Lymington Harbour Commissioners

Lymington Saltmarsh Recharge by Bottom Placement: 2021 Monitoring Report

Updated bathymetric survey review produced in fulfilment of Condition 5.2.11 of Marine Licence L/2014/00396/2

May 2021





Innovative Thinking - Sustainable Solutions

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Summary

This document was produced to discharge Condition 5.2.11 of Marine Licence L/2014/00396/2. This licence, issued by the Marine Management Organisation (MMO), provides consent for Lymington Harbour Commissioners' (LHC) to carry out '*disposal of dredged material and beneficial reuse (saltmarsh recharge) of material from Lymington Harbour*'

Condition 5.2.11 of this licence states that:

> *The licence holder must conduct a bathymetric survey of the saltmarsh recharge site prior to and upon completion of each campaign. A report with the findings of these surveys must be submitted to the MMO within 6 months of the completion of each campaign every two years.*
>
> *Reason: To monitor the impacts of the disposal activities on the area.*

The LHC's beneficial reuse site is located at the seaward edge of a rapidly eroding saltmarsh (referred to as Boiler Marsh) which currently protects Lymington Harbour. As required, this report reviews the findings from bathymetric surveys of this reuse site which were completed before and after the latest two dredge sediment recharge campaigns.

The two most recent recharge campaigns were carried out during the 2019/20 and 2020/21 winter periods. The bathymetric surveys of the reuse site, as reviewed here, were undertaken before and after these campaigns in September 2019, January 2020, September 2020 and January 2021. As an extra task. this report also reviews available topographic Light Detection and Ranging (LiDAR) data that is collected by the Environment Agency.

This is the second biennial report produced in fulfilment of Condition 5.2.11. The previous review (ABPmer, 2019) described conditions prior to and following the recharge campaigns in the 2017/18 and 2018/19 winters. It also summarised the results of all the preceding physical and ecological monitoring up until the January 2019 bathymetric survey.

The results show that much of the sediment is remaining *in situ* at the placement location and there is a progressive build-up of sediment at the site. One sign of this is that the locations where sediment is being placed has very slightly adjusted as a result. As certain parts of the site become shallower and less accessible to the hopper barges, sediment is increasingly being placed slightly seaward of, or to the east of, previous locations.

There are losses of sediment between the winter campaigns, as was expected. The extent of these losses varies between years and is influenced by the composition of the sediment and the deposit location. During 2020 (between the two most recent campaigns), the sediment was again relatively stable, and more than half was retained. It total, around 40,000 m^3 of material has been placed here over the last seven years and around half of this was still in place at the time of the most recent surveys.

The ongoing and regular recharge placements have been effective in creating a raised mudflat bed around 1.5 ha in size. As described within the previous biennial report, the continued regular/annual placement of sediment at this deposit site is expected to further help to maintain (and potentially build up) this feature, although its size and persistence will always be influenced by a range of factors, including the consolidation of the deposits as well as the occurrence and nature of storm events.

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1 Introduction

1.1 Report background

This document has been produced to discharge Condition 5.2.11 of Marine Management Organisation (MMO) Marine Licence L/2014/00396/2. This licence provides consent for the '*disposal of dredged material and beneficial reuse (saltmarsh recharge) of material from Lymington Harbour*', and Condition 5.2.11 states that:

> *'The licence holder must conduct a bathymetric survey of the saltmarsh recharge site prior to and upon completion of each campaign. A report with the findings of these surveys must be submitted to the MMO within 6 months of the completion of each campaign every two years.*
>
> *Reason: To monitor the impacts of the disposal activities on the area.'*

Under this licence, the Lymington Harbour Commissioners (LHC) are placing a maximum of 10,000 tonnes of dredged sediment at a registered disposal ground each winter. This new deposit ground, which was first licensed for the 2017/18 winter, lies directly in front of the marshes that protect Lymington Harbour (see Figure 1 and Image 1 and Image 2).

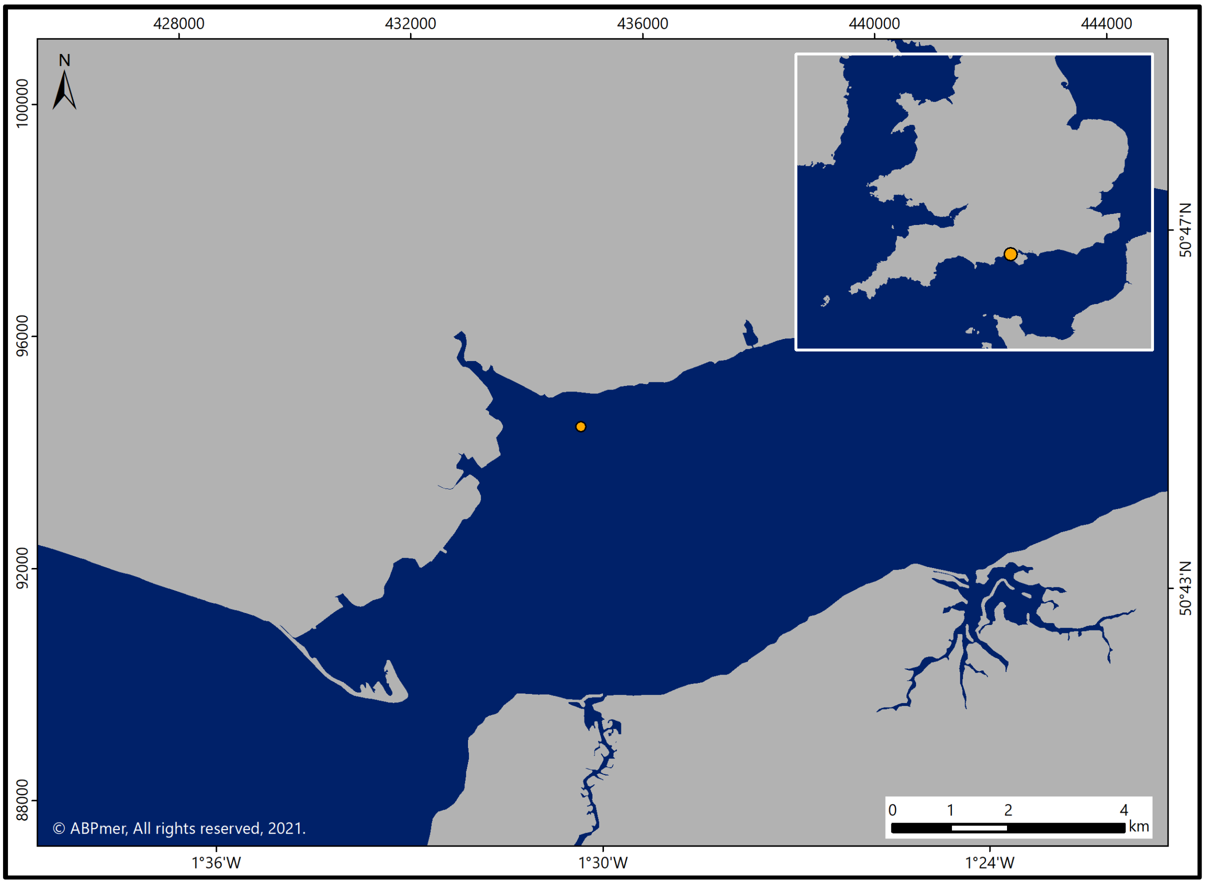


Figure 1. Location of the LHC licensed beneficial reuse site

The marshes at the deposit site (and adjacent) are rapidly eroding, and sediment is being progressively exported from the area as they deteriorate. This reuse work is therefore being done to help physically protect these declining habitats, as well as enhance the supply and retention of sediment in the area.

This 'alternative/beneficial use of dredged material' activity is scheduled to occur annually from 2017/18 to 2023/24. It is carried out over the winter months; and, so far, four annual campaigns have been completed under the extant marine licence. These campaigns were undertaken during the winter months of 2017/18, 2018/19, 2019/20 and 2020/21.

In fulfilment of Condition 5.2.11, the LHC carries out regular bathymetric surveys of the sediment deposit site. There have been eight such surveys completed between June 2017 and January 2021 (see Section 2 for detail). Prior to this work, the LHC also completed six bathymetric surveys between October 2014 and January 2017 as part of an earlier marine licence application and implementation process (MMO Ref L/2014/00084/6). This preceding licence provided permission for an initial series of annual saltmarsh recharge trials that were conducted between 2014 and 2016. Previous survey reports were prepared to accompany this work (Black and Veatch, 2016 and 2017).

Source Landwatch UAV survey for Solent Forum (February 2019)

Image 1. View of Boiler Marsh in front of Lymington harbour

Results from all the surveys undertaken up to January 2019 were also reviewed in the first biennial report prepared and issued to the MMO under licence L/2014/00396/2 (ABPmer, 2019). The previous review described conditions prior to and following the recharge campaigns in the 2017/18 and 2018/19 winters. The 2019 biennial report also summarised all the results of all the preceding physical and ecological monitoring up until the January 2019 bathymetric survey. To provide the next required two-yearly report, this report now reviews results from the latest four surveys, with the update encompassing the latest recharge campaigns carried out during the 2019/20 and 2020/21 winter periods.

1.2 Project background

In recent years, LHC have carried out ‘bottom-placement’ recharge work in front of the Boiler Marsh complex at the mouth of the Lymington Estuary (see Figure 1 and Image 1 and Image 2), as an alternative to placing dredge arisings at a licensed subtidal disposal ground at ‘Hurst Fort’ (Ref. WI080). For this recharge work, dredged material (silt) is loaded into barges by back hoe, at the channel and mooring dredge areas in the inner Lymington Estuary. Subsequently, the barges move to the new disposal ground and discharge the sediment by opening the hopper doors in the bottom of the barge, before then returning to the dredging site(s) to collect more sediment.

The aim of these campaigns is to place sediment as high up the intertidal area as is feasible, so that it has the greatest chance of either feeding the adjacent marsh or acting as a gradually eroding ‘sacrificial bund’ feature to temporarily shield this part of the inner marsh from erosion.

Image 2. Close up view of the beneficial deposit ground in front of Boiler Marsh

To help achieve these aims, and to extend the amount of time that the deposited sediment remains *in situ*, the disposal is undertaken only on the larger high tides. To also help with these objectives, an effort is made to place each new deposit as close as possible to, or even on top of, previous ones.

This approach is also designed maximise the amount of sediment that can be placed within the deposit ground. To achieve this, the barges are guided into their deposit location by post markers. The deposition process itself lasts only a few minutes.

As outlined above, the recharge work at Boiler Marsh was licensed in two phases, as follows:

- **As initial trials for three years under a licence dated 13 November 2015:** Consent for the disposal of dredged material as a three-year beneficial use trial that started in late 2014 and completed in late 2016 (Marine Licence Ref L/2014/00084/6); and
- **As ongoing work for seven years under licence dated 28 September 2017:** Variation consent to dredge into the lower river and for the annual beneficial bottom placement of up to 10,000 tonnes of dredged material at the established saltmarsh recharge site, until December 2024 (Marine Licence L/2014/00396/2).

A summary of these campaigns, including the volumes of sediment used, is presented in Table 1.

Table 1. Intertidal bottom placement campaigns at Lymington over the past seven years[1]

Years	Quantity (Wet Tonnes)	Quantity (m^3)	Notes	MMO Licence References
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	
2019/20 (Nov to Jan)	8,740	7,600	Year 6 Main Licence	
2020/21 (Nov to Jan)	7,211	6,270	Year 7 Main Licence	

1.3 Report structure

This report is structured as follows

- **Introduction** (this section): Provides background details about the licensing and surveying programme;
- **Results** (Section 2): Summarises past survey findings and is divided into the following sub-sections:
  - Previous surveys (2014 to 2019) (Section 2.2);
  - Latest bathymetric surveys (2019 to 2021) (Section 2.3); and
- **Conclusions** (Section 3): Outlines the key survey findings.

1 Where volumes were made available as tonnages only for the LHC bottom placements, a 1.3 conversion factor for 'soft silt mud' (HELCOM, 2015) is used to provide an estimate in both units.

2 Survey Results

2.1 Introduction

In this section, the findings from the four most recent bathymetric surveys (carried out in September 2019, January 2020, September 2020 and January 2021) are analysed and compared against previous survey results[2]. Following an approach adopted for the previous biennial report (ABPmer, 2019), this review also includes extra analysis of available topographic LiDAR data collected by the Environment Agency. Further details about the surveys and the data analysis and presentation work are presented below.

2.1.1 Bathymetric surveys and analysis

The extents of the bathymetric surveys are shown on Figure 2. This includes the eight most recent bathymetric surveys (conducted under the extant marine licence), as well as the baseline survey in 2014. This figure also shows the sediment disposal locations for each of the four annual sediment placement campaigns under the extant marine licence. Additional charts displaying the echosounder survey lines and bathymetry contours from these surveys are also presented in Appendix A.

In addition, Figure 2 shows the position of three transect lines from which topographic profiles were extracted to facilitate between-survey comparisons. The positions of these three transects are consistent with previous monitoring reports and the resulting topographic cross-sections are presented in Figure 3 to Figure 5 (see Section 2.3).

The broader spatial changes in bed levels over the survey area are also illustrated in Figure 6 to Figure 12 (see Section 2.3). These figures include descriptions of the bed level changes before and after each winter dredge campaign, as well as changes over the spring, summer and autumn months of 2018 (Figure 7) and 2020 (Figure 11). Finally, Figure 12 (in Section 2.3) describes the net change in bed levels between the baseline survey in October 2014 and the most recent survey in January 2021.

