10.5 *	+10.5 (0.0[#])	+12.5 (+2.0[#])	+6 (-6.5[#])
Stake F				Installed	+17.9 *	+17.4 (-0.5[#])	+13.9(-3.5[#])	+11.4 (-2.5[#])
Stake G				Installed	+8.2	+10.7 (+2.5[#])	+10.7 (0.0)	+18.7 (+8.0[#])
Stake H				Installed	+30.5 *	+30.5 (0.0[#])	+28.5 (-2.0)	+27.5 (-1.0[#])
Stake I				Installed	+29.5	+29.0 (-0.5[#])	+28.0 (-1.0[#])	+26.0 (-2.0[#])
Stake J				Installed	+2.5 *	+3.0 (+0.5[#])	+3.0 (0.0[#])	No reading
Stake K				Installed	+4.5 *	+4.5 (0.0[#])	+4.5 (0.0[#])	+4.0 (-0.5[#])
Stake L				Installed	+1.0 *	No reading	No reading	Not visible***
Stake M				Installed	+4.0	+4.0 (0.0[#])	+4.0 (0.0[#])	Not visible****
Stake N				Installed	+5.2 *	+11.2 (+6.0[#])	+8.7 (-2.5[#])	No reading
Stake O				Installed	+3.5 *	+8.0 (+4.5[#])	No reading	No reading

* There was a layer of green algal growth over substratum influencing readings by up to maximum of 2 cm.
** This stake was in water at the time of the survey so unable to get a definable accretion level.
*** This stake was covered in too much algae to take a reading, but the sediment elevation appeared to have had reduced by a few centimetres
**** Stake M is no longer readable as covered in *Fucus spiralis*. The channel has moved slightly, and the stake was more exposed in the 2020 survey than in the 2015 survey.
[#] These values in brackets describe the sediment elevation change between the 2013–2014, 2014–2015 and the 2015-2020 surveys. All other values in the table express change from the time that the stake was put in place.

Prior to the recharge work, Stake A was located on the crest of a clay mound while Stake I was located at a lower elevation. At Stake I therefore the depth of sediment deposition following the recharge was greater than at Stake A (see shown in Image 3 and Image 4 and Table 2). Between 2015 and 2020 the bed elevation at these two sites bed elevations reduced by 2 cm and 3.5 cm respectively.

A reduction in bed elevation in the northern part of the recharge site was also recorded in 2015. This will be due to the continuing compaction of the sediment (especially during the first few years after the recharge) but also because some sediment will have been washed out of the area. It appears that much of the exported sediment may only have moved into the southern part of the site as well as into the very northernmost marsh-edge fringes of the recharge area.

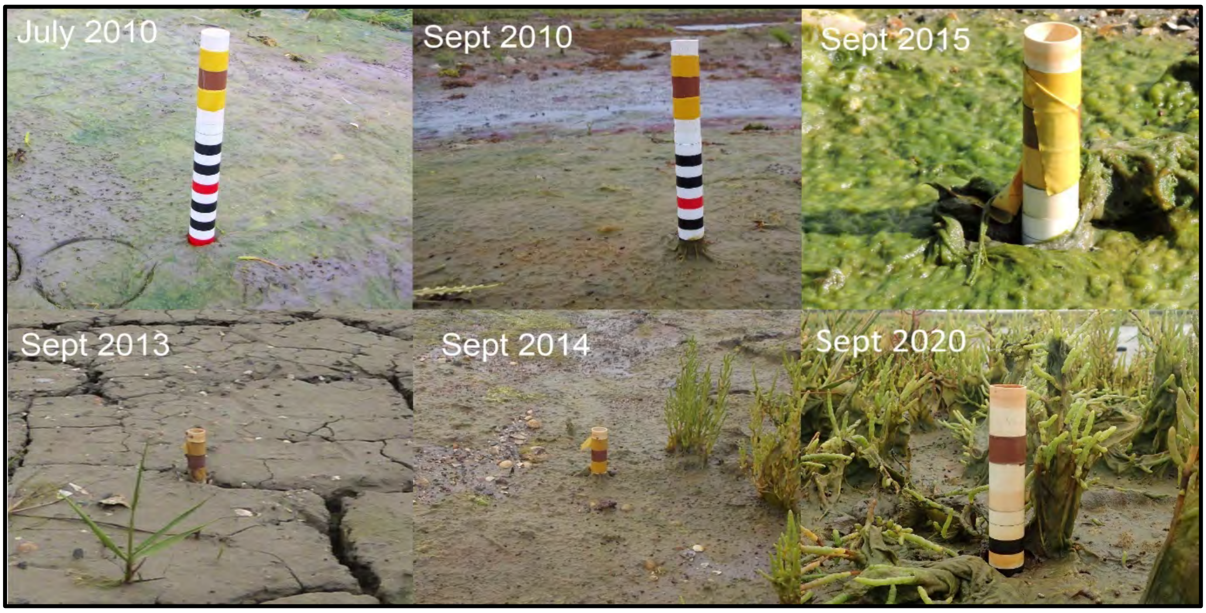
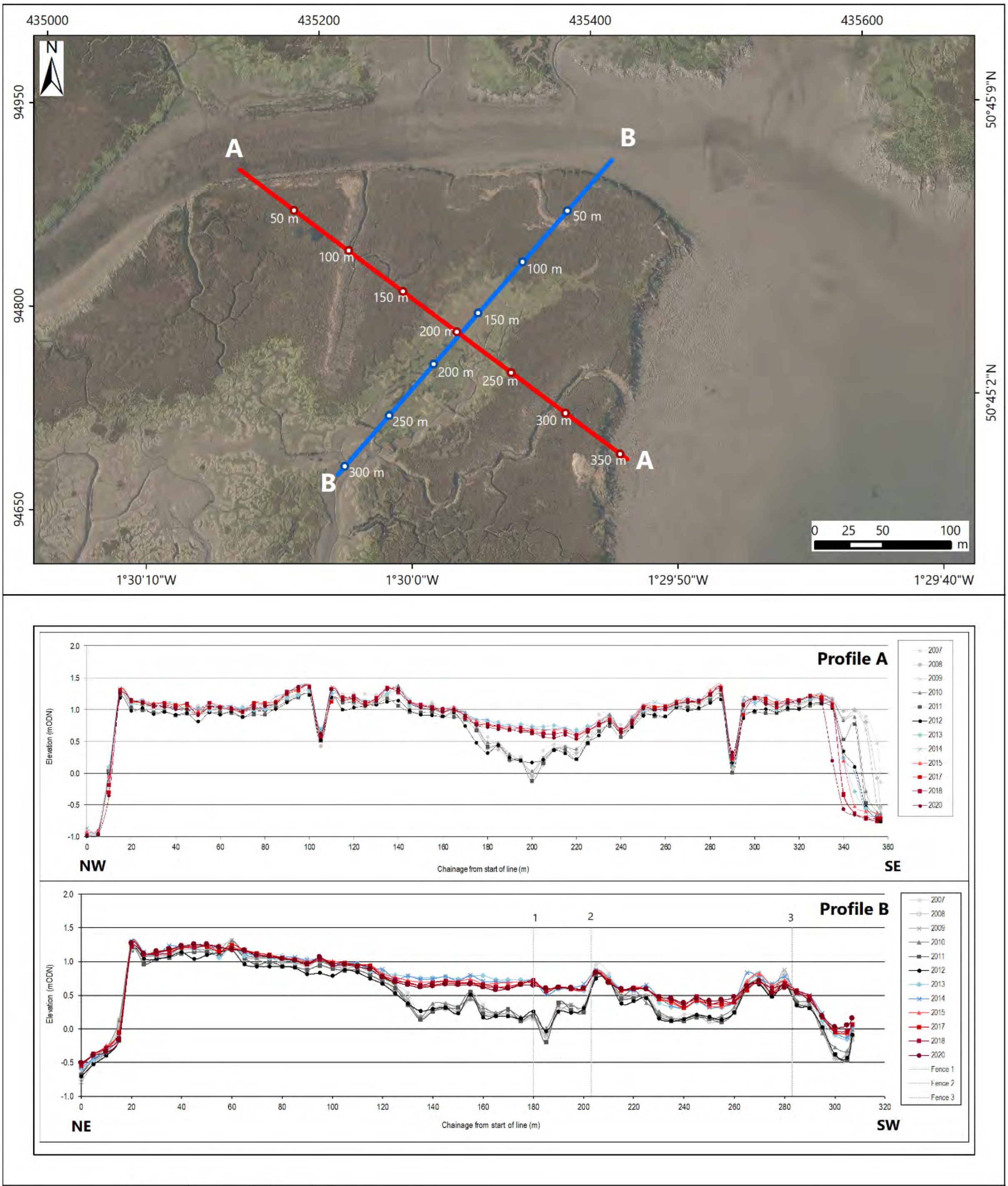


Image 4. Stake A before and after 2012/13 recharge work (for site location see Figure 5)

The apparent movement of sediment from the north to the south of the site is illustrated by the LiDAR results in Figure 6. This shows two cross section profiles of the recharge area. These indicate that there has been net accretion in the southern part of the site that is similar in scale to the net bed level reduction in the northern part.

To further illustrate this change, Image 5 shows the same cross section profiles but only for 2011 (just before the recharge) and then 2013, 2017 and 2020. This describes a slight lowering of bed elevations at the north and accretion to the south in the years after the recharge.

There has also been some modest accretion at the very northernmost fringes of the recharge area. This is indicated, in part, by accretion at Stake G which lies at the very top of the site near to the first discharge point (see Figure 5 and Table A7 in Appendix A). This accretion has occurred through a localised build-up of sediment around a dense patch of *Salicornia* spp. A small narrow drainage channel has developed and deepened next to the stake and, as it has done so, a mound of sediment has grown and encroached across the stake location. Similar small-scale and localised accretion and creek maturation has occurred elsewhere at the top of the site around Boundary Post 3 (see Section 3.2.2).



Date	By	QA
Oct 20	CRB	NKD

Coordinate System
British National Grid

Projection
Transverse Mercator

Project no. 4909
R3472_Fig_6_Boiler_Marsh_XS_A4

Profile A

Profile B

Lidar data for each winter season are unfiltered and were recorded in the following months/years:

- December 2007
- November 2008
- October 2009
- November 2010
- January/February 2012
- January 2013
- March 2014
- November 2014
- January/February 2016
- February 2018
- March 2020

Lidar data supplied by the Environment Agency 2007, 2008, 2009, 2010, 2012, 2013, 2014, 2015, 2017, 2018 & 2020.
CCO, 2019. © ABPmer, All rights reserved, 2020.

Figure 6. Cross section elevations of Boiler Marsh using EA LiDAR data

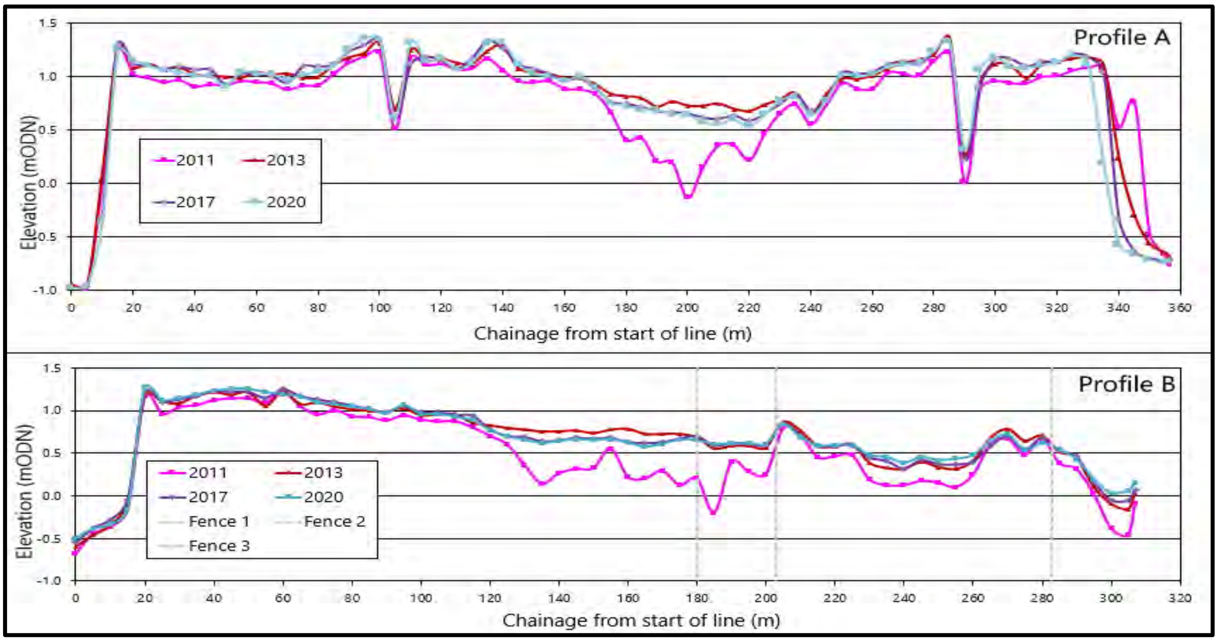


Image 5. LiDAR cross sections based on four surveys between from 2011 and 2020 only[7]

Outside the recharge area

The LiDAR cross sections in Figure 6 and Image 5 also show that there has been net accretion in areas outside the recharge area to the south (i.e. seaward of the main deposition area). To illustrate how this has influenced the habitats, Image 6 show views of the area to the south of the recharge site before and after the recharge (in 2011 and 2020). As suggested in previous monitoring reports, this accretion is likely to be occurring because of reduced volumes and speeds of water flow though this area on each tide.

