Crail Harbour
BPEO – Additional Risk Assessment

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1 INTRODUCTION

1.1 Scope of Report

This report provides further consideration and risk assessment of the sediment quality within Crail harbour recently sampled by Fife Council in support of the associated dredge application. It is understood that the dredge volumes to be removed from the harbour are between 1,000 and 1,500m^3 in total. It is understood due to the small nature of the harbour and limited access; that all dredging works will be undertaken from adjacent land/harbour and material placed on rocks to the east of the site for natural dispersal by tides. It is understood that has been the previously agreed method of disposal.

This report is to be read in conjunction with the BPEO report prepared by Fife Council.

1.2 Chemical Data

4 sediment samples were collected from the harbour and tested by RPS. The data can be reviewed in the Pre-Dredge Sample form submitted as part of the licence application. The results are summarised below with summary tables presented in Appendix A.

1.2.1 Metals

The majority of metals were below their respective Revised Action Level 1 (RAL 1) with the following notable exceptions:

- Chromium – 2 of 4 samples recorded cadmium levels above RAL1. The maximum concentration recorded was 77.2 mg/kg in Sample B.
- Copper – 1 of 4 samples recorded copper levels above RAL1. The maximum concentration recorded was 132 mg/kg in Sample C.
- Mercury – 1 of 4 samples recorded mercury levels above RAL1. The maximum concentration recorded was 0.32 mg/kg in Sample B.
- Nickel – 1 of 4 samples recorded nickel levels above RAL1. The maximum concentration recorded was 53.98 mg/kg in Sample B.
- Zinc - 1 of 4 samples recorded zinc levels above RAL1. The maximum concentration recorded was 130 mg/kg in Sample B.

RAL 2 levels were not exceeded in any of the samples tested.

1.2.2 Tributyl Tin (TBT)

All samples recorded TBT at concentrations below RAL 1. The maximum concentration recorded was 0.01 mg/kg in Sample C.

1.2.3 Polyaromatic Hydrocarbons (PAHs)

3 of 4 samples recorded concentrations of more than one individual PAH species above RAL 1.

1.2.4 Polychlorinated Biphenyls (PCBs)

All samples recorded individual PCB congeners below RAL 1. The maximum concentration individual congener recorded was 0.0028 mg/kg.

1.2.5 Total Hydrocarbons (THC)

3 of 4 samples recorded hydrocarbons above RAL 1. The maximum concentration was 160 mg/kg in Sample B.

These exceedances are considered further in Section 2.

2 FURTHER ASSESSMENT

As detailed in Section 1, on the basis of the exceedances recorded for Action Level 1, further assessment to determine the suitability of the material for sea disposal is deemed a requirement as requested by Marine Scotland. All summary tables are presented in Appendix A.

The approach for this further assessment is outlined as follows:

- Provide an overview of the proposed dredge works and the identified disposal site; and
- Compare existing chemical data with other recognised sediment assessment criteria including those listed below. Summary tables are provided in Appendix A.

Background Assessment Concentration (BAC) - BACs were developed by the OSPAR Commission (OSPAR) for testing whether concentrations are near background levels. Mean concentrations significantly below the BAC are said to be near background. However, it should be noted that river catchments have their own unique geochemical finger prints and are also governed by the geology within the catchment, so in theory one set of background level values is not applicable to all situations;

Effects Range Low (ERL) - ERLs were developed by the United States Environmental Protection Agency (USEPA) for assessing the ecological significance of sediment concentrations. Concentrations below the ERL rarely cause adverse effects in marine organisms. Concentrations above the ERL will often cause adverse effects in some marine organisms;

Probable Effects Level (PEL) – PELs (Marine) have been adopted from the Canadian Environmental Quality Guidelines http://www.ccme.ca/en/resources/canadian_environmental_quality_guidelines/) If a concentration is recorded above the PEL this is the probable effect range within which adverse effects frequently occur. The Threshold Effect levels (TELs) have been included in the summary table in Appendix B, but have not been used as part of the further assessment as they typically fall below the RAL1

Review of potential risks to the list of receptors identified in "Water Framework Directive Assessment: estuarine and coastal waters (https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters) to draw conclusions from available information and provide recommendation for proposed disposal routes.

2.1 Dredge and Disposal Site

The dredge site is located within Crail Harbour.

It is proposed that the dredged material is disposed of over the harbour wall into the intertidal zone, where sediment will be dispersed by rising and falling tides. This has been the historic practice previously. No background chemical data is available for the disposal site.

2.2 Analytical Data Review

Existing analytical data for the proposed dredge site is provided in Summary Table A in Appendix A. This data has been summarised against RAL 1 & 2, the BAC, ERL and PEL. As detailed previously, the data has not been reviewed against the Canadian TEL as these numbers are typically lower than RAL1. A summary of the findings is detailed below:

2.2.1 Action Level 1

The majority of contaminants were below their respective RAL 1 with the following exceptions:

- Chromium – 2 of 4 samples recorded cadmium levels above RAL1.
- Copper – 1 of 4 samples recorded copper levels above RAL1.
- Mercury – 1 of 4 samples recorded mercury levels above RAL1.
- Nickel – 1 of 4 samples recorded nickel levels above RAL1.
- Zinc – 1 of 4 samples recorded zinc levels above RAL 1.
- PAHs – 3 of 4 samples recorded concentrations of more than one individual PAH species above RAL 1.
- THC – 3 of 4 samples recorded hydrocarbons above RAL 1.

2.2.2 BAC Review

Exceedances of the BAC (where one is available) were recorded as follows:

- Copper – 3 of 4 samples recorded copper levels above the BAC.
- Mercury – 3 of 4 samples recorded mercury levels above the BAC.
- Nickel – 1 of 4 samples recorded nickel levels above the BAC.
- Lead – 1 of 4 samples recorded lead levels above the BAC.
- Zinc – 1 of 4 samples recorded zinc levels above the BAC.
- PAHs – 4 of 4 samples recorded concentrations of more than one individual PAH species above the BAC.

2.2.3 ERL & PEL Review

The ERL, where one is available, was exceeded for copper (1 sample), mercury (1 sample) and PAH (1 sample).

The PEL, where one is available, was exceeded for copper (1 sample) and for one PAH species (1 sample). The PAH exceedance is noted to be marginal (0.13 mg/kg recorded for Acenaphthylene vs. PEL of 0.128 mg/kg)

2.3 Averages

Review of the averaged data for all the data has been undertaken i.e. considering the material as a single volume for disposal. The review of average data against the available adopted assessment criteria can be summarised as follows:

- Averaged concentrations exceeded RAL1 for copper, at least one PAH species and THC.
- Average concentrations exceeded ERL for copper and mercury (marginally) where one is available for review.
- No average concentrations exceed the PEL where one is available for review.
- All samples recorded average concentrations below RAL2 where they exist.

2.4 Chemical Assessment Conclusions

A number of samples record exceedances of RAL 1 including metals, PAHs and THC. No samples recorded contaminant levels in exceedance of RAL 2.

A number of ERL exceedances have been recorded, and two exceedances of PEL were recorded for individual samