Eyemouth Harbour Trust (EHT)

Eyemouth Harbour Maintenance Dredging Support

Best Practicable Environmental Option

ASSIGNMENT A101031-S00
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CONTENTS

ACRONYMS

ACRONYM	DEFINITION
AL	Action Level
BPEO	Best Practicable Environmental Option
CD	Chart Datum
DBT	Dibutyltin
ERL	Effects Range Low
ERM	Effects Range Median
EHT	Eyemouth Harbour Trust
HMW	High Molecular Weight
LMW	Low Molecular Weight
LOD	Limit of Detection
m^3	Metres squared
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MD-LOT	Marine Directorate – Licensing Operations Team
N	Number of assessment criteria applied in each module
nm	Nautical mile
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated biphenyl
SBC	Scottish Borders Council
SHA	Statutory Harbour Authority
TBT	Tributyl tin
THC	Total Hydrocarbon Content
TSHD	Trailing Suction Hopper Dredge
UK	United Kingdom

1 INTRODUCTION

Eyemouth Harbour Trust (EHT) as the Statutory Harbour Authority (SHA) for Eyemouth Harbour is obligated to maintain charted water depths within the harbour to ensure safe navigation and maintenance dredging may be required in the case of sudden sedimentation events and gradual sediment build up (see Figure 1-1). EHT is therefore applying for approval for an exempted activity under The Marine Licensing (Exempted Activities) (Scottish Inshore Region) Order 2011 for harbour dredging and applying to Marine Directorate – Licensing Operations Team (MD-LOT) for approval under the Marine Licensing (Exempted Activities) (Scottish Inshore Region) Order 2011 article 26, and for a marine licence under the Marine (Scotland) Act 2010 for sea deposit of dredged material.

At present it is estimated that the annual maintenance dredging requirement for the harbour, as a whole, is approximately 30,000-35,000 wet tonnes (approx. 27,000 cubic metres, (m^3)) per year. The total amount applied for over the three-year period will be 100,000 wet tonnes, with the anticipated split being 30,000 wet tonnes in year 1, and 35,000 wet tonnes in years 2 and 3.

The number of dredging campaigns required per year and the volume of material to be dredged will be dependent on weather events and sediment accumulation and therefore an exact annual amount is unknown. Maintenance dredging may be carried out at any point during the year. The area most likely to be dredged (Area C), consists mainly of sand and requires to be dredging routinely to allow deeper draft vessels to use Eyemouth harbour. Areas A, B and D are less likely to need to be dredged.

Under the Marine (Scotland) Act 2010, when deposit of a substance or object, here dredged material, is proposed, the practical availability of any alternative method of dealing with the substance or object must be considered. Dredging guidance from Scottish Government's Marine Directorate – Licensing Operations Team (MD-LOT) states: "*that all sea deposit marine licence applications must be supported by a detailed assessment of the alternative options which sets out the reasons, including financial, that have led to the conclusion that deposit of the materials at sea is the Best Practicable Environmental Option (BPEO)*" (Scottish Government, 2015). The BPEO assessment also takes into consideration the physical and chemical composition of the dredged material in determining the suitability for the material for use options and sea deposit.

This BPEO report sets out the process and outcomes of the BPEO assessment performed to determine the best use of the maintenance dredged material. This report should be read in conjunction with the Eyemouth Harbour Maintenance Dredging Environmental Appraisal (Xodus document no. A-101031-S00-A-REPT-002).

Figure 1-1 – Eyemouth Harbour limits and proposed dredging locations.

2 CHEMICAL AND PHYSICAL CHARACTERISTICS OF THE DREDGED MATERIAL

Characterisation of the chemical and physical properties of material to be dredged is a pre-requisite requirement prior to undertaking dredging and disposal at sea to ensure that the material to be dredged does not contain contaminants and is suitable for disposal at sea (should the BPEO conclude this is the best option for disposal of the material). 'OSPAR Guidelines for the Management of Dredged Material at Sea' (OSPAR Commission, 2024) states that the substances that are considered of most concern for the marine environment are those with combined properties of persistence, toxicity and liability to bioaccumulate. Typically, the contaminants associated with dredged material which are routinely tested for include organotin compounds, heavy metals, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and oils (OSPAR, 2024). The OSPAR Guidelines require each Contracting Party (including the United Kingdom (UK)) to set national Action Levels (AL) for these common sediment contaminants. The Scottish AL's are set in the Pre-disposal Sampling Guidance Version 2 – November 2017 (Scottish government, 2017). Dredged material with contaminant concentrations below AL1 are considered to be of little environmental concern for sea deposit and are generally accepted for sea deposit should the BPEO conclude this to be the best option. Material with concentrations above AL2 is considered unsuitable for normal deposit at sea but may be suitable for other management options. Material with concentrations between AL1 and AL2 requires more detailed assessment before suitability for deposit at sea can be determined.

Sediment samples of the dredge area were collected and analysed in June 2025 to support this BPEO. Four surface grab samples and one core sample were collected from the areas which require maintenance dredging and analysed in line with MD-LOT's pre-disposal Sampling Guidance, Version 2 – November 2017 (Scottish Government, 2017). Additionally, three samples were collected from the beach face at Eyemouth to support potential future plans for beach replenishment. The beach sampling locations are excluded from further analysis within this BPEO as they are not relevant for the consideration of whether the dredged material may be suitable for sea deposit.

The sampling locations are shown in Figure 2-1. All samples were collected from their proposed positions. It is anticipated that dredging will be performed to excavate the surficial sediments deposited within the area to return seabed levels back to charted depths. It is not anticipated that dredging will lower the charted seabed level by > 1 metre disturbing underlying deposits

The sampling showed that surficial sediments in area C is predominantly comprised of sand, while in areas B and D sediments are composed of a mix of sand and silt sized material.