Image 6. View south west from Boundary Post 1 (BP1) before the recharge and in 2020

This accretion indicates that more stable conditions have been created beyond just the location of the recharge area itself. It is possible, that some of the recent LHC beneficial use deposits in front of Boiler Marsh (see Figure 3 and Figure 4) may be contributing some of the sediment that is accreting in this area.

7 See Figure 6 for cross section

From these results it is evident that many of the findings and, relatively subtle, trends that were described in late 2015 are again apparent in 2020. Back in 2015 a similar pattern of relatively small bed elevation changes was recorded (between 0-4 cm). Typically, there were reductions of 1 cm in bed elevation in the northern part of the site and more stable conditions, and occasional accretion, to the south. At that time, sediment was also being deposited just outside the recharge area in front of the southernmost fence.

In summary, therefore, the site has adjusted slightly in the years since 2015. The recharge sediment and the environment created by it have, however, remained relatively stable. The majority of the deposited sediment has evidently remained in place. The site still appears to be in balance with no signs of substantial net sediment import to or export from the deposition area.

3.2.2 Habitat development

Saltmarsh plants within the recharge area

As outlined in Section 2.2, the species composition of saltmarshes within and surrounding the recharge area were surveyed to identify any observable changes over time. Photographs of the site from the established fixed-point locations are shown in Appendix A along with photographs of the individual quadrat sites. The results from the 0.25 m^2 and 4 m^2 quadrats are also presented in Table 2 to Table 4 for both the 2015 and 2020 surveys.

The plant coverage on the recharge area itself was much the same in 2020 as it was in 2015. As in past years it is mainly *Salicornia* spp. that are found in patches across to the northern part of the site. When the deposited sediment was placed at this site in 2012 and 2013 it only reached an elevation that was suitable for marsh plant growth in areas close to the sediment discharge points on this north side. Elsewhere across the rest of the recharge area, marsh plants (again mainly *Salicornia*) were recorded in patches in and around the elevated clay mounds across the site

There was only modest change in this recharge marsh coverage during 2020. This is because there has not been widespread accretion of sediment and instead there has been a very slight drop in bed elevations (as described in the preceding section). However, during the 2020 survey there was a slightly greater coverage of *Salicornia* in the central section of the recharge area and a denser plant cover along the northernmost fringes when compared with previous years.

To illustrate this change, photographs of the central section are shown in Image 7. These were taken from Boundary Point 2 in 2020, 2015 and 2014. This denser coverage of *Salicornia* on the northernmost fringes of the site is illustrated by the photographs taken from Boundary Post 3 which are shown in Image 8. These photographs describe conditions at the top of the recharge area before, and in the years after, the recharge work.

To some degree, the difference between 2015 and 2020 will be a function of variability in weather conditions over the preceding summers leading to differences in the timing and extent of *Salicornia* growth. This is probably the case across the central section. However, there does appear to have been some slight accretion in front of BP3 (Image 8). This is evidenced both by the increase in plant density and the maturing of a small drainage channel that runs through this part of the site. It is likely that the growth of *Salicornia* after the recharge has helped to trap sediment and contributed to this modest and localised sediment accretion.

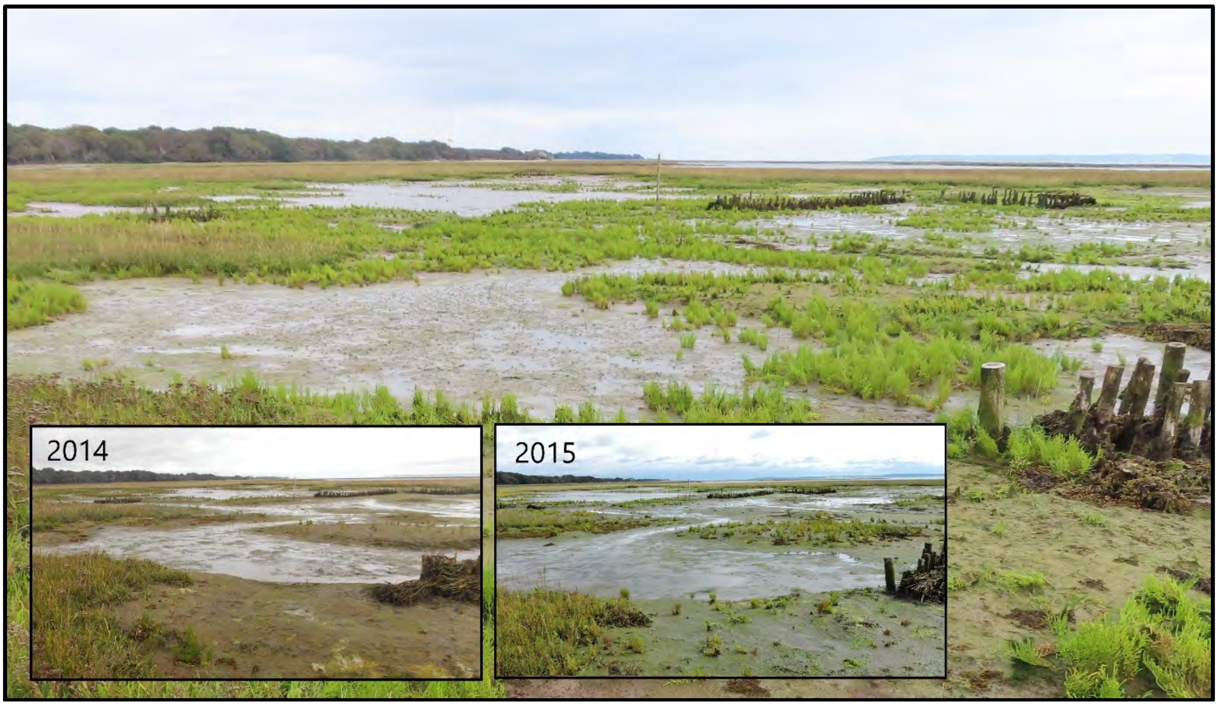


Image 7. View north west from Boundary Post 2 (BP2) from 2014, 2015 and 2020

Mudflat habitat within the recharge area

Within the recharge area, the lower-lying deposited sediment has also further developed into an invertebrate rich mudflat habitat. The infauna within the mud was not analysed quantitatively during these surveys but it is clear from visual observations in 2020 that there are high abundances of lugworm, ragworm and mud snails across different parts and different elevations of the recharge area. A photograph of the mudflat habitat with high abundances of invertebrates (including visible lugworm casts), as taken from the Boundary Post 8, is shown as Image 9.

Given the elevation of this mudflat and its locations in front of the marsh edges, it is likely that these are typically enriched infaunal assemblages with a relatively low diversity but a comparatively high abundance of key dominant and site-tolerant species. This represents a qualitative improvement on the baseline conditions because, prior to recharge, there was much less healthy mudflat habitat present in the recharge area

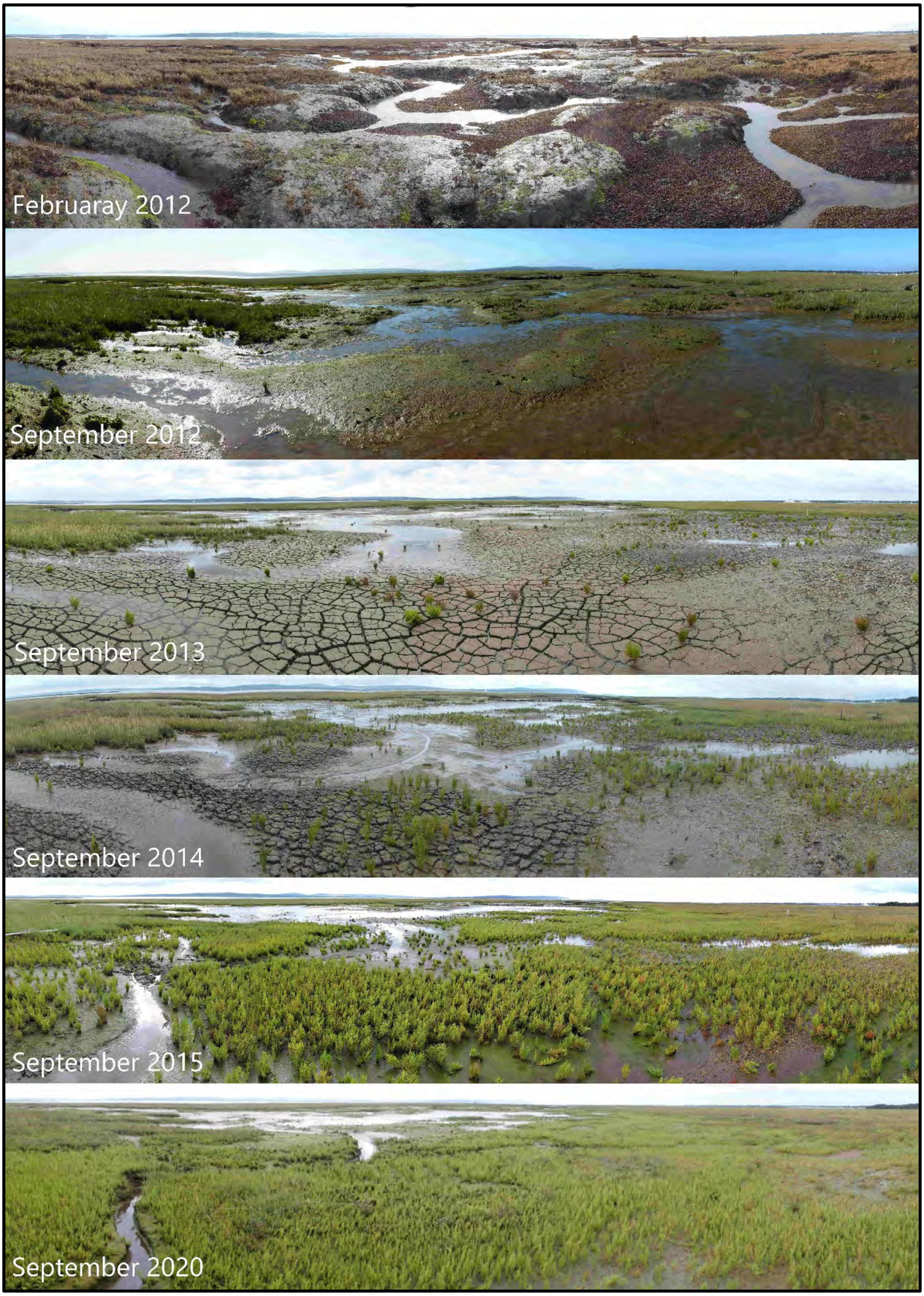


Image 8. **View south from Boundary Post 3 (BP3) showing habitat change over time**

Saltmarshes surrounding the recharge area

The marshes surrounding the recharge area have not altered substantially in 2020. The dominant species and the amount of vegetation cover within the quadrats was generally the same as in previous years.

There were some slight difference between years in the recorded abundances of some of the less abundant species. This includes, for example, lower records of species such as annual sea-blite and saltmarsh grass in the quadrats in 2020. However, these are most likely to be a function of inter-annual variability and subtle differences in site positioning between 2015 and 2020.

In general, therefore, there was no indication of a notable change. Based on the recorded data and onsite observations, the quality of the surrounding marshes appeared to be the same as in previous years

Image 9. View north from Boundary Post 8 (BP8) showing mudflat and internal fencing

The main exception to this was at Site Q5. At this site there was a distinct reduction in plant cover. This will be because of the lower elevation of this site and the fact that a channel is still trying to form through the marsh at this location.

While the deposited sediment in the recharge area will have slowed the rate of habitat erosion at this site and stalled the physical development of the channel that is fracturing the marsh, it cannot reduce the extent to which higher water levels reach this area and have ecological consequences for the marsh. This ecological effect is evident in the area around Site Q5 (see Figure 5).

