New BPEO for Macduff

1.0 INTRODUCTION

1.1 Background

Macduff is primarily a commercial fishing and maintenance port. There is a large fishing fleet which operates from Macduff and the harbour has a completely enclosed Fish Market which facilitates daily fish landings. The harbour is well renowned in the region for its slipway facilities through which it accommodates a substantial range of vessel types for repairs and maintenance. There are four available repair berths available at any one time and the slipway can handle boats up to 350T, 25m in length and 10m in beam.

Supporting and supplementing those repair and maintenance activities is the local company, Macduff Shipyards, who construct steel hulled fishing vessels as well as traditional wooden boats. In recent years the yard has diversified into other types of vessels from work boats, pilot boats and survey craft but also consolidating its position in the fishing vessels industry. Alongside the shipyard, the wider Macduff Shipyards Group have facilities for crane hire, profilers, precision engineering, deck machinery, stern gear, deep sea seals as well as projects and builds all of which contribute to a vibrant industrial environment at the harbour.

Aberdeenshire Council, as statutory harbour authority, has a duty to maintain safe navigation for vessels within the basins of Macduff harbour and its approach channels. Historically, a dredge vessel fitted with either a backhoe excavator or grab crane and on-board hopper has been used to carry out the dredging works. The associated dredged material has then been disposed of at sea, at the Macduff Deposit Site (OSLO code: CR050), located approximately 1 nautical mile from the harbour.

Requirements for maintenance dredging at Macduff harbour are less frequent compared to neighbouring Banff harbour, situated just across Banff Bay. Indeed, while Banff requires annual dredging, Macduff has seen a comparatively smaller volume removed. For example, since 2016 just over 3,000 m^3 of sediment has been extracted from the harbour basins while throughout that same period more than double, roughly 6,800 m^3, has been taken from Banff. Local knowledge indicates that dredging frequency between Macduff and Banff harbours can alternate depending on the course of the Deveron, and at present, the sedimentation rates at Macduff seem to be at a reduced level. This of course is a dynamic situation and is likely to change over time.

The Council most recently held a licence to dredge Macduff harbour between February 2016 and February 2019 (ref. 04456/12/0) and hence there is a need to apply for a new licence. The new licence is being requested for a duration of 12 months and permission is being sought to remove up to 5,000 m^3 of material from different areas throughout the Harbour, including the West, Middle and Princess Royal basins as well as the entrance channel.

1.2 Scope of the Report

Under section 27(2) of the Marine (Scotland) Act 2010, Marine Scotland have an obligation to consider the availability of practical alternatives when considering applications involving disposal of substance(s) or object(s) at sea. The objective of this report is therefore to identify the Best Practicable Environmental Option (BPEO) for disposal of sediment arising from maintenance dredging operations at Macduff Harbour. It has been prepared in support of Aberdeenshire Council's application for a 12-month Marine Licence for Dredging and Sea Disposal. The assessment of the BPEO will take into consideration possible social, environmental and economic impacts that dredging activities might have and how any negative effects can be mitigated or minimised. This process is in accordance with guidelines for the management of dredged material set out by the OSPAR Commission [1].

1.3 Report Structure

Following this introduction, Section 2 will describe the material to be dredged from Macduff Harbour and Section 3 will then outline a number of disposal options that have been considered. The most feasible disposal options will be carried forward with the Best Practicable Environmental Option identified in Section 4.

2.0 DESCRIPTION OF MATERIAL TO BE DREDGED

2.1 Source of Materials

Macduff Harbour is situated at the mouth of the River Deveron, on the eastern edge of Banff Bay. Given the local geography, the most likely source for sediment at the harbour is from the Deveron and offshore from the North Sea, although this assertion remains to be backed up with physical evidence. There are also no direct measurements available of sediment flux at the harbour but based on recent dredging requirements the in-fill rates can be loosely estimated to be on the order of 1,000 m^3 per year. This of course is a highly dynamic working assumption and is subject to change over time.

2.2 Sampling Analysis of Sediment in Banff Harbour

2.2.1 Data Collection

Aspect Land and Hydrographic Surveyors were commissioned by Aberdeenshire Council to collect three sets of sediment samples from Macduff Harbour in November 2019. The samples were collected using a Van Veen 0.045 m^3 surface grab, from locations that were pre-approved by Marine Scotland. The sampling location plan, survey report and results of the sample analysis are included in Appendices 1, 2 and 3, respectively.

2.2.2 Physical Characteristics of Sediment to be Dredged

The samples collected across the harbour reveal quite distinctive physical characteristics at each of the three locations. For example, material from the West basin is predominantly sand (82.8%) with a moderate amount of mud (14.1%) and a small amount of gravel (3.1%). The middle basin returned a gravelly muddy sand with much higher gravel (17%) and mud (24.4%) content. The composition of the Princess Royal basin sediment was the most balanced of the three samples, being classified as a muddy sandy gravel, with sand / gravel / mud fractions of 40.6%/36.8%/22.6%, respectively.

