MERSEA HARBOUR PROTECTION TRUST

Mersea Harbour and Tollesbury Wick Climate Change Adaptation Recharge Project

Response to queries raised by consultees, advisers and the Marine Management Organisation review of licence application MLA/2016/00386

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Contents

The marine licence application to which this document refers and this environmental statement supplementary information may be viewed online in the Marine Management Organisation's Public Register at:
www.gov.uk/check-marine-licence-register

Introduction

The Mersea Harbour Protection Trust (MHPT) submitted licence application MLA/2016/00386 to the Marine Management Organisation (MMO) on 21 September 2016. The MMO began the consultation for this application in March 2017. The MMO's comments on the application, following consultation with regulators, non-government organisations and interest groups, were set out in their letter to the MHPT, dated 29 June 2017.

The MHPT have considered and addressed the points raised in the letter with reference to the information contained in the Environmental Statement (2016).

Marine heritage

MMO comments:

'1.1 Concerns have been raised concerning the level of detail included in the assessment of heritage features. The MMO is, therefore, unable to accurately assess impacts to marine heritage. It is noted that the works are in proximity to multiple designated and undesignated heritage assets. Advice is provided in the sections below concerning sources of information and heritage assists that should be included in an assessment. Further information must be provided to suitably assess the presence of archaeological remains, their significance, likely impacts and proposed mitigation.

1.2 Sources of information that should be considered:

- Essex National Mapping Programme and Essex Historic Environment Record (both available from Essex County Council);
- The National Record of the Historic Environment (NRHE available from www.pastscape.org.uk);
- And other relevant cartographic or documentary sources.

1.3 The proposed works areas (including potential anchorage and access routes) are located in proximity to a number of designated and undesignated heritage assets. In particular:

- Two scheduled fish weirs are located in the intertidal zone at West Mersea and Tollesbury Wick in proximity to the recharge sites (NHLE 1019104 and 1019581 respectively).
- A stranded wreck site on Packing Marsh Island (NHRE 832441);
- A wooden hulk on mudflats at Old Hall Marshes (NRHE 802248).

Moreover, the proposal is located in areas of high potential for the survival of previously unidentified archaeological remains, attested by the recent discovery of a timber trackway of potential prehistoric date and other timber features off Coopers Beach (http://www.mola.org.uk/blog/citizan-discover-prehistoric-archaeology-essex-coast).'

MHPT response to Points 1.1 and 1.3

The location of features of historical interest in the Mersea Quarters area and at East Mersea, their distance from the recharge proposal sites, and the potential for the recharge to impact these assets have been fully assessed below and the conclusions are summarised in Table 1. The map shows the position of these artefacts in relation to the recharge (Figure 1).

Table 1. Heritage assets – Mersea Quarters and East Mersea				
Monument number and reference source	**Description**	**Location – description and grid reference**	**Proximity to proposed recharge site(s)**	**Impact of proposed recharge**
NHLE 1019104 https://historicengland.org.uk/listing/the-list/list-entry/1019104	Scheduled fish weir	570m SE of St Peter's Well. TM 00995 11957	720m east of eastern extremity of Cobmarsh Island recharge	No impact during construction No impact operationally
NHLE 1019581 https://www.historicengland.org.uk/listing/the-list/list-entry/1019581	Scheduled fish weir	Northern end of the Nass TL 99935 11077	450m south-east of southern edge of Old Hall recharge. 1.4km north-east of eastern extremity of Tollesbury Wick recharge	No impact during construction No impact operationally
NHRE 832441 http://pastscape.org.uk/hob.aspx?hob_id=832441#aRt	Stranded wreck	Intertidal Packing Marsh Island TL 99824 12254	Immediately west of predicted recharge migration, Packing Marsh Island	No impact during construction Minor beneficial impact operationally
NHRE 802248 www.pastscape.org.uk	Remnants of a small wooden boat (described as a 'wooden hulk' under Point 1.3 above)	West of Old Hall Point TL 99573 11316	10m north of northern extremity of Old Hall recharge	No impact during construction Minor beneficial impact operationally
Unscheduled feature of historic interest http://www.mola.org.uk/blog/citizan-discover-prehistoric-archaeology-essex-coast **Note:** the MHPT licence application and ES were submitted to the MMO on 21 September 2016 before this historic feature was reported and investigated. The MMO did not undertake the consultation with regulators etc until March 2017.	Prehistoric timbers – late Bronze Age wooden trackway, 495 BC	Coopers Beach, East Mersea 650 metres offshore Grid ref TM 06111 13272	6km east of eastern extremity of Cobmarsh Island recharge	No impact during construction No impact operationally

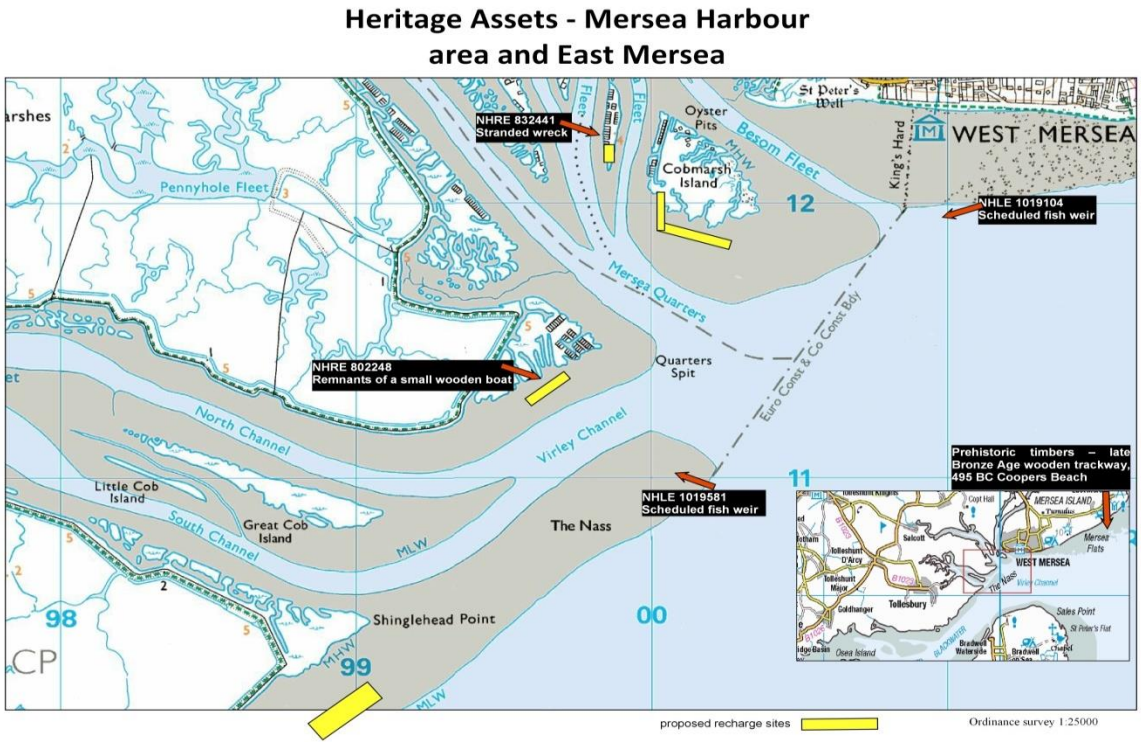

Figure 1. Features of historical interest in relation to recharge proposal sites (Jim Pullen).

NHLE 1019104 – Scheduled fish weir south-east of St Peter's Well

The fish weir is located 720m south-east of the Cobmarsh Island recharge proposal site.

Impact identification - 1

Construction phase: Potential to impact the fish weir while accessing the proposal site and during delivery of material

Impact assessment

The dredger will follow navigable channels until it reaches Cobmarsh Island. The vessel will be positioned as close as possible to the delivery site on the lower south shore of Cobmarsh Island, just below -1.95m ODN. The dredger will be at least 720m away from the fish weir while discharging its cargo at high water. As a result, there will be **no impact** on the fish weir while accessing the site, anchoring the vessel, and delivering material.

Mitigation
No mitigation required.

Residual impact

No impact.

Impact identification - 2

Operational phase: Potential for the fish weir to be impacted by recharge material

Impact assessment

As described in Section 5.3.2.2 of the ES (2016), recharge deposited at the south-eastern point of Cobmarsh Island has been monitored since placement in 1995. This material is 230m closer to the fish weir than the current proposal. Monitoring over 19 years has demonstrated that this earlier recharge has not advanced seaward following deposition. Natural processes have moved the material landward and north-westward along the eastern saltmarsh edge while, on the south side of the island, these deposited sands and gravels have migrated westward with some shoreward movement but otherwise following the line of mean low water neap tides – identified as the seaward edge of the saltmarsh in 1888 (Figure 21 of the ES). The current proposal places material parallel to the south shore of Cobmarsh Island around the mean low water neap tideline where it is predicted to remain relatively in situ with some migration shoreward during storm events (as described in Section 13.1 Physical processes, Impact Identification 2, of the ES). It is considered that there will be **no impact** on the fish weir resulting from migration of recharge material, post placement.