Table 3. Saltmarsh Species Frequency at 0.25 m² Quadrat Sample Site (2015)

Common Name	Latin Name/Quadrat	1	3	4	5	6	7	8	9	10	11
Sea Aster	*Aster tripolium*	1			1			1		2	
Sea Purslane	*Atriplex portulacoides*	7		15		14		25	10	25	
Sea Lavender	*Limonium vulgare*	24	2	13	12		19		11		
Saltmarsh-grass	*Puccinelia maritima*	5	9	8	20	25	25		14		
Glasswort	*Salicornia spp*	25	23	25	25	25	25	6	24	14	2
Cord-grass	*Spartina anglica*	18	15	20	14	25	20	23	21	17	
Annual Sea-blite	*Suaeda maritima*	2			5	2	4	2		7	
Vegetation % Cover (rest mud or water)		80	40	95	60	98	95	98	70	98	2

Values for plant species indicate number of 'cells' in which species were present within 25 10 x 10 cm cells within a 0.25 m² quadrat; Site 11 located on recharge area while other sites are located on the established surrounding marsh (see Figure 3)

Table 4. Saltmarsh Species Percentage Cover at 4 m² Quadrat Sample Site (2015)

Common Name	Latin Name/Quadrat	1	3	4	5	6	7	8	9	10	11
Sea Aster	*Aster tripolium*	1		10	5	1	1	1	2	3	
Sea Purslane	*Atriplex portulacoides*	5	3	15		40	5	50	20	80	
Sea Lavender	*Limonium vulgare*	20	20	25	15	7	25	10	10	4	
Saltmarsh-grass	*Puccinelia maritima*	2	2	5	10	10	3	1	5		
Glasswort	*Salicornia spp*	35	34	10	32	10	30	5	8	5	40
Cord-grass	*Spartina anglica*	10	10	30	10	30	25	25	30	5	
Annual Sea-blite	*Suaeda maritima*	1	1		3		2	3		1	
Vegetation % Cover (rest mud or water)		74	70	95	75	98	91	95	75	98	40

All values shown indicate the percentage cover of species present within a 4 m² quadrat

Table 5. Saltmarsh Species Frequency at 0.25 m² Quadrat Sample Site (2020)

Common Name	Latin Name/Quadrat	1	3	4	5	6	7	8	9	10	11
Sea Aster	*Aster tripolium*			4							
Sea Purslane	*Atriplex portulacoides*		10	19		25	3	24	13	24	
Sea Lavender	*Limonium vulgare*	18	12	7	24		10	25	20	8	
Saltmarsh-grass	*Puccinelia maritima*				7		12	12	6		
Glasswort	*Salicornia spp*	22	18	25	23		25	14	24	6	4
Cord-grass	*Spartina anglica*	25	3	20	12	25	25	20	25	12	
Annual Sea-blite	*Suaeda maritima*					12	1			9	
Vegetation % Cover (rest mud or water)		99	75	90	70	99	95	99	95	99	15

See notes in Table 3

Table 6. Saltmarsh Species Percentage Cover at 4 m² Quadrat Sample Site (2020)

Common Name	Latin Name/Quadrat	1	3	4	5	6	7	8	9	10	11
Sea Aster	*Aster tripolium*			5	1	1			2	3	
Sea Purslane	*Atriplex portulacoides*		50	25	15	65	5	30	25	80	
Sea Lavender	*Limonium vulgare*	40	10	5	10	5	40	50	20	5	
Saltmarsh-grass	*Puccinelia maritima*				9		5	3	3		
Glasswort	*Salicornia spp*	20	10	40	5		20	5	5		30
Cord-grass	*Spartina anglica*	30	10	15	10	16	16	10	20	10	
Annual Sea-blite	*Suaeda maritima*					10	4			2	
Vegetation % Cover (rest mud or water)		90	80	90	50	97	90	98	75	100	30

See notes in Table 4

3.3 Estuary morphology

3.3.1 Ferry effects

The W-Class Wightlink ferries began operating in Lymington (replacing the established C-Class vessels on this service) almost 11 years ago, in early 2009. The worst-case effect of this vessel change was predicted to be a slight acceleration of low shore mudflat erosion along the length of the Lymington Estuary Channel through which the ferry service operates.

The effects were predicted by Natural England through the application of a mathematical model. Using this tool, an area of potential loss was calculated which was based on a net erosive loss of mudflat at the lowest intertidal point (at Chart Datum (CD)). To this loss was added an extra measure of 'half the loss at Mean Low Water'. This MLW measure was used as an indicator of a qualitative change to low shore mudflat habitat.

The model which describes this combined 'CD loss and MLW change' effect is influenced by, and therefore sensitive to, the speed of the ferries and the number of trips they make over a year. Since the ferries began operating, the vessel speeds have been lower and the number of trips taken fewer than anticipated within the original model. As such, the modelled effects are also lower than originally anticipated. This is discussed further in the conclusions section of this report.

When considering the effects of the ferries it was also agreed during the consenting process, that these predicted effects would be uncertain, small and dwarfed by natural processes. The aim of the monitoring therefore is to review the morphology of the Lymington estuary (especially the CD or MLW alignments), describe any detectable changes, and determine whether there are any ferry effects that can be dissociated from other influencing activities and natural processes.

3.3.2 Observed changes

To first illustrate the broad conditions and major morphological adjustments along the length of the estuary, the net changes in bed elevation are shown in Figure 7 using Environment Agency LiDAR data. This is shown in the form of elevation 'difference plots' for the periods 2008 to 2020 and 2014 to 2020 in Figure 7. Similar plots, but of the wider area, are also shown as Figure 3 and Figure 4.

These show an established, and now very well-understood, pattern of ongoing marsh edge retreat occurring throughout the length of the estuary south of the harbour's wave breaks. The exposed outer estuary marshes continue to retreat at the fastest rates. On these plots there are also some signs of the mudflat lowering on the western side of the outer estuary.

In the more sheltered areas inside the channel (i.e. away from the estuary mouth), there are clear signs of accretion around the rock armour breakwaters. This is especially evident on the western side of the channel. The LHC recharge that was carried out in 2012 and 2013 is also visible. Figure 3 and also Image 10 provide further descriptions about these key features.

On the evidence of these LiDAR elevation difference plots, there are no signs of distinct changes to the intertidal morphology along the length of the sheltered inner channel. To examine this further though, the alignments of the CD and MLW elevations are shown in Figure 8 to Figure 10. Figure 8 and Figure 9 respectively show the alignment of CD and MLW using LHC bathymetric data from 1993 to 2019. Figure 10 shows the MLW alignment using LiDAR data from 2008 to 2020 (i.e. roughly corresponding to the period in which the W Class ferry has been in operation).

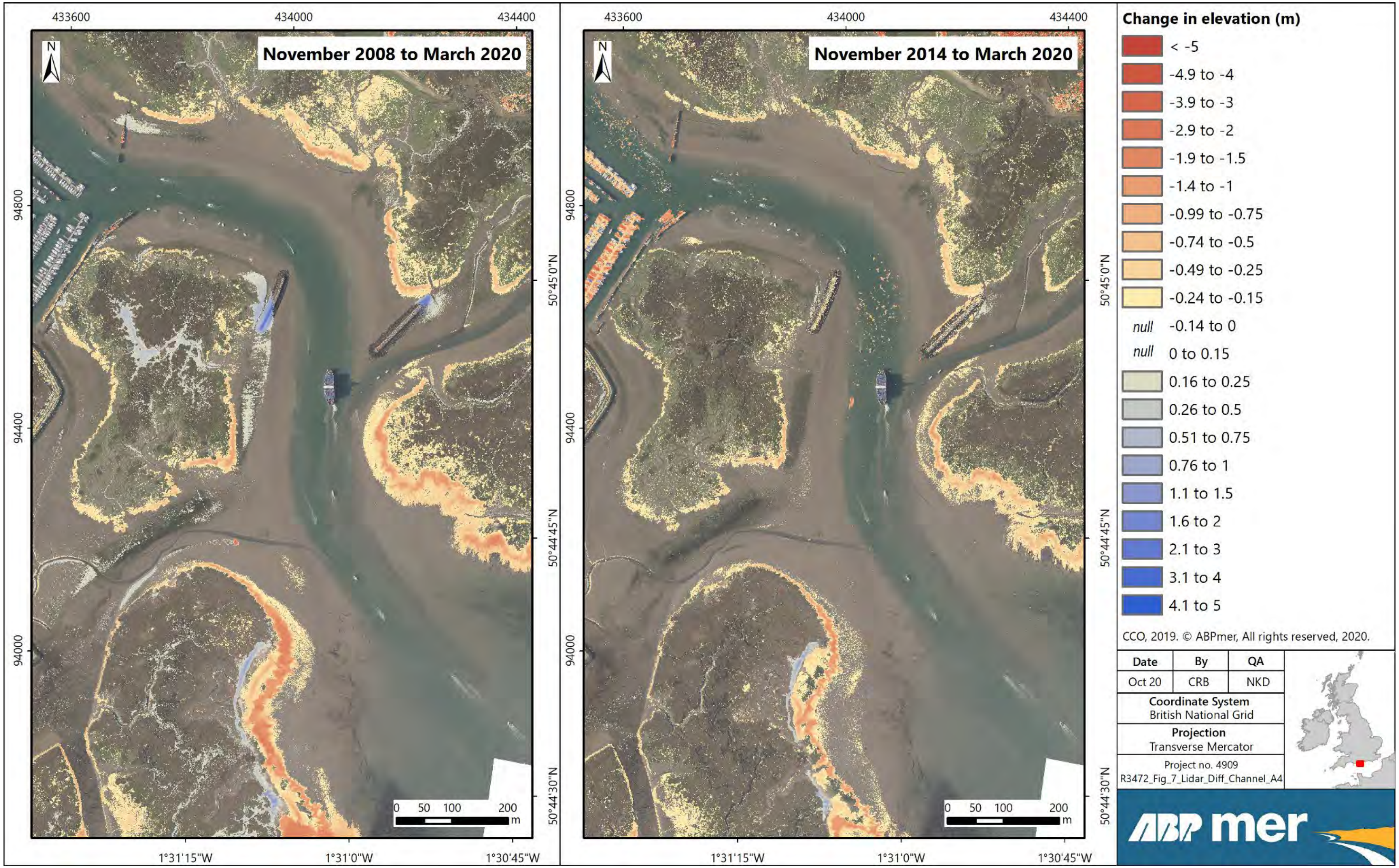
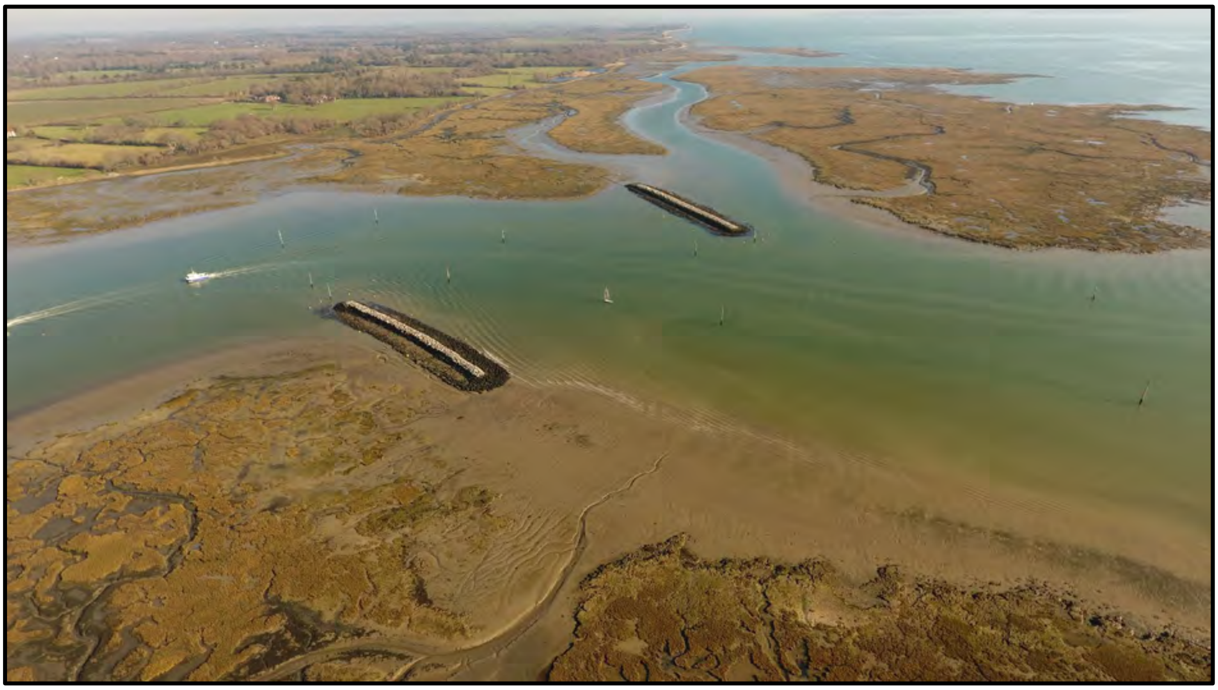


Figure 7. Habitat elevation change along Lymington channel (LiDAR data 2008 to 2020)

In all these plots the change that is clearly detectable is, again, the widening of the outer estuary. In this area there is a distinctive retreat of both the CD (Figure 8) and MLW (Figure 9 and Figure 10) positions. This is occurring on both banks but is most notable on the east side due to its greater exposure to south-west storms over relatively large fetch distances. The latest survey (in September 2019) shows that the channel mouth at both CD and MLW is now at its largest recorded width.

This retreat of the CD and MLW at the river mouth is evidently occurring relatively consistently year on year (in the same way that the adjacent marshes are progressively eroding). Some inconsistency and inter-annual variability is indicated by the alignments shown in Figure 8 to Figure 10 This may reflect some physical variation but is more likely to be due to accuracies of the survey readings. Given that the elevation readings are technically accurate to either ±20 cm for bathymetry or ±15 cm for LiDAR, large spatial variations in the recorded tidal positions can occur. This is especially true on flat intertidal surfaces.



Source: Landwatch Consulting for Solent Forum BUDS project

Image 10. View east over the Lymington River (February 2019)

In the more sheltered sections of the (inner) estuary above Pylewell Post, the recorded CD and MLW alignments shown in Figure 8 to Figure 10 are relatively consistent. The recorded positions across all the survey lines plotted are confined to a comparatively narrow 10-20 m-wide zone. The accuracy of survey readings will again influence the recorded positions within these zones although this effect will be less evident at CD because of the relative steepness of the bed profile when compared with MLW. However, across these narrow zones, no consistent temporal change is evident.