All the plots in Figure 6 to Figure 12 are displayed over a background image of the intertidal area that was obtained from UAV (Unmanned Aerial Vehicle) survey. This survey was done in February 2019 by Landwatch Consulting to inform the Solent Forum's 'Beneficial Use of Dredging in the Solent Project' (BUDS) project (ABPmer, 2020). This aerial view is also shown as Image 1.

On the bathymetry difference plots, any changes within the ±0.2 m range are not displayed. This was done to avoid having too much 'noise' in the data and to ensure that only definite and measurable changes are described. The ±0.2 m range was used based on a consideration of both the vertical accuracy of bathymetric survey equipment[3] and inherent variabilities associated with interpolation of point survey data in a GIS environment.

In many figures there are still thin lateral bars of colour in the seaward portion of the study area. These are most likely 'noise' generated by the digital processing of the surveys as well as a reflection of general sediment movements in a dynamic location.

2 All the bathymetric surveys were carried out by Shoreline Surveys Ltd and a consistent survey methodology was applied throughout the monitoring programme.

3 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.

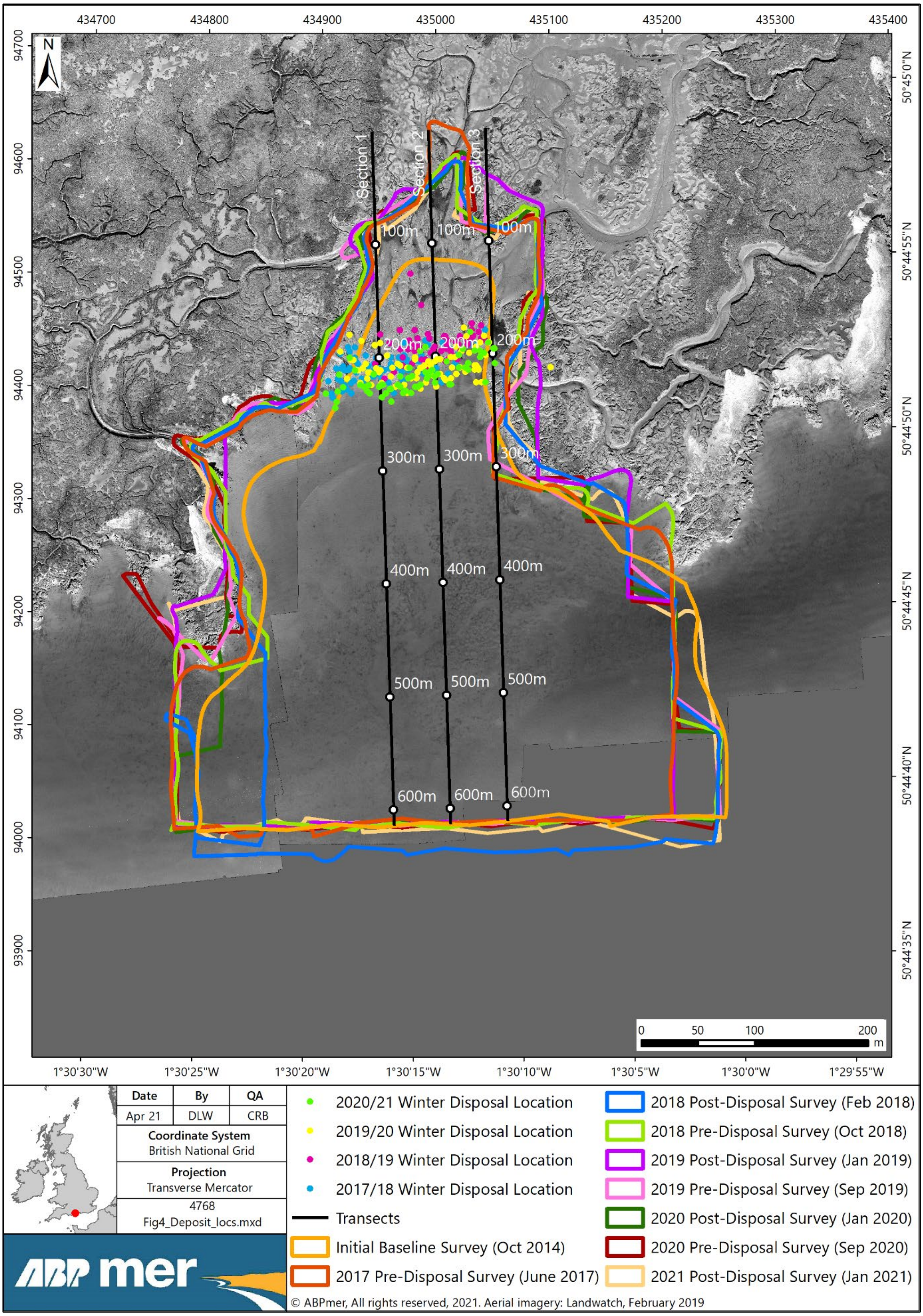


Figure 2. **Extent of bathymetric surveys with location of deposit sites and transects**

2.1.2 Extra LiDAR surveys and analysis

Following the methods applied in the preceding review (ABPmer, 2019), LiDAR data was also analysed. In this case, the results from seven different surveys were used. These included data from two surveys conducted in 2007 and 2013, which was before any disposal work was carried out. It also includes five surveys which were undertaken in 2014, 2015, 2017, 2018 and 2020 when the bottom placement reuse initiative was underway. The most recent of these was collected in March 2020.

Using these datasets, a 'difference plot' was created which spatially illustrates the net bed elevation changes in the area between the 2007 and the 2020 surveys. This is shown at the top of Figure 13. The stated vertical accuracy of LiDAR data is around ±0.15 m, and so changes within this range are not displayed on the difference plot. To then compare the results from all these LiDAR surveys, data was extracted from a single transect across Boiler Marsh and including the LHC deposit location, to create a topographic profile. The transect position and the resulting cross section profiles are also shown in Figure 13 (see Section 2.3).

2.2 Previous surveys results (2014 to 2019)

The surveys undertaken between 2014 and 2019 included several bathymetric surveys, as well as analyses of benthic invertebrates and water quality conditions. They were carried out to describe the baseline conditions, inform marine licence applications, and evaluate the work in fulfilment of the marine licence conditions. The results of this past work were review by Black and Veatch (2016 and 2017) and ABPmer (2019). The findings are summarised below to provide a context for this latest review. For further details about the methods and the results, please refer to the original reports.

Over the 2014 to 2019 period, ten bathymetric surveys were carried out around the disposal site. These were undertaken before and after disposal campaigns as follows:

- October 2014 Pre-disposal survey (baseline);
- January 2015 Post-disposal survey;
- October 2015 Pre-disposal survey;
- December 2015 Post-disposal survey;
- September 2016 Pre-disposal survey;
- January 2017 Post-disposal survey;
- June 2017 Pre-disposal survey;
- February 2018 Post-disposal survey;
- October 2018 Pre-disposal survey; and
- Jan 2019 Post-disposal survey.

In their review of the bathymetric surveys undertaken at the reuse site up until January 2017, Black and Veatch (2017) found that a good proportion of the deposited sediment was staying in place and that the degree of persistence was influenced by the physical conditions at the deposit ground. A general seabed elevation increase was recorded of up to 0.6 m, and this increased to more than 0.7 m in relatively sheltered areas.

In some of the more exposed areas, Black and Veatch (2017) found only a minor difference in bed level compared with the pre-placement condition. This was attributed to the effects of wave and tidal action. On average, the authors recorded a rise in bed level of 0.36 m after September 2016, and an average difference of 0.66 m compared to the October 2014 baseline data.

The next four bathymetry surveys, undertaken between June 2017 and January 2019, were then reviewed by ABPmer (2019). The plots that were created to show the changes in bed elevation between surveys are reproduced as Figure 3 to Figure 8 in Section 2.3.

The 2019 review described how the behaviour of the deposited sediment and the resulting bathymetry changes were different over the 2017/18 and 2018/19 campaigns. A greater proportion of the deposited sediment was retained on site during the 2017/18 winter than was the case in 2018/19. The bed elevation increases at the placement site after deposition were around 0.6 m following the 2017/18 winter campaign, but lower (at around 0.15 m) during the 2018/19 winter. This was attributed, in part, to the placed sediment being less consolidated in 2018/19 and therefore more susceptible to being washed away. However, it would also have been related to less material having been deposited during the second of these two annual campaigns (i.e. 7,143 m^3 and 4,958 m^3 for 2017/18 and 2018/19 respectively).

In addition to these bathymetric surveys, a baseline intertidal benthic study was carried out by the Environment Agency in September 2016. This compared the benthic assemblages in the deposit ground after the first three trials with those at adjacent control locations. For this study, nine sediment cores were collected (using a 0.01 m^2 hand corer) to analyse the benthic invertebrates; samples were also taken to describe the sediment composition (Black and Veatch, 2017). It was found that macrofaunal abundance and diversity varied across the three sites and that the assemblages generally reflected the variable nature of the local environment.

During the 2015 trial, water quality analyses were also carried out. These were done by having a monitoring buoy deployed close to the recharge site (but below mean low water) which recorded turbidity, temperature and dissolved oxygen concentrations at ten-minute intervals from 27 October to 8 December 2015. From the data obtained it was concluded that the observed fluctuations in turbidity and dissolved oxygen were not directly related to placement activity, but instead were responses to tidal state and wind (Black and Veatch, 2017).

2.3 Latest bathymetry results (2019 to 2021)

The latest four bathymetry surveys (describing conditions on the disposal ground before and after the 2019/20 and 2020/21 disposal campaigns) were undertaken on the following occasions:

- September 2019 Pre disposal survey,
- January 2020 Post-disposal survey;
- September 2020 Pre-disposal survey; and
- January 2021 Post-disposal survey.

The outcome of these campaigns and the topographic changes they describe, are illustrated in the following figures (as further described in Section 2.1):

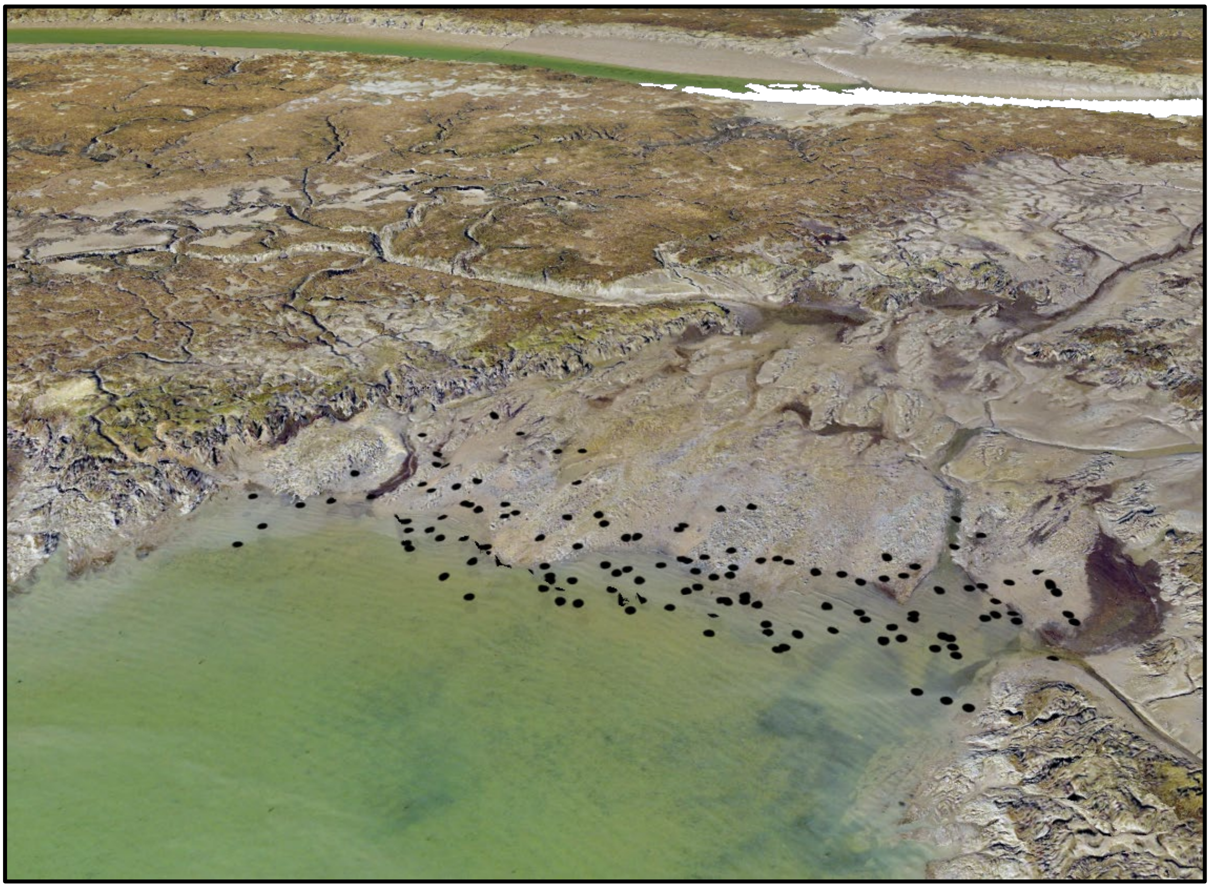
- Three bathymetry cross sections showing topographic profiles are presented in Figure 3 to Figure 5;
- Seven bathymetry ‘difference plots’ showing spatial changes in bed levels between various years are illustrated in Figure 6 to Figure 12; and
- A LiDAR ‘difference plot’ that includes a long cross-shore profile across Boiler Marsh and the deposit area Figure 13.