2.2.3 Chemical Analysis of Sediment to be Dredged

The samples were submitted for chemical analysis in line with Marine Scotland requirements (see Appendix 3 for full results). Table 1 highlights the main findings in relation to the presence of Organotins, Trace Metals and Polycyclic Aromatic Hydrocarbons (PAHs) compared to Marine Scotland's designated Action Levels (AL's).

Table 1 Summary of chemical analysis findings at each sample location in relation to Marine Scotland AL's

Substance	**Comments**
Organotins	Levels of DBT were found to be negligible at all three sample locations however, TBT values exceeded AL1 in the middle basin and exceeded AL2 in the Princess Royal Basin.
Trace Metals	The presence of all trace metals was below AL1 for samples in the Middle basin of the harbour. Only Cu was above AL1 in the Princess Royal Basin while the West basin sample returned levels of Cd, Cr, Cu, Ni and Zn which exceeded AL1 but in all cases, the values were comfortably below AL2.
PAHs	Nearly all measured PAHs were found to exceed the corresponding 10 or 100 µg/kg AL at all three locations. The exceptions being Acenapthene, Acenapthylene, Flourene and Napthalene, all of which were below the AL set by Marine Scotland.

The results of averaging the (dry weight) data across all three sample locations are shown in Tables 2 and 3 below. These averaged values are deemed to give a more general picture of the overall condition of the sediment to be dredged and are less prone to distortions that can be introduced by local effects and a limited sample size.

Table 2 Averaged levels of Trace Metals and Organotins in the Macduff Harbour sediment (mg/kg, Dry weight)

As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	DBT	TBT
5.2	0.3	48.3	48.0	0.04	16.1	13.7	125.7	0.21	0.51

With reference to Table 2, of the trace metals, it is only Cu which exceeds AL1 and the value of 48 mg/kg is considerably less than the AL2 threshold of 300 mg/kg. Of the Organotins, the averaged value of TBT is 0.51 mg/kg which exceeds AL2 by 0.01 mg/kg.

Table 3 Averaged levels of PAHs in the Macduff Harbour sediment (µg/kg, Dry weight)

ACTH	ACHY	ANTH	BAA	BAP	BBF	BEP	BENZ	BKF	C1N	C1P	C2N
15.2	31.1	198.3	528.7	686.3	662.0	487.0	423.7	351.7	128.8	532.7	134.7
C3N	**CHRY**	**DBEN**	**FLNT**	**FLNE**	**INDY**	**NAPT**	**PERY**	**PHEN**	**PYRE**	**THC**	
147.0	677.3	110.7	866.7	46.5	441.7	57.3	205.6	318.3	1,089.7	1,718,667	

The averaged PAH results presented in Table 3 reflect the overall high PAH content observed at each individual sample location with all but 4 of the measured parameters exceeding their corresponding Marine Scotland action level. A more detailed assessment of the results listed above is carried out in the next section.

2.2.4 Discussion

Two important points have been highlighted from the results presented in section 2.2.3 which require further attention. The first is the levels of TBT found in the Middle basin and Princess Royal basin samples. Second is the generally high PAH content of the sediment samples, again particularly in the Princess Royal Basin.

To place these results in context and to identify any underlying trends in the data, it would be useful to refer to analysis carried out in previous years. Unfortunately, it seems that samples from the harbour were last collected and analysed in 2006. In addition, the locations of the 2006 samples were confined to the quayside of the middle basin, far removed from the location of the most recent 2019 samples. Furthermore, there is no accompanying analysis report so it is not clear how parameters from the 2006 data have been calculated and as such it is not clear whether the results can be directly compared. For example, in the 2006 results a parameter denoted “TBT+” is reported with a value of 86 but with no accompanying units. Thus, it is assumed that this is a normalised (dimensionless) variable, but the normalisation procedure is not known, making comparisons with the 2019 data impossible. This is an important point to bear in mind and highlights the necessity, going forward, of the harbour authority and licensing authority working together to ensure that consistent and regular monitoring is undertaken.