There is no indication, therefore, of detectable and ongoing retreat of the CD or MLW positions outside of the outer estuary area. Instead, in recent surveys the CD and MLW positions along much of the inner channel, are often aligned on the channel side rather than to landward which would technically indicate a narrowing rather than a widening of the channel. In reality, though, the channel edges are thought to be relatively stable and not changing in any net direction that can be detected.

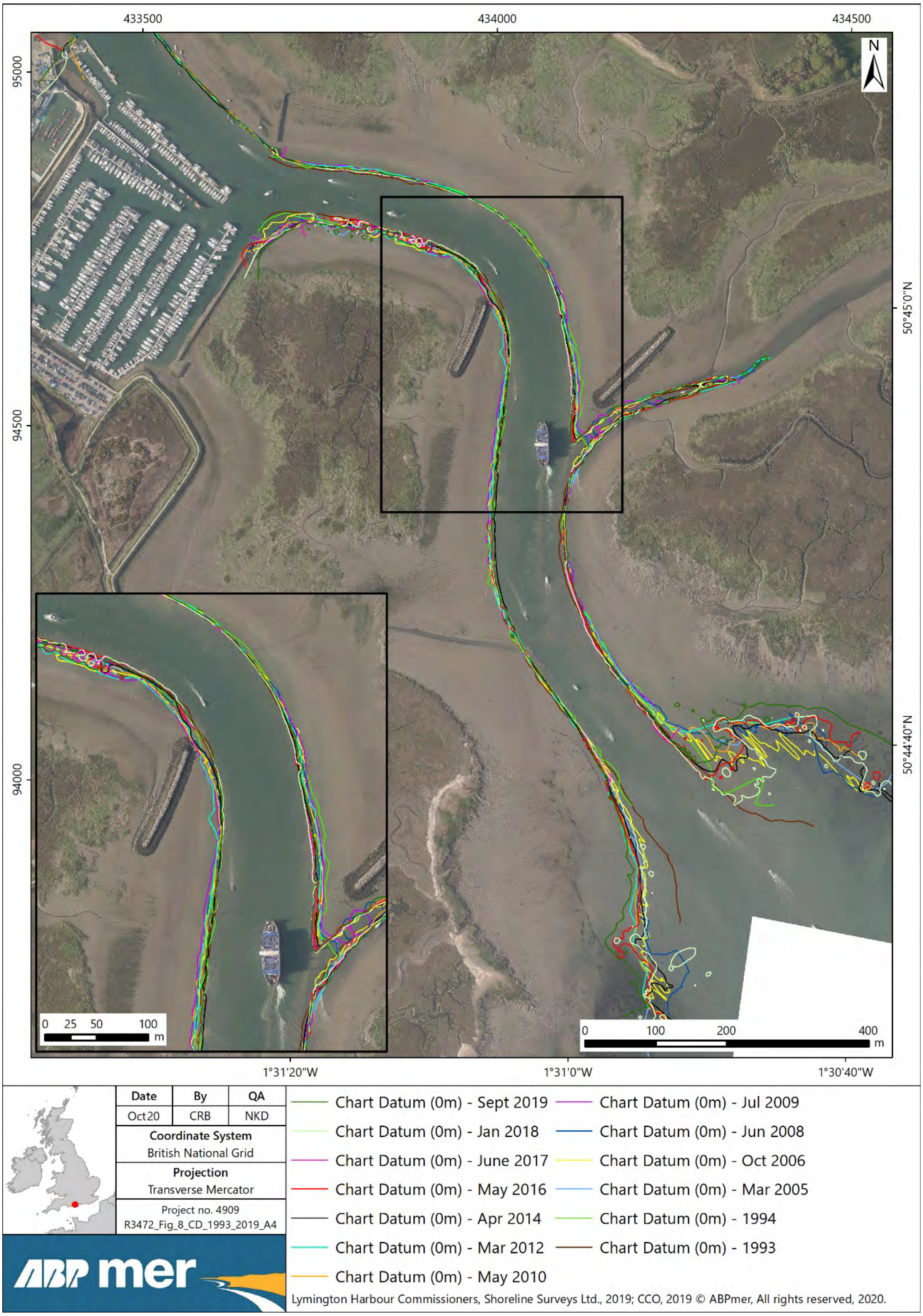


Figure 8. Changes in CD alignment based on LHC bathymetry data 1993 to 2019

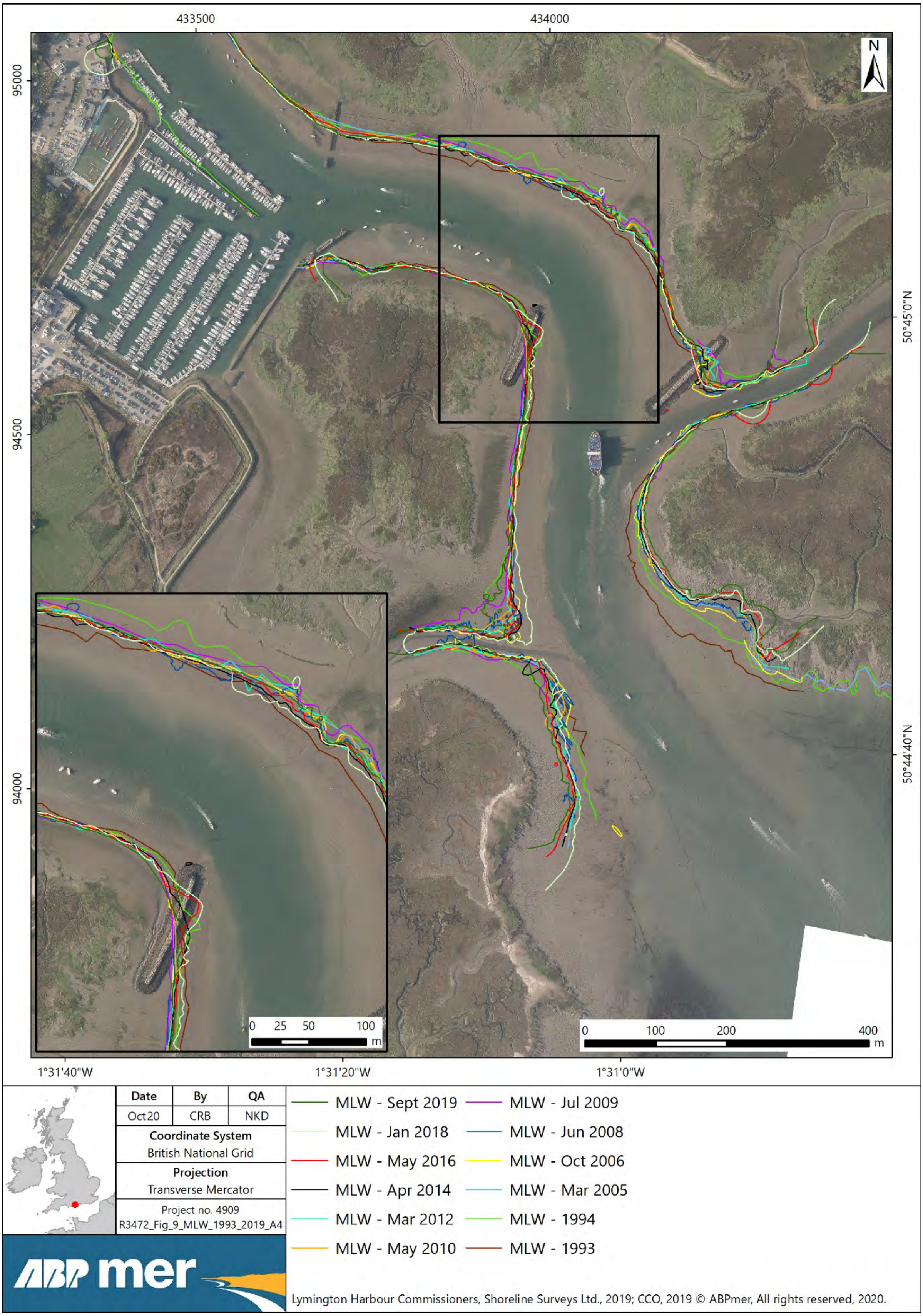


Figure 9. Changes in MLW alignment based on bathymetry data 1993 to 2019

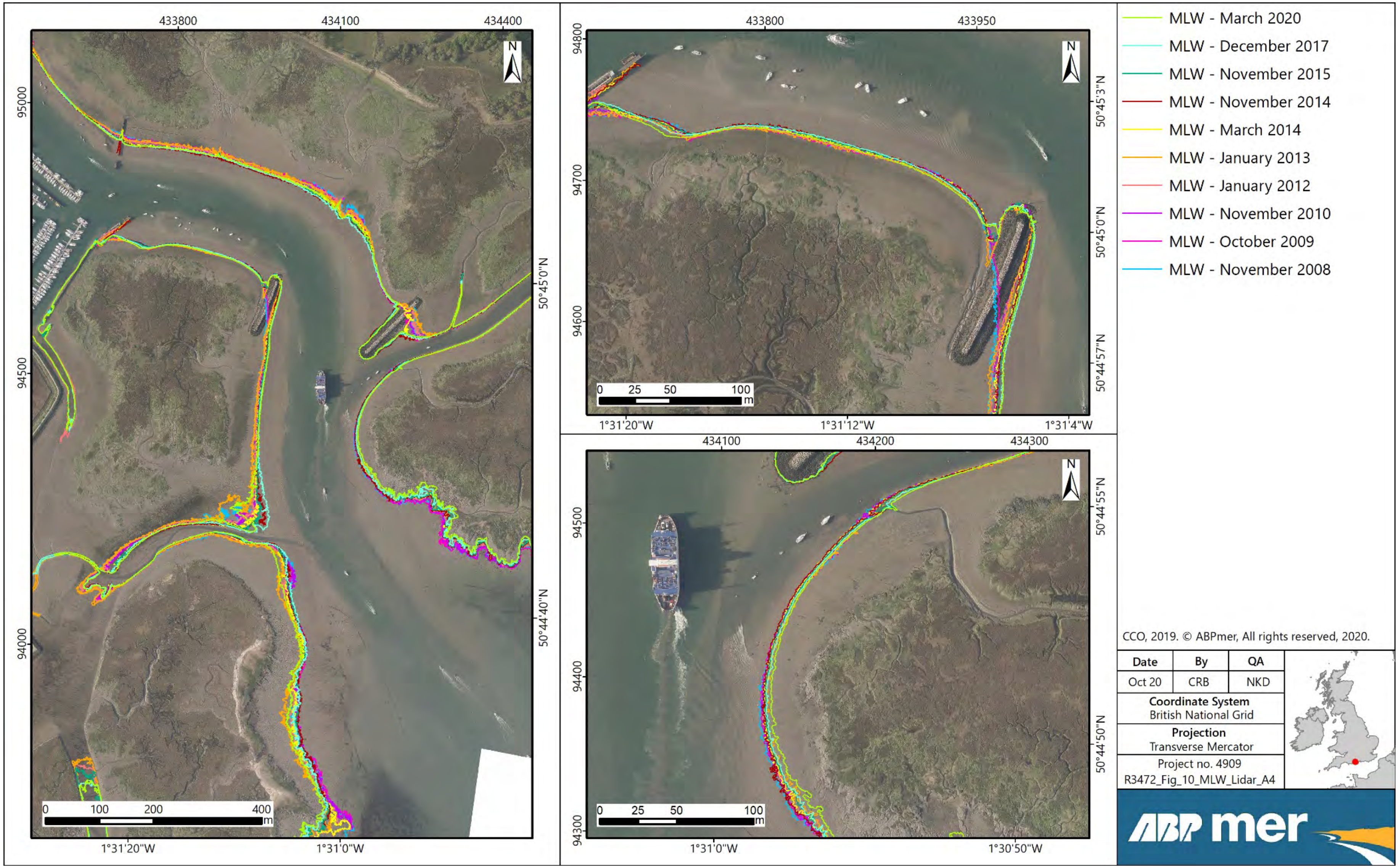


Figure 10. Changes in MLW alignment based on EA LiDAR data 2008 to 2020

To finally check whether any effects can be identified subtidally, plots of the cross sections at Harpers Post South, Cocked Hat, Bag of Halfpence and Seymour's Post are shown in Figure 11 to Figure 14. For each cross section a plot is shown which includes data from all available bathymetric surveys the LHC has carried out from 1988 to 2019. However, because there is so much data on these plots, additional plots covering just six of these surveys (2005 and 2014 to 2019) are shown in Image 11 to help clarify any contemporary trends.

From Figure 11 to Figure 14 there are signs of the dredging activities that have been carried out over the last few years. The 2014 dredging campaign is evident in Cocked Hat Post cross section (Figure 12 and Image 11).

The 2016 dredging campaign is also very clearly shown in the Seymour's Post cross section (Figure 12 and Image 11). There is also some indication of slight accretion having taken place over intertidal mudflat on the west side of the channel at Seymour's Post. Net accretion over parts of the mudflat in this region of the estuary was also observed during preceding surveys (ABPmer 2014a) and is also indicated by the LiDAR difference plot in Figure 7.