Figure 2-1 Sediment Sampling Locations

2.1 Chemical analysis

The samples were analysed in accordance with MD-LOT's Pre-disposal Sampling Guidance, Version 2 – November 2017 (Scottish Government, 2017) and assessed against the Scottish AL's. The results are summarised below. In comparison with the 2022 results, the component levels and sediment composition are similar to the 2025 results. Based on the 2022 sample analysis, the dredged material was deemed by MD-LOT to be suitable for sea deposit.

All Tributyltin (TBT) and dibutyltin (DBT) concentration were below AL1 (while Scotland has not set an AL1 or AL2 for DBT, the same AL1 is assumed for DBT as for TBT as per Mason *et al.* (2022).

All PCB concentrations in the sediment samples were below AL1.

The average heavy metals concentrations were all below the AL1, but some individual samples exceeded AL1 for cadmium, copper, nickel and zinc (Table 2-1). As any exceedance are minor or negligible and highly localised with contaminant averages well below AL1, the results of the analyses performed confirm that the material is suitable for sea deposit if this option is chosen following the BPEO assessment.

Table 2-1 Sediment sample contaminant AL1 exceedances from 2023 sampling

CONTAMINANTS	AL1 (MG/KG DRY WEIGHT)	AL2 (MG/KG DRY WEIGHT)	EYEMOUTH 2025 SAMPLES	FURTHER CONSIDERATION
Cadmium	0.4	4	4/5 samples had an exceedance of AL1 at 0.54 mg/kg	The AL1 exceedance is significantly below AL2. The average concentration of all nickel samples is 0.14 mg/kg which is considerably below AL1.
Copper	30	300	4/5 samples had an exceedance of AL1 at 55.5 mg/kg	The AL1 exceedance is only 25.5 mg/kg above AL1 so considered a marginal exceedance. The average concentration of all copper samples is 11.9 mg/kg and considerably below AL1.
Nickel	30	150	4/5 samples had an exceedance of AL1 at 32.3 mg/kg	The AL1 exceedance is significantly below AL2. The average concentration of all nickel samples is 11.8 mg/kg which is considerably below AL1.
Zinc	130	600	4/5 samples had an exceedance of AL1. The maximum concentration recorded was 202 mg/kg which is considerably below AL2.	The average concentration of all zinc samples is 46.6 mg/kg and considerably below AL1.

The testing showed that concentrations of some PAH's exceeded AL1 for the majority of the samples, and exceeded the AL1 for C1-phenanthrene, diben(ah)anthracene, fluoranthene, pyrene and total hydrocarbon content (THC[1]) sample averages. Since there are no established AL2 thresholds for PAHs and THC, an alternative assessment method was applied using low and high molecular weight (LMW and HMW) groupings, as described by Mason *et al*. (2022). This approach provides a proxy for evaluating potential environmental effects:

- LMW PAHs include: naphthalene, acenaphthene, fluorene, anthracene, C1-naphthalenes, acenaphthylene, and phenanthrene, and the sum of these compounds was used in assessing the environmental effect. LMW PAHs are less likely to bioaccumulate and have a lower chronic toxicity than HMW PAHs, but are more acutely toxic due to high solubility.
- HMW PAHs (larger molecules, including polymers) include: fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(a)pyrene, and dibenz(a,h)anthracene, and the sum of these compounds was used in assessing the environmental effect. HMW PAHs have lower acute toxicity due to lower bioavailability and lower solubility, but they are more persistent in the environment and have a higher chronic toxicity due to bioaccumulation.

To compare these groupings to established benchmarks, the sums of LMW PAHs and HMW PAHs were compared to the Effects Range Low (ERL) and Effects Range Median (ERM) values. The concentrations below the ERL value represent a "minimal effects" range; a range intended to estimate conditions in which effects would be rarely observed (Long *et al*. 1995). Concentrations equal to, and above, the ERL and below the ERM represent a "possible-effects" range within which effects would occasionally occur, while the concentrations equivalent to, and above, the ERM value represent a "probable-effects" range within which effects would frequently occur. This system used by regulators in the United states mirrors the OSPAR AL1 and AL2 system, with ERL acting as a proxy for AL1 and ERM acting as a proxy for AL2. The review of UK's AL's for the dredged material carried out by Mason *et al*. (2022) on behalf of the Centre for Environment, Fisheries and Aquaculture Science (Cefas) recommends that UK PAHs should be evaluated based on the summed PAHs for LMW and HMW and the thresholds should be based on ERL/ERMs as this is the most sensitive method for assessing the toxicity of these compounds compared to available alternatives. The proposed HMW and LMW ERL and ERM concentration are shown in Table 2-2.

Table 2-2 Effects Range Low and Effects Range Median Values Proposed for PAHs by Mason et al. 2022

	ERL (µG/KG)	ERM (µG/KG)
Sum Low Molecular Weight PAHs	552	3160

[1] *THC is currently used informally by regulators to assess the suitability of dredged material for sea deposit (Mason et al. 2022). However, THC has limitations: it does not indicate toxicity, shows high variability between laboratories, and tends to be overly conservative—often resulting in sediment samples failing the threshold and requiring further evidence and assessment. While the average sample THC is above AL1, this is not considered to make the material unsuitable for sea deposit.*

	ERL (µG/KG)	ERM (µG/KG)
Sum Low Molecular Weight PAHs	1700	9600

All average concentrations for both LMW and HMW PAHs were below their respective ERL and ERM thresholds (see Appendix A). The only exception was grab sample 3, where the LMW PAH concentration slightly exceeded the ERL (712 µg/kg in the sample, compared to 552 µg/kg ERL). In absence of an established AL2 for PAHs, the ERL and ERM method was used to assess the environmental effects from the dredged material, and based on these analyses the assessment concludes that the material is suitable for sea deposit based on the PAH concentrations.

In conclusion, the review of the sediment sampling analysis results indicates that the material is suitable for sea deposit should this be the BPEO.