During the deposit campaigns, there were again signs of sediment persistence as well as evidence of a continual increase in the overall volume of sediment being retained on site over time. This is evident in Figure 9 and Figure 10, which show the raised bed elevations from each of the two campaigns. The deposits cover an area of around 1 ha each time. The collective result of all the deposits made at this site is that an area of about 1.5 ha has been raised by over 1 m above baseline bed levels; this is indicated by Figure 3, Figure 4 and Figure 12.

The changes over the last two winters are also shown in more detail by the cross-sections in Figure 3 to Figure 5. They show that sediment was placed to depths of between 0.5 to 0.6 m across the accessible seaward edge of the disposal ground during both winters[4].

There are also signs of some shallower placements, around 0.3 m deep, at positions further inshore during in the 2019/20 winter (see Figure 3, Section 1, chainages 165 to 200 m). This is where bed elevations are higher, due to past deposits, and these sites will only be accessible on the largest tides. These higher areas were probably inaccessible during the 2020/21 winter because much of the sediment that was placed in 2019/20 was still in place by the start of the following campaign in September 2020. Between the 2019/20 and 2020/21 campaigns, the 0.5 m to 0.6 m deep layers of sediment that had been placed here over previous deposits had dropped by around 0.1 to 0.3 m. This means that more than half of the placed sediment was still at the placement site by September 2020.

It is apparent from Figure 9 and Figure 10, as well as the disposal points in Figure 2, that hopper barges are having to deposit progressively further seaward of previous placements as the inshore areas become less accessible/higher. Also, the sediment is increasingly being placed across the full width of the disposal area and into the eastern side, whereas in the first campaign, the placements were mainly in the western section (see Figure 6). This is further illustrated in Image 3, which shows the location of the 2019/20 and 2020/21 deposit sites laid over a 3D image of the deposit ground.



ABPmer image using Landwatch aerial photo from February 2019 laid over 2020 Lidar and 2021 bathymetry data

Image 3. Placement site showing deposit locations during 2019/20 and 2020/21 campaigns

[4] In the 2019/20 winter, around 7,600 m³ sediment was deposited (see Table 1) in 80 discrete locations. In 2020/21 it was 6,270 m³ in 66 locations

This change in the deposition locations is itself encouraging. It further reflects the fact that large proportions of the previous deposits are remaining in place and reducing the water depths in the areas closest to the marsh edge.

2.3.1 Additional LiDAR results (2007 to 2020)

The results of the LiDAR analyses (see Figure 13 and Image 4) further support the findings of the bathymetry survey analysis. It describes the area where sediment has been placed, and remained *in situ,* by comparing bed elevation changes between 2013 and 2020. Part of the deposit site is visible as the blue area on the upper image in Figure 13 that lies between chainage positions 680 m and 860 m on the transect.

The transect in Figure 13 shows that around 1 m depth of sediment has been added to the deposit site. It also illustrates the historic placements that were made between 2014 and 2018. In each case, the deposited area extends seawards as a result of the sequential sediment placements. This advancing of the deposit area has been described above and is also shown in the topographic outputs in Image 4.

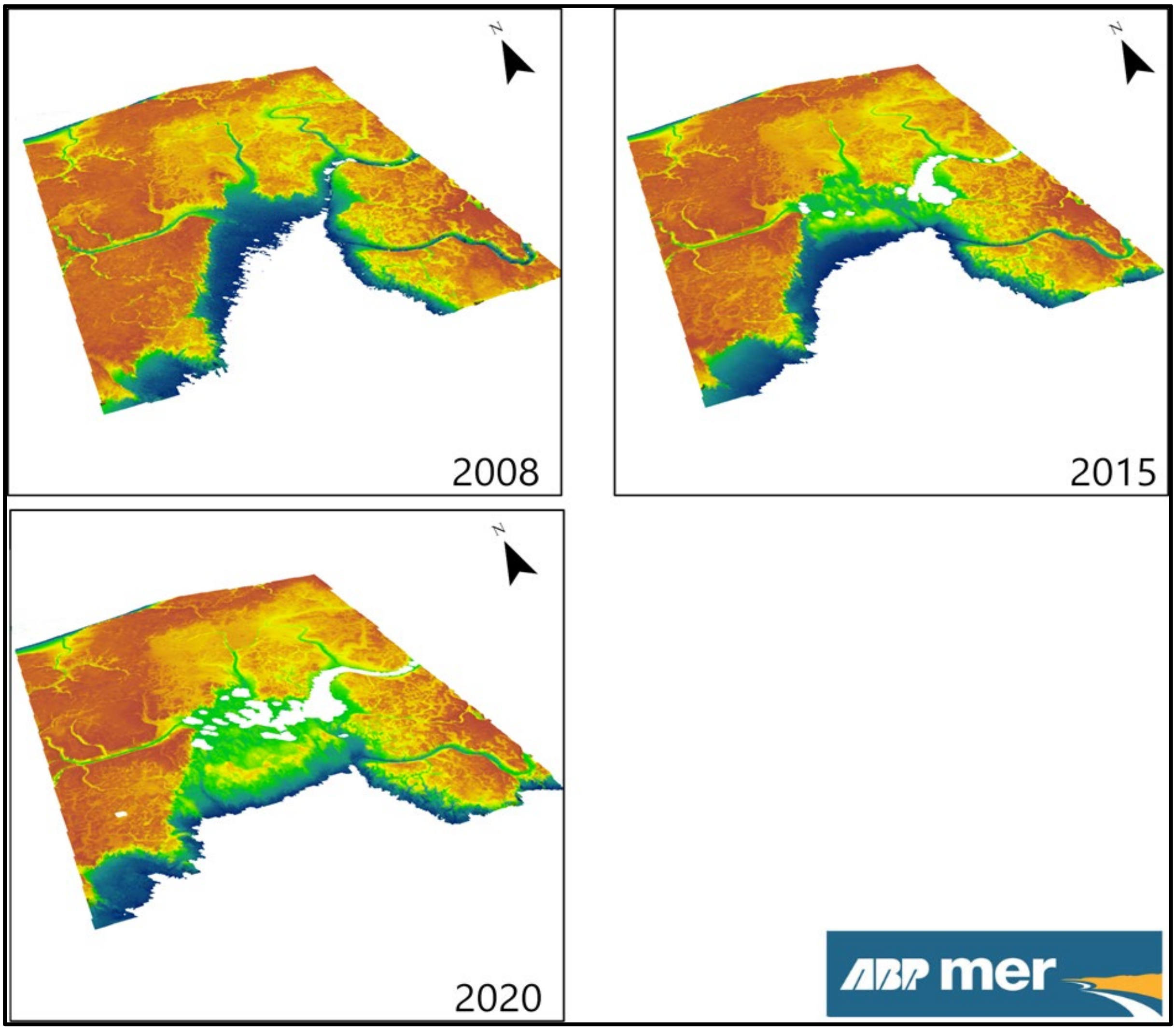


Image 4. Comparison of the placement site topography in 2008, 2015 and 2020

The latest LiDAR survey was undertaken in March 2020, at which time all depositions had taken place for the 2019/20 campaign. The cross-section shows how much of the previously deposited sediment is still in place, but also that most of the sediment which was deposited in 2017/18 has moved away and had all but disappeared by 2019/20.

Also, it indicates that only small amounts of additional sediment (at the 790 m chainage) were placed along the profile locations (and remained here) during the latest two winter campaigns. This will probably be because sediment is now being preferentially placed further to the east of the deposit ground, and not so much along this transect.

The most recent deposits from the 2020/21 campaign are not shown by this analysis. These will be described when future LiDAR surveys are undertaken under the regional monitoring programme.

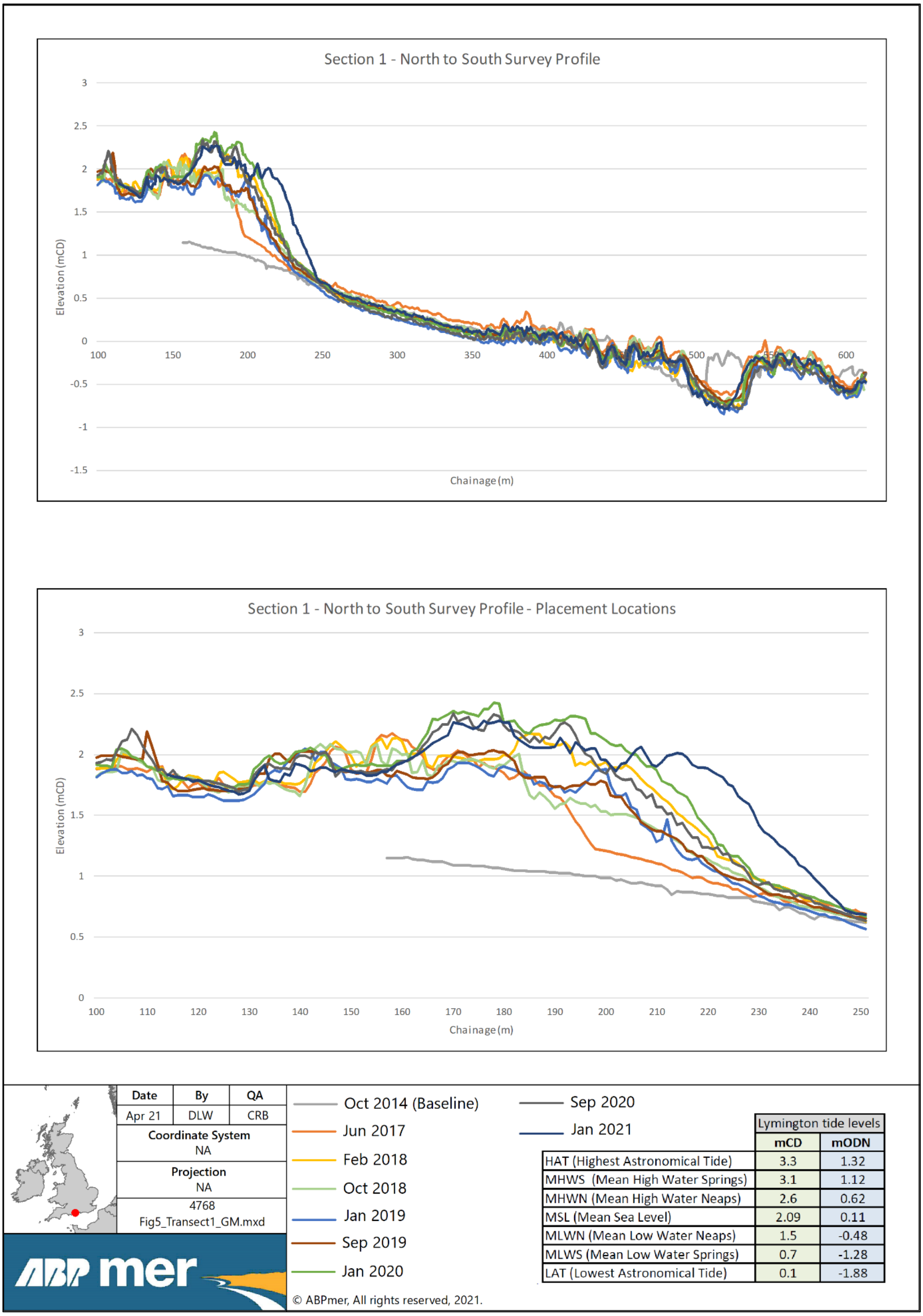
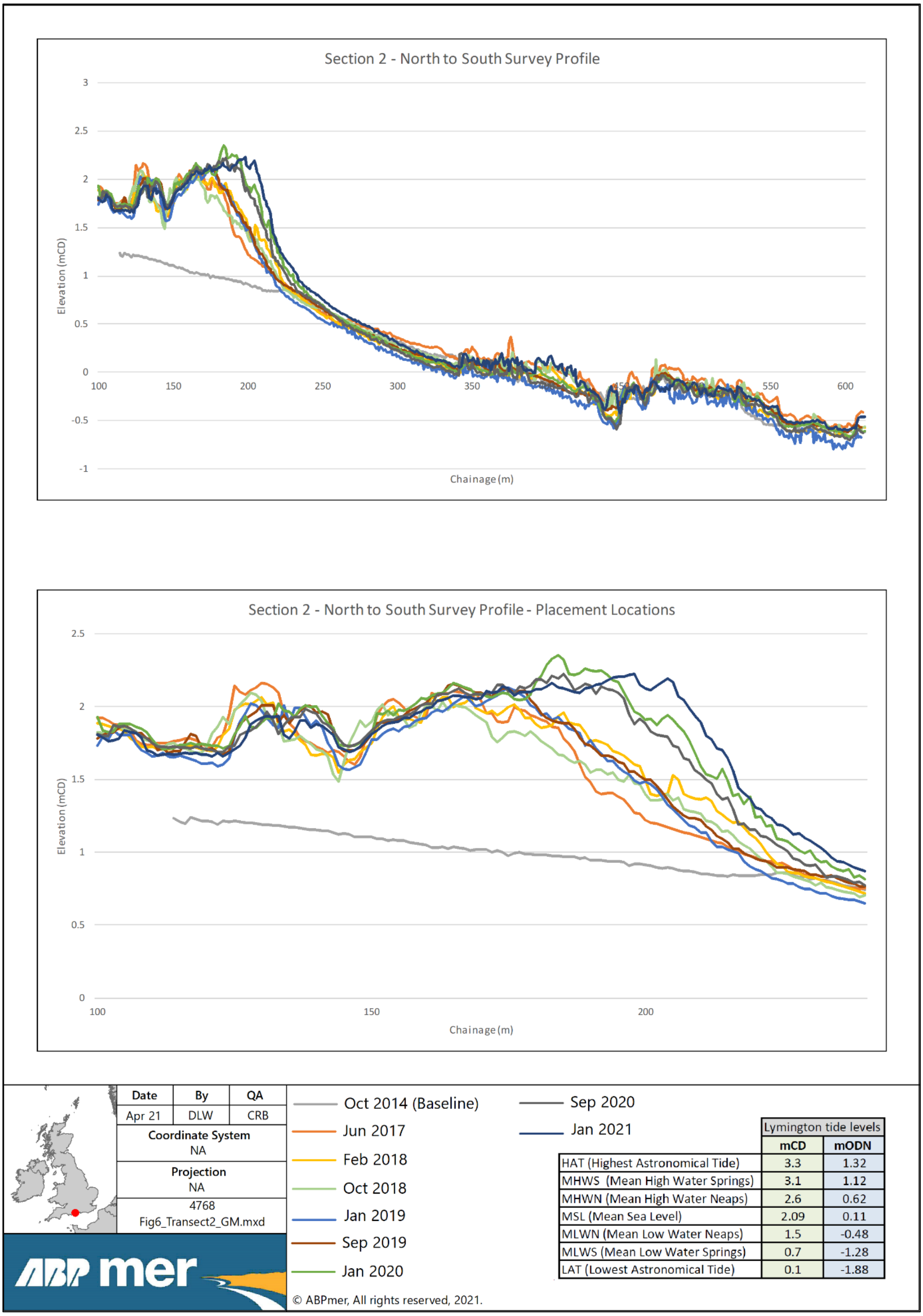