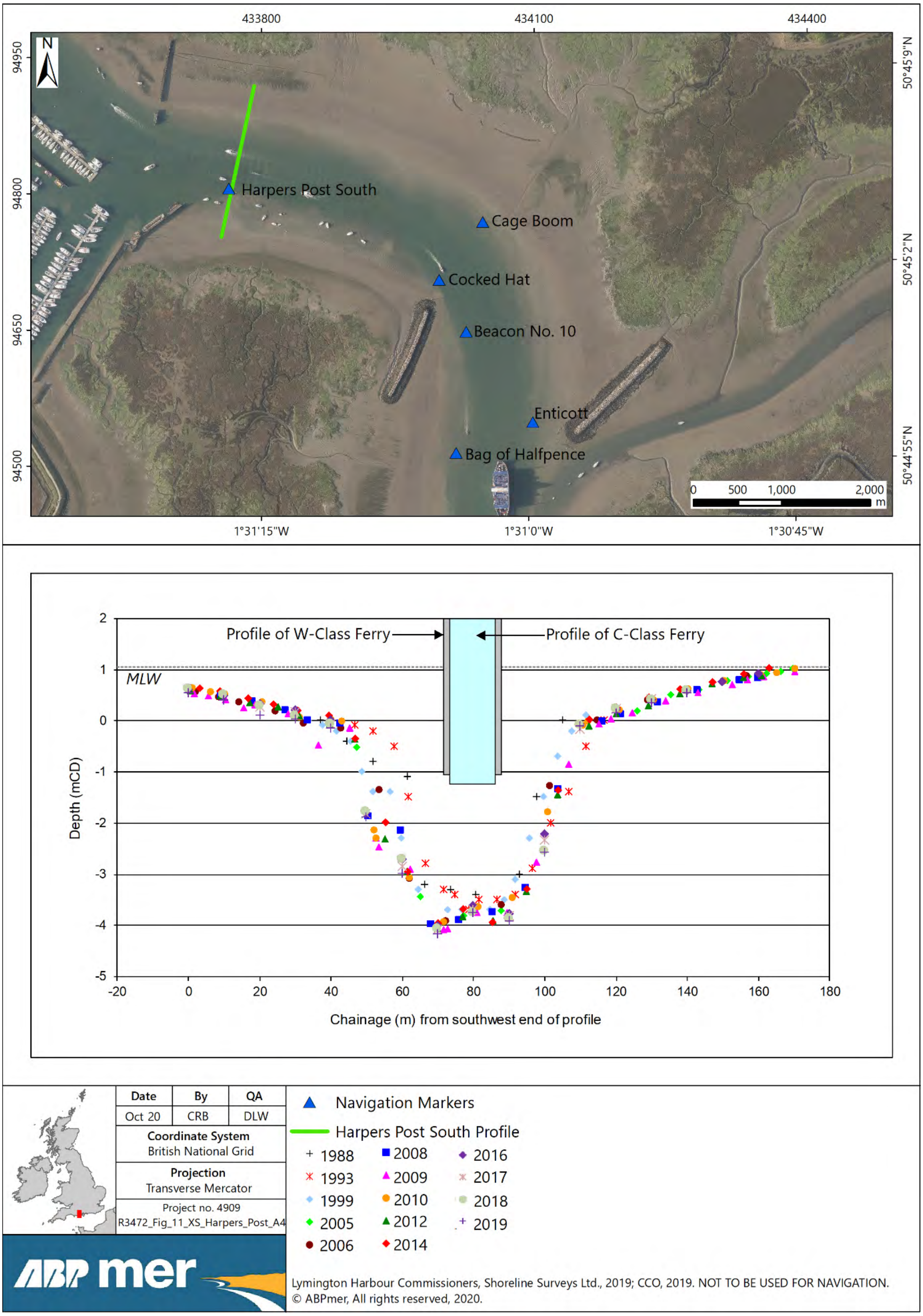


Figure 11. Channel cross section near Harpers Post South (1988 to 2019)

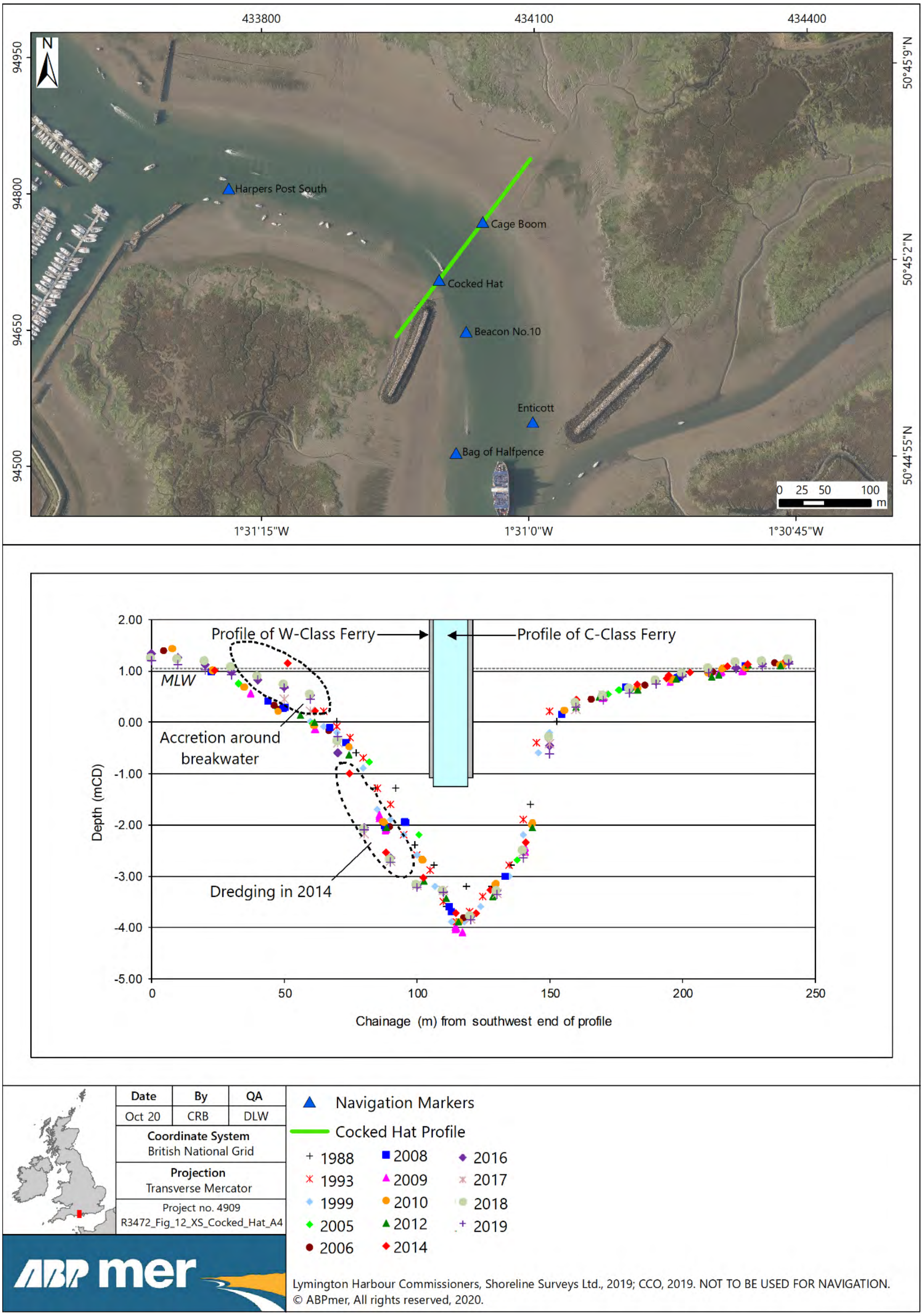


Figure 12. Channel cross section near Cocked Hat Post (1988 to 2019)