3 AVAILABLE OPTIONS FOR USE AND DISPOSAL OF DREDGED MATERIAL

The BPEO assessment is a systematic assessment of the practicality, health and safety, environmental and cost implications of alternative dredged material use options. The BPEO determination takes into account the Waste Hierarchy set out in Article 4(1) of the EU Waste Framework Directive (2008/98/EC) (European Parliament and of the Council, 2008). The Waste (Scotland) Regulations 2012 implement the Waste Framework Directive obligations in Scotland. Furthermore, the Environmental Protection Act 1990 section 34 makes it the duty of everyone who produces, keeps or manages controlled waste, or as a broker or dealer has control of such waste, to take all such measures available to that person as are reasonable in the circumstances to apply the waste hierarchy set out in Article 4(1) of the Waste Directive. The waste Hierarchy places emphasis on minimisation and re-use of dredged material, with sea deposit only being used if no alternative options are available.

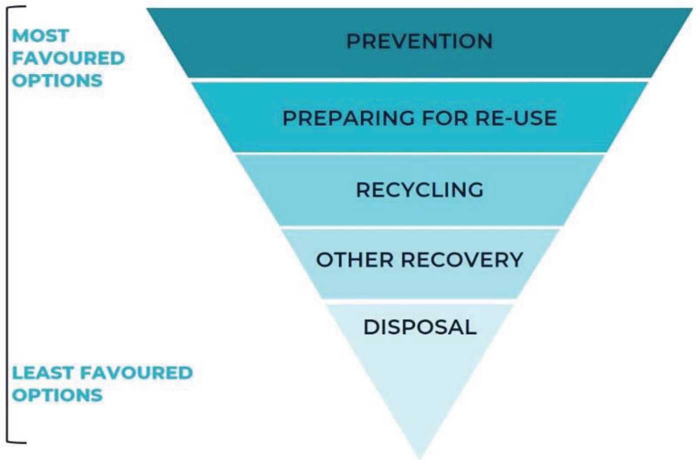

Figure 3-1 Waste Hierarchy for Options for use of Dredged Material

The key stages of the BPEO assessment are:

1. Identification of options (see section 3.1);
2. Screening of options (see section 3.2);
3. Selection of assessment criteria (see section 4.1);
4. Analysis and evaluation of options based on the criteria (see section 4.2); and
5. Evaluation of BPEO (see section 4.3).

The following sections set out the key stages of the BPEO assessment.

3.1 Identification of options

A long list of options for dealing with the dredged material was developed with EHT and considered the known opportunities which had been explored during the previous maintenance dredging campaigns, as well as potential new options. The identification process also considers the particulars of the dredging campaign, including timing and dredge volumes over the three-year period for which a licence is applied for. The options considered are summarised in Table 3-1.

Table 3-1 Screening of potential dredged material use options

LOCATION	TYPE	OPTION	ASSESSMENT	SCREENED IN FOR FURTHER CONSIDERATION? (Y/N)
Sea	N/A	Do nothing/no dredging	On completion of maintenance dredging: Eyemouth has the obligation (as the SHA) to maintain the navigable depth of the channel and approach to the port. Maintenance dredging will be necessary to maintain the channel depth in an event of gradual or sudden accumulation of material in the channel. Dredging will only take place if and when necessary. It is however not a viable option to not perform maintenance dredging when necessary.	No
Land	Disposal	Disposal on land (landfill site)	Where dredged material is disposed on land, dewatering of the dredged material is required prior to the material being transported by truck to a landfill site. Dewatering requires extensive space, either for a drying lagoon or a dewatering facility at the quayside, which is not available at the port. This combined with the transportation requirements (multiple truck loads), additional permit costs, nuisance, noise and risk of contamination of public roads from spillage or leakage. and road vehicle emissions and wear and damage to road infrastructure mean this option is not preferable. Existing landfill sites would need to be able to receive up to 35,000 wet tonnes (~24,000 dry tonnes) of dredged material annually during the project. The closest open landfall site to Eyemouth is the East Ayrshire landfall site in East Ayrshire, located 121.7 miles away from the port. This site can accommodate 2,809,973 tonnes of waste annually. A standard 3 axle lorry has a capacity of 26 tonnes. That would lead to 928 truckloads being required to transport the material to landfill. Should only material from the inner harbour be moved (dredge areas A, B and D, totalling ~3,000 wet tonnes or ~2,000 dry tonnes), this would amount to 78 truckloads. Due to the distance and processing requirements for the landfill site disposal, and associated emissions,	No

LOCATION	TYPE	OPTION	ASSESSMENT	SCREENED IN FOR FURTHER CONSIDERATION? (Y/N)
			this option is discounted. Furthermore, the material is considered suitable for disposal at sea at the Eyemouth Sea Deposit Site.	
Land	Disposal	Incineration on land	The material that will accumulate in the navigation channel is likely to mostly be composed of sand with only limited fine sediment content . This material is not combustible, and due to the high water content, is difficult and inefficient to burn. Consequently, incineration is not a suitable option for material disposal.	No
Land	Habitat creation or improvement	Agricultural use	Dredged material may be suitable for use as an agricultural soil if the material is treated to remove salt and if the material contains a high amount of silt and organic components as opposed to gravel and sand. Further analysis of the material would be required to determine the suitability of the material as agricultural soil. Desalination also requires extensive space which is not available at the port. A Waste Management Exemption from SEPA may be required. East Scottish regions already have plentiful arable land that can support vegetable, fruit and cereal farming for human consumption (Scottish Government, 2023: https://www.gov.scot/publications/results-scottish-agricultural-census-june-2023/pages/most-of-scotlands-area-is-used-for-agriculture/) and there is no requirement for imported soil material. This option is therefore not considered further.	No
Sea	N/A	Using methods that do not require disposal	Dredging methods such as plough, agitation or water injection dredging do not require the loading of the material on a vessel and transport of dredged material to a location outside of the dredging site. Plough dredging is proposed for seabed levelling but it is not considered a feasible option due to the requirement to excavate and relocate material away from the infilled channel. Plough dredging is most appropriate for moving small amounts of material short distances. If plough dredging alone was performed, the campaign would not be sustainable due to the duration of plough dregge activities and the likelihood of increased dredging requirements as sediments moved out of the channel, rapidly infill	No