Mitigation
No mitigation required.

Residual impact

No impact.

NHLE 1019581 – Scheduled fish weir at the northern end of the Nass, at the mouth of Tollesbury Fleet

This fish weir dates from the middle Saxon period. In relation to the recharge proposal sites it is located 450m south-east of the southern foreshore of Old Hall and 1.4km north-east of the eastern extremity of the Tollesbury Wick location.

Impact identification - 1

Construction phase: Potential to impact the fish weir while accessing the site and during delivery of material

Impact assessment

The dredger will follow the navigable channels until it reaches the proposal sites. The vessel will be positioned as close as possible to the delivery areas: located on the lower south shore of Old Hall Marshes, just below -1.5m ODN, and the lower shore (around -0.85m ODN) south-west of Shinglehead Point, Tollesbury Wick (refer to Section 3.2 of the ES). While unloading the cargo the dredger will be stabilised by the hydraulic spud. As the discharge operations will be taking place at high tide between 450m and 1.4km from the fish weir, there will be **no impact** on the Nass fish weir while the dredger accesses the site, anchors and delivers to the destination sites.

Mitigation
No mitigation required.

Residual impact

No impact.

Impact identification - 2

Operational phase: Potential for the fish weir to be impacted by recharge material

Impact assessment

As described in Section 3.2 of the ES, the recharge at Tollesbury Wick will supplement recharge placed in 1999, both raising the height of the existing bund and extending it by 45m at the north-eastern end, placing onto mud flat between -0.85 and +1.5 ODN. High accuracy photogrammetry, undertaken in 2014, has been used to determine the position of the 1999 recharge since placement and this has been fully described in Section 5.3.2.5i of the ES. The consolidated shingle bank configuration has been fairly stable over this 15-year period (refer to Figure 37 of the ES). There has been some slight shoreward movement and, although the ridge has extended marginally at the north-eastern end, any material moved upriver on the flood tide is checked by the stronger ebb current. Based on the results obtained from studying the spatial distribution of the earlier recharge, there is no indication that natural processes would, or could, move the material a distance of 1.4km to the northern end of the Nass.

Placement of recharge at Old Hall south shore would be expected to perform in a similar way to the sands and gravels deposited at the southern point of Old Hall Marshes (Tollesbury North Channel foreshore) in 1998. These have mostly remained at the placement location with limited movement shoreward and north-eastward (refer to Section 5.3.2.4, Figures 30 & 35, of the ES). The material has not moved seaward ie south-eastward toward the Virley Channel and the northern end of the Nass. The new material is therefore not predicted to move seaward; it will be aligned to the foreshore in a single bund, which, as evidenced at Tollesbury Wick, and with the new design profile, will give considerable stability to the structure.

The considerations outlined above lead to the conclusion that there will be **no impact** on the fish weir during the operational phase.

Mitigation
No mitigation required.

Residual impact

No impact.

NHRE 832441 - Stranded wreck, condition unknown

The entry described as a 'standard wreck, condition unknown' is the remains of the sailing smack, Rosetta, built in Jersey in 1876. The Rosetta was used to transport potatoes from the Channel Islands before becoming the committee boat of the Tollesbury and Mersea Native Oyster Company, around 1912. She was abandoned sometime between the First and Second World Wars and beached on Packing Marsh Island. In the early 1950s a local boat-builder removed the mast to rig out an oyster smack (pers comm, John Milgate). The location of the Rosetta is indicated in Figure 2 (and in Figure 1 above) and her condition in 2017 is shown in Figure 3.

Figure 2. The location of the Rosetta (Googe earth: image © 2017 Getmapping plc, imagery date 1/1/2005).

Figure 3. Shows the condition of the Rosetta on 14 August 2017 (photo Jim Pullen). The timbers are rotting and very little remains of the smack.

Impact identification - 1

Construction phase: Potential to impact the 'stranded wreck' while accessing the site and during delivery of material

Impact assessment

The dredger will follow navigable channels until it reaches the proposal site just before high water. The vessel will be manoeuvred into position as close as possible to the delivery location at the southern end of Packing Marsh Island, below -0.49m ODN (refer to Figure 1). The centre of the recharge placement site is 30m from the centre of the wreck. The closest the recharge edge is to the wreck is 10m due west. However the recharge deposit area lies mostly to the south of the Rosetta. The delivery area is sufficiently far away from the wreck to avoid any damage. There will be **no impact** on the wreck as the dredger accesses the site, anchors and discharges its load.

Mitigation
No mitigation required.

Residual impact

No impact

Impact identification - 2

Operational phase: Potential for the 'stranded wreck' to be impacted by recharge material

Impact assessment

Section 5.3.2.3i of the ES describes the movement of recharge placed to the southern end of Packing Marsh Island in 1998: 'A combination of southerly winds and the flood tide has pushed the recharge shoreward over the centre of the island's eroded foreshore and around the eastern and western fringes. The defensive ridge formed by the recharge around the margins has obtained a height of +2.9m ODN and has redefined the 1888 shoreline (Figures 27 & 28).'

The 1998 recharge passed mostly to the east of the Rosetta with some material moving around it conferring a protective benefit.

Section 13.1 of the ES describes the location of the proposed recharge placement and its predetermined course based on the movements of the earlier recharge. It is proposed to deliver the same quantity of dredgings as deposited in 1998 as a single mound between -0.5 ODN and +2.5m ODN. The new sands and gravels are expected to move northward hugging the eastern and western shoreline, and would be expected to maintain the present configuration, creating additional protection to the wreck. As a result, a category of **minor beneficial** significance is assigned.

Mitigation
No mitigation required.

Residual impact

A residual impact of **minor beneficial** significance is concluded.

NHRE 802248 - Remnants of a small wooden boat (described as a 'wooden hulk' in MMO Point 1.3 above)

This artefact is located 10m to the north of the landward edge of recharge planned to run parallel with the southern shoreline of Old Hall between -1.5 and +0.149 ODN (refer to Section 3.2, Table 3 of the ES). A series of posts are protruding just above ground level, for a length of around 35m, and described in the record as the remnants of a small wooden boat (Figure 4).

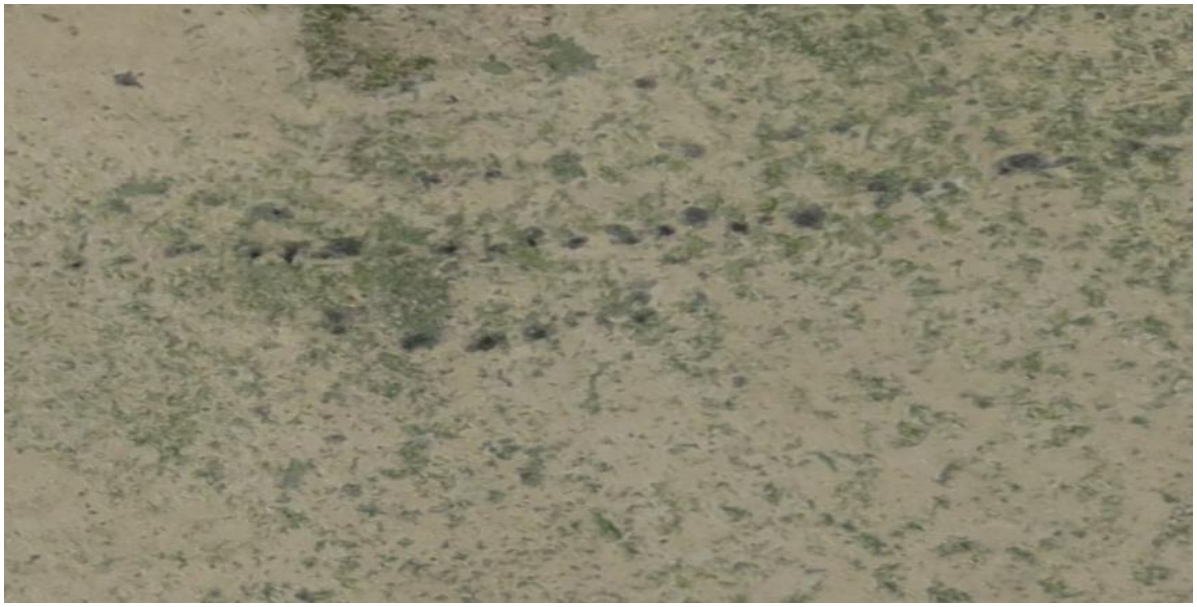

Figure 4. Feature described as the remnants of a small wooden boat on the southern foreshore of Old Hall (high resolution Tiff image, 2014, Jim Pullen).