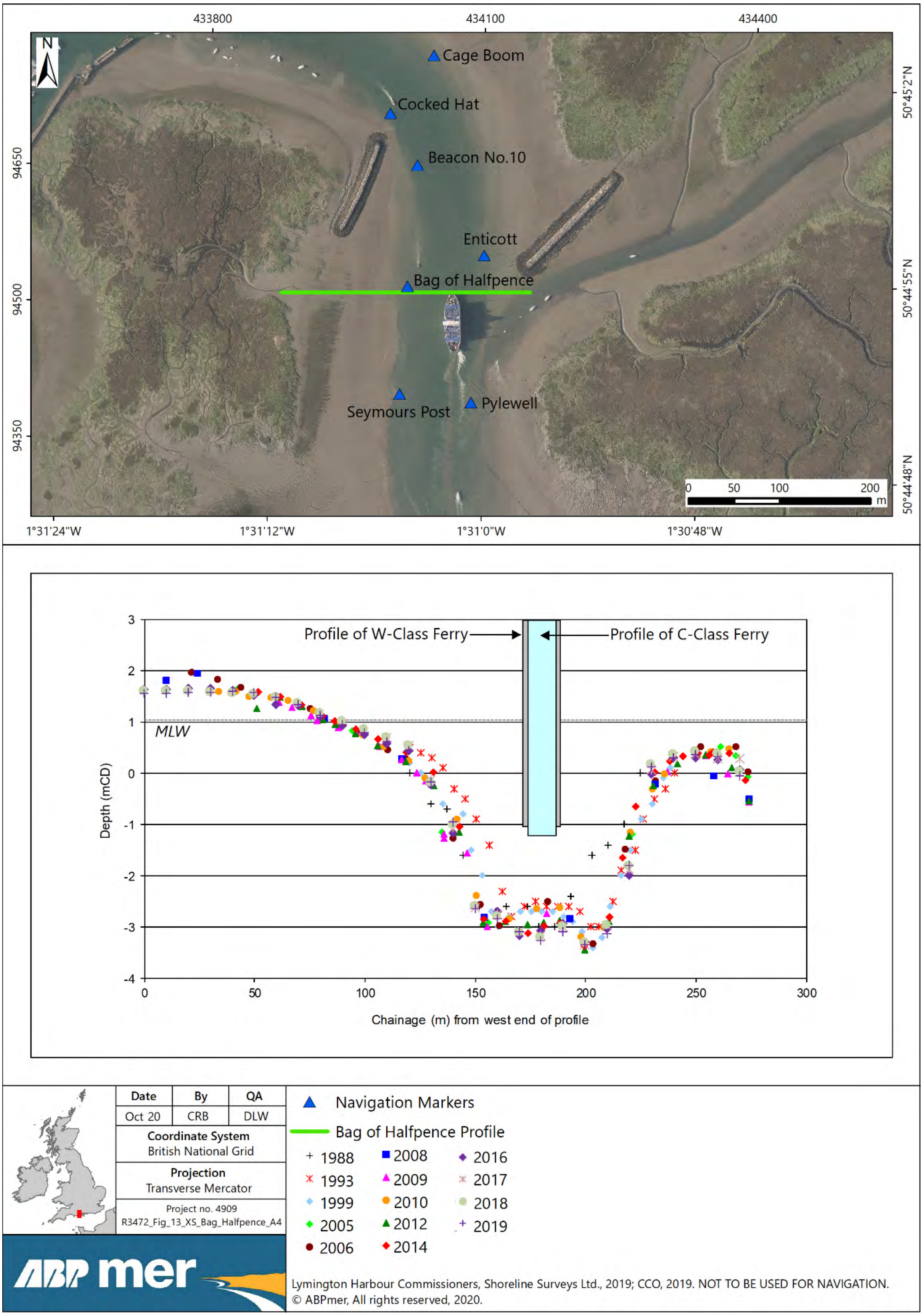


Figure 13. **Channel cross section near Bag of Halfpence Post (1988 to 2019)**

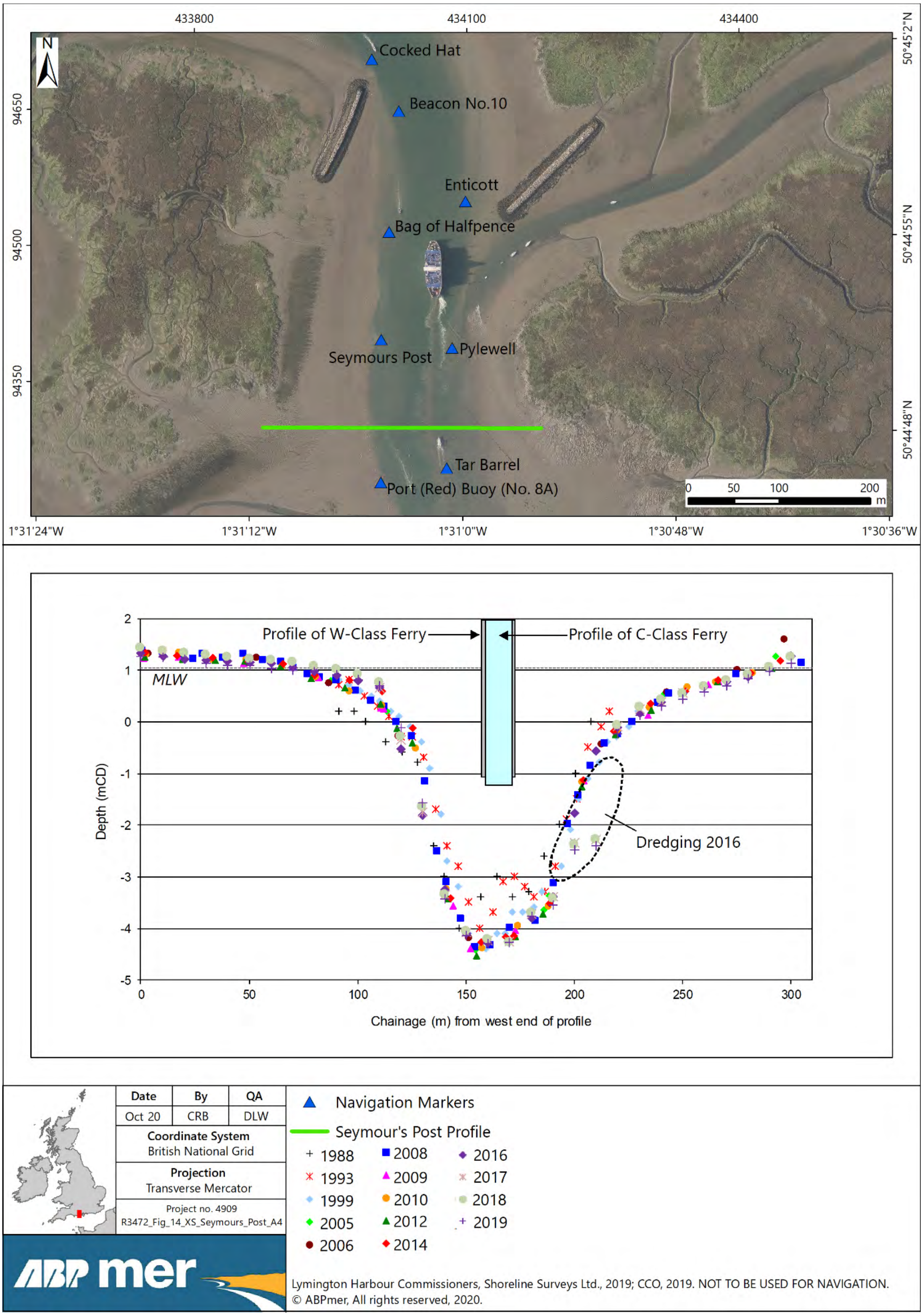


Figure 14. **Channel cross section near Seymour's Post (1988 to 2019)**

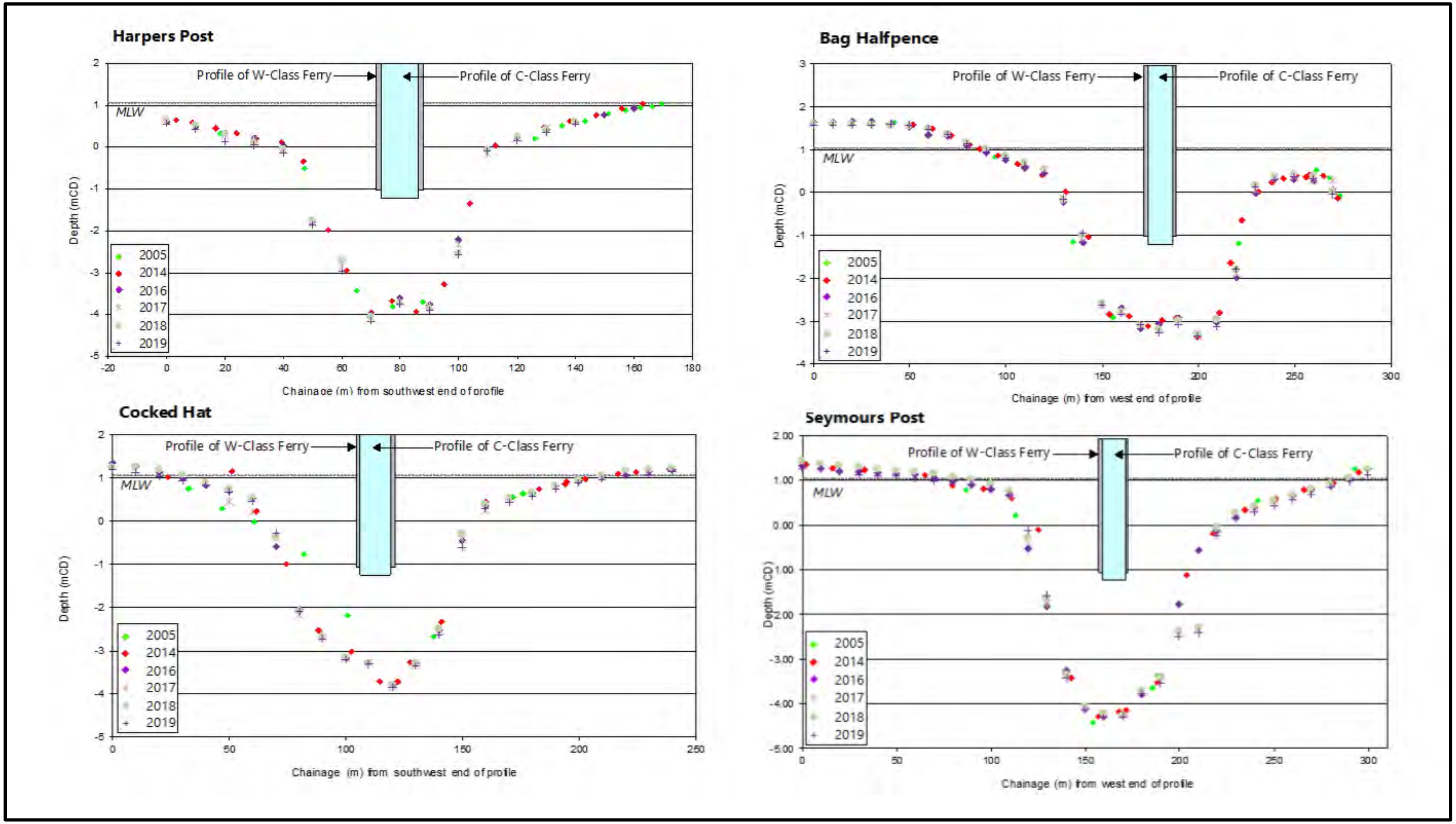


Image 11. Selected data (from 2005, 2014 to 2019) for each of four channel cross sections

4 Conclusions

This review has shown that the physical trends and ecological conditions along the Lymington channel and at the mitigation site are very much the same in 2020 as they were five years ago. There is no observable effect from the ferry operations on the mudflat habitat along the length of the channel and the recharge area is stable and still functioning well.

On this basis, and with due recognition to the relevant Conservation Objectives, it is concluded that there has been no effect on the integrity of the Solent EMS. It is, however, the role of the EMP to make this judgment (see Section 1.2). Therefore, to inform this panel's view, some concluding comments are presented below.

4.1 Ferry effects

Before the W-Class ferry service started operating, it was recognised that any effects from these ferries would be uncertain, small and dwarfed by natural processes. However, if such an effect did occur, it was understood that this would be in the form of a widening of the cross sectional area of the channel and ongoing mudflat erosion along the low-shore edges of the estuary for 1 km length on both sides of it. It was also understood that the largest effects would happen during the earlier stages of the service's operation when the channel was comparatively narrower. Then, as it widens over time (largely from natural processes) any contributory effect of the ferry would diminish.

From the evidence collected, there are no signs of the upgraded W-Class ferry service having such distinguishable effects on the channel shape or intertidal habitat within the estuary after 11 years of service. The channel cross sections have remained relatively stable or have been widened sub-tidally by the maintenance dredging work and there is no indication of a net lateral retreat of the lower shore areas (as defined by the CD or MLW alignments).

It was stated in the preceding monitoring report (ABPmer 2014a), that there was no indication that any ferry effects will ever be distinguished from all other natural or man-made forcing factors. This conclusion can be reaffirmed here using a further 5 years of data. By now the service should have caused 60 to 70% of the full effect that was theorised for its full 30-year operational life. This is based on the conceptual/mathematical model that was developed to judge ferry effects during the planning and marine licence application processes.

The conceptual prediction was based on the theoretical worst-case modelled effects and included assumptions about the trippage rate and vessel speeds. It used a baseline rate of 21,000 trips/year and assumed the 'impact to trippage' relationship was linear. Since the W-class ferry came into service in 2009, the trippage rate has consistently been lower than this. Hence, the conceptual/theoretical impact must also be lower. From the start of its operation to 2020 the completed and scheduled trips are:

- 2009 - 16,646 trips representing a 21% reduction in conceptual erosion rate;
- 2010 - 17,516 trips representing a 17% reduction in conceptual erosion rate;
- 2011 - 16,828 trips representing a 20% reduction in conceptual erosion rate;
- 2012 - 16,456 trips representing a 22% reduction in conceptual erosion rate;
- 2013 - 14,000 trips representing a 33% reduction in conceptual erosion rate;
- 2014 - 11,550 trips representing a 45% reduction in conceptual erosion rate;
- 2015 - 11,000 trips (estimate) which represents a 48% reduction in the conceptual erosion rate.
- 2016 - 10,762 trips representing a 49% reduction in conceptual erosion rate;
- 2017 - 10,651 trips representing a 49% reduction in conceptual erosion rate;

- 2018 - 10,479 trips representing a 50% reduction in conceptual erosion rate;
- 2019 - 10,526 trips representing a 50% reduction in conceptual erosion rate; and
- 2020 – 5,440 trips representing a 74% reduction in conceptual erosion rate;

Since 2015 therefore, the service has been operating at about half the rate that was used for the model. And, in 2020, the trippage was even further reduced because of the COVID-19 pandemic. During this year the route was suspended for over three months during lock-down and there was a reduced service before lock-down and following reopening.

Taking account of the net reduction in trippage from 2009 to 2020, and assuming there will be around a 20% reduction (from 21,000/year) throughout the residual life of the ferries, the projected and theoretical final ferry impacts (after 30 years) reduces from 2 ha to 1.4 ha. If there is a long-term 50% reduction in trippage, then the theoretical impact will be closer to 1.2 ha.

The conceptual model also used a baseline ferry speed of 6 knots with the 'impact to speed' relationship being more sensitive and non-linear (it is derived from the difference between the fourth-root of the speed change). In 2009 and 2010 the average was around 6 knots but in early 2011 the speed was formally reduced (for the 1 km section below the wave screens, which is relevant here). Monitoring of the speeds also began on 21 June 2011.

The ferries are now operating within the 5.5 knot speed limit and this will continue, if required, over this full 30-year life-span of these ferries. Since 2011 annual average speed has ranged between around 5 and 5.5 knots and this equates to a 30% to 50% reduction in the conceptual erosion rate. The vessel speed monitoring for the last three years are as follows:

- August to December 2018 average 5.38 knot;
- January to December 2019 average 5.38 knot; and
- January to December 2020 average 5.47 knot.

These average speeds correspond to a 30 to 35% reduction in the conceptual erosion rate. Once this reduction is taken into account, and assuming that speeds will not exceed 5.5 knots in the future, the overall theoretical impact of the ferries is reduced further to between 0.81 and 0.96 ha (depending on whether there is a 20% or 50% reduction in trippage as described above). In theory though, around 0.57 ha of this projected habitat loss and change to low shore mudflat (i.e. 60 to 70 %) should already have occurred by now based on this model.

These calculations provide an indication as to the scale of the theoretical effects that should have occurred by now. However, this is very theoretical and based on many assumptions. In reality, evidence from the monitoring work and other observations within the estuary, indicate that any physical or ecological effects from the ferry are minor and undetectable.

4.2 Other changes and natural processes

The wider environment is, of course, continuing to change. As described in past studies, the marshes are continuing to retreat at quite a rapid rate in many areas (especially on their wave-exposed outer edges) and the mouth of the estuary is continuing to widen due to natural processes. These changes have been consistently recorded during the monitoring programme.

In more sheltered parts of the channel, the spatial and temporal patterns of intertidal habitat changes are more subtle with few clear trends indicated by the survey data. In these comparatively sheltered areas, the marsh edges are still retreating, but at a slower rate. At the same time, the position of the lower channel edge remains relatively stable (as modulated by dredging that is undertaken to maintain the alignment of the navigable approaches) so that, along the channel edge, a gradual relaxation of the mudflat profile, and an increase in its extent over time, must be occurring.

The bathymetric and topographic analyses show areas of accretion and erosion over the mudflat along the channel. This includes an area of accretion on the inner west side and erosion on the outer west. These changes correspond to the spatial patterns of change that were described in previous reporting (ABPmer, 2014a). These changes are influenced by factors such as the rock armour breakwaters but also indicate how the channel is trying to adjust and probably 'seek' a more naturally sinusoidal shape.

These ongoing changes are a key consideration when thinking about the EMS Conservations Objectives. This is because judgements about whether a Conservations Objective is failed is made 'subject to natural change'. The three objectives that are relevant is this case are:

- No decrease in extent from an established baseline, subject to natural change;
- Shore profile should not deviate significantly from an established baseline, subject to natural change; and
- Presence and abundance of suitable prey species should not deviate significantly from an established baseline, subject to natural change.

It is evident that the mudflat extent has increased inside the channel and decreased at the estuary mouth. The shoreline profiles have also gently adjusted in many areas. However, these changes, and any consequences this might have for feeding birds (which will be minor or insignificant and either positive or negative depending on the location) are due to the effects of natural processes and change in this system.

4.3 Recharge Area

The recharge mitigation site has performed well. Most of the sediment deposited within the recharge area has remained in place and the area outside it, to the south, also has a greater volume of sediment than was present prior to the works being carried out. The quality of the habitats within and around the recharge area are enhanced relative to the baseline conditions.

