Note / Memo **HaskoningDHV UK Ltd.**

To:	Marine Management Organisation
From:	Christa Page
Date:	25 March 2022
Copy:	Joshua Riley; Jamie Ellis; Steven Rayner; Matt Greaves
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Subject: **South Bank Quay Phase 1 (MLA/2020/00506) - Monitoring plan**

1 Introduction

South Tees Development Limited (STDL) has a marine licence for Phase 1 of the South Bank Quay project (reference L/2021/00333/1). There are a number of conditions within the marine licence that relate to, or are linked to, protecting migratory fish within the Tees estuary. These are listed in **Table 1.1**.

Table 1.1 Relevant marine licence conditions relating to the protection of migratory fish (taken from marine licence L/2021/00333/1)

Condition reference	Condition	Reason
5.2.8	No dredging not covered under statutory harbour authority powers can be conducted during the period from 1st July to 31st August (inclusive) without written permission from the Marine Management Organisation (MMO). Permission will only be granted if agreement has been reached that only 1 dredge campaign is taking place at this time. No other dredging will take place on the River Tees during this period'	To avoid impacts during peak migration times for species as Atlantic Salmon and European Eel'
5.2.9	If permission is granted by the MMO to undertake dredging operation during 1st July to 31st August (inclusive), dissolved oxygen levels must be monitored prior to the dredging activity, as a minimum, monitored every hour during the dredging activity. If a drop of 1m/g of dissolved oxygen is observed, than the dredging activity must temporarily pause for a period of 6 hours (a tidal cycle) or until the reading returns to the previously observed level. Recorded data must be shared with the Environment Agency upon completion of the	To maintain, improve and develop all salmon, trout, lamprey, smelt and freshwater fisheries, under the Salmon and Freshwater Fisheries Act. 1975 (SSFA) as modified by the Marine and Coastal Access Act, 2009.

Condition reference	Condition	Reason
	licensed activities, no later than 10 working days after their completion. The MMO must be sent a copy within 7 days of the data being issued.	
5.2.10	Dredging must be limited to working on one side of the estuary channel at a time	To restrict suspended sediment plumes to one side of the estuary at a time, in order to reduce loss of tern foraging habitat

While Condition 5.2.10 lists protection of tern foraging habitat as the reason for its requirement, it is linked to migratory fish given that Environment Agency guidance recommends that the limit of any plume should be restricted to ≤25% of the cross-sectional area of the channel for 95% of the time. While this limit is more commonly applied to temperature plumes, the Environment Agency has stated on previous projects that it is a valid consideration for both turbidity and dissolved oxygen (DO) (ECMAS advice to PSO team in Anglian on proposed Harwich Agitation dredging trial, August 2020) .

Given the difficulties in avoiding dredging during the months of July and August, further correspondence with the MMO indicated that they would add to Condition 5.2.8 the requirement for an agreement that no maintenance dredging would be undertaken during these months if dredging for the South Bank project was to proceed. This led to an additional Condition 5.2.9 to monitor DO in these months with dredging to be halted for a specified amount of time if concentrations dropped by 1mg/l.

However, it is considered likely that agreement from PDT to cease maintenance dredging in the Tees during July and August will be difficult to achieve. Therefore, discussion has been held with the MMO regarding alternative mitigation to that required in Conditions 5.2.8 and linked Condition 5.2.9 around the potential monitoring of suspended solid concentrations (hereafter “SSC”) and associated active management.

Purpose of this document:
This monitoring plan aims to present alternative mitigation for consideration by the MMO to allow both maintenance and non-maintenance dredging to proceed during the months of July and August (i.e. it seeks to provide alternative acceptable mitigation to that stipulated in Condition 5.2.8 and replace that required for Condition 5.2.9). Condition 5.2.10 will be adhered to, in order to assist in reducing the cross-sectional area of the estuary impacted by any sediment plumes resulting from dredging activities therefore this monitoring plan accounts for adherence to this condition in the proposed strategy.

2 Proposed monitoring strategy

2.1 Predicted environmental impacts

The Environmental Impact Assessment (EIA) Report (Royal HaskoningDHV, 2020) predicted that during dredging associated with the South Bank project that sediment suspended within the dredging plumes will

fall to the riverbed, either soon after disturbance or spillage during the dredging operation (for coarser-grained sediment fractions), or at a point in time within a few minutes to a few hours after this if it is carried in suspension by the prevailing currents (for finer-grained sediment fractions) (Royal HaskoningDHV, 2020). Near surface predictions are presented in **Figure 2.1**. Note that near bed predictions are very similar therefore are not presented separately here and that these predictions are for the cumulative effects of Phase 1 and Phase 2 therefore very much represent a worst case scenario.

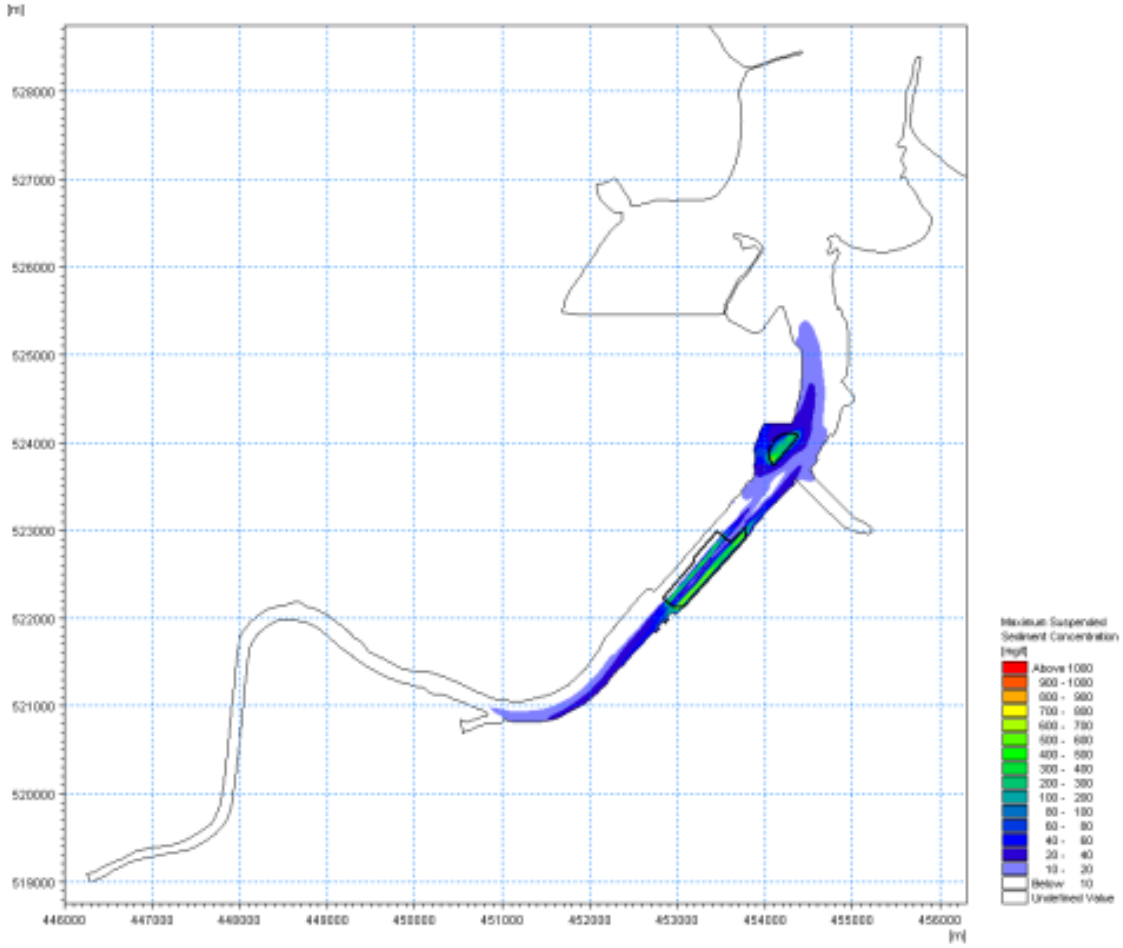

Figure 2-1 Maximum enhanced suspended solids concentrations (near surface layer) arising from dredging activities during Phase 1 and Phase 2 (therefore represents worst case)

Linked to the relatively limited extent of the sediment plume, the EIA Report (Royal HaskoningDHV, 2020) states that long term effects on DO concentrations are unlikely to be experienced within the Tees estuary alongside the fact that a significant component of the dredged material is geological sediment which is unlikely to contain significant amounts of organic matter (the introduction of organic matter into the water column is broken down by microbial activity (i.e. respiration) resulting in a short-term demand on DO

concentrations). Given the link between these two parameters, controls on SSC would also ensure effects on DO concentrations are minimised.

The Cumulative Impact Assessment (CIA) of the EIA report then considers the potential cumulative effects of the proposed scheme with other dredging projects on marine water quality, specifically SSC. To summarise, it is predicted that whilst the sediment plumes could combine to cover a larger area of the estuary, additive effects in terms of increasing sediment peaks were not predicted. This is because the maximum concentrations of suspended solids for all projects are predicted to be localised to the dredging activity and quickly disperse with distance from the dredger. Additionally, as outlined for South Bank, peaks are relatively short lived (approximately an hour at a time for South Bank for example, see **Figure 2.2**). The chances of these peaks occurring at the same time and in the same location was therefore considered to be remote even if dredging occurred concurrently.

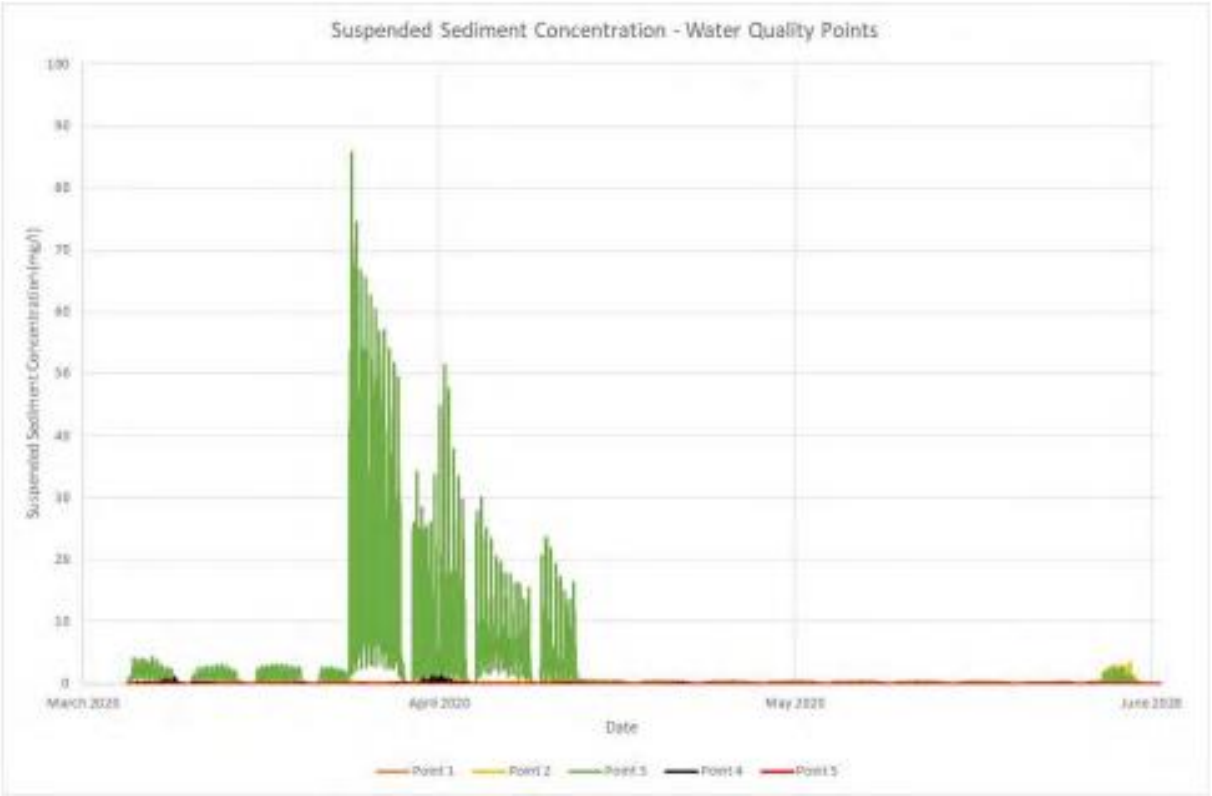

Figure 2-2 Time series plots showing short term nature of sediment peaks (green is Smith's Dock Water Quality monitoring point, the only point to indicate any change to background concentrations in the modelling).

With specific reference to fish, it was considered that the proposed mitigation measures for each project relating to only dredging one side of the channel at a time would remove the risk of a barrier covering the extent of the cross-sectional area of the estuary as plume predictions indicate narrow plumes following tidal/riverine flows. Navigational safety would also restrict dredging on opposite sides of the estuary. Overall, therefore, it was concluded likely that whilst some of the cross-sectional area of the estuary could

experience elevated levels of SSC, part would remain relatively unaffected or experience increases in line with natural background variation caused by riverine or storm disturbance.

2.2 Outline methodology

To develop the methodology, the process outlined in the CEDA paper 'Assessing and evaluating environmental turbidity limits for dredging' (CEDA 2020) has been reviewed and simplified into the following stages:

1. Develop a system understanding.
2. Identify receptors.
3. Determine critical stress levels for receptors (threshold value).
4. Select a relevant measurable parameter and determine the trigger levels.
5. Determine where the turbidity limit applies based on the influence areas, the sensitive receptors and the dredging plan.
6. Define a sufficient, practical and cost-efficient monitoring strategy.

These stages are considered in turn and described below.

2.2.1 Develop a system understanding

In terms of the baseline suspended solids, concentrations are generally low within the estuary and within Tees Bay. The highest observed values tend to occur on spring tides and extreme values are attributed to either high rainfall or storm events. In general, the baseline is dominated by freshwater inputs in the reaches above Middlesbrough and marine influences in reaches located further downstream.

In the vicinity of the proposed scheme (i.e. in the Tees Dock area) concentrations measured, for the most part, are less than 20mg/l with short-term peaks from 40 to 80mg/l (Royal Haskoning, 2006). In terms of the tidal sequence, the highest suspended sediment levels occur close to high water. After storm periods, higher concentrations of suspended sediment have been noted around the Shell Jetty, but with little penetration further up the estuary.

Predicted impacts associated with the dredging are outlined in **Section 2.1** above. This indicates that dredge plumes tend to be narrow and follow tidal flows thus indicating dredging on one side of the estuary allows the other side to remain relatively unaffected or experiences increases within natural baseline variation.

In terms of DO, the 2019 Water Framework Directive (WFD) compliance information for the water body in which the dredging would occur indicates that the 'Tees' is high status for this parameter.

2.2.2 Identify receptors

It has been shown that turbidity increases in water bodies, although affecting some fish species to complete their migration routes, do not impact European eel (Vohs *et* al. 1993; De Casamajor *et al.* 1999). The vertical location of glass eels is also related mainly to turbidity (and phases of lunar cycle), with migrating individuals in turbid waters found through the entire water column, while in clear water they move close to

the bottom of the river or seabed (De Casamajor *et al.* 1999). As a result, it is proposed that the monitoring strategy focuses on protecting Atlantic Salmon given that this is the species considered to be the most sensitive to dredging related sediment plumes.

2.2.3 Determine critical stress levels for receptors (threshold value)

To determine threshold levels for Atlantic Salmon, a literature review was conducted. The most informative being The Effects of Turbidity and Suspended Sediments on ESA-Listed Species from Projects Occurring in the Greater Atlantic Region, published in July 2018 by NOAA Fisheries. This paper reviews published and grey literature and develops exposure concentration and duration thresholds for listed species to use in the analysis of projects that generate suspended sediments. Concentrations in the literature are not, however, specific to Atlantic salmon, as most of the salmonid studies have occurred on West Coast salmon species. However, these species are similar to Atlantic salmon, and therefore they are considered a suitable proxy in the absence of Atlantic salmon-specific studies. It is therefore proposed that these thresholds are used to determine trigger values against which monitoring can be compared and active management implemented if required. The threshold values detailed in NOAA (2018) are reproduced in **Table 2.1**. Note that in selecting these exposure thresholds and durations for adult and juvenile Atlantic salmon, the levels specified by NOAA (2018) account for the cumulative effects to the species if also subjected to additional uncontrollable environmental stressors such as extreme temperature and DO levels. The levels also apply to adult and juvenile salmonids combined, accounting for the slightly lower tolerance levels of juveniles to SSC (Wilber and Clarke, 2001).

Table 2.1 Thresholds for exposure duration for adult and juvenile Atlantic Salmon (reproduced from NOAA Fisheries 2018)

Threshold	Description	Justification (summarised from paper)
1	<1,000mg/l at any one time and not lasting for more than 3 hours	Represents maximum SSC and exposure duration that salmon can experience without mortality. Threshold is set with the assumption that salmon will move away from the sediment generating activity. If they do not, this threshold exposure for three hours is not expected to result in mortality.
2	<50mg/l (above baseline/ambient concentrations) for no more than 24 hours	Set much lower than 1 because fish become less tolerant of higher SSC as exposure duration increases. Below this level, harmful effects are not predicted.
3	<10mg/l (above baseline/ambient concentrations) for no more than 144 hours (six days) after the first 24 hours of exposure	Much lower than threshold 1 as salmon tolerance is lowered with increasing exposure duration. Set at this level to ensure expected effects are insignificant.

2.2.4 Select a relevant measurable parameter and determine the trigger levels

Given the thresholds outlined in **Section 2.2.3**, proposed trigger levels are presented in **Table 2.2**.

Table 2.2 Proposed trigger values

Trigger	Description (concentration and timeframe)	Justification
1	50mg/l above ambient conditions continuously for more than 24 hours	This is not altered from the threshold values as it is considered that below this, harmful effects are not predicted.
2	1000mg/l for more than two hours	Thresholds already contain an element of conservatism therefore it was not considered necessary to reduce this value further. However, the timeframe over which the concentration can continuously occur has been reduced to allow for potential delays between monitoring reports and transfer into SSC (see **Section 2.2.5**)

A trigger value equating to threshold 3 in **Table 2.1** is not proposed given that modelled time series plots do not indicate peaks lasting longer than an hour at a time (see **Figure 2.2**).

The thresholds and trigger values are based on SSC, however, analysis for SSC can only be undertaken in a laboratory as the water sample has to be filtered to determine the dry weight of suspended solids per unit volume of water and reported in milligrams of solids per litre (mg/l). However, turbidity is an optical water quality parameter that can be monitored instantaneously by measuring the optical backscatter with a turbidity sensor. The turbidity sensor measures turbidity levels in Nephelometric Turbidity Units (NTU) or Formazin turbidity units (FTU). Turbidity is easy to measure quickly but a universal relationship between turbidity and SSC does not exist. A correlation graph must therefore be produced prior to monitoring to allow translation of turbidity measurements into SSCs on a site-specific basis. This is undertaken by collecting water samples for analysis for both turbidity and SSC and the results plotted to determine the relationship between the two parameters. Given that SSC cannot be measured in real-time, the measurable parameter is therefore proposed to be turbidity which will be translated into SSC via a site-specific correlation graph.

2.2.5 Determine where the turbidity limit applies based on the influence areas, the sensitive receptors and the dredging plan

If dredging is to be undertaken in July and August, it is proposed that two monitoring buoys are installed at least one week prior to dredging commencing to recover baseline readings. Two monitoring buoys are proposed as using more would cause unwanted disruption to navigation in the Tees and therefore not considered acceptable. During this period, water samples (number to be determined) will also be collected and sent for analysis to develop the correlation graph and determine an appropriate baseline. A specialist contractor will be used to deploy the buoys and collect the water samples.