LOCATION	TYPE	OPTION	ASSESSMENT	SCREENED IN FOR FURTHER CONSIDERATION? (Y/N)
			the channel. This option is therefore not considered sustainable. Agitation and water injection dredging are also not considered sustainable due to the prevailing hydrodynamic and sedimentological conditions. This option is/is therefore not considered further.	
Sea/Land	Habitat creation or improvement	Beach/coastal recharge	This option uses the dredged material beneficially for the purposes of habitat creation or enhancement. As the dredged material's physical properties typically have to be similar to those of the receiving environment to ensure no habitat type alteration or loss of visual and other amenities takes place, beach or coastal recharge are considered viable options. Whether the dredged material can be used for habitat creation or improvement depends on the availability of suitable receiving environments where environmental enhancement is required. Use of dredged material on land/beneficial use also requires separate permits. The material dredged from the mouth of the basin may also be suited for beach recharge offsite. This requires the landowner's permission following identification of a suitable receiving environment. As the owner of some of the seabed at Eyemouth Beach between MHWS and Mean Low Water Springs (MLWS), EHT plays a role in supporting any coastal protection options within its jurisdiction. EHT is also keen to ensure that any material that enters the dredged channel at the harbour is maintained in the local sediment cell as far as practicable, and not removed from the system to the Eyemouth Sea Deposit Site (FO080). This option would, however, require testing of the receiving environment, further permits and an agreement between the parties before the dredging and placement takes place. Due to the surrounding environment around Eyemouth harbour comprising of sandflats and the potential local habitat erosion, the material could potentially used for habitat beach or coastal recharge. This option is considered further.	Yes

LOCATION	TYPE	OPTION	ASSESSMENT	SCREENED IN FOR FURTHER CONSIDERATION? (Y/N)
Sea/Land	Engineering uses	On-site reuse in reprofiling or as construction material	The dredged material could potentially be used on site for site reprofiling and as construction material during site development activities. The dredged material is primarily sand with silt content in the inner harbour, and as such the material could be considered to have some uses in construction. The saline content of the dredged material makes it unsuitable as a construction material without grading, washing, drying and storage. This may make this option uneconomical and unpractical. Furthermore, there are no ongoing construction projects in Eyemouth Harbour or in the vicinity of the site which would require sand. This option is therefore not considered further.	No
Sea/Land	Engineering uses	Offsite use/recycling as aggregate or construction material	The material to be dredged material is primarily sand with silt in the inner harbour, and as such the material could be considered to have some uses in construction. The saline content of the dredged material makes it unsuitable as a construction material without grading, washing, drying and storage. The material could however be used as aggregate or as construction material if sorted and graded. This may make this option uneconomical and unpractical. The material could be provided to local users if the time of dredging aligned with the needs of potential local users. Due to the unpredictable timings of the dredging campaign, it would be challenging for the port's commercial team to find suitable end users. The material may also comprise a larger fraction of silt, limiting the suitability of the material as aggregate or construction material. The transportation and handling costs of the material would also be higher than the market cost of aggregate and construction materials, limiting potential re-sale opportunities. This option is however considered further.	Yes
Sea	Aquatic placement	Deposit at a sea deposit site	Eyemouth Sea Deposit Site is located approximately 5 km from the dredge area and as such the cost and transport requirements associated with deposit at the sea deposit sites are low and logistically feasible. This option would involve deposit of the material into an area intended for receiving dredged material. This option is taken forward for further consideration.	Yes

3.2 Options screening

Following the compilation of a long list of potential options for dredged material use, each option was screened 'in' or 'out' from further consideration based on feasibility of the options. The options considered and outcome of the screening are provided in Table 3-1, alongside justification for screening out those options which have not been taken forward for further consideration.

Following the screening of potential dredged material options, the following were carried over to the detailed, quantitative BPEO stage:

1. Beach/coastal recharge;
2. Offsite use/recycling as aggregate or construction material; and
3. Deposit at a sea deposit site.

A summary of the necessary works or methodology for each option being taken forward for detailed BPEO assessment is provided below.

3.2.1 Beach/coastal recharge

This option uses the dredged material beneficially for the purposes of habitat creation or environment enhancement. The dredged material's physical properties typically have to be similar to those of the receiving environment to ensure no habitat type alteration or loss of visual and other amenities takes place. As the material is expected to consist of sand with some fractions of silt, beach or coastal recharge are considered viable options. The material could be delivered by vessels to the subtidal area where it would be released (for subtidal refurbishment) or pumped or rainbowed to the beach (unlikely to be feasible due to the space constraints within Eyemouth Harbour and Beach). Alternatively, the material could be loaded onto trucks and transported to the area where recharge is required, where it would be spread by bulldozers. All these options add to the cost of the operation.

Whether the dredged material can be used for habitat creation or improvement depends on the availability of suitable receiving environments where environmental enhancement is required. EHT would like to beneficially use the arisings from future maintenance dredging campaigns for nourishment of the Eyemouth Beach or the subtidal area, providing benefit to the local environment. The Dynamic Coast website[2] shows the predicted coastal erosion around Eyemouth until 2100. The predictions indicate that coastal erosion in Eyemouth has already taken place, and that erosion will continue in the future. It is likely that the town will be required to take steps to prevent flooding in the future, and indeed the Scottish Borders Council (SBC) has conducted a flood study and is carrying out coastal processes modelling to look at the hydro-sedimentary processes governing the area. Options for coastal protection considered include both hard defences (e.g., groynes and concrete walls) as well as soft defences (beach recharge) . As the owner of some of the seabed at Eyemouth Beach between MHWS and MLWS, EHT plays a role in supporting any coastal protection options within its jurisdiction. EHT is also keen to ensure that any material that enters the dredged channel at the harbour is maintained in the local sediment cell as far as practicable, and not removed from the system to the Eyemouth Sea Deposit Site (FO080).