The recharge has achieved its core objective, which was to slow the physical progression of the major channel though Boiler Marsh. The retention of sediment within the area around the site has meant that there has been a net reversal of this physical process. This process has not been stopped though and Boiler Marsh will still become severed in the future. The recent localised ecological deterioration of the lower elevation marshes at the top of the recharge site (a consequence of greater tidal inundation) is evidence of this. However, the physical fracturing of the marshes has clearly been stalled.

It is also encouraging that no substantial damage has occurred to the basic structural framework of the protective fences that define the site and the area of the original sediment deposition. Many of these fences remain at least partially buried in the sediment and others that are more exposed have lost internal bales and some of the poldering that is inter-woven through the main posts. However, the main posts and much of the poldering still remain and the lower-lying outer fence are covered in *Fucus spiralis* (see Image 12) that will help to restrict flow speeds through the fences and will assist with sediment retention.

Given that much of the dredge sediment remains in place after nearly eight years, that the environment more broadly has clearly been altered by this work and the fences have retained a good degree structural integrity, it is likely that this site will remain in a good condition for several more years (perhaps a decade or more).

Image 12. View of outer fences line from Boundary Posts BP9 (left) and BP1 (right)

The major concern for the Boiler Marsh, and other marshes locally, of course, is that they are continuing to erode on their outer faces. Image 13 shows an aerial image of the eastern Boiler Marsh (from April 2019) to illustrate the position of the recharge relative to the eroding outer edges.

This process is not something that can be, or needs to be, substantially influenced by the Wightlink recharge and is unrelated to the mitigation requirements in this case. However, it is recognised that many regional stakeholders aspire to use much greater volumes of dredge sediment to further protect these marshes in the future. This has been the focus of the Solent Forum BUDS project. The Wightlink recharge site with its fences still largely in place could become a valuable receptor site for such sediment in the future. For this to happen, though, the EMP would have to be assured that the site is no longer needed for the specific purposes of mitigating the ferry operations.

Image 13. April 2019 aerial view of eastern Boiler Marsh (CCO website)

5 References

For a full list of supporting technical and scientific literature please see preceding reports. This section outlines the key monitoring and assessment reports produced specifically for this project.

5.1 Ferry and recharge monitoring reports issued to EMP

ABPmer (2012a) Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 19, February 2012. ABP Marine Environmental Research Ltd, Report No. R.1556s.

ABPmer (2012b) Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 20, December 2012. ABP Marine Environmental Research Ltd, Report No. R.1556t.

ABPmer (2012c) Wightlink – Replacement Lymington to Yarmouth Ferries: First Annual Mitigation and Monitoring Report (October 2012) Progress Report 1 and 3rd Report for the Environment Management Panel December 2012. ABP Marine Environmental Research Ltd, Report No. R.2007.

ABPmer (2013a) Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 21 and 4th Report for the Environment Management Panel June 2013. ABP Marine Environmental Research Ltd, Report No. R.1556u.

ABPmer (2013b) Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 22 and 5th Report for the Environment Management Panel November 2013. ABP Marine Environmental Research Ltd, Report No. R.1556v.

ABPmer (2013c) Replacement Lymington to Yarmouth Ferries: Second Annual Mitigation and Monitoring Report Progress Report 2 and 6th Report for the Environment Management Panel December 2013

ABPmer (2014a) Evaluating Possible Effects of the Lymington to Yarmouth Ferries. Monitoring Report 23 and 7th Report for the Environmental Management Panel. ABP Marine Environmental Research Ltd, Report No. R.1556w.

ABPmer (2014b) Lymington to Yarmouth Ferries. Third Annual Mitigation Report. Progress Report 3 and 8th Report for the Environmental Management Panel. ABP Marine Environmental Research Ltd, Report No. R. 2313.

ABPmer (2015a) Lymington to Yarmouth Ferries. 9th Report for the Environment Management Panel. ABP Marine Environmental Research Ltd, Report No. R. 2512.

ABPmer (2015b). Lymington to Yarmouth Ferries. Case summary. Wightlink Ltd. December 2015 R.2557.

5.2 Previous ferry monitoring progress reports (2009 to 2011)

ABP Marine Environmental Research Ltd, Report No. R.1556a Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 1, July 2009.

ABP Marine Environmental Research Ltd, Report No. R.1556b. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 2, August 2009.

ABP Marine Environmental Research Ltd, Report No. R.1556c. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 3, August 2009.

ABP Marine Environmental Research Ltd, Report No. R.1556d. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 4, September 2009.

ABP Marine Environmental Research Ltd, Report No. R.1556e. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 5, October 2009.

ABP Marine Environmental Research Ltd, Report No. R.1556f. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 6, January 2010.

ABP Marine Environmental Research Ltd, Report No. R.1556g. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 7, April 2010.

ABP Marine Environmental Research Ltd, Report No. R.1556h. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 8, April 2010.

ABP Marine Environmental Research Ltd, Report No. R.1556i. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 9, May 2010.

ABP Marine Environmental Research Ltd, Report No. R.1556j. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 10, July 2010.

ABP Marine Environmental Research Ltd, Report No. R.1556k. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 11, September 2010.

ABP Marine Environmental Research Ltd, Report No. R.1556l. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 12, February 2011.

ABP Marine Environmental Research Ltd, Report No. R.1556m. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 13, April 2011.

ABP Marine Environmental Research Ltd, Report No. R.1556n. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 14, May 2011.

ABP Marine Environmental Research Ltd, Report No. R.1556o. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 15, May 2011.

ABP Marine Environmental Research Ltd, Report No. R.1556p. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 16, July 2011.

ABP Marine Environmental Research Ltd, Report No. R.1556q. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 17, September 2011.

ABP Marine Environmental Research Ltd, Report No. R.1556r. Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 18, October 2011.

5.3 Projects assessment work and other literature

ABPmer (2009). Wightlink - Replacement Lymington to Yarmouth Ferries: Information for Appropriate Assessment (Supplement to ABP Marine Environmental Research Ltd, Report No. R.1509). Agreed Protocols for Monitoring the Effects of the W-Class Ferries (July 2009).

ABPmer (2010). Wightlink - Replacement Lymington to Yarmouth Ferries: Method Statement for the Recharge/Habitat Creation Work. ABP Marine Environmental Research Ltd, Report No. R.1687. October

ABPmer (2018). Beneficial Use of Dredge Sediment in the Solent (BUDS), Phase 1 Project Scoping and Partnership Building, ABPmer Report No. R.2845. A report produced by ABPmer for the Solent Forum.

ABPmer (2019). Lymington Saltmarsh Recharge by Bottom Placement: 2019 Monitoring Report, July 2019 Bathymetric Survey Report produced in fulfilment of Condition 5.2.11 of Marine Licence L/2014/00396/2, ABPmer Report No. R.3242. A report produced by ABPmer for Lymington Harbour Commissioners, July 2019.

ABPmer (2020). Lymington to Yarmouth Ferries: Mitigation and Monitoring (2020), Five-year update and 10th Report for the Environment Management Panel, ABPmer Report No. R.3472. A report produced by ABPmer for Wightlink Ltd., December 2020..

Black and Veatch (2016) Lymington Harbour Commissioners Saltmarsh Recharge by Bottom Dumping - Phase 2 Interim Bathymetric Survey and Water Quality Monitoring Report, March 2016. Black and Veatch. 22p

Black and Veatch (2017) Lymington Harbour Commissioners Saltmarsh Recharge by Bottom Dumping – Phase 3 Final Monitoring Report, June 2017. Black and Veatch. 27p.

Black and Veatch (2020) Lymington Harbour Commissioners Harbour Protection Strategy-Phasing Review (June 2020)

ERM and ABPmer (2010) Technical Report to Inform the Appropriate Assessment carried out by Wightlink Limited. Report for Wightlink dated 5 November 2010 Reference 0111339. Annex B. ERM and ABP Marine Environmental Research Ltd.

HELCOM (2015). HELCOM Guidelines for Management of Dredged Material at Sea Adopted by HELCOM 36-2015 on 4 March 2015. Available at: http://www.helcom.fi/Lists/Publications/HELCOM%20Guidelines%20for%20Management%20of%20Dredged%20Material%20at%20Sea.pdf

6 Abbreviations/Acronyms

BP	Boundary Points
BUDS	Beneficial Use of Dredging in The Solent
CCO	Channel Coast Observatory
CD	Chart Datum
EA	Environment Agency
EC	European Commission
EIA	Environmental Impact Assessment
EMP	Environmental Management Panel
EMS	European Marine Site
ES	Environmental Statement
GPS	Global Positioning System
Grad	graduated stakes names
Ha	Hectare
HELCOM	Convention on the Protection of the Marine Environment of the Baltic Sea Area
HRA	Habitats Regulations Assessment
IHO	International Hydrographic Organization
LHC	Lymington Harbour Commissioners
LiDAR	Light Detection and Ranging
MHW	Mean High Water
MHWN	Mean High Water Neap tides
MLW	Mean Low Water
MLWS	Mean Low Water Spring tides
MMO	Marine Management Organisation
NE	Natural England
OS	Ordnance Survey
Q	Quadrat Sampling Sites
Ramsar	International treaty for the conservation and sustainable utilisation of wetlands
SAC	Special Area of Conservation
SNCO	Special Nature Conservation Order
SPA	Special Protection Area
UK	United Kingdom

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Appendix

Innovative Thinking - Sustainable Solutions

ABP mer

A Photographs from Recharge Area

A.1 Introduction

This appendix presents the photographic results from the surveys undertaken within and around the recharge area. This information is presented in the following sections and tables:

A.1.1 Fixed-point panoramas from boundary posts

- Table A1. Fixed-Point Panoramic Views from Boundary Posts (September 2012)
- Table A2. Fixed-Point Panoramic Views from Boundary Posts (September 2013)
- Table A3. Fixed Point Panoramic Views from Boundary Posts (September 2014)
- Table A4. Fixed Point Panoramic Views from Boundary Posts (September 2015)
- Table A5. Fixed Point Panoramic Views from Boundary Posts (September 2020)

A.1.2 Graduated stakes

- Table A6. Graduated Stake Photographs 2010 to 2015 and 2020 (Stakes A, C, D)
- Table A7. Graduated Stake Photographs 2010 to 2015 and 2020 (Stakes E, F, G)
- Table A8. Graduated Stake Photographs 2010 to 2015 and 2020 (Stakes H, I J)
- Table A9. Graduated Stake Photographs 2010 to 2015 and 2020 (Stakes K, L, M)
- Table A10. Graduated Stake Photographs 2010 to 2015 and 2020 (Stakes N and O)

A.1.3 Saltmarsh quadrats

- Table A11 Saltmarsh Quadrat Photographs 2010 to 2015 (Quadrats 1 to 3)
- Table A12. Saltmarsh Quadrat Photographs 2010 to 2015 (Quadrats 4 to 6)
- Table A13. Saltmarsh Quadrat Photographs 2010 to 2015 (Quadrats 7 to 9)
- Table A14. Saltmarsh Quadrat Photographs 2010 to 2015 (Quadrats 10 and 11)

A.2 Fixed-point photograph record

Table A1. Fixed-Point Panoramic Views from Boundary Posts (September 2012)

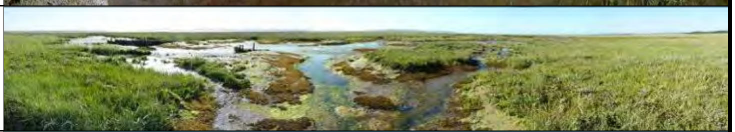
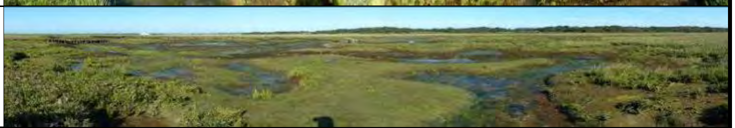
Position	Code	Date	Panoramic View
Boundary Post 1	BP1	5 September 2012	
Boundary Post 2	BP2	5 September 2012	
Photo Position 2.5	P2.5	5 September 2012	
Boundary Post 3	BP3	5 September 2012	
Boundary Post 4	BP4	5 September 2012	
Boundary Post 5	BP5	5 September 2012	
Boundary Post 6	BP6	5 September 2012	
Boundary Post 7	BP7	5 September 2012	
Boundary Post 8	BP8	5 September 2012	
Boundary Post 9	BP9	5 September 2012	

Table A2. Fixed-Point Panoramic Views from Boundary Posts (September 2013)

Position	Code	Date	Panoramic View
Boundary Post 1	BP1	11 September 2013	
Boundary Post 2	BP2	11 September 2013	
Photo Position 2.5	P2.5	11 September 2013	
Boundary Post 3	BP3	11 September 2013	
Boundary Post 4	BP4	11 September 2013	
Boundary Post 5	BP5	11 September 2013	
Boundary Post 6	BP6	11 September 2013	
Boundary Post 7	BP7	11 September 2013	
Boundary Post 8	BP8	11 September 2013	
Boundary Post 9	BP9	11 September 2013	

Table A3. Fixed Point Panoramic Views from Boundary Posts (September 2014)