Figure 3. **Topographic profile along Section 1 (see Figure 2 for section location)**



Lymington tide levels	mCD	mODN
HAT (Highest Astronomical Tide)	3.3	1.32
MHWS (Mean High Water Springs)	3.1	1.12
MHWN (Mean High Water Neaps)	2.6	0.62
MSL (Mean Sea Level)	2.09	0.11
MLWN (Mean Low Water Neaps)	1.5	-0.48
MLWS (Mean Low Water Springs)	0.7	-1.28
LAT (Lowest Astronomical Tide)	0.1	-1.88

Figure 4. Topographic profile along Section 2 (see Figure 2 for section location)

Date	By	QA
Apr 21	DLW	CRB
Coordinate System NA		
Projection NA		
4768 Fig7_Transect3_GM.mxd		

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- Oct 2014 (Baseline)
- Jun 2017
- Feb 2018
- Oct 2018
- Jan 2019
- Sep 2019
- Jan 2020
- Sep 2020
- Jan 2021

Lymington tide levels	mCD	mODN
HAT (Highest Astronomical Tide)	3.3	1.32
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MLWS (Mean Low Water Springs)	0.7	-1.28
LAT (Lowest Astronomical Tide)	0.1	-1.88

Figure 5. Topographic profile along Section 3 (see Figure 2 for section location)

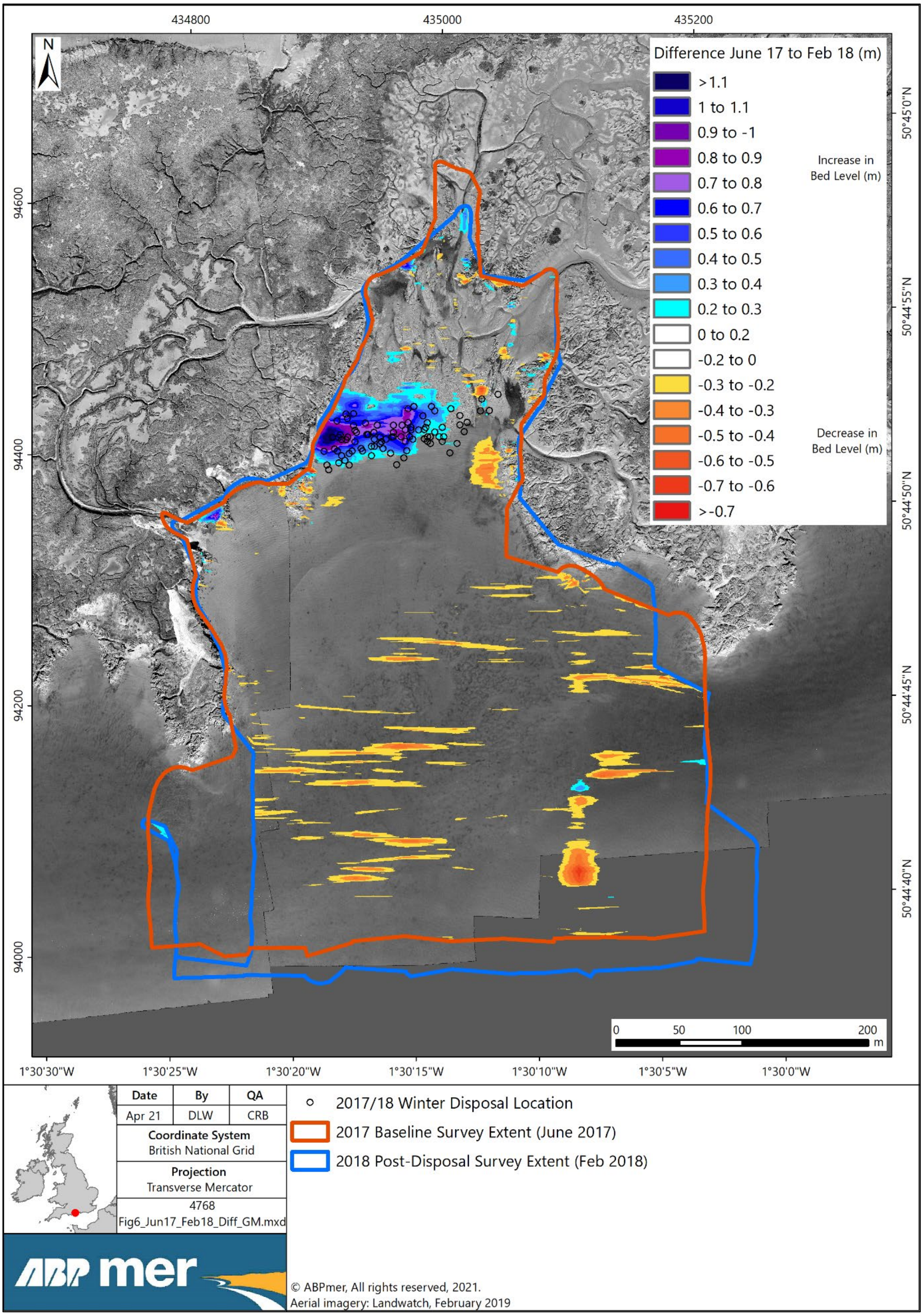
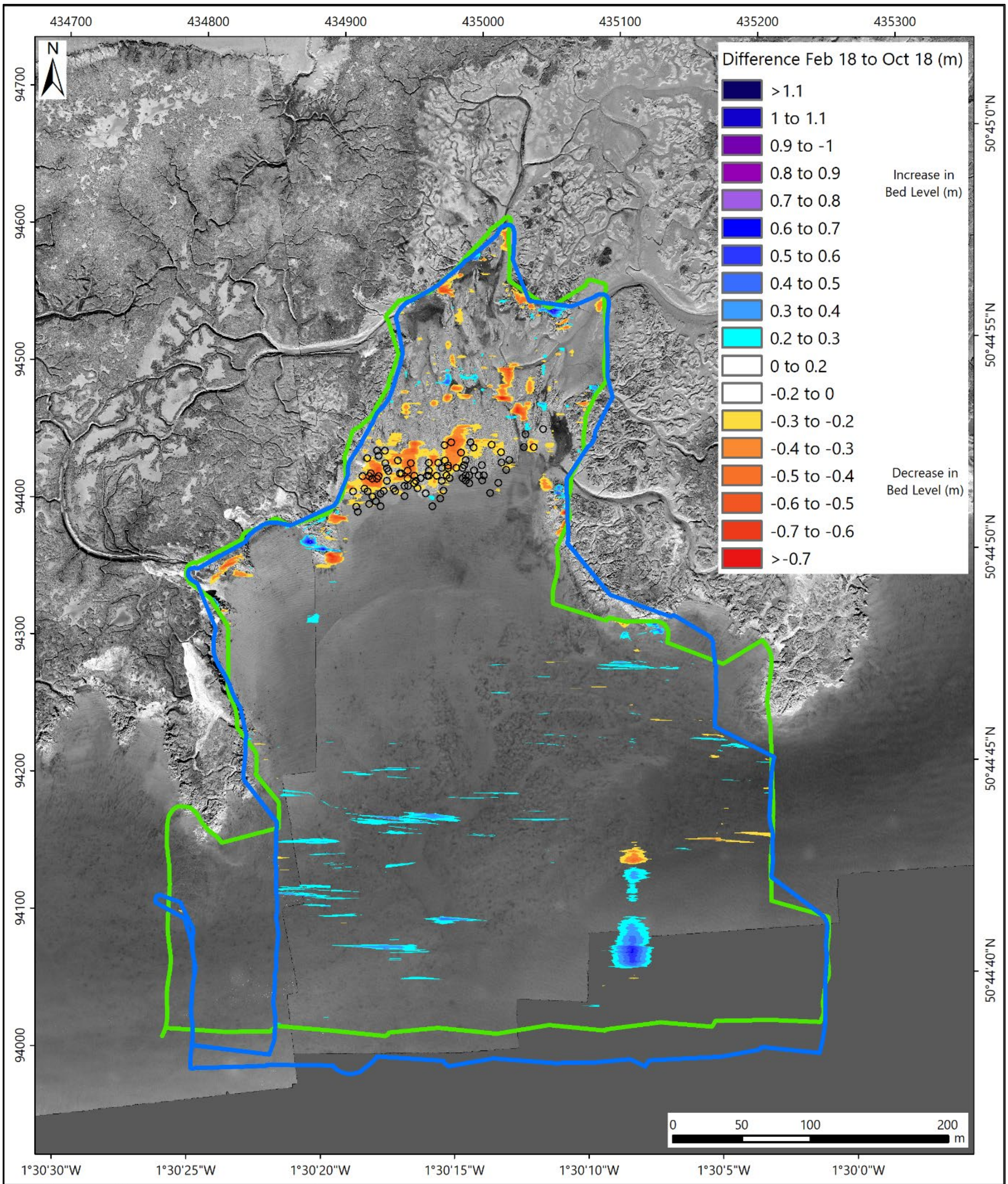


Figure 6. Bed level change before and after the 2017/18 disposal campaign



Date	By	QA
Apr 21	DLW	CRB
Coordinate System British National Grid		
Projection Transverse Mercator		
4768 Fig7_Feb18_Oct18_Diff_GM.mxd		

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Aerial imagery: Landwatch, February 2019