Taking the above circumstances into consideration, a degree of educated reasoning will have to be applied in the interpretation of the most recent data. Looking firstly to the elevated levels of TBT found at the harbour. TBT is a highly effective anti-fouling paint and its use was widespread until recently, where a global ban on its use was enforced [2]. At Macduff, levels of TBT in the sediments are seen to diminish rapidly with increasing distance from the Slipway. This is consistent with the Slipway, and the corresponding boat maintenance activities, being the primary source of the TBT. The Slipway was upgraded in 2007 and sump tanks were installed to catch wash water from the slipway repair cradles. There is a strict testing and disposal procedure for boats which are suspected of having TBT presence on their hulls. Only wash water free from contaminants is discharged from the sumps to the Princess Royal basin. In support of this, Appendix 4 shows the results of a random water sample taken from the sump in December 2019. Only trace amounts of TBT were identified (6.97 ng/ml) in the sample, providing some confidence that the pollution control measures are working as anticipated. Furthermore, the Council have recently ordered the cleaning of the sump tanks and this will be carried out at routine intervals to minimise the possibility of residual contaminant build up in the sump tanks. Therefore, the elevated TBT levels are believed to be historical in nature, more a signature of past activities prior to the change in legislation and prior to the upgrade in pollution control measures at the Slipway. Subsequently, the observed levels are not deemed to be at risk of increasing but rather will continue to steadily decline, consistent with wider trends measured elsewhere [3]. This decline will typically occur through natural degradation processes. Such processes are complex, and TBT can persist in sediment for several years which is why it is still detectable at the present time [4].

TBT is known to have an adverse biological effect on organisms, even at low concentrations, such as defective shell growth in *Crassostrea gigas* oysters and imposex in dog-whelks (sp. *Nucella*) [2]. However, no such species are reported to be habiting at or near to the sea disposal site, so any potential negative ecological hazards are not expected to be realised. In addition, the amount of dredged material to be taken from the Princess Royal Basin will make up less than a third of the total amount of material to be removed, thus further mitigating its potential negative effects.

Looking next to the high levels of PAHs found in the samples, a number of explanations can be provided. The most significant contributing factor is believed to be a recent fuel spill which occurred at the harbour in August 2019. Appendix 5 provides some further details and photographs of the incident and subsequent clean up efforts. Characteristic ratios of Fluoranthene to Pyrene are found to be 0.83 and 0.64 in the Middle basin and Princess Royal basin, respectively, which is primarily where the spill occurred. Values of these ratios being significantly below 1 supports the hypothesis that the dominant source for the contamination is petrogenic in nature [5]. Another possible source of PAHs is from vessels berthed along the North Pier of the harbour, which spans both the Princess Royal and Middle basins. There is currently no provision of shore power along this pier and as such, some vessels have been known to keep their engines running to maintain power to the ships on board facilities while moored at the harbour. However, the Harbour Authority are actively engaged in steps to install shore power points along the North Pier, thus negating this source of contamination in the longer term. There is also likely to be a contribution to PAH content from surface run-off along the piers, which are relatively heavily trafficked by industrial vehicles, including road cranes, transit vans and other light plant. Furthermore, while the disposal of bilge tanks is not permitted within the harbour it is difficult to enforce and unfortunately, there is no guarantee that this is always strictly adhered to, so some contribution to the contamination may come from oily bilge residue. Similar to nearby Banff Harbour, additional contaminants may be transported to the harbour via the River Deveron, which itself may be subject to pollution from agricultural run-off and industrial activities (e.g. Macduff distillery). This is a difficult source to quantify however, as there are no known records of water / sediment sampling from the mouth of the Deveron and Banff Bay in the vicinity of the harbour.

For trace metals and PAHs, the environmental significance of the results can be determined using the ‘Effects Range Low’/’Effects Range Median’ (ERL/ERM) methodology of Long et al [6]. The ERL/ERM thresholds have been derived from a large database of studies into the toxicity effects of sediment on benthic communities. Adverse biological effects are rarely seen for contaminant concentrations below the ERL while the ERM may be viewed as an upper threshold, beyond which adverse biological effects may be anticipated to occur more frequently. Table 4 compares the measured samples from Macduff exceeding Marine Scotland Action Levels against the ERL / ERM thresholds.

Table 4 Comparison of averaged (Dry weight) levels of Trace Metals and PAH in exceedance of AL1 against ERL and ERM thresholds (where available)

Substance	**Cu**	**ANTH**	**BAA**	**BAP**	**BBF**	**BEP**	**BENZ**	**BKF**	**C1N**	**C1P**
Measured	30.7	198.3	528.7	686.3	662.0	487.0	423.7	351.7	128.8	523.7
ERL	34	85	63	600	665	N/A	N/A	N/A	N/A	N/A
ERM	270	1100	260	5100	2600	N/A	N/A	N/A	N/A	N/A

Table 4 cotd.