[2] *https://snh.maps.arcgis.com/apps/webappviewer/index.html?id=78047dbef80f4a74acc192ac21c9d4e0*

The core sample taken from the mouth of the Eyemouth basin mainly comprised of sand. Given that this area (Area C Figure 2-1), is the area where the greatest sediment accumulation is observed, it is likely that the physical characteristics of the sediment would be comparative to those sediments sampled from the beach face which also were dominantly comprised of sand. The properties of the sediments also reflect the properties of sediments sampled in 2022 within the same area (Area C), providing confidence that sedimentological properties of surficial sediments existing within, or transported to, this area have not changed significantly since 2022. Where the surficial sediments are comprised of greater silt content (i.e. as observed in samples collected from Area B and D),such material may not be suitable for beneficial re-use in support of beach recharge. .

While EHT is committed to exploring beneficial use options as evidenced by the collection of beach samples during the 2022 and 2025 sampling campaigns, the organisation is waiting for the results of the SBC modelling to determine whether material placed on the beach or in the subtidal area in Eyemouth would behave in such a manner to as to not cause issues for safe navigation and long-term use of the site, but to also ensure the material does not migrate directly back to the harbour, causing a need for additional dredging. EHT is also developing a site characterisation study to look at investigations that should be undertaken to support proposals for beneficial use in the vicinity of the harbour. Should these investigations suggest that beneficial use is a viable option for the location, EHT will consider this in future applications.

3.2.2 Offsite use/recycling as aggregate or construction material

As discussed in Section 2, the grab samples were found to consist of mainly sand and silt. As the sediment samples show, the material would need to be dewatered, sorted and graded if use as aggregate or construction material was taken forward. The saline content of the dredged material makes it unsuitable as a construction material without grading, washing, drying and storage. This may make this option uneconomical and unpractical. The material could be sold to local users if the time of dredging aligned with the needs of potential local users. However, due to the small quantity of material dredged and the unpredictable timing of the dredging campaign, it would be challenging for the port's commercial team to find suitable end users. The material may also comprise of a larger fraction of silt, limiting the suitability of the material as aggregate or construction material. The transportation and handling costs of the material would also be higher than the market cost of aggregate and construction materials, limiting potential re-sale opportunities.

3.2.3 Deposit at a sea deposit site

The Eyemouth open sea deposit site is located approximately 5 km away from the harbour (Figure 3-2). The deposit site substrates are predominantly sand and silt, similar to the dredged material. The dredged material could be directly transported from the dredge site on the Trailing Suction Hopper Dredge (TSHD) or a barge and bottom discharged at the sea deposit site. Dredging and bottom discharge would be quick and unlikely to limit the operations of the port as the dredging will be quickly completed. This also reduced the emissions and costs of the operation.