Impact identification - 1

Construction phase: Potential to impact this feature while accessing the site and during delivery of material

Impact assessment

The dredger will follow navigable channels until it reaches the proposal site where it will be positioned as close as possible to the delivery location on the lower, southern, Old Hall foreshore, below -1.5m ODN. While unloading the cargo, on the ebb tide, the dredger will be stabilised by the hydraulic spud. As the boat remnants are located 10m from the edge of the target area, there will be **no impact** on this feature as the dredger accesses the site, anchors, and delivers the sands and gravels.

Mitigation
No mitigation required.

Residual impact

No impact.

Impact identification - 2

Operational phase: Potential for the 'remnants of a small wooden boat' to be impacted by recharge material

Impact assessment

Recharge placed on the southern shore at Old Hall would be expected to perform in a similar manner to the sands and gravels deposited at the southern point of Old Hall Marshes (Tollesbury North Channel foreshore) in 1998. These have mostly remained at the placement location, with limited movement shoreward and north-eastward due to wind and wave action and onshore currents (refer to Section 5.3.2.4, Figures 30 & 35, of the ES). The new material will be aligned to the foreshore in a single bund, which, as evidenced at Tollesbury Wick, and with the new design profile, will lend considerable stability to the structure.

Silt deposition inside the recharge bund and any shoreward movement of the recharge material will protect this artefact in situ. This impact is considered to be of **minor beneficial** significance.

Mitigation
No mitigation required.

Residual impact

A residual impact of **minor beneficial** significance is concluded.

Pre-historic timbers, Coopers Beach, East Mersea

These recently discovered timbers were exposed by the winter storms in 2016. It should be noted that the MHPT licence application and ES were submitted to the MMO on 21 September 2016, before the timbers were reported and investigated. The MMO did not undertake the consultation on the MHPT licence application until March 2017.

The pre-historic timbers are thought to be the remains of a wooden trackway of Bronze Age origin. They were found at Coopers Beach, off of Mersea Island, at the western mouth of the Colne estuary, some 6km away from the nearest recharge proposal site. The timbers have been lifted for radio-carbon dating and preservation. They are currently in London but will be returned to West Mersea to be displayed at the Mersea Museum (pers comm, Mark Dixon, MHPT Project Manager). Recent on-site surveys (25 July 2017) carried out by archaeologists from the Coastal and Intertidal Zone Archaeological Network (CITiZAN) have confirmed that the remaining exposed timbers are undergoing rapid deterioration due to natural tidal forces and episodic storms.

Impact identification

Operational phase: Potential for the proposal sites to be located in areas of 'high potential for the survival of previously unidentified archaeological remains' connected with the finds at Coopers Beach

Impact assessment

The proposed recharge locations are not connected with the Coopers Beach site. None of the proposal sites lie off of Mersea Island, nor are they located in the vicinity of this discovery which lies at the mouth of the Colne Estuary. The proposal sites are situated within the Blackwater Estuary and the nearest recharge location, at Cobmarsh Island, is 6km from the Coopers Beach site.

The recharge at the locations described in the ES will protect the foreshore. Silt deposition is predicted to occur inside the recharge bunds with the potential for some shoreward movement of the recharge material during storm events. Effectively, the recharge will offer protection to the foreshore and resistance to erosion. Should any yet unexposed artefacts be present under the surface, they would be protected in this more sheltered situation. Currently there is no evidence of new exposures and this has been confirmed by CITiZAN volunteers (pers comm, Mark Dixon, MHPT Project Manager). As there is no connection with the Coopers Beach site and as no evidence has been found of any historical features of the kind discovered at Coopers Beach, recharging to the proposal sites would have **no impact.**

It had already been stated in the ES (Section 13.5) that site surveys would take place prior to placing dredgings to account for any artefacts newly revealed as a result of erosive processes. The MHPT propose that a walkover of the new recharge proposal sites at Old Hall, Cobmarsh Island, and the extension at the north-eastern end of the bund at Tollesbury Wick, is carried out by CITiZAN volunteers, prior to placement. Should any artefacts likely to be of historical significance be found they will be described, photographed and the dimensions recorded. The Mersea Harbour Protection Trust would then consult with coastal archaeologists from CITiZAN to determine whether further investigations should be carried out. The outcome would be reported to Historic England.

Mitigation
No mitigation required.

Residual impact

No impact.

A walkover of the proposal sites at Old Hall, Cobmarsh Island, and the extension at the north-eastern end of the proposed bund at Tollesbury Wick, is proposed to be carried out prior to placement to check if any features of historic interest have become exposed due to erosive processes.

Coastal processes

MMO comment:

'2.1 Section 5.2.2.1 - Material at sites 7 (off the Guard) and 81 (Harwich deep) have been selected for the scheme. In tables 6 and 7 the description of the sediment is dominated by sand with gravel as a secondary descriptor. Initially it appears that this dredge does not have enough gravel to be suitable for deposition on the 4 sites. This is important as the larger particle sizes are required to resist wave action. Please provide Particle Size Analysis for all sites involved.'

MHPT response to Point 2.1

Assessment of suitability of material for placement

As explained in Section 5.2.2.1 of the ES, of the 120 trial pits excavated by Harwich Haven Authority, 24 were identified as potential sediment winning areas for beneficial use. Of these, only two had been sampled by Cefas, trial pit 7 (off of The Guard) and trial pit 81 (Harwich Deep). Trial pit 7 was profiled in the material details in the licence application giving a gravel to sand ration of approximately 3:2.

As there were no further trial pits sampled by Cefas, the sediment profiles of the remaining trial pits identified from the Geotechnical Engineering report (Geotechnical Engineering Ltd, 2013) as containing a significant proportion of sands and gravels, have been examined.

29, 30, 31, 31A, 32, 33, 36, 64, 65, 66, 67, 68, 72, 77, 80, 82, 83, 84, 88, 89, 90, 104

From the trial pits listed above, 29, 30, 32 and 68 were shortlisted and the sediment sampled from sites 29, 30 and 32 are shown to have a higher gravel content than trial pit 7, while trial pit 68 demonstrates similar ratios to 7. The particle size distribution, as profiled in the Geotechnical report, is provided in Table 2. This table also includes the trial pit profiles described by Geotechnical Engineering Ltd (GEL) for pits 7 & 81 and the Cefas sample data for comparison.

Table 2. Trial pit particle size distributions for pits 7, 81, 29, 30, 32 & 68

Sediment type	Fraction % GEL	Cefas	Description of sample	GEL sample depth (m)	GEL ground level (m)
Trial pit 7 (Cefas sample no: 2013/03242)					
Clay	1	-	GEL: Yellow-brown slightly silty very sandy gravel Cefas: Brown slightly muddy gravelly sand	1.30	-15.30CD
Silt	0	-			
Silt and clay	1	2.85			
Sand	42	50.38 (of which 23.98 very coarse & coarse sand)			
Gravel	57	46.77			
Cobble and boulder	0	-			
Trial pit 81 (Cefas sample no: 2013/03222)					
Clay	10	-	GEL: Grey clayey silty sand Cefas: Brown slightly muddy sand	0.30	-15.00CD
Silt	11	-			
Silt and clay	21	9.70			
Sand	79	90.20 (of which 49.35 fine, very fine sand)			
Gravel	0	0.10			
Cobble and boulder	0	-			

Table 2. Trial pit particle size distributions for pits 7, 81, 29, 30, 32 & 68					
Sediment type	Fraction % GEL	Cefas	Description of sample	GEL sample depth (m)	GEL ground level (m)
Trial pit 29					
Clay	1		Yellow-brown slightly silty sandy gravel	0.40	-15.50CD
Silt	0				
Silt and clay	1				
Sand	17				
Gravel	81				
Cobble and boulder	1				
Trial pit 30					
Clay	4		Brown clayey very sandy gravel	0.00	-15.00CD
Silt	6				
Silt and clay	10				
Sand	37				
Gravel	53				
Cobble and boulder	0				
Trial pit 32					
Clay	0		Orange-brown slightly silty very sandy gravel	0.10	-14.50CD
Silt	1				
Silt and clay	1				
Sand	25				
Gravel	74				
Cobble and boulder	0				
Trial pit 68					
Clay	2		Brown slightly silty slightly clayey very sandy gravel	0.30	-15.50CD
Silt	1				
Silt and clay	3				
Sand	44				
Gravel	53				
Cobble and boulder	0				

The gravel to sand ratios of trial pits 29, 30, 32 and 68 are given in Table 3.

Table 3. Gravel to sand ratios in trial pits 29, 30, 32 and 68	
Trial Pit	Gravel to sand ratio
29	4:1
30	5:4
32	3:1
68	11:9

Of the samples graded by GEL, trial pits 29 and 32, between Landguard Point and the Platters, have a high ratio of gravel to sand, approaching 4:1 at location 29, and 3:1 at the site of trial pit 32. Based on the particle size distribution of trial pit 29, including its high gravel to sand ratio and low silt content, the relative percentages of sediments for delivery to the four recharge sites is given in Table 4.