Substance	**C2N**	**C3N**	**CHRY**	**DBEN**	**FLNT**	**INDY**	**PERY**	**PHEN**	**PYRE**
Measured	134.7	147.0	677.3	110.7	866.7	441.7	205.6	318.3	1089.7
ERL	N/A	N/A	384	63	600	N/A	N/A	240	665
ERM	N/A	N/A	2800	260	5100	N/A	N/A	1500	2600

With reference to Table 4 all contaminants in exceedance of AL1 are found to be comfortably below the corresponding ERM values (where they are available), suggesting the likelihood of adverse biological effects occurring from the disposal of the sediments is low. This is further supported by recalling that PAH levels are believed to have been temporarily boosted to artificially high levels as a consequence of the 2019 fuel spill. These levels will continue to degrade naturally over time but any sediment being considered for disposal in the immediate future are still not deemed to pose a significant environmental or ecological threat.

3.0 APPRAISAL OF DISPOSAL OPTIONS

3.1 Introduction

This section will discuss all available disposal options for the dredge materials. If the method is considered impractical, the reasons will be explained for its exclusion from the remainder of the report. Those options considered as practical will be carried through for further analysis.

3.2 Option 1: Sea Disposal

Macduff Harbour acts as an artificial sediment trap with most of the sediment accumulating in the harbour originated from the River Deveron and offshore from the North Sea. Sea disposal thus allows the return of this material to those same coastal waters and in doing so, increases the potential to nourish adjacent beaches which may otherwise suffer from depletion if excessive removal to land takes place. Further, sea disposal avoids the environmental problems and safety constraints of such activity, and it avoids filling valuable landfill capacity with substantial columns of material which it is believed can best be relocated in the sea.

Decision on option: *Carry forward for further analysis*

3.3 Option 2: Beach Recharge

The used dredged material for beach nourishment has been investigated and, although having a number of disadvantages in comparison to direct sea disposal, it does still remain a viable option. However, with the presence of minor pollutants following the recent sampling analysis, it would need to be investigated whether their presence would pose any environmental threat if used for beach replenishment. The nearest beach replenishment dump box is in Banff which would involve a 3 mile road haul through both Macduff and Banff. Due to accessibility problems within the Harbour basins and channel, the material cannot be collected by land-based plant and would instead need to be collected by grab or cutter suction units mounted on a dredge vessel. This would then have to be transferred to a holding basin on the quayside or directly transferred to road haulage units, involving contamination and additional resources and expense. Whilst we are aware that the quantities arising from the Banff Harbour Marina Dredge are easily dispersed on the adjacent beaches, we would have to investigate how this process would handle the greater quantities arising from the Macduff dredge.

Decision on Option: *Carry forward for further analysis*

3.4 Option 3: Agricultural Use

Having spoken to local businesses who specialise in providing composting and soil conditioning services to the agricultural sector it has been confirmed that the dredged material is unsuitable for spreading on agricultural land, or for soil conditioning of reclaimed land due to the high salt content. The salt would have to be removed from the sand before it could be used in this manner. This option for disposal can therefore be discounted.

Decision on Option: *Discard*

3.5 Option 4: Reclamation

The possible use of the dredged material for land reclamation has been investigated, and no demand has been found due to the unreliability and inconsistency of total and daily potential supply rates.

Decision on option: *Discard*

3.6 Option 5: Landfill

There are no landfill sites within easy reach of Macduff or indeed any of the Council's harbours and the Environmental Health Departments of the local Councils have been approached to identify suitable sites elsewhere. Moray Council have indicated that they cannot handle the quantities of material involved, which even when dried are substantial, at the sites which they have available. Aberdeenshire Council are also unable to accept thousands of cubic metres of dredged material, either in a dried or 'as-dredged' state, at inland sites.

Decision on option: *Discard*

3.7 Option 6: Land Incineration and Subsequent Disposal of Residue

As the main component of the dredge spoil is sand, incineration of the material is not economically viable. Indeed, results from the Scottish Environment Protection Agency1 show that in 2018 there was no recorded incineration of dredging spoils anywhere in Scotland, suggesting that in general this is not an appropriate solution.

Decision on option: *Discard*

4.0 SUMMARY & IDENTIFICATION OF BEST PRACTICABLE ENVIRONMENTAL OPTION

Six options have been considered for the disposal of dredged material. The options of agricultural use, reclamation, landfill, and land incineration were discounted at the earliest stage due to the unsuitability and small quantity of material and lack of appropriate disposal sites.

The option of beach nourishment was brought forward for comparison with the option of direct disposal to sea. The comparison was made on the grounds of key operational, environmental, and economic factors. Beach nourishment, although not to be entirely dismissed, displayed greater impacts on health and safety, had higher financial outlays and was operationally far less efficient. It would also likely garner significant public opposition due the increased disturbance to residents in both Banff and Macduff and its overall higher detrimental environmental impact.

It is thus concluded that the present system of placement in an approved offshore sea disposal site is the Best Practicable Environmental Option, and that such placement is considered to be an acceptable disposal option in terms of The Marine Scotland Act 2010.

REFERENCES

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