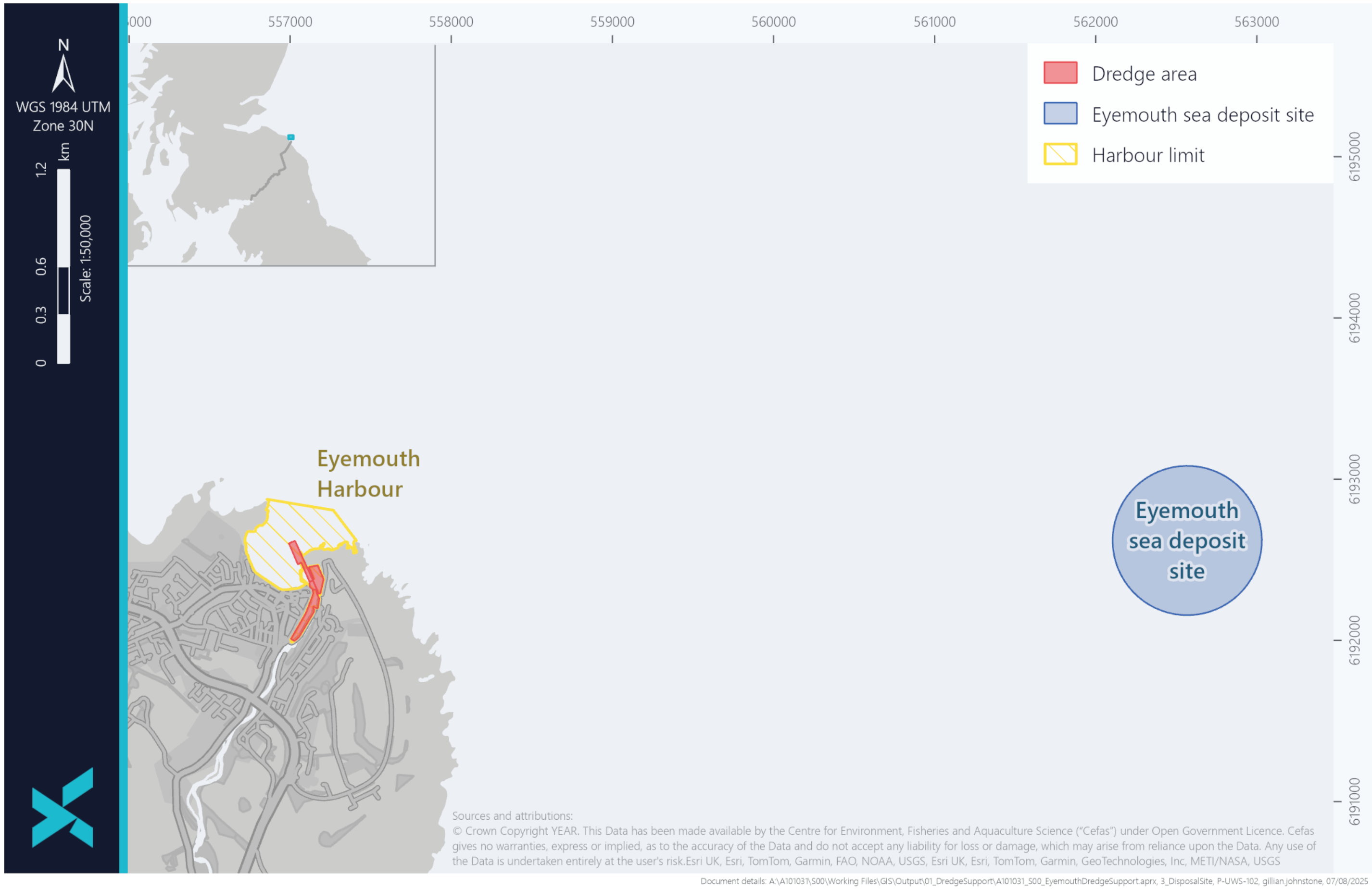

Figure 3-2 Eyemouth Designated Sea Deposit Site and the Dredge Area

4 BPEO EVALUATION

4.1 Selection of BPEO assessment criteria

In order to undertake an impartial and structured comparison of the various BPEO options, a weighted ranking system with a pre-defined set of assessment criteria was used. The criteria were selected specifically for use for Eyemouth Harbour and the assessment is based on a four-module assessment. Each module contains a set of criteria (Table 4-1),allocated equally. The four modules include:

- Practicability (25%);
- Health and safety (25%);
- Environmental Assessment (25%); and
- Cost assessment (25%).

Table 4-1 BPEO assessment criteria

CRITERIA	SPECIFICS
Environmental	Land waste generation
	Further treatment or environmental impacts due to treatment
	Transport requirements
	Marine environmental impact
	Policy/legislative acceptability
Practicability	Space and weight requirements.
	Downtime/delay risk/temporal restrictions
	Requirement to treat/process material before use, i.e. suitability for deposit (eg. change chemical and physical properties, desalination, drying)
	Commercial/equipment/technology availability, maturity and deployment speed (including availability of vessels and facilities) e.g. if specific treatment is required
	Performance (including discharge rate, excluding down time)
Health and safety	Personnel Safety, including potential effect on injury and plant accident frequency
	Health and safety implications to members of the public
	Navigation safety (e.g. multiple vessels in close proximity, tight working areas)
Cost	Capital cost (e.g., requirement to purchase pipes or a vessel, new deposit site opening, treatment facility)

CRITERIA	SPECIFICS
	Capital cost (£) (e.g. requirement to purchase pipes or a vessel, new deposit site opening, treatment facility)
	Operating cost to port (£ per m^3), including treatment and handling costs
	Risk to port operations, third party involvement

Each module is broken down into a series of criteria, each with an equal ranking, which is fully presented in Appendix B. It should be noted that whilst each module may contain a different number of questions, because the average result for each module is calculated (by dividing the score by the number of questions) the effect of this variation in module criteria on the result (Section 4.3) is minimised. The criteria were developed by Xodus considering EHT's experience with dredging operations, including costs for different options (Table 4-2).

Table 4-2 Costs of dredged material use options

COSTS (£) PER M^3 OF DREDGED MATERIAL			
Option	Beneficial use - coastal replenishment/beach nourishment	Recycling - aggregate as a resource	Sea deposit
Dredging	3-5	3-5	2-6
Pump ashore	5-9	6-9	n/a
Pipeline for beach recharge	5-10	n/a	n/a
Onshore handling from point of deposit	2	2	n/a
Profiling - on site or on beach	2	n/a	n/a
Total	17-28	11-16	5-8

4.2 Quantitative BPEO assessment

The full quantitative BPEO assessment is provided in Appendix AB of this document. For each option, a relative score was allocated. These scores were used to calculate a proportionally weighted BPEO indicator (B_i) to produce a relative ranking of options to assist in the identification of the BPEO. The B_i was calculated using the Equation 1:

$$B_i = B_P + B_{HS} + B_{EA} + B_{EC} \quad (1)$$

Where:

B_P =(SP/N)WP

B_{HS} =(SHS/N)WHS

B_{EA} = (SEA/N)WEA

B_{EC} = (SEC/N)WEC

- Bi = Overall BPEO indicator
- B_P = Practicability indicator
- B_{HS} = Health and safety practicability indicator
- B_{EA} = Environmental assessment indicator
- B_{EC} = Economic cost indicator
- S_P = Sum of assessment criteria scores for practicability
- S_{HS} = Sum of assessment criteria scores health and safety assessment
- S_{EA} = Sum of assessment criteria scores for environmental assessment
- S_{EC} = Sum of assessment criteria scores for economic cost
- N = Number of assessment criteria applied in each module
- W_P = Assessment module weighting for practicability (25%)
- W_{HS} = Assessment module weighting for health and safety (25%)
- W_{EA} = Assessment module weighting for environmental assessment (25%)
- W_{EC} = Assessment module weighting for economic cost (25%)

The B_i is relatively sensitive to the assessment module weight (hence the importance of correctly setting the module weight at the start of the BPEO process); however, sensitivity analysis of the scoring assured that the resulting outputs were representative.

4.3 BPEO assessment

The quantitative assessment of the different BPEO options is shown in Table 4-3. The quantitative assessment ranks the BPEO options as follows, with the highest index value indicating the overall best option:

- Beneficial use - coastal replenishment/beach nourishment – B_i = 3.45
- Recycling - aggregate as a resource – B_i = 2.85
- Sea deposit – B_i = 4.41

Taking a holistic view of the the engineering practicability, environmental considerations, cost, health and safety related aspects into account as detailed in Appendix AB, sea deposit of dredged material at sea deposit site is the BPEO. These results are summarised in Table 4-3.