Figure 7. Bed level change between February and October 2018

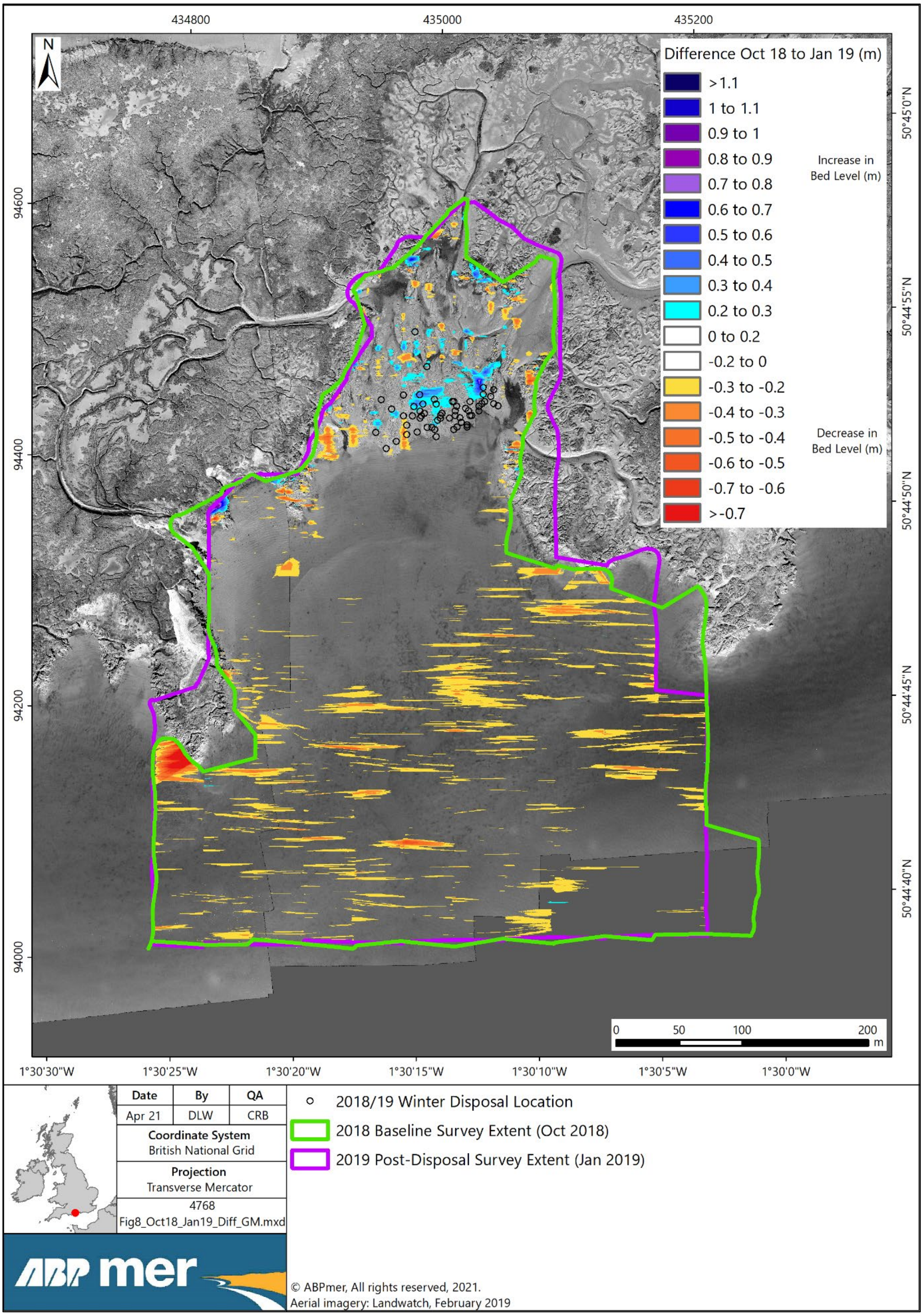

Figure 8. Bed level change before and after the 2018/19 disposal campaign

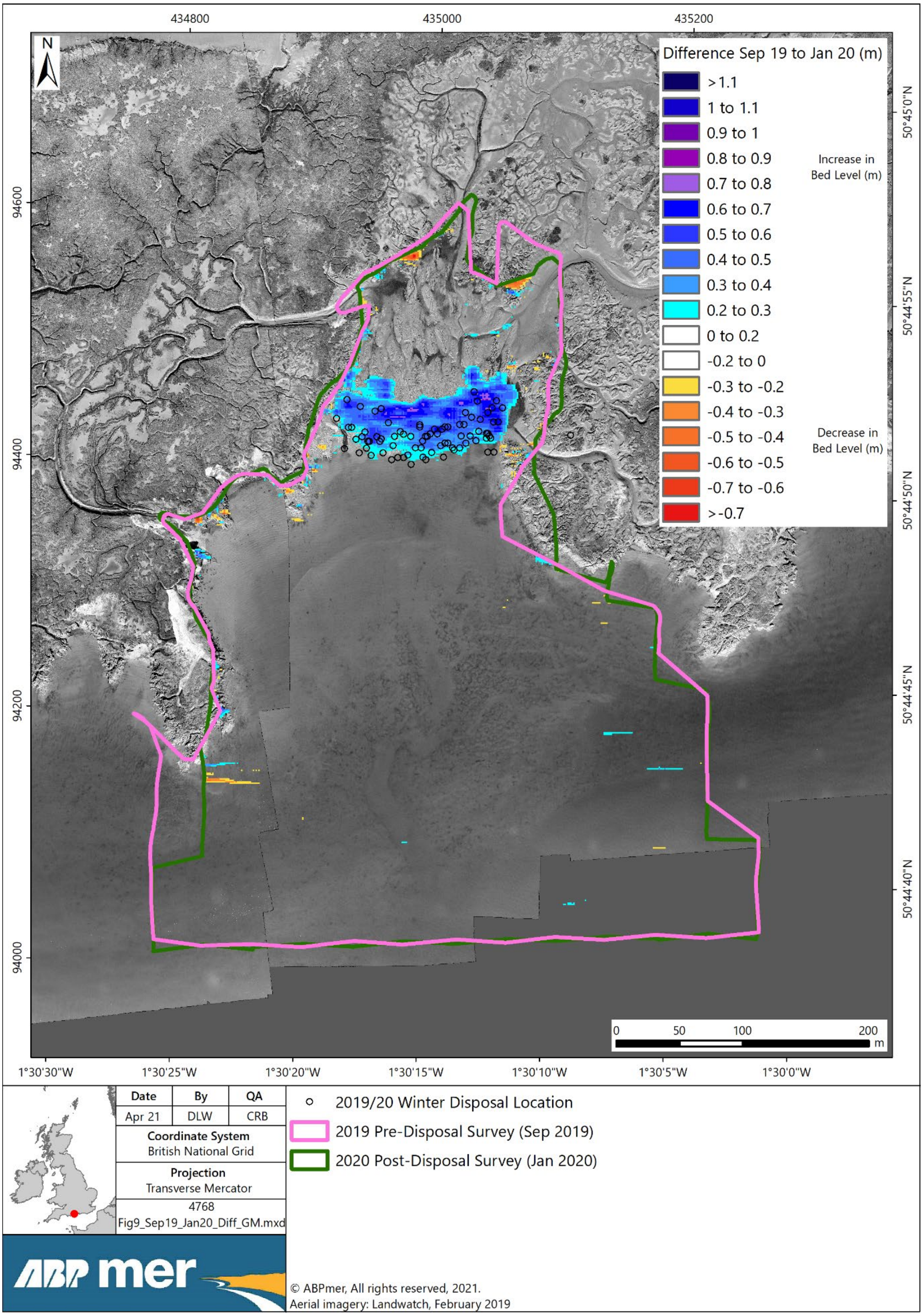

Figure 9. **Bed level change before and after the 2019/20 disposal campaign**

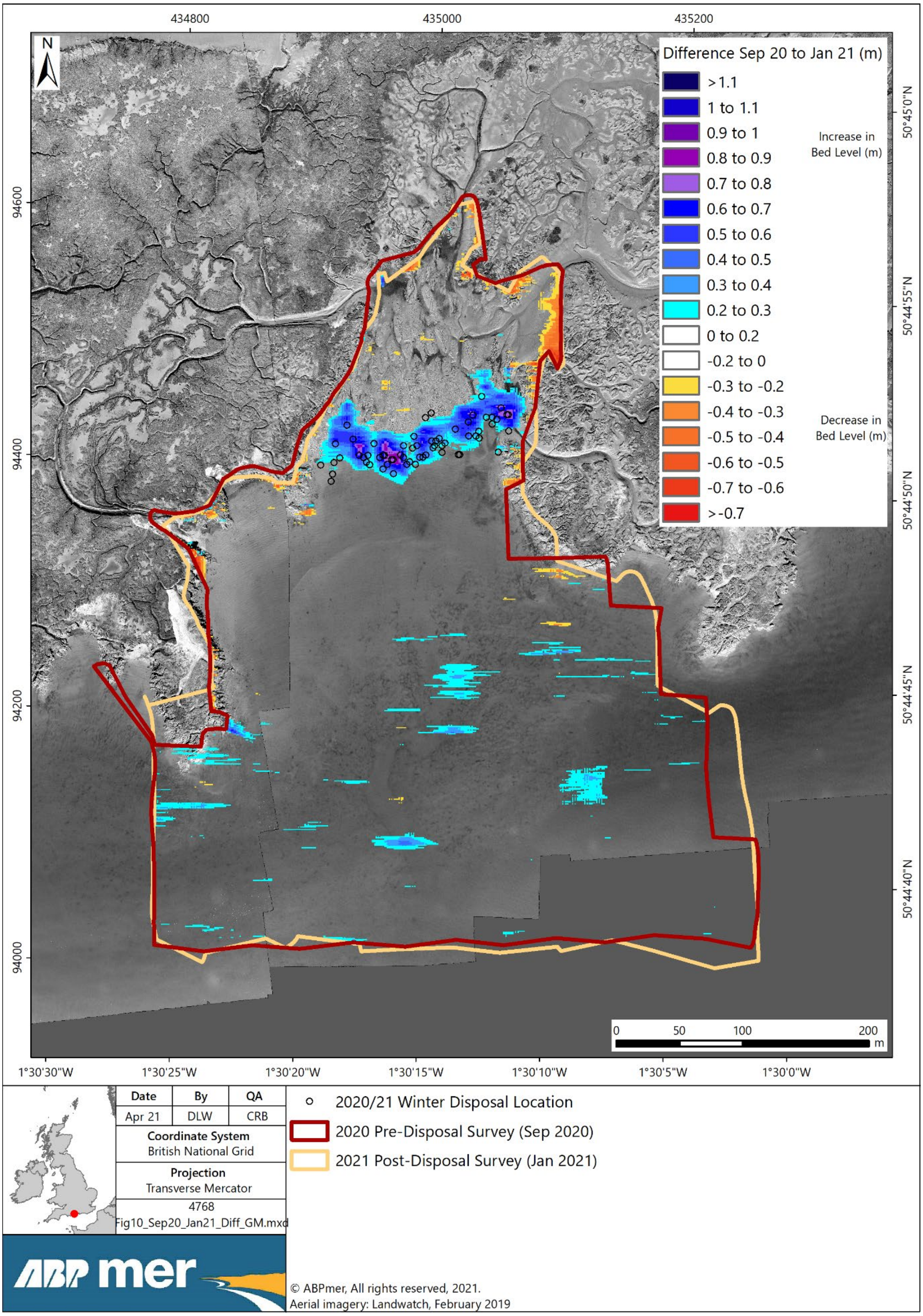

Figure 10. **Bed level change before and after the 2020/21 disposal campaign**

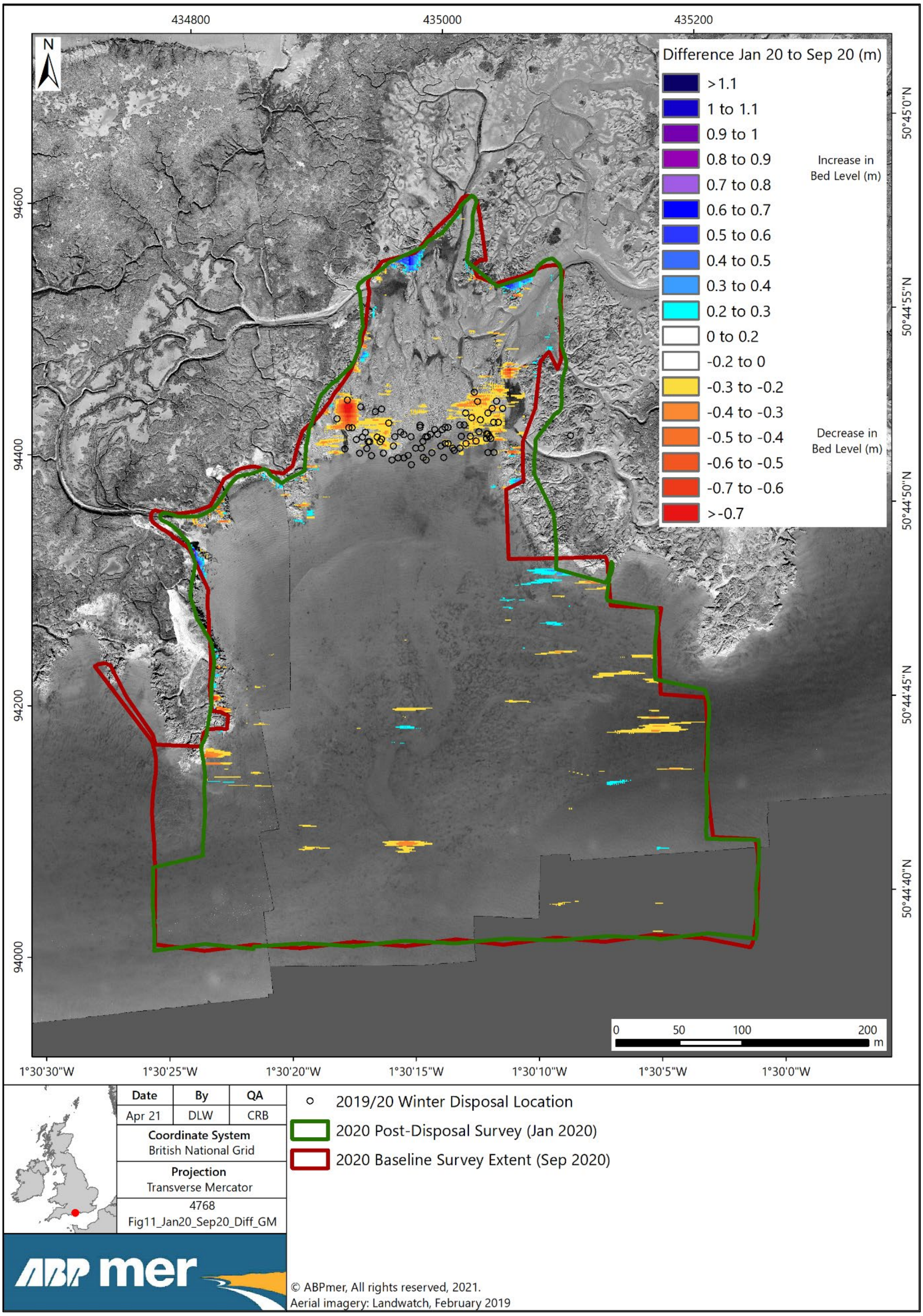

Figure 11. **Bed level change between January to September 2020**

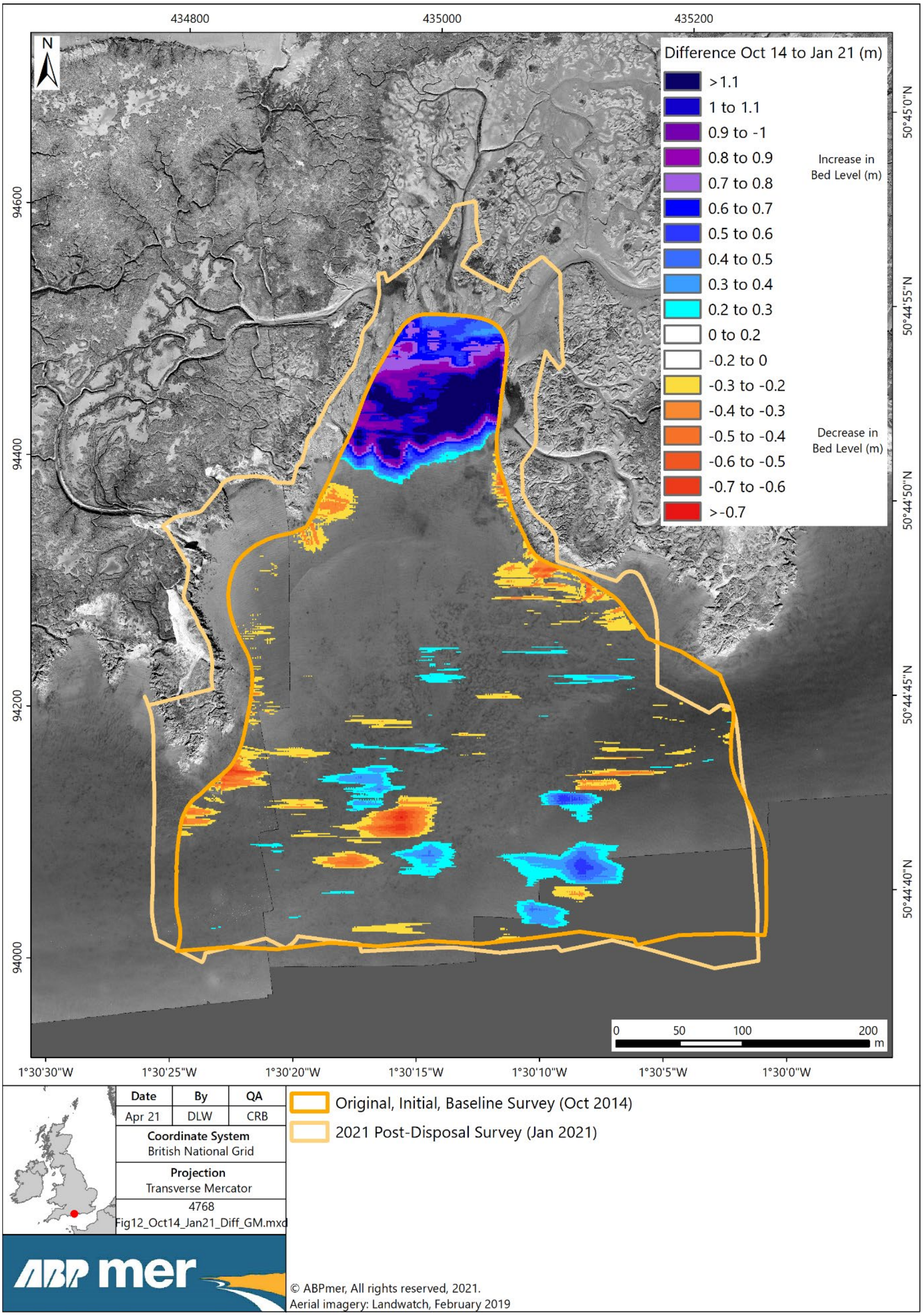

Figure 12 Net bed level change between October 2014 and January 2021 surveys

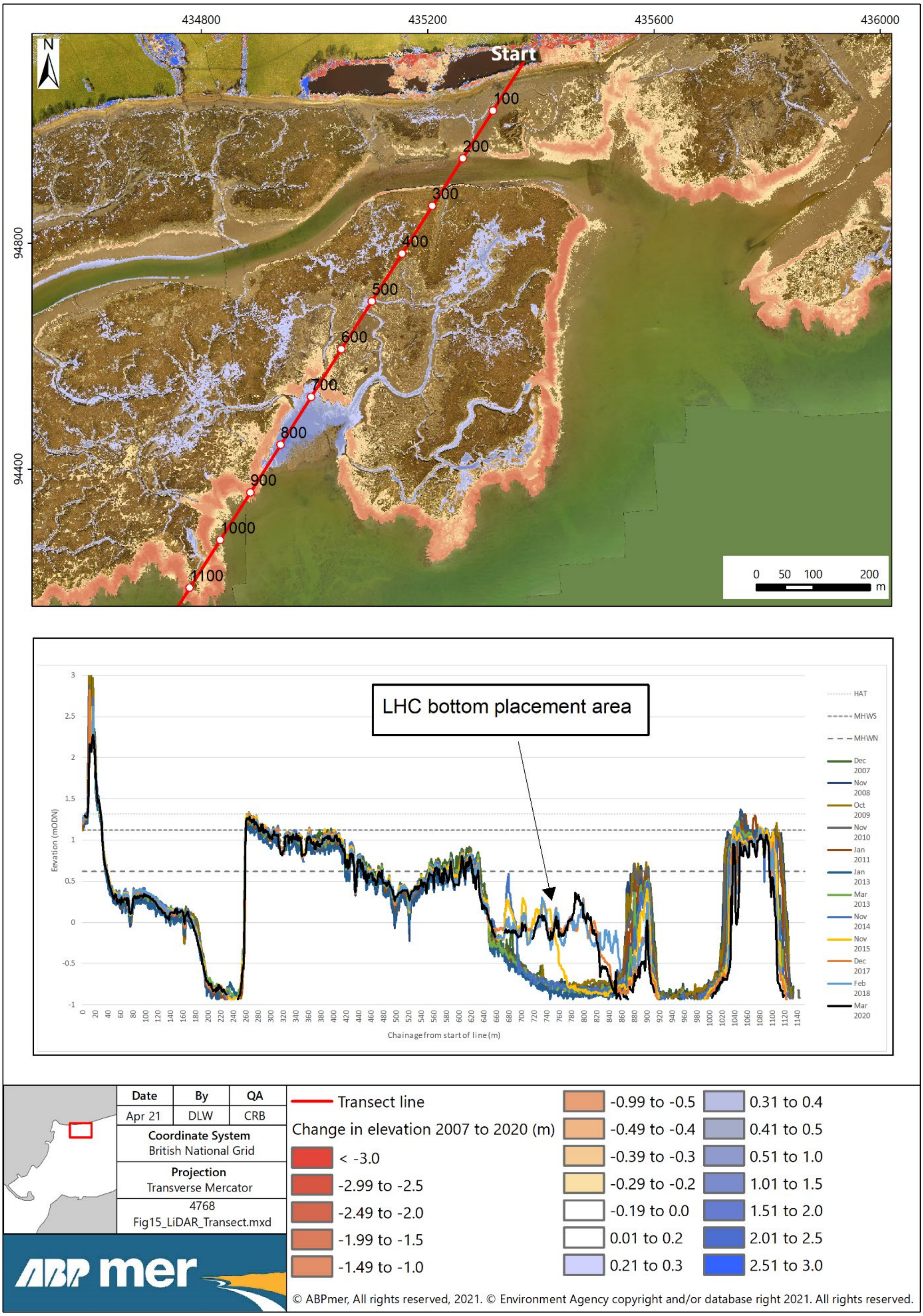

Figure 13. Changes in bed elevation across Boiler Marsh and deposit site using LiDAR data

3 Conclusions

This report presents results from the latest LHC monitoring of the Boiler Marsh beneficial reuse site. Four new bathymetric surveys were undertaken between 2019 and 2021 to describe the response of the deposited sediment during, and following, the 2019/20 and 2020/21 winter disposal campaigns.

The results show that much of the sediment is remaining *in situ* at the placement site and that there is a progressive build-up of sediment. One sign of this is that the locations where sediment is being placed have progressively been very slightly adjusted over time. As certain parts of the site become shallower and less accessible to the hopper barges, sediment is increasingly being placed slightly seaward, or to the east, of previous locations. The relative persistence of the material will have been helped by the manner in which the disposal work is being done, with deposits being placed on top of, or as close as possible to, previous ones.