The monitoring buoys will remain in place during the dredging and for one week after the end of dredging given that modelling indicates that the majority of the sediment will fall to the riverbed, either soon after disturbance or spillage within a few minutes to a few hours (Royal HaskoningDHV, 2020). As a result, it is considered that one week of monitoring post completion of the dredge is adequate to illustrate a return to baseline conditions.

The buoys will house monitoring systems which as a minimum, would monitor turbidity, temperature and dissolved oxygen in real time. Data will be automatically transmitted from each buoy to a secure system online for access avoiding the need to physically recover the buoy to retrieve the data. Turbidity readings would then be translated into SSC. In July and August only, the results will be provided directly to the dredging contractor for monitoring against the trigger values as outlined in **Section 2.2.4** and implementing of management actions as outlined in **Section 2.2.6**.

Based on the predicted plume modelling output, the monitoring buoys are proposed to be positioned as follows (actual monitoring locations will be subject to agreement with PDT to ensure navigational safety):

- Site 1: this site would reflect concentrations of suspended solids on the east side of the channel.
- Site 2: this site would reflect concentrations of suspended solids on the west side of the channel.

The buoy locations therefore ensure readings are collected from both sides of the channel to ensure a barrier does not form across the cross sectional area of the estuary.

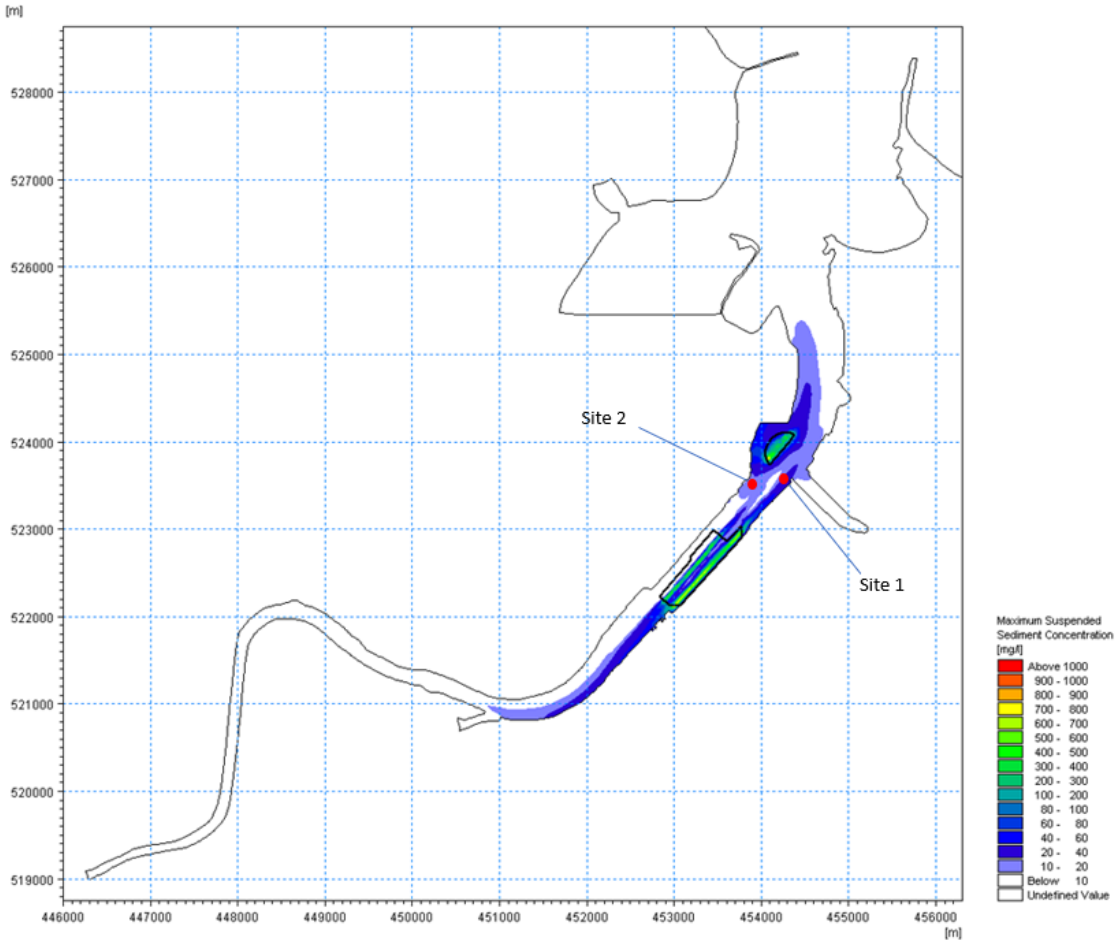

Figure 2-3 Proposed monitoring buoy locations

2.2.6 Monitoring and active management strategy

It is proposed that comparisons of SSC are made between the two monitoring buoys and their determined baseline (collected prior to dredging commencing). If both buoys show an increase in 50mg/l over baseline for more than 24 hours, indicating an effect across the width of the estuary, then the following management actions will be put in place:

- Adjust the overflow position of the dredger;
- Minimise the de-watering process

If the difference falls below 50mg/l for one or both of the buoys then the dredging can recommence without the management actions in place.

If either of the buoys measures a concentration of 1000mg/l continuously for two hours then it is proposed that dredging temporarily pauses for a period of six hours (a tidal cycle). If SSC do not return to below 1000mg/l after six hours, it is proposed that dredging re-commences rather than wait for levels to return to below 1000mg/l if one of the buoys indicates concentrations lower than 50mg/l concentrations. The reason being is that if one side of the channel is relatively unaffected then fish can still migrate.