Table 4. Quantities of material to be deposited, by type				
Deposition site	Material, size range and relative %	Specific gravity	Amount to be deposited (dry tonnes)	Amount to be deposited (wet tonnes)
Packing Marsh Island	Clay (1%)	1.80	100	115
	Silt and clay (1%)	1.40	62.50	70
	Sand (0.063 – 2mm) (17)	1.90	1,360	1,615
	Gravel (2mm – 63mm) (81%)	1.80	6,075	7,290
	Boulder and cobble (1%)	2.00	100	100

Table 4. Quantities of material to be deposited, by type				
Deposition site	Material, size range and relative %	Specific gravity	Amount to be deposited (dry tonnes)	Amount to be deposited (wet tonnes)
Cobmarsh Island	Clay (1%)	1.80	960	1104
	Silt and clay (1%)	1.40	600	672
	Sand (0.063 – 2mm) (17%)	1.90	13,056	15,504
	Gravel (2mm – 63mm) (81%)	1.80	58,320	69,984
	Boulder and cobble (1%)	2.00	960	960
Old Hall	Clay (1%)	1.80	800	920
	Silt and clay (1%)	1.40	500	560
	Sand (0.063 – 2mm) (17%)	1.90	10,880	12,920
	Gravel (2mm – 63mm) (81%)	1.80	48,600	58,320
	Boulder and cobble (1%)	2.00	800	800
Tollesbury Wick	Clay (1%)	1.80	100	115
	Silt and clay (1%)	1.40	62.50	70
	Sand (0.063 – 2mm) (17%)	1.90	1,360	1,615
	Gravel (2mm – 63mm) (81%)	1.80	6,075	7,290
	Boulder and cobble (1%)	2.00	100	100

The Mersea Harbour Protection Trust will engage with Harwich Haven Authority to obtain recharge material with a preferred average gravel:sand ratio of 3:1, subject to HHA operational control.

Once in situ, the sediments undergo a natural sorting process influenced by wave and tidal action. Post-placement sediment profile data obtained from the Environment Agency (1999) for the bund at Tollesbury Wick (the template for the design of the new recharge bunds), shows particle size distributions at varying heights from 0m ODN to +2.5m ODN (Table 5). The ratio of gravel to sand ranges from 1:1.75 to 1:4. The highest proportion of gravel is associated with a bund height of +1mODN. The data from which this output is derived is provided in Appendix 1. As outlined in the ES, the sand and gravel bund at Tollesbury Wick has been shown to remain reasonably stable while being able to respond to tidal influences.

Table 5. Particle size analysis of core samples taken from Tollesbury Wick recharge bund, October 1999 (Environment Agency, 1999).				
Height above ODN (m)	**Wentworth class**	**% in sample**	**Total % and size range (mm)**	**Approximate ratios gravel:sand**
+2.5	Coarse gravel	4.59	Gravel 26.61	5:12 (1:2.4)
	Medium gravel	9.17		
	Fine gravel	7.77		
	Very fine gravel	5.08		
	Very coarse sand	5.36	Sand 73.15	
	Coarse sand	10.23		
	Medium sand	28.39		
	Fine sand	27.27		
	Very fine sand	1.90		
	Silt	0.24	Silt 0.24	
+2	Coarse gravel	3.44	Gravel 27.19	5:12 (1:2.4)
	Medium gravel	9.15		
	Fine gravel	6.46		
	Very fine gravel	8.14		
	Very coarse sand	7.24	Sand 72.35	
	Coarse sand	12.33		

Table 5. Particle size analysis of core samples taken from Tollesbury Wick recharge bund, October 1999 (Environment Agency, 1999).				
Height above ODN (m)	**Wentworth class**	**% in sample**	**Total % and size range (mm)**	**Approximate ratios gravel:sand**
	Medium sand	25.65		
	Fine sand	24.24		
	Very fine sand	2.89		
	Silt	0.46	Silt 0.46	
+1	Coarse gravel	5.29	Gravel 38.44	
	Medium gravel	13.76		
	Fine gravel	9.35		
	Very fine gravel	10.04		
	Very coarse sand	6.5	Sand 60.72	2:3 (1:1.75)
	Coarse sand	7.47		
	Medium sand	13.17		
	Fine sand	28.13		
	Very fine sand	5.45		
	Silt	0.81	Silt 0.81	
0	Coarse gravel	0	Gravel 18.55	
	Medium gravel	6.92		
	Fine gravel	4.26		
	Very fine gravel	7.37		
	Very coarse sand	9.00	Sand 74.93	4:15 (1:4)
	Coarse sand	20.77		
	Medium sand	26.60		
	Fine sand	14.23		
	Very fine sand	4.33		
	Silt	6.52	Silt 6.52	

MMO comment:

'2.2 Current meter monitoring (Table 17) will not be possible as reoccupying the same site with the same water depths is virtually impossible in estuarine situations where bathymetry can change rapidly. It is recommended that a high quality photographic survey should be undertaken, before, during and after placement of the material. A set of standard locations should be established along with a sampling regime over the months. Please provide an updated proposed methodology.'

MHPT response to Point 2.2

It has been explained in Table 17 of the ES (2016) that digital surface modelling will be undertaken to monitor any changes in surface elevation above ODN and any spatial redistribution of material. The timing and frequency of monitoring is also provided in the table ie 'immediately post-placement then at annual intervals for 5 years'. It is also stated in Table 17 that a pre-placement survey has already been done (see Table 6 below). The collection of data to generate a digital surface model can be carried out either using LiDAR technology, which measures the distance between light sensors and terrain features, or, by undertaking high accuracy photogrammetry. The MHPT are deploying the latter technique which requires obtaining aerial stereophotos to plot the exact positions of surface points (refer to images in Section 5.3.2 of the ES). This is the best method for plotting temporal and spatial changes over small areas. A perspective at ground level will also be provided by implementing a fixed-point photography survey.

As well as monitoring surface elevation and supplementing this with a ground survey, the MHPT will be carrying out bathymetry surveys to monitor any changes in surface elevation below ODN (also indicated in Table 17 of the ES and shown in the excerpt in Table 6).

Table 6. Excerpt from Table 17, Section 14 of the Environmental Statement (2016), with reference to monitoring.				
Monitoring parameter	**Purpose**	**Location**	**Pre-placement survey**	**Post placement monitoring - timing and frequency**
Surface elevation	Digital surface modelling to monitor any changes in surface elevation above ODN level and any spatial redistribution of material.	All recharge sites	2014	Immediately post-placement then at annual intervals for 5 years.
Bathymetry	To monitor any changes in surface elevation below ODN level and any spatial redistribution of material.	All recharge sites	Data to be collected.	Immediately post placement then annually for 3 years.

Note: To address the MMO's concerns about 'slippage', raised under Point 5.2 below, the MHPT has increased the frequency of monitoring in the first year after placement (refer to Table 17 at the end of this document, adjusted to account for this).

The methodology which will be used to monitor surface and sub-surface elevations is described below.

Monitoring methodology for surface and sub-surface elevations

High accuracy photogrammetry – unmanned aerial vehicle (UAV) survey methodology

A Trimble explorer (cm edition) high-accuracy global positioning system (GPS) will be used to collect and mark ground control points (GCP). Each GCP will be marked with a bold marker that can be easily identified from a UAV camera working at a height of 75m above ground level (AGL). GCPs will be collected to an accuracy of 10mm horizontally and 15mm vertically by means of post processing collected GPS data.

A pre-programmed flight path will be set up to calculate how many photographs will be required to cover the whole site with the necessary overlap of photos to achieve the desired accuracy and coverage. All permissions to fly in the desired area will be gained and checked with the Civil Aviation Authority (CAA).

The survey grid will be flown and photos collected on board the UAV. A quality check will be carried out to ensure that the mission has been successful in the field.

Subsequently the photos will be loaded into the photogrammetry software and the GCPs loaded and matched.

A GeoTiff image to a resolution of 2cm per pixel will be produced by the software along with a very high-resolution 3D model/point cloud similar to LiDAR data. This two-data set will be used to very accurately plot movement of material over time, along with volume calculations and altitude data, throughout the whole site. It will also be possible to integrate spot heights and gradients anywhere in the data set.

Along with the UAV overview, fixed points will be determined by means of GPS and marked with a robust stake to implement a fixed-point photography survey throughout the monitoring period.

Bathymetry survey methodology

A survey grid will be pre-programmed into a Hummingbird side-scan sonar unit at 50m intervals. The survey will commence approximately 2.5 hours before high tide (assuming smooth sea conditions) to ensure all ground within the survey area can be accessed.

The vessel (an Alaska 6m dory with a 115hp Mariner outboard) will make successive sweeps of the area along with some cross-reference lines to ensure full coverage. The data

collected will be processed through a hydrographic survey GIS programme where tide corrections are applied. Data will then be corrected from Chart Datum to Ordnance Datum Newlyn.