There are losses of sediment between the winter campaigns, as was expected. The extent of these losses varies between years and is influenced by the composition of the sediment and the deposit location. During 2020 (between the two most recent campaigns), the sediment was again relatively stable, and more than half was retained. It total, around 40,000 m^3 have been placed here over the last seven years, and around half of this was still in place at the time of the most recent surveys.

The ongoing and regular recharge placements have been effective in creating a raised bed feature which is around 1.5 ha in size. This will be acting as 'sacrificial bund' feature that will be protecting parts of the inner marsh and helping to retain sediment in the area. There has still been no clear/detectable change to the marshes behind but benefits to the land-side areas from localised erosion reduction and/or improved bed accretion may become apparent (i.e. detectable by the bathymetry and LiDAR survey techniques) over time.

The continued regular/annual placement of sediment at this deposit site is expected to further help to maintain and potentially build up this feature, although its size and persistence will always be influenced by a range of factors, including the consolidation of the deposits as well as the occurrence and nature of storm events.

4 References

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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

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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 [last accessed March 2018]

5 Abbreviations/Acronyms

BUDS	Beneficial Use of Dredging in the Solent
CD	Chart Datum
GIS	Geographic Information System
HAT	Highest Astronomical Tide
HELCOM	Baltic Marine Environment Protection Commission, (aka Helsinki Commission)
IHO	International Hydrographic Organization
LAT	Lowest Astronomical Tide
LHC	Lymington Harbour Commissioners
LiDAR	Light Detection and Ranging
MHWN	Mean High Water Neaps
MHWS	Mean High Water Spring
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MSL	Mean Sea Level
ODN	Ordnance Datum Newlyn
UAV	Unmanned Aerial Vehicle