3 Reporting

All recorded data will be collated and summarised in a short report alongside dredging activity logs. The report will include:

- Sampling methodology.
- Dredging activity logs.
- Any difficulties encountered during sampling and changes proposed as a result.
- All data produced by the two buoys and conversion of turbidity readings to SSC.
- Any instances of trigger value exceedances.
- Adaptive Management / Actions taken when exceedances have occurred.
- Cross-referencing of buoy data with fish-count data as recommended by the MMO.

To be consistent with the requirements stipulated in Condition 5.2.9, recorded data (i.e. buoy data) will be shared with the Environment Agency upon completion of the licensed activities, no later than 10 working days after their completion. The MMO will also be sent a copy within seven days of the data being issued. The full report will be provided within two months of dredging activities being completed.

4 References

1. CEDA (2020). Assessing and Evaluating Environmental Turbidity Limits for Dredging [online]. Available at: http://www.dredging.org/media/ceda/org/documents/resources/cedaonline/2020-05-AETL.pdf Accessed March 2022.

2. De Casamajor, M.N., Bru, N and Prouzet, P (1999). Influence de la luminosité nocturne et de la turbidité sur le comportement vertical de migration de la civelle d'anguille (Anguilla anguilla L.) dans l'estuaire de l'Adour. Bull. Fr. Pêche Piscic. 355, 327-347.

3. Environment Agency (2020) Estuarine and Coastal Monitoring & Assessment Service Task Ref 10EAN. ECMAS advice to PSO team in Anglian on proposed Harwich Agitation dredging trial. 21th Aug 2020

4. NOAA Fisheries (2018) The effects of turbidity and suspended sediments on ESA-Listed Species from Projects occurring in the Greater Atlantic Region. Greater Atlantic Regions Policy Series 18-02.

5. Royal Haskoning (2006) Northern Gateway Container Terminal: Environmental Statement. April 2006. Final Report 9R2629.

6. Royal HaskoningDHV (2020) South Bank Quay Environmental Impact Assessment (EIA) Report

7. Vohs, P., Moore, I and Ramsey, J (1993). Critical review of the effects of turbidity on aquatic organisms of large rivers. US Wildlife Service.

8. Wilber DH, Clarke, DG. 2001. Biological effects of suspended sediments: a review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management 21(4): 855-875.