The data can then be merged with the UAV data set to obtain one data set for the whole site. With the information obtained from the surveys it will be possible to integrate spot heights and gradients anywhere in the data set.

Shellfish

MMO comment

'Section 13.3.4 of ES – Evaluation of Impacts. Impact Identification 2 Page 115. You have stated that turbidity monitoring will be conducted, along with inspection of the oyster beds. Clarification is required as to whether this means further turbidity monitoring or other monitoring. If it is not turbidity monitoring, please provide a methodology for inspection.'

MHPT response re: shellfish

This refers to the monitoring of the commercial oyster beds to account for any settlement of silts during the construction phase. The oystermen who own the Several Order and private oyster layings in the creeks (Figure 5) will advise the MHPT if sediment build-up in the oyster cultivation areas is being observed above the upper range normally encountered in the estuary. Silt levels can vary dramatically in the Blackwater Estuary depending on wind strength and direction: the combination of a high tide and an easterly wind can increase the concentration of silt in suspension from a background level of 50ppm to 600+ppm within a 24-hour period. There is no methodology for inspection; the oystermen routinely check the layings and would use their judgement based on their extensive experience of managing the oyster beds. The local oystermen are part of the MHPT committee and instigated the recharge project to assist in protecting their fishery.

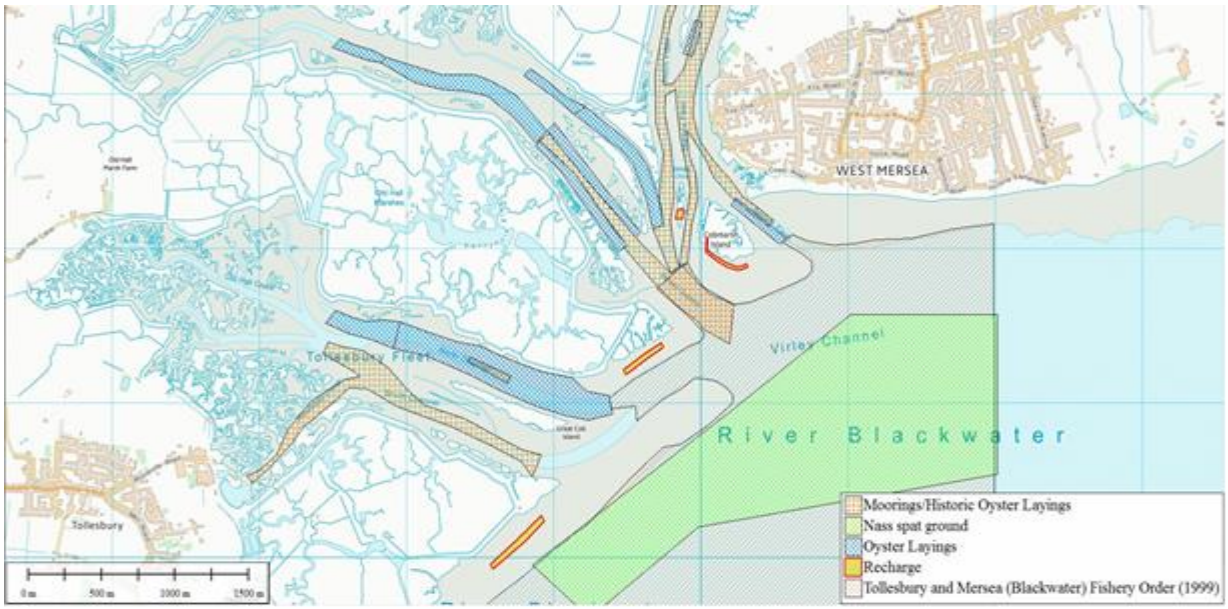

Figure 5. Private oyster layings and location of historic layings now utilised for moorings relative to the recharge areas. The map also shows the Nass spat ground within the Tollesbury and Mersea (Blackwater) Fishery Order (1999). (Jim Pullen. Source: OS Vector Map District 1:50000.)
This map appeared as Figure 66 in the ES.

Noise

MMO comment

'4.1 It has been noted that there are no noise, dust, or light pollution impact assessments. Please provide further information to show how these impacts have been considered, if mitigation is required, including the identification of the nearest noise sensitive premises.'

MHPT response to Point 4.1

We understand from the MMO that Maldon District Council has made this enquiry. Two of the proposal sites lie within the Maldon District Council boundary: Old Hall and Tollesbury Wick.

Impact identification

Construction phase: Potential to impact noise quality

Impact assessment

It was explained in Section 13.8 of the ES that significant noise impacts will be avoided as there is no requirement for large-scale importation of material by road. The dredgings will be brought in by sea and the capacity of the dredger's hopper is such that the number of trips required to deliver material are minimised. This section also stated that the nearest residences to the recharge proposal sites are house boats, located around 500m from the Cobmarsh and Packing Marsh Island recharge sites, and the properties on Coast Road, over 650m away. (These properties are within Colchester Borough Council's jurisdiction.) It was also stated that information will be circulated to local residents advising them of the work schedule.

Within Maldon District Council's authority there are no properties near the foreshore at the Old Hall and Tollesbury Wick proposal sites. Immediately landward of both sites, there are extensive areas of freshwater grazing marsh which are managed as nature reserves and are part of the Blackwater Estuary Site of Special Scientific Interest, Special Protection Area for Wild Birds and Ramsar site (Wetlands of International Importance). The location and features of these areas have been described in the ES in Sections 5.3.1, 5.3.2.4 and 5.3.2.5. The nearest residential dwellings - measuring from the most westerly edge of the recharge deposition site at Tollesbury Wick - are just over 2km away. The proximity of the nearest residence to the Old Hall site is 3km away. To give some idea of scale, 2km is the distance from Maldon District Council offices to Heybridge Basin, as the crow flies. There is a public footpath along the sea wall at Tollesbury Wick and Old Hall Marshes.

There will be no mechanical plant on the foreshore associated with the recharge operation; the delivery method deployed by the dredger will ensure material is distributed across the sites. Once the vessel has been manoeuvred into position, the anchor spud will be lowered and engine power will be reduced to minimum throttle. The pump will then be engaged to commence cannon-discharging over the bow to the target area. This will continue for around 40 minutes as the tide starts to ebb. The acoustic impact while unloading will derive from the muted noise of the engine and the sound made as the jet of water, mixed with sand and gravel, hits the surface waters. The noise is of a very low frequency. If working at capacity, two loads would be deposited per 24 hours, with a total of 27 loads to be

discharged to Old Hall foreshore and four to Tollesbury Wick (see Section 3.2.4 of the ES). However, in reality, the frequency of visits is likely to be staggered. Recreational use of the sea wall footpath at Old Hall and Tollesbury Wick would not be restricted during delivery. The video link below gives an indication of sound levels associated with the discharge process.

https://www.youtube.com/watch?v=1gZrfVPHZL8

Given the distance of the foreshore recharge sites from potentially noise sensitive premises, the limited working window for access and discharge, and the vessel operating at minimal noise levels for the short duration of the procedure. It is considered that the noise impact will be of **negligible** significance.

Mitigation
No mitigation required.

Residual impact

The residual impact is of **negligible** significance.

Impact identification

Construction phase: Potential to impact air quality due to 'dust'

Impact assessment

It was explained in Section 13.8 of the ES that significant impacts to air quality will be avoided as there is no requirement for large-scale importation of material by road. The dredger will cannon-discharge a mixture of sands and gravels, mixed with sea water, onto the foreshore, through the water column (only the final loads will be deposited above the water surface). Along with the shingle, the mixture is likely to contain very small amounts of silts and organic deposits. The velocity of the downdraught from the water jet, and wave action, will wash these fines into the recharge material fairly rapidly. This procedure would not create dust and there would be **no impact** on air quality.

Mitigation
No mitigation required.

Residual impact

No impact.

Impact identification

Construction phase: Potential to cause light pollution

Impact assessment

The hold of the dredger will be illuminated during the discharge operation while operating at night. The dredger will also be showing navigation lights, including those legally required to be displayed in connection with its activity. Given the distance from the nearest residential property and the short timescale for unloading, it has been concluded that local residents will not be significantly disturbed by light. The impact is therefore of **negligible** significance.

Mitigation
No mitigation required.

Residual impact

A residual impact of **negligible** significance is concluded.

Other marine users

MMO comments

‘5.1. Section 14.4 More detail is required in the ES regarding impacts on other marine users and proposed mitigation with regards to communication with other marine users and harbour authorities including notifications.’

‘5.2. Also required is details of any impacts on commercial fishing activities and proposed mitigation to ensure access to vessels, vehicles, moorings and landings will be maintained.’