Table 4-3 BPEO Assessment Results Providing a Quantitative Score for Each Option Assessed

CRITERIA	BEACH/COASTAL RECHARGE	OFFSITE USE/RECYCLING AS AGGREGATE OR CONSTRUCTION MATERIAL	DEPOSIT AT A SEA DEPOSIT SITE
Practicability			
Additional space and weight requirements.	4	1	5
Downtime/delay risk/temporal restrictions	3	1	5
Requirement to treat/process material before use, i.e. suitability for deposit (e.g. change chemical and physical properties, desalination, drying)	4	1	5
Commercial/equipment/technology availability, maturity and deployment speed (including availability of vessels and facilities) e.g. if specific treatment is required	4	3	5
Performance (including discharge rate, excluding down time)	1	1	5
BP ((Sum/N) x W) (W=25%) (N=5)	0.80	0.35	1.25
Health and Safety			
Personnel Safety, including potential effect on injury and plant accident frequency	3	3	4
Health and safety implications to members of the public	3	3	5

CRITERIA	BEACH/COASTAL RECHARGE	OFFSITE USE/RECYCLING AS AGGREGATE OR CONSTRUCTION MATERIAL	DEPOSIT AT A SEA DEPOSIT SITE
Navigation safety (e.g. multiple vessels in close proximity, tight working areas)	4	4	4
BHS ((Sum/N) x W) (W=25%) (N=3)	0.83	0.83	1.08
Environmental Assessment			
Land waste generation	5	4	5
Further treatment or environmental impacts due to treatment	4	2	5
Transport requirements	4	2	4
Marine environmental impact	5	3	4
Policy/legislative acceptability	5	4	4
Public and stakeholder acceptability (including visual and amenity implications, business reputation and impacts on other marine users)	4	4	4
BEA ((Sum/N x W) (W=25%) (N=6)	1.13	0.79	1.08
Cost Assessment			
Capital cost (£) (eg. requirement to purchase pipes or a vessel, new deposit site opening, treatment facility)	4	5	5
Operating cost to port (£ per m^3), including treatment and handling costs	2	3	5

CRITERIA	BEACH/COASTAL RECHARGE	OFFSITE USE/RECYCLING AS AGGREGATE OR CONSTRUCTION MATERIAL	DEPOSIT AT A SEA DEPOSIT SITE
Risk on port operations also benefit (money to be made?) third party involvement	3	2	5
Commercial value to port	2	4	1
BEC ((Sum/N x W) (W=25%) (N=4)	0.69	0.88	1
BI =BP+BHS+BEA+BEC	3.45	2.85	4.41

4.4 Conclusion

This BPEO assessment was carried out to systematically identify the best option for the disposal of Eyemouth Harbour's maintenance dredge material over three years of dredging. The BPEO assessment showed that taking a holistic view of the environmental, cost, practicability and health and safety related aspects of the different dredged material use options, sea deposit at the nearby deposit site is the best option. This assessment was largely driven by the proximity of the sea deposit site to the dredge area, as well as the cost, transport and handling requirements of the other options assessment. EHT is collaborating with the SBC to investigate potential beneficial use options in the vicinity of the harbour and should these investigations (including modelling) support potential beneficial use as one of the preferred coastal management options in the area, EHT will look for opportunities to enable this using the dredged material.

A dredging approval and a marine licence application have therefore been prepared for submission to MD-LOT for dredging of up to 100,000 m^3 of material, with sea deposit at the Eyemouth Sea Deposit Site, over a three-year period. The environmental impacts from the dredging and sea deposit operations are assessed fully in the accompanying Environmental Appraisal (Xodus document no A-101031-S00-A-REPT-002).

5 REFERENCES

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APPENDIX A CHEMICAL ANALYSIS

Table 5-1 Dry weight (µg/kg) LMW PAHs (blue) and HMW PAHs (green) concentrations. The sole ERL (equivalent to AL1) exceedance is shown in yellow.

SAMPLES	MOISTURE CONTENT	ACENAPTH	ACENAPHY	ANTHRACN	BAA	BAP	BBF	BEP	BENZGHIP	BKF	C1N	C1PHEN	C2N	C3N	CHRYSENE	DBENZAH	FLUORANT	FLUORENE	INDPYR	NAPTH	PERYLENE	PHENANT	PYRENE	THC	SUM LMW	SUM HMW
Core 1	0.177	1	1.34	2.42	11.9	13.7	10.2	8.44	6.47	10.7	1	6.37	1	1	12.6	1.71	20.7	1	7.47	1	3.43	4.72	18.5	2030	12.48	79.11
Grab 1	0.706	17.6	29.3	58.9	159	207	218	178	165	197	104	352	190	227	200	36.7	287	37.6	167	49.3	117	153	303	985000	449.7	1192.7
Grab 2	0.705	5	30.1	68.6	207	264	251	209	196	241	110	438	217	176	245	42.3	360	39.7	203	67.7	151	155	361	946000	476.1	1479.3
Grab 3	0.704	21.9	43.1	105	279	280	281	229	215	286	147	535	258	250	294	46.8	481	55.6	208	68	123	271	457	1040000	711.6	1837.8
Grab 4	0.66	25.6	52.4	68.1	292	393	369	299	258	359	85	428	154	195	357	59.9	553	43.5	292	59.9	113	178	501	769000	512.5	2155.9
Average		14.22	31.248	60.604	189.78	231.54	225.84	184.688	168.094	218.74	89.4	351.874	164	169.8	221.72	37.482	340.34	35.48	175.494	49.18	101.486	152.344	328.1	748406	432	1348