Position	Code	Date	Panoramic View
Boundary Post 1	BP1	1 September 2014	
Boundary Post 2	BP2	1 September 2014	
Photo Position 2.5	P2.5	1 September 2014	
Boundary Post 3	BP3	1 September 2014	
Boundary Post 4	BP4	1 September 2014	
Boundary Post 5	BP5	1 September 2014	
Boundary Post 6	BP6	1 September 2014	
Boundary Post 7	BP7	1 September 2014	
Boundary Post 8	BP8	1 September 2014	
Boundary Post 9	BP9	1 September 2014	

Table A4. Fixed Point Panoramic Views from Boundary Posts (September 2015)

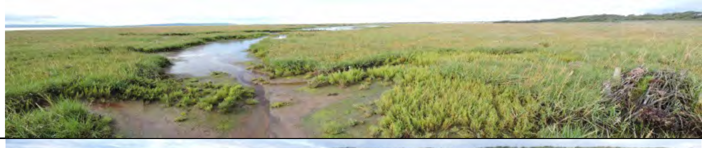
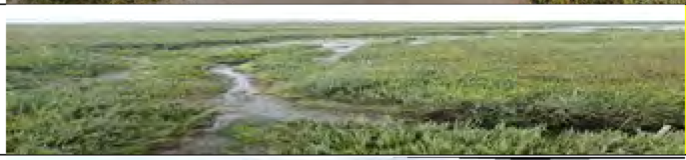
Position	Code	Date	Panoramic View
Boundary Post 1	BP1	22 September 2015	
Boundary Post 2	BP2	22 September 2015	
Photo Position 2.5	P2.5	22 September 2015	
Boundary Post 3	BP3	22 September 2015	
Boundary Post 4	BP4	22 September 2015	
Boundary Post 5	BP5	22 September 2015	
Boundary Post 6	BP6	22 September 2015	
Boundary Post 7	BP7	22 September 2015	
Boundary Post 8	BP8	22 September 2015	
Boundary Post 9	BP9	22 September 2015	

Table A5. Fixed Point Panoramic Views from Boundary Posts (September 2020)

Position	Code	Date	Panoramic View
Boundary Post 1	BP1	12 August 2020	
Boundary Post 2	BP2	12 August 2020	
Photo Position 2.5	P2.5	12 August 2020	
Boundary Post 3	BP3	12 August 2020	
Boundary Post 4	BP4	12 August 2020	
Boundary Post 5	BP5	12 August 2020	
Boundary Post 6	BP6	12 August 2020	
Boundary Post 7	BP7	12 August 2020	
Boundary Post 8	BP8	12 August 2020	
Boundary Post 9	BP9	12 August 2020	

A.3 Graduated stake photograph record

Table A6. Graduated Stake Photographs 2010 to 2020 (Stakes A, C, D)

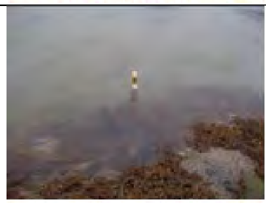
Graduated Stake Number	Graduated Stake A (Near Core Sample Site A)	Graduated Stake C (Near Core Sample Site C and Post 1)	Graduated Stake D (Near Core Sample Site D and Post 8)
Graduated Stake Colour Code			
Position X	435201.45	435153.70	435189.85
Position Y	94871.39	94819.15	94783.02
Deployment Photo 15 July 2010 (date when installed)			
Baseline Survey 14 September 2010			
After Recharge Survey 5 September 2012	Not Taken		
11 September 2013			
Year 1 post Recharge 1 September 2014			
Year 2 post Recharge 22 September 2015			
Year 7 post Recharge 9 September 2020			

Table A7. Graduated Stake Photographs 2010 to 2020 (Stakes E, F, G)

Graduated Stake Number	Graduated Stake E (Near Boundary Post 7);	Graduated Stake F (Near Boundary Post 6)	Graduated Stake G (Near Boundary Post 5)
Graduated Stake Colour Code			
Position X	435220.01	435242.22	435304.71
Position Y	94810.80	94852.09	94899.64
After Recharge Survey 5 September 2012 (date when installed)			
11 September 2013			
Year 1 post Recharge 1 September 2014			
Year 2 post Recharge 22 September 2015			
Year 7 post Recharge 22 September 2020			

Table A8. Graduated Stake Photographs 2010 to 2020 (Stakes H, I J)

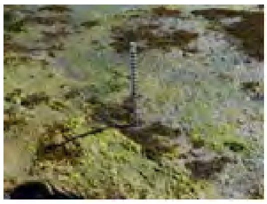
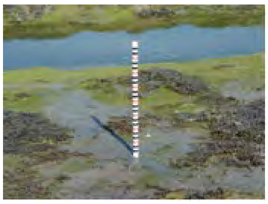
Graduated Stake Number	Graduated Stake H (Near Boundary Post 4)	Graduated Stake I (Near Boundary Photo Position 2.5)	Graduated Stake J (Near Boundary Post 1 and Graduated Stake C, Inside Site)
Graduated Stake Colour Code			
Actual Position X	435258.83	435209.18	435138.70
Actual Position Y	94879.79	94878.05	94782.91
After Recharge Survey 5 September 2012 (date when installed)			
11 September 2013			
Year 1 post Recharge 1 September 2014			
Year 2 post Recharge 22 September 2015			
Year 7 post Recharge 9 September 2020			

Table A9. Graduated Stake Photographs 2010 to 2020 (Stakes K, L, M)

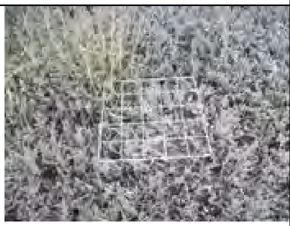
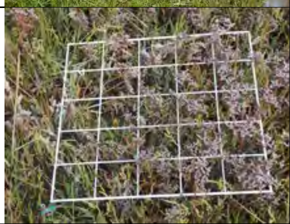
Graduated Stake Number	Graduated Stake K (Near Boundary Post 1 But Outside Site Near Fence 1)	Graduated Stake L (Near Boundary Post 9 But Outside Site Near Fence 1)	Graduated Stake M (Near Boundary Post 9 But Inside Site Near Fence 1)
Graduated Stake Colour Code			
Position X	435120.26	435153.88	435168.54
Position Y	94782.04	94759.85	94767.98
After Recharge Survey 5 September 2012 (date when installed)			
11 September 2013			
Year 1 post Recharge 1 September 2014			
Year 2 post Recharge 22 September 2015			
Year 7 post Recharge 9 September 2020			

Table A10. Graduated Stake Photographs 2010 to 2020 (Stakes N and O)

Graduated Stake Colour Code	Graduated Stake N (Near Boundary Post 8 But Outside Site Near Fence 6)	Graduated Stake O (Near Boundary Post 8 But Inside Site Near Fence 6)
Graduated Stake Colour Code		
Position X	435191.84	435195.93
Position Y	94773.24	94777.45
After Recharge Survey 5 September 2012 (date when installed)		
11 September 2013		
Year 1 post Recharge 1 September 2014		
Year 2 post Recharge 22 September 2015		
Year 7 post Recharge 9 September 2020		

A.4 Saltmarsh quadrat photographic record

Table A11. Saltmarsh Quadrat Photographs 2010 to 2020 (Quadrats 1 to 3)

Saltmarsh Quadrat No	Quadrat No. 1	Quadrat No. 2	Quadrat No. 3
Marker Colour Code (used from 2012)			
Position X	435172.25	435205.16	435245.11
Position Y	94747.23	94741.10	94789.42
Baseline Survey 14 September 2010			
Baseline Survey 8 September 2011			
After Recharge Survey 5 September 2012			
11 September 2013 (0.5 m² Quadrat)			
11 September 2013 (4 m² Quadrat)		n/a	
1 September 2014 (0.5 m² Quadrat)			
1 September 2014 (4 m² Quadrat)		n/a	

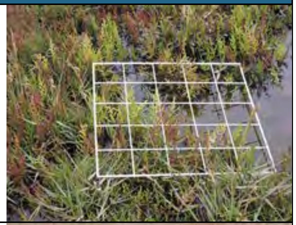
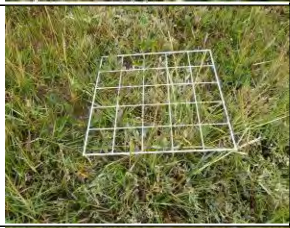
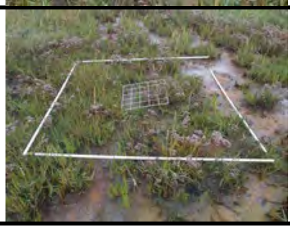
Saltmarsh Quadrat No	Quadrat No. 1	Quadrat No. 2	Quadrat No. 3
22 September 2015 (0.5 m^2 Quadrat)		n/a	
22 September 2015 (4 m^2 Quadrat		n/a	
9 September 2020 (0.5 m^2 Quadrat)		n/a	
9 September 2020 (4 m^2 Quadrat		n/a	

Table A12. Saltmarsh Quadrat Photographs 2010 to 2020 (Quadrats 4 to 6)

Saltmarsh Quadrat No	Quadrat No. 4	Quadrat No. 5	Quadrat No. 6
Marker Colour Code (used from 2012)			
Position X	435286.74	435305.84	435113.28
Position Y	94839.49	94926.81	94809.65
Baseline Survey 14 September 2010			
Baseline Survey 8 September 2011			
After Recharge Survey 5 September 2012			
11 September 2013 (0.5 m² Quadrat)			
11 September 2013 (4 m² Quadrat)			
1 September 2014 (0.5 m² Quadrat)			
1 September 2014 (4 m² Quadrat)			

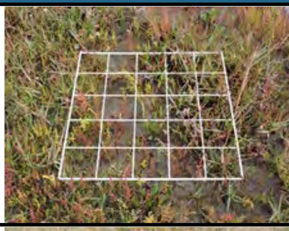
Saltmarsh Quadrat No	Quadrat No. 4	Quadrat No. 5	Quadrat No. 6
22 September 2015 (0.5 m^2 Quadrat)			
22 September 2015 (4 m^2 Quadrat			
9 September 2020 (0.5 m^2 Quadrat)			
9 September 2020 (4 m^2 Quadrat)			

Table A13. Saltmarsh Quadrat Photographs 2010 to 2020 (Quadrats 7 to 9)

Saltmarsh Quadrat No	Quadrat No. 7	Quadrat No. 8	Quadrat No. 9
Marker Colour Code (used from 2012)			
Actual Position X	435135.18	435205.51	435246.84
Actual Position Y	94856.50	94930.69	94930.29
Baseline Survey 2 14 September 2010			
Baseline Survey 3 8 September 2011			
Post-Recharge Survey 4 5 September 2012			
11 September 2013 (0.5 m² Quadrat)			
11 September 2013 (4 m² Quadrat)			
1 September 2014 (0.5 m² Quadrat)			
1 September 2014 (4 m² Quadrat)			

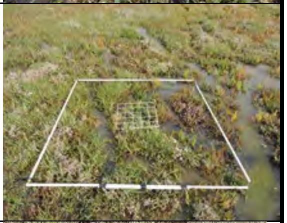
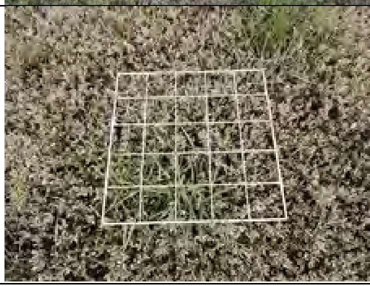
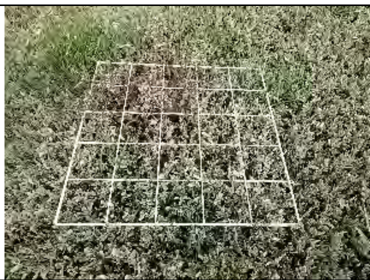
Saltmarsh Quadrat No	Quadrat No. 7	Quadrat No. 8	Quadrat No. 9
22 September 2015 (0.5 m² Quadrat)			
22 September 2015 (4 m² Quadrat)			
9 September 2020 (0.5 m² Quadrat)			
22 September 2020 (4 m² Quadrat)			

Table A14. Saltmarsh Quadrat Photographs 2010 to 2020 (Quadrats 10 and 11)

Saltmarsh Quadrat No	Quadrat No. 10	Quadrat No. 11
Marker Colour Code (used from 2012)		
Actual Position X	435268.85	
Actual Position Y	94950.13	
Baseline Survey 2 14 September 2010		**n/a**
Baseline Survey 3 September 2011		**n/a**
Post-Recharge Survey 4 5 September 2012		**n/a**
11 September 2013 (0.5 m^2 Quadrat)		
11 September 2013 (4 m^2 Quadrat)		

Saltmarsh Quadrat No	Quadrat No. 10	Quadrat No. 11
1 September 2014 (0.5 m^2 Quadrat)		
1 September 2014 (4 m^2 Quadrat)		
22 September 2015 (0.5 m^2 Quadrat)		
22 September 2015 (4 m^2 Quadrat		
9 September 2020 (0.5 m^2 Quadrat)		
22 September 2020 (4 m^2 Quadrat)		

Contact Us

ABPmer

Quayside Suite,
Medina Chambers
Town Quay, Southampton
SO14 2AQ

T +44 (0) 23 8071 1840
F +44 (0) 23 8071 1841
E enquiries@abpmer.co.uk

www.abpmer.co.uk

ABP mer