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Appendix



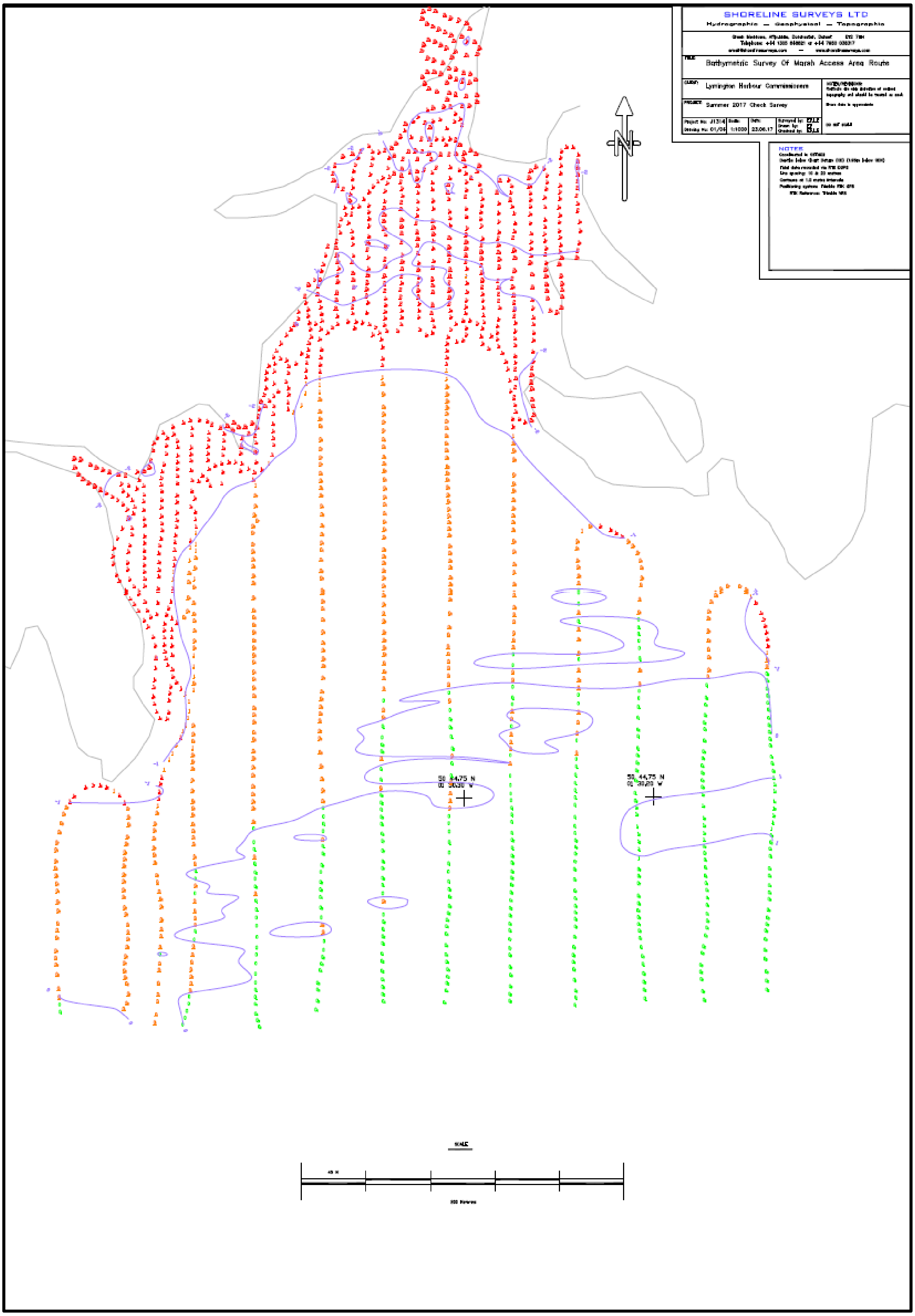


Innovative Thinking - Sustainable Solutions

A Bathymetric Charts

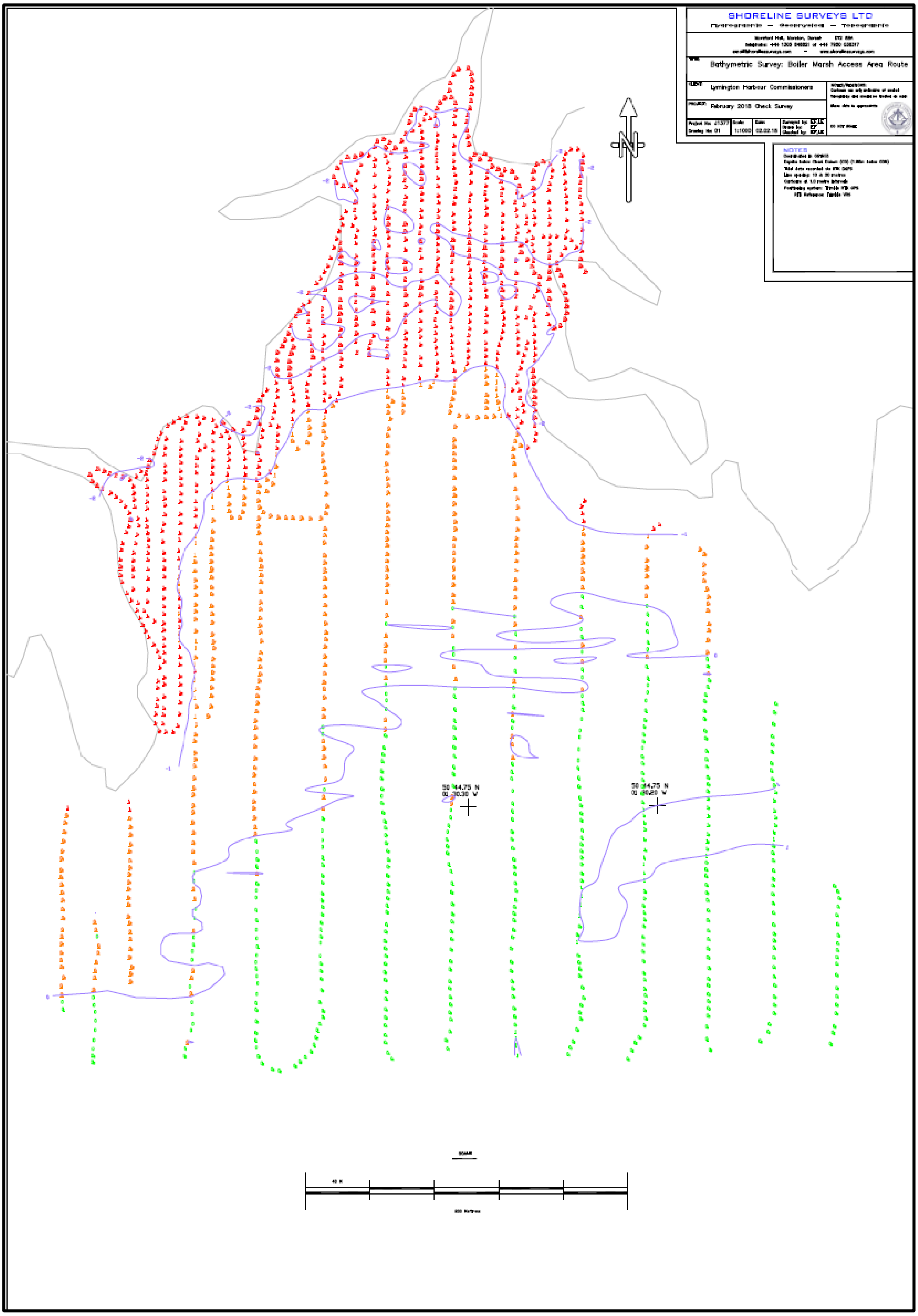
Eight survey charts produced by Shoreline Surveys Ltd. are displayed below (Figure A1 to Figure A8). These describe the results of the following bathymetric surveys:

- June 2017 Pre disposal;
- February 2018 Post disposal;
- October 2018 Pre disposal;
- January 2019 Post disposal.
- September 2019 Pre disposal;
- January 2020 Post disposal;
- September 2020 Pre disposal; and
- January 2021 Post disposal.