APPENDIX B BPEO ASSESSMENT

CRITERIA	1	2	3	4	5	BEACH/COASTAL RECHARGE	OFFSITE USE/RECYCLING AS AGGREGATE OR CONSTRUCTION MATERIAL	DEPOSIT AT A SEA DEPOSIT SITE
Practicability (W = 25%)								
Additional space and weight requirements.	Major space & weight issues (e.g. storage of material)	High space & weight issues (e.g. storage of material)	Moderate space & weight issues (e.g. storage of material)	Low space & weight issues can be managed within existing layout	No space & weight issues	4	1	5
Downtime/delay risk/temporal restrictions	Likely downtime risks or temporal restrictions	High downtime risks or temporal restrictions (weeks)	Moderate downtime risks or temporal restrictions (days)	Low downtime risks or temporal restrictions (hours)	No downtime or temporal restrictions	3	1	5
Requirement to treat/process material before use, i.e. suitability for deposit (eg. change chemical and physical properties, desalination, drying)	Extensive treatment/processing required	High amount of treatment/processing required	Some treatment/processing required	Minimal treatment/processing required	No treatment/processing required	4	1	5
Commercial/equipment/technology availability, maturity and deployment speed (including availability of vessels and facilities) e.g. if specific treatment is required	Technology available in Europe or available within 5 years	Technology should be available within 3 to 5 years	Process at pilot trial stage	Can quickly be made available to port or recently implemented	Currently available to port, proven track record	4	3	5
Performance (including discharge rate, excluding down time)	Poor performance to date or significant uncertainty over performance. Very slow (eg. discharge requires transportation elsewhere)	Mixed performance to date or slow discharge rate (e.g. via a pipeline)	Acceptable performance. and has potential to meet objective. Moderate discharge rate (e.g. rainbowing)	Sound performance. Performs consistently to meet objective. Quick but controlled discharge	Technology better than requirements of objective. Immediate and uncontrolled discharge (e.g. bottom dumping)	1	1	5
Health & Safety (W = 25%)								
Personnel Safety Potential effect on injury and plant accident frequency	Likely/expected injuries to occur	Occasional conditions may allow injuries to occur	Seldom/in exceptional conditions injuries may occur	Unlikely/reasonable to expect no injures to occur.	Negligible potential for increased illness or injury.	3	3	4
Health and safety implications to members of the public	Likely/expected injuries to occur	Occasional conditions may allow injuries to occur	Seldom/in exceptional conditions injuries may occur	Unlikely/reasonable to expect no injures to occur.	Negligible potential for increased illness or injury.	3	3	5
Navigation safety (eg. multiple vessels in close proximity, tight working areas)	Severely restricted site with multiple vessels and trips	Highly restricted site with multiple vessels and trips	Seldom/in exceptional conditions navigation safety issues may arise	Unlikely/reasonable to expect no navigation safety issues due to small amount of vessel traffic and space available	Negligible navigation safety issues, minimal additional vessel traffic needed	4	4	4
Environmental Assessment (W = 25%)								
Land waste generation	High waste generated during operation which will be disposed of at a hazardous landfill site	Moderate waste generated during operation which will be disposed of at a hazardous or non-hazardous landfill site	Low waste generated during operation which will be disposed of at a non-hazardous landfill site	Minor amount of waste generated during operation which will be disposed of at a non-hazardous landfill site	Negligible to no wastes arising	5	4	5

CRITERIA	1	2	3	4	5	BEACH/COASTAL RECHARGE	OFFSITE USE/RECYCLING AS AGGREGATE OR CONSTRUCTION MATERIAL	DEPOSIT AT A SEA DEPOSIT SITE
Further treatment or environmental impacts due to treatment	Unacceptable – further treatment, processing and transport to processing site required far away from location of dredging	High further treatment, processing and transport to processing site required, often outwith the region where the activity takes place	Moderate further treatment, processing and transport to a regional processing site required	Minor (local) treatment or additional onward transport to facilitate processing required	Negligible treatment or additional onward transport to facilitate processing required	4	2	5
Transport requirements	Major transport requirements, >50 km distance and multiple vessels and land transport options required	High transport requirements, 10-50 km, multiple vessels and/or land transportation option required	Moderate transport requirements, >10 km or multiple a vessel and land transportation required	Minimal/local transport requirements (< 2 km), using a single vessel	No transport requirements	4	2	4
Marine environmental impact	Persistent/ irreversible landscape scale environmental impact. With widespread impacts to sensitive environments and/or major water bodies	Localized, severe but reversible impact, medium-long term environmental impact. Marine environment is able to fully recover from the impact	Localized, short-medium term environmental impact. Marine environment is able to fully recover from the impact	Localized, short term environmental impact. Marine environment is able to fully recover from the impact or slightly benefit from the proposal	Low probability of any adverse environmental impact to the marine environment - potential for environmental benefits	5	3	4
Policy/legislative acceptability	Not in line with policies	Aligns poorly with policies	Acceptable alignment with policies	In line with policies but not top option	In line with all policies	5	4	4
Public and stakeholder acceptability (including visual and amenity implications, business reputation and impacts on other marine users)	Not acceptable, major and permanent adverse impacts	Low acceptability, long lasting major adverse impacts	Moderate acceptability, moderate duration and adverse impact	High acceptability, short duration and low adverse impacts, some benefits	Public support, negligible or temporary adverse impacts or added benefits	4	4	4
Cost Assessment (W = 25%)								
Capital cost (£) (e.g. requirement to purchase pipes or a vessel, new deposit site opening, treatment facility)	High >50,000	Medium to high 15,000-50,000	Medium 5,000-15,000	Low <5,000	No capital cost	4	5	5
Operating cost to port (£ per m³), including treatment and handling costs	High >20	Medium to high 15-20	Medium 10-15	Low to medium 5-10	Low <5	2	3	5
Risk to port operations, third party involvement	Risk of stopping dredging	High risk of slowing down dredging (> 1 day additional time)	Medium risk of slowing down dredging (up to 1 day additional dredging time)	Low risk of slowing down dredging (up to half a day additional dredging time)	Slowing down dredging unlikely/limited	3	2	5
Commercial value to port	No value, only high costs to port	Limited value to port	+/- 0	Low commercial value - some costs recoverable or alternative use options to port	High commercial value internally or externally	2	4	1