MHPT response to Point 5.1

The ES does not include a Section 14.4. However, ‘Section 13.7 Impact Identification 1’, considers communications and notifications to marine users during the construction phase and has been copied from the ES (see below). There is no harbour authority in the lower Blackwater Estuary.

13.7 Navigation and marine recreation

Impact identification - 1

Construction phase: Potential to impact navigation and marine recreation

Impact assessment

During the construction phase a ‘Notice to Mariners’ advising of the timing of the disposal activity will be issued and information posters will be displayed at all the local sailing clubs. The dredger will be clearly displaying navigation lights and shapes indicating she is engaged in an activity and restricted in her ability to manoeuvre. The impact is considered to be of **negligible** significance.

Mitigation
No mitigation required.

Residual impact

A residual impact of **negligible** significance is concluded.

To avoid further repetition, considerations of access by boat users - requested by the MMO in Point 5.2 with regard to commercial fishing - are discussed under commercial fishing activities below.

MHPT response to point 5.2

MMO: '5.2. Also required is details of any impacts on commercial fishing activities and proposed mitigation to ensure access to vessels, vehicles, moorings and landings will be maintained.'

Impact identification - 1

Construction phase and operational phase: Potential to impact commercial fishing activities

Impact assessment

Section 6 of the ES explains that West Mersea supports an inshore commercial fishing fleet of 12 registered and licensed vessels (Marine Management Organisation, May 2016). These boats engage in trawling in the mouth of the Blackwater and Colne estuaries, targeting sole, bass, cod and thornback ray. Other boats working the area are based at Brightlingsea, Wivenhoe, Tollesbury and Maldon. Drift netting takes place in the outer mouth of the estuary.

Following a Habitats Regulations Assessment on the impact of trawling in the Essex Estuaries Special Area of Conservation (SAC), a byelaw has been drafted by the Kent and Essex Inshore Fisheries and Conservation Authority (K&EIFCA) to prohibit bottom trawling inside the Blackwater Estuary upriver of the mouth (K&EIFCA, 2016). The only major drift netting in the estuary is for herring in winter but this takes place in deep water and not in the shallow harbour area where the dredger will be operating.

The placement of recharge in the 1990s did not impact commercial fishing. Commercial fishermen are represented on the MHPT committee and have been consulted at every stage of the recharge proposal. It is their opinion that the proposals are minor works within a very large area and unlikely to have any impact on their activities (pers comm, Mark Dixon, MHPT Project Manager).

The map in Section 3.2 of the ES shows the location of the recharge sites in relation to the mouth of the Blackwater Estuary, and the map in Section 1.2 provides a wider view of the estuary mouth and Bradwell-on-Sea. These are reproduced below (see Figures 6 & 7). The operation of the dredger, as described in the ES, at the locations shown in Figure 6 would have a **negligible** impact on commercial fishing activity.

The impact is considered to be of **negligible** significance.

Mitigation
No mitigation required.

Residual impact

A residual impact of **negligible** significance is concluded.

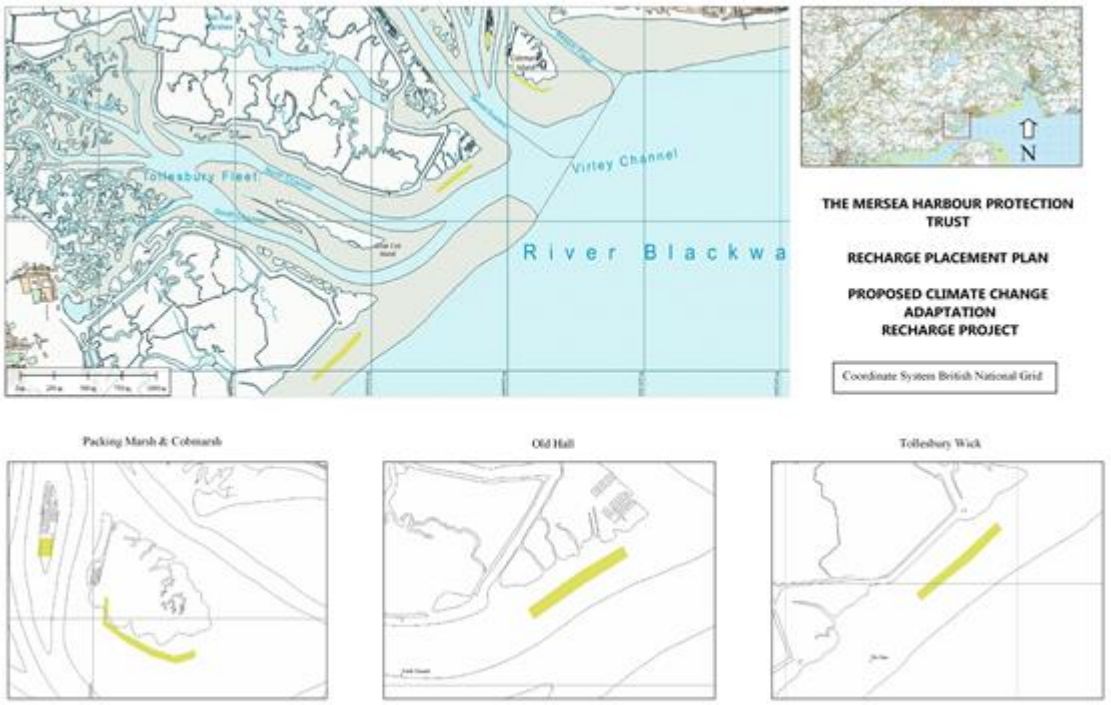

Figure 6. Plan diagram showing proposed recharge placement locations [Jim Pullen, 2014; (c) Crown Copyright OS opendata 50k vector mapping 2015 - OS 50k Great Britain 2013]. This is Figure 4 in the ES.

Figure 7. Mersea Harbour [(c) Environment Agency 1997]. This is Figure 2 in the ES.

Impact identification - 1

Construction phase: Potential to impact access to vessels, vehicles, moorings and landings

Impact assessment

All access, disembarkation, and landings of catch occur via the landing pontoon on the Strood Channel in Mersea Harbour, to the west of West Mersea village. There are moorings in the creeks around Cobmarsh Island - in the Besom Fleet to the east of Cobmarsh, and Mersea Fleet, between Cobmarsh and Packing Marsh Islands. The fairway to the west of Packing Marsh Island, Thorn Fleet, contains moorings. There are also moorings in the Salcott Channel, south of Packing Marsh Island and east of Old Hall, and in the upper South Channel, which lies to the north of Tollesbury Wick (refer to Figure 7, above, and Figure 8 below).

The dredger will be delivering material at high tide over a 40-minute period. It would not prevent access to moorings or landings to the pontoon. There are no moorings or landings directly in the vicinity of the recharge proposal sites at Old Hall and Tollesbury Wick, and craft entering or leaving the South Channel, located between these two sites, would not be restricted. All of the recharge sites are located in the outer harbour. The alignment of the vessel while discharging would not prevent passage through the navigable channels. There will be no restriction to vehicle access as there is no shore-based work associated with the delivery of the dredgings. It is concluded that the impact will be of **no significance** regarding 'vehicles' and will be of **negligible** significance to vessels, moorings and landings.

Mitigation
No mitigation required.

Residual impact

A residual impact of **no significance**, regarding vehicles, and of **negligible** significance regarding vessels, moorings and landings is concluded.

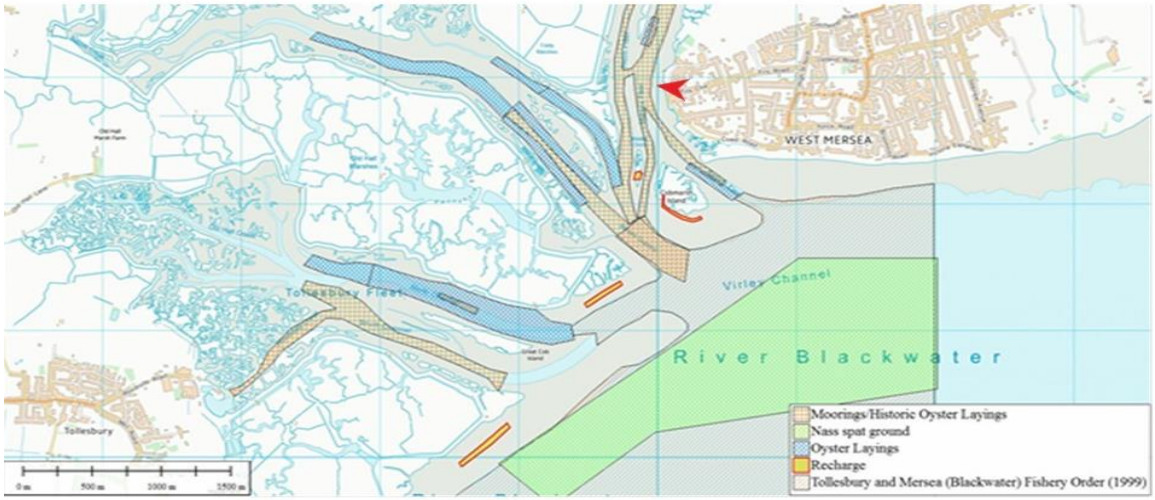

Figure 8. Indicates the landing jetty at West Mersea (red arrow) and the mooring areas (the sites of old oyster layings). Adapted from Figure 66 of the ES (Carol Reid). (Jim Pullen. Source: OS Vector Map District 1:50000.)