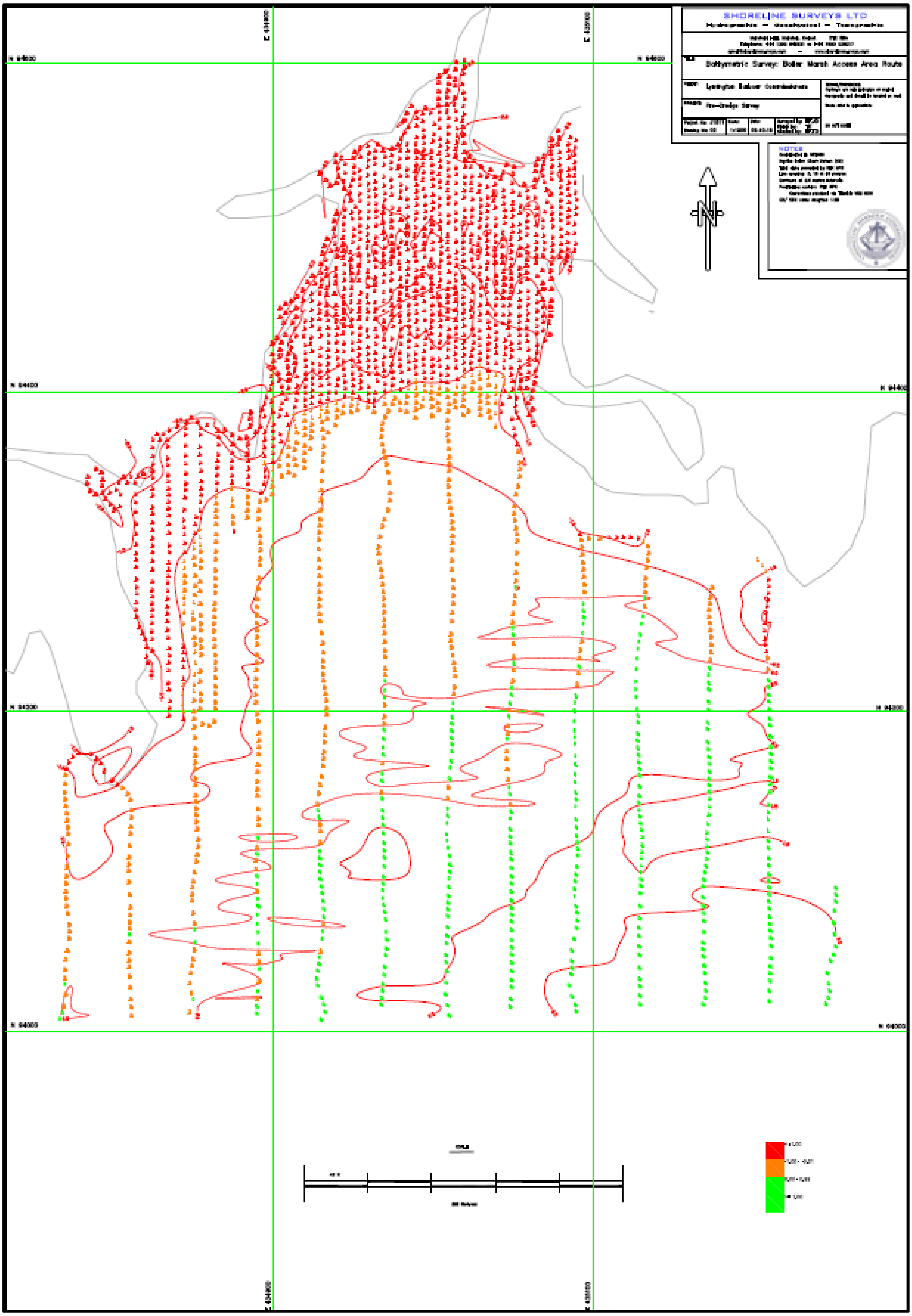
Source: Shoreline Surveys, 2017

Figure A1, Survey lines and contours for June 2017 bathymetry survey



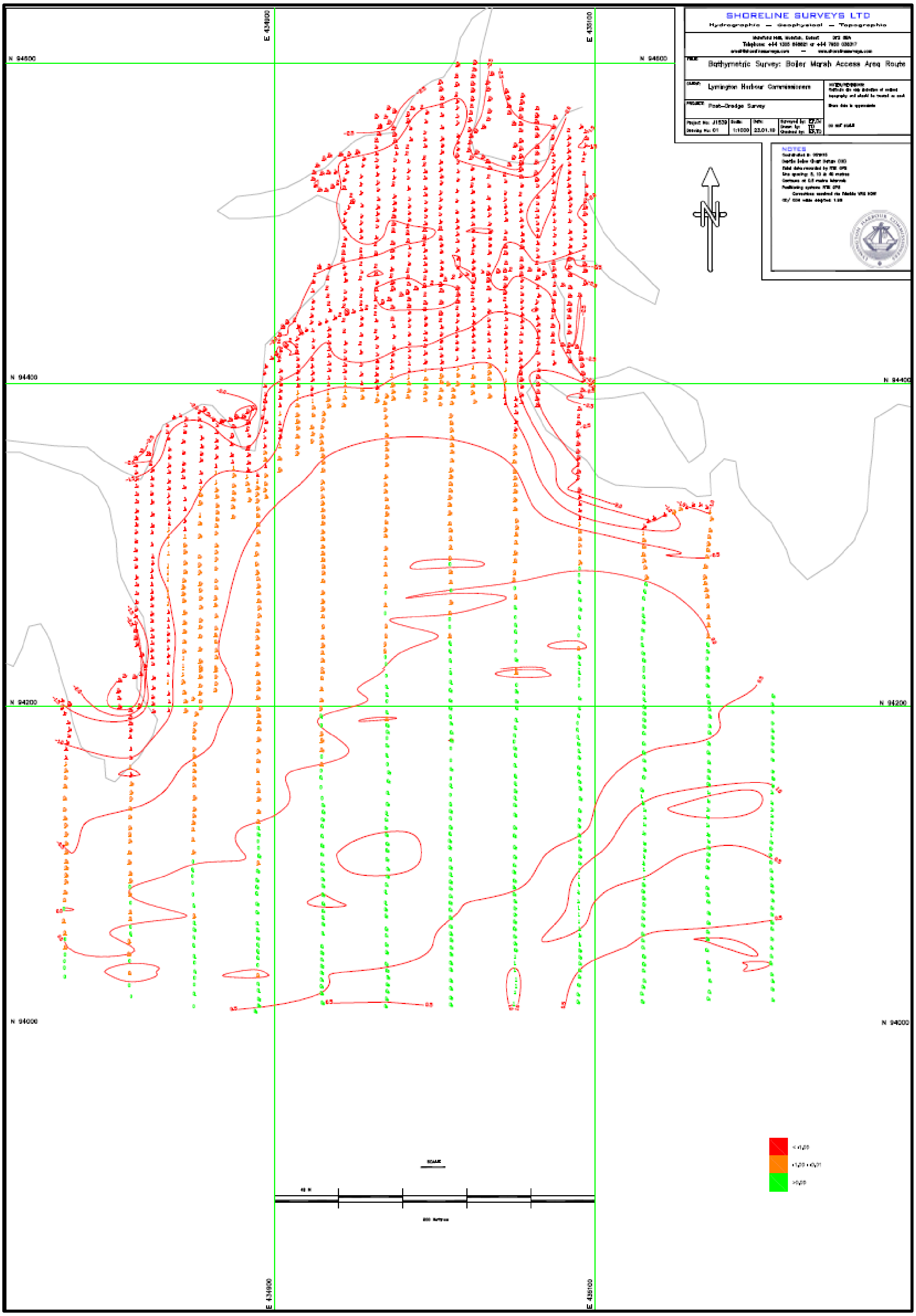
Source: Shoreline Surveys, 2018a

Figure A2. Survey lines and contours for February 2018 bathymetry survey



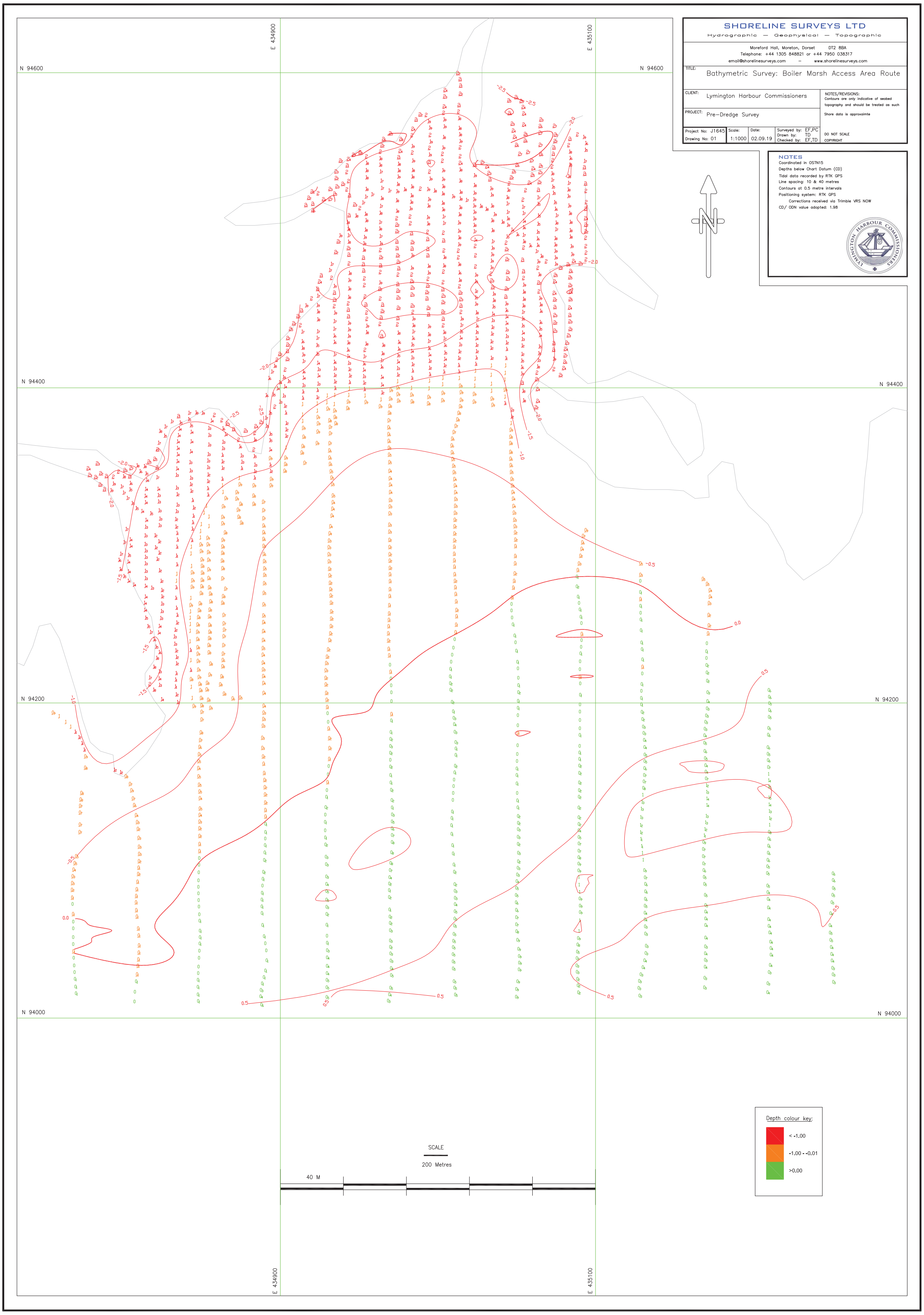
Source: Shoreline Surveys, 2018b

Figure A3. Survey lines and contours for October 2018 bathymetry survey



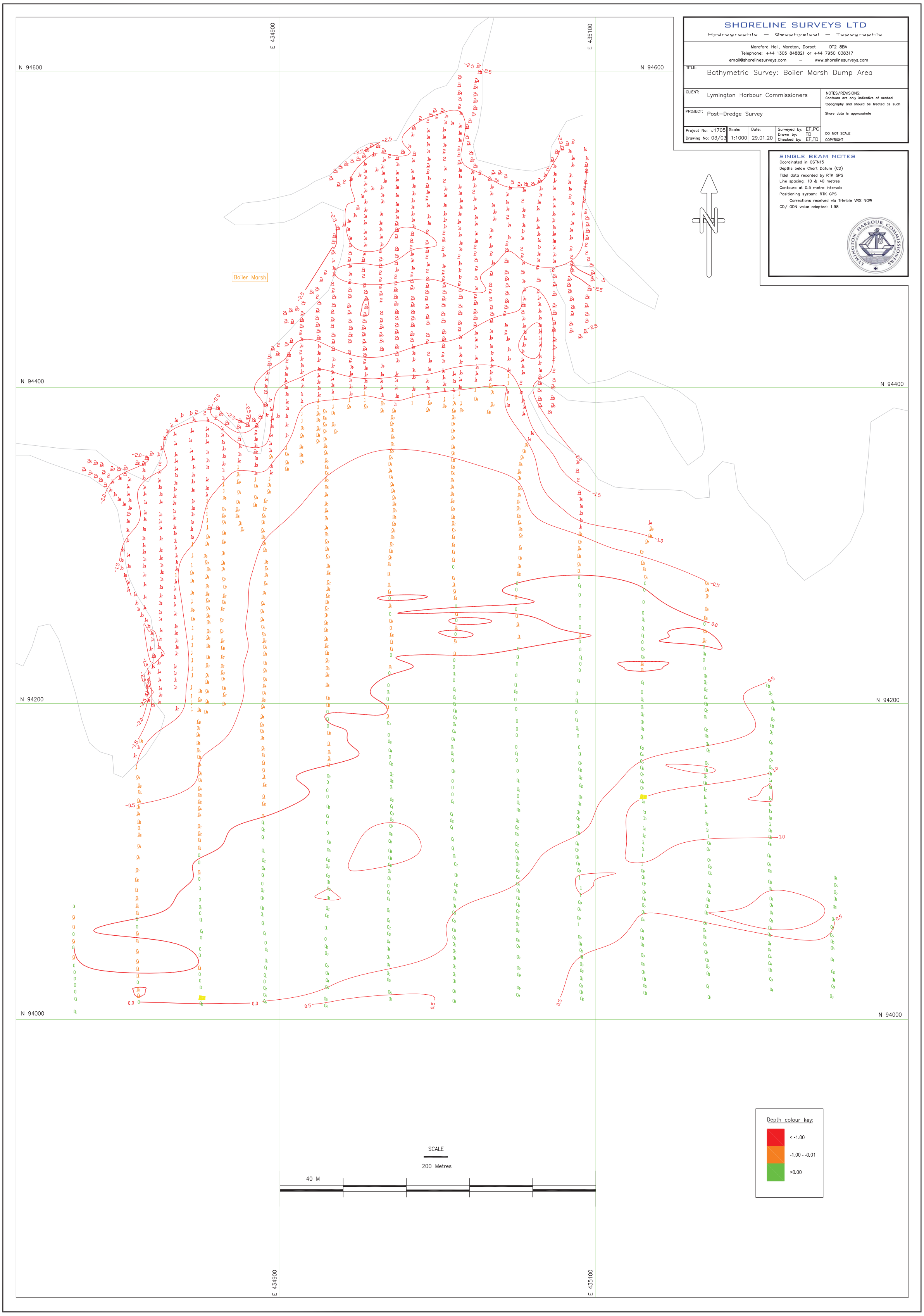
Source: Shoreline Surveys, 2019

Figure A4. Survey lines and contours for January 2019 bathymetry survey



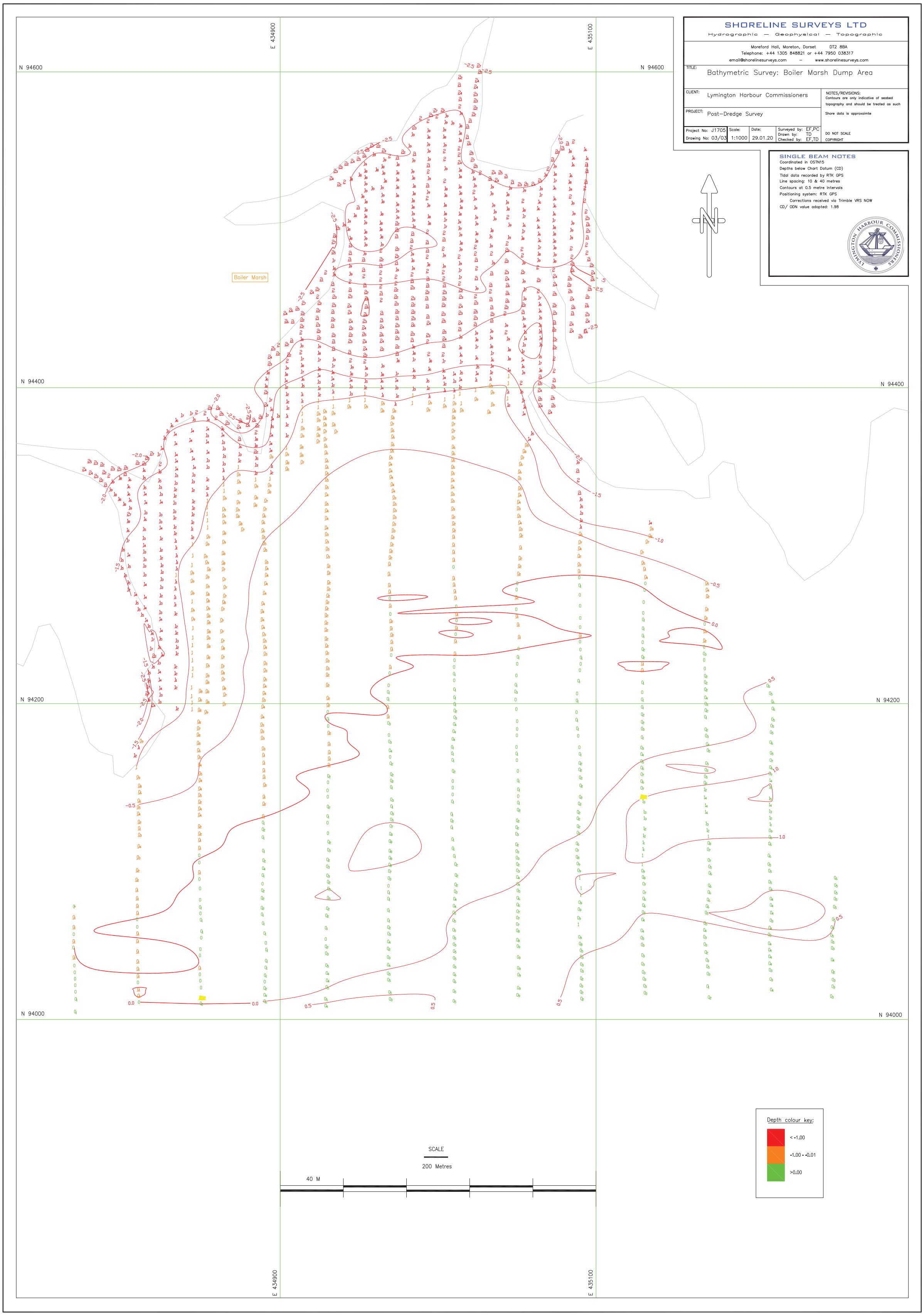
Source: Shoreline Surveys, 2019

Figure A5. Survey lines and contours for September 2019 bathymetry survey



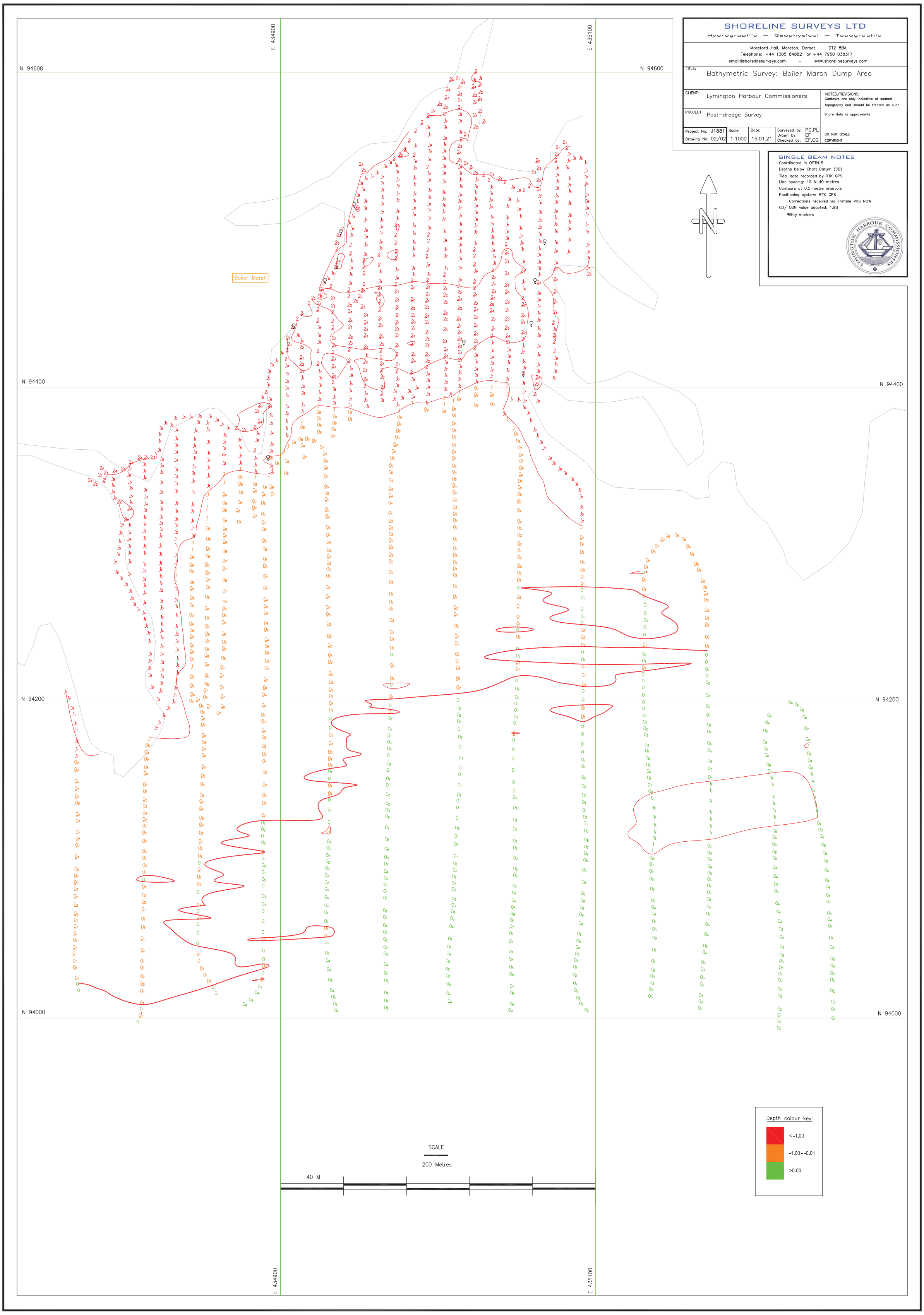
Source: Shoreline Surveys, 2019

Figure A6. **Survey lines and contours for January 2020 bathymetry survey**



Source: Shoreline Surveys, 2019

Figure A7. Survey lines and contours for September 2020 bathymetry survey



Source: Shoreline Surveys, 2019

Figure A8. Survey lines and contours for January 2021 bathymetry survey

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