Impact identification - 2

Operational phase: Potential to impact access to vessels, moorings and landings.

Impact assessment

The material is being placed on the foreshore. The seaward edge of the recharge will be marked by withies. There will be **no impact** on access to vessels, moorings and landings.

Mitigation
No mitigation required.

Residual impact

No impact.

Potential Post Consent Works

MMO comments - concerns have been raised about a lack of information in the following areas:

'5.1 Introduction of Invasive or Non-Native Species (INNS). Information on the biosecurity measures that will be implemented to prevent the spread of INNS is required. Alongside mitigation measures, remedial actions should be detailed in case contamination does occur.'

'5.2 Post Consent Monitoring. Further information on the methodology for monitoring the settlement of material to ensure dredged material does not migrate from recharge areas is required. This should include proposed inspection timetable and methodology and the proposed mitigations if slippage is identified.'

'5.3 Proposals for how post consent monitoring information will be provided to the MMO must be provided; this will likely be in the form of a Monitoring Report. Details should include, but not be limited to, what information the report will include, how often the report will be submitted and for how long. Actions should be detailed for situations where an adverse impact is identified.'

MHPT response to Point 5.1 - Introduction of invasive or non-native species (INNS)

MMO: '5.1 Introduction of Invasive or Non-Native Species (INNS). Information on the biosecurity measures that will be implemented to prevent the spread of INNS is required. Alongside mitigation measures, remedial actions should be detailed in case contamination does occur.'

In Section 13.3.9 of the ES it was stated that 'The Mersea Harbour Protection Trust will require assurances from Harwich Haven Authority (HHA) and the marine operator that strict biosecurity procedures are followed.' HHA will undertake appropriate survey and assessment, in due course, to ensure that key INNS are not present in the dredge areas (pers comm, John Brien, Harbour Engineer, HHA).

In the event that, after depositing the material, invasive or non-native species are discovered within the MHPT placement areas, it would be impossible to determine unequivocally whether this has occurred as a direct result of importing sediment; species could be introduced via other pathways, for example, on the hulls of boats visiting the Mersea Harbour. It would not be possible to provide any detail of remedial actions without knowing which species might be introduced. However, the MHPT would undertake any practicable measures to try to control or eradicate any non-native or invasive species identified within the recharge survey area, in line with national policy. Those carrying out monitoring and inspection visits to the recharge sites will be made aware of species that could pose significant threats to biodiversity or economic interests. This would facilitate early detection increasing the chances of eradication.

Invasive and non-native species known to occur in the Mersea Harbour at present are:

Slipper limpet (*Crepidula fornicata)*
American oyster drill (*Urosalpinx cinerea*)
Pacific oyster (*Crassostrea gigas*)
Manila clam (*Venerupis phillipinarum*)
American hard shell clam (*Mercenaria mercenaria*)
Australasian barnacle (*Austrominius modestus*) – found on Cobmarsh Island foreshore during MHPT marine biotope survey – see Section 5.3.10 of ES
Japanese wireweed (*Sargassum muticum*)

MHPT response to Point 5.2 - Post consent monitoring

MMO: '5.2 Post Consent Monitoring. Further information on the methodology for monitoring the settlement of material to ensure dredged material does not migrate from recharge areas is required. This should include proposed inspection timetable and methodology and the proposed mitigations if slippage is identified.'

As explained in the MHPT response to Paragraph 2.2 in the MMO letter (under the heading 'Coastal processes'), the methodology to be deployed for monitoring the recharge material spatially and temporally was stated in Table 17 of the ES. Detailed information on the methodology has been provided in the Section 2.2 response.

An inspection timetable was provided in Table 17 of the ES with regard to the fencing at Cobmarsh and Packing Marsh Islands (see excerpt in Table 7). This stated that (further) fencing would be constructed if it is considered that the material needs to be retained. To provide assurance with regard to the MMO's concerns about slippage, it is proposed to increase the frequency of surface elevation and bathymetry monitoring to six-monthly intervals in the first year, at all sites. Adjustments to the monitoring timetable are provided in the revised Table 17 at the end of this document. Should aerial and ground monitoring indicate significant slippage of the recharge bunds at Cobmarsh Island, Old Hall and Tollesbury Wick, fencing could be constructed at strategic points to retain material. The MHPT do not anticipate that post-placement fencing would be required to seaward.

Table 7. Excerpt from Table 17 (Section 14 of the ES) with reference to retainment of recharge.

Retainment of recharge	To ensure material is retained where considered to be more vulnerable to wind and wave events.	Cobmarsh and Packing Marsh Islands	To construct fences prior to placement: work will be timed to avoid the breeding bird season and overwintering season.	Checks to be carried out monthly for the first 3 months post-placement. Subsequently monitoring to be carried out quarterly to check condition and repair as required; <u>further fences to be constructed should monitoring demonstrate the need for this.</u> Additional checks to be undertaken prior to predicted severe weather events and post severe events. Ongoing.

MHPT response to Point 5.3 - Proposals for how post consent monitoring information will be provided to the MMO

MMO: '5.3 Proposals for how post consent monitoring information will be provided to the MMO must be provided; this will likely be in the form of a Monitoring Report. Details should include, but not be limited to, what information the report will include, how often the report will be submitted and for how long. Actions should be detailed for situations where an adverse impact is identified.'

A baseline report will be prepared and submitted to the MMO detailing the results of the surface elevation and bathymetry surveys carried out before and immediately after placement of recharge material. Subsequently, a report on surface elevation and bathymetry will be submitted to the MMO six months after the recharge operation. Thereafter, a written report will be prepared annually for the MMO up to a maximum of five years (although some of the reporting periods will conclude after three years) based on the surveys scheduled in Table 17 of the ES. Table 17 has been revised to account of the slippage concerns raised by the MMO in Point 5.2, and to include walkover surveys for INNS during ground surveys and inspection visits (see below).

With regard to identifying potential adverse impacts, action to be taken to contain any slippage has been described in the Point 5.2 response above. In the unlikely event that recharge material were to encroach into the channel and restrict navigation, and providing that this is proven to be due to the recharge and not the result of natural processes, the MHPT will take responsibility for removing the obstruction deploying a barge-mounted, back-hoe digger.

Table 17 (revised, August 2017). Proposed monitoring programme pre and post placement.				
Monitoring parameter	**Purpose**	**Location**	**Pre-placement survey**	**Post placement monitoring - timing and frequency**
Current speed and direction	To monitor any changes in tidal flow velocity and direction.	South shore, Old Hall Point and Mersea Fleet, Cobmarsh Island	16 June 2015 Carried out during a spring tide at 30 minute intervals 2 -3 hours before and after high tide.	Immediately post placement then annually for 3 years.
Surface elevation	Digital surface modelling to monitor any changes in surface elevation above ODN level and any spatial redistribution of material. To be accompanied by fixed-point photography to monitor changes at ground level.	All recharge sites	Undertaken 2014 (to be updated prior to recharge operations).	Immediately post-placement then at 6-monthly intervals in the first year followed by annual surveys for 5 years.
Bathymetry	To monitor any changes in surface elevation below ODN level and any spatial redistribution of material.	All recharge sites	Data to be collected.	Immediately post-placement then at 6-monthly intervals in the first year followed by annual surveys for 3 years.
Silt deposition	To measure build-up of silts inside the recharge bunds.	Cobmarsh, Old Hall and Tollesbury Wick	-	At 6-monthly intervals for 1 year then annually for 3 years.
Intertidal marine communities	To record any changes in abundance of marine invertebrates and community types, and to record presence of invasive species.	All recharge sites repeating 2015 transect survey.	August/September 2015	Once, in August/September, 3 years post placement. To account for concerns raised by the MMO regarding invasive and non-native species (INNS), walkover surveys to be carried out during ground monitoring and inspection visits to the recharge sites.
Bird feeding - overwinter	To monitor bird usage of intertidal flats.	Cobmarsh Island and Old Hall foreshore inside recharge bunds.	Over at least 2 seasons prior to placement, recording on 2 separate occasions between October and March.	Over 3 seasons.
Bird nesting	To monitor nesting of all bird	All recharge	Further monitoring of	Annually over 3 years, with 2 counts

Table 17 (revised, August 2017). Proposed monitoring programme pre and post placement.				
Monitoring parameter	**Purpose**	**Location**	**Pre-placement survey**	**Post placement monitoring - timing and frequency**
	species, with particular focus on the Annex 1 species, the little tern, counting nests and young. Monitoring of little tern in the Blackwater Estuary is already underway through the little tern recovery project (RSPB, 2016) and data is being shared with the MHPT.	proposal sites (and earlier recharge sites).	current recharge sites for at least one season prior to new recharge placement.	each season in June and July.
Bird roosting	To monitor bird usage of new recharge.	All recharge proposal sites (and earlier recharge sites).	-	Annually over 3 years – 2 counts between October and March.
Turbidity as a surrogate for considering potential for sedimentation on oyster beds	To assess any increases in turbidity, from an established baseline and the potential for silts to settle on private oyster beds and the free grounds during discharge of early loads.	Private oyster beds in the harbour creeks and the grounds south of West Mersea.	Water samples will be taken at fixed locations for testing within 2 hours of the start of an ebb tide during calm conditions and during easterly winds, to obtain a baseline.	Sampling during the early discharge of material to compare with baseline along with monitoring, by the oystermen, of oyster beds for silt settlement. Any significant increases above baseline levels may require a change to the discharge regime. No monitoring would be required post placement.
Retainment of recharge	To ensure material is retained where considered to be more vulnerable to wind and wave events.	Cobmarsh and Packing Marsh Islands	To construct fences prior to placement: work will be timed to avoid the breeding bird season and overwintering season.	Checks to be carried out monthly for the first 3 months post-placement. Subsequently monitoring to be carried out quarterly to check condition and repair as required; further fences to be constructed should monitoring demonstrate the need for this. Additional checks to be undertaken prior to predicted severe weather events and post severe events. Ongoing.

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Environmental Statement (2016). Mersea Harbour and Tollesbury Wick Climate change adaptation recharge project. Prepared for the Mersea Harbour Protection Trust by Carol Reid.

Geotechnical Engineering Limited (2013). Harwich Channel – factual report on ground investigation. Prepared for Harwich Haven Authority for project: Deepening of Approach Channel to Harwich Haven. Report reference: 28343.

Kent and Essex Inshore Fisheries and Conservation Authority (2016). http://www.kentandessex-ifca.gov.uk/wp-content/uploads/2016/09/EE-byelaw-IA.pdf

Appendix 1

The information in Table 5 is derived from HR Wallingford's grading curve profile data, produced from core samples obtained from the existing Tollesbury Wick recharge bund one year after placement in October 1999 (Environment Agency, 1999). Wentworth size classes have been applied and percentages of component sediments calculated below.

Appendix 1. Particle size distribution at different shore levels, Tollesbury Wick recharge bund (EA, 1999)				
Sediment type	**Mesh size (mm) – from HR data**	**Size range and Wentworth class**	**% undersize – from HR data**	**% retained**
Shore level +2.5ODN				
Gravel	31.75	Coarse gravel		
	28.58	Coarse gravel		
	25.40	Coarse gravel	100	0
	22.23	Coarse gravel	95.41	4.59
	19.05	Coarse gravel 16 – 32mm	95.41	0
	15.88	Medium gravel	93.60	1.81
	12.70	Medium gravel	92.00	1.60
	9.52	Medium gravel 8 – 16mm	86.24	5.76
	8.0	Fine gravel	83.42	2.82
	5.6	Fine gravel 4 – 8mm	78.47	4.95
	4.0	Very fine gravel	76.05	2.42
	2.8	Very fine gravel 2 – 4mm	73.39	2.66
Sand	2.00	Very coarse sand	70.87	2.52
	1.40	Very coarse sand 1 – 2mm	68.03	2.84
	1.00	Coarse sand	64.65	3.38
	0.71	Coarse sand 0.5 – 1mm	57.80	6.85
	0.50	Medium sand	46.24	11.56
	0.35	Medium sand 0.25 – 0.50mm	29.41	16.83
	0.25	Fine sand	8.12	21.29
	0.18	Fine sand 0.125 – 0.25mm	2.14	5.98
	0.125	Very fine sand	0.61	1.53
	0.09	Very fine sand 0.0625 – 0.125mm	0.24	0.37
Silt	0.063	Silt (0.002 - 0.063 mm)	0.15	0.09
				0.15

Appendix 1. Particle size distribution at different shore levels, Tollesbury Wick recharge bund (EA, 1999)				
Sediment type	**Mesh size (mm) – from HR data**	**Size range and Wentworth class**	**% undersize – from HR data**	**% retained**
				100
Shore level +2.0ODN				
Gravel	31.75	Coarse gravel		
	28.58	Coarse gravel		
	25.40	Coarse gravel		
	22.23	Coarse gravel	100	0
	19.05	Coarse gravel 16 – 32mm	96.56	3.44
	15.88	Medium gravel	94.55	2.01
	12.70	Medium gravel	92.42	2.13
	9.52	Medium gravel 8 – 16mm	87.41	5.01
	8.0	Fine gravel	86.82	0.59
	5.6	Fine gravel 4 – 8mm	80.95	5.87
	4.0	Very fine gravel	76.75	4.20
	2.8	Very fine gravel 2 – 4mm	72.81	3.94
Sand	2.00	Very coarse sand	69.26	3.55
	1.40	Very coarse sand 1 – 2mm	65.57	3.69
	1.00	Coarse sand	60.79	4.78
	0.71	Coarse sand 0.5 – 1mm	53.24	7.55
	0.50	Medium sand	41.69	11.55
	0.35	Medium sand 0.25 – 0.50mm	27.59	14.1
	0.25	Fine sand	9.30	18.29
	0.18	Fine sand 0.125 – 0.25mm	3.35	5.95
	0.125	Very fine sand	1.03	2.32
	0.09	Very fine sand 0.0625 – 0.125mm	0.46	0.57
Silt	0.063	Silt (0.002 - 0.063 mm)	0.33	0.13
				0.33
				100
Shore level +1mODN				
Gravel	31.75	Coarse gravel		
	28.58	Coarse gravel	100.00	
	25.40	Coarse gravel	94.71	5.29
	22.23	Coarse gravel	94.71	0
	19.05	Coarse gravel 16 – 32mm	94.71	0
	15.88	Medium gravel	86.97	7.74
	12.70	Medium gravel	85.62	1.35
	9.52	Medium gravel 8 – 16mm	80.95	4.67
	8.0	Fine gravel	77.94	3.01
	5.6	Fine gravel 4 – 8mm	71.60	6.34
	4.0	Very fine gravel	66.29	5.31
	2.8	Very fine gravel 2 – 4mm	61.56	4.73
Sand	2.00	Very coarse sand	58.12	3.44
	1.40	Very coarse sand 1 – 2mm	55.06	3.06
	1.00	Coarse sand	52.07	2.99
	0.71	Coarse sand 0.5 – 1mm	47.59	4.48
	0.50	Medium sand	41.93	5.66
	0.35	Medium sand 0.25 – 0.50mm	34.42	7.51
	0.25	Fine sand	17.83	16.59
	0.18	Fine sand 0.125 – 0.25mm	6.29	11.54
	0.125	Very fine sand	1.80	4.49
	0.09	Very fine sand 0.0625 – 0.125mm	0.84	0.96
Silt	0.063	Silt (0.002 - 0.063 mm)	0.71	0.13
				0.71
				100
Shore level 0mODN				
Gravel	31.75	Coarse gravel		
	28.58	Coarse gravel		
	25.40	Coarse gravel		
	22.23	Coarse gravel		
	19.05	Coarse gravel 16 – 32mm		

Appendix 1. Particle size distribution at different shore levels, Tollesbury Wick recharge bund (EA, 1999)				
Sediment type	**Mesh size (mm) – from HR data**	**Size range and Wentworth class**	**% undersize – from HR data**	**% retained**
	15.88	Medium gravel	100.00	0
	12.70	Medium gravel	97.84	2.16
	9.52	Medium gravel 8 – 16mm	93.08	4.76
	8.0	Fine gravel	91.92	1.16
	5.6	Fine gravel 4 – 8mm	88.82	3.10
	4.0	Very fine gravel	85.81	3.01
	2.8	Very fine gravel 2 – 4mm	81.45	4.36
Sand	2.00	Very coarse sand	77.25	4.20
	1.40	Very coarse sand 1 – 2mm	72.45	4.80
	1.00	Coarse sand	64.96	7.49
	0.71	Coarse sand 0.5 – 1mm	51.68	13.28
	0.50	Medium sand	36.36	15.32
	0.35	Medium sand 0.25 – 0.50mm	25.08	11.28
	0.25	Fine sand	15.54	9.54
	0.18	Fine sand 0.125 – 0.25mm	10.85	4.69
	0.125	Very fine sand	7.74	3.11
	0.09	Very fine sand 0.0625 – 0.125mm	6.52	1.22
Silt	0.063	Silt (0.002 - 0.063 mm)	5.54	0.98
				5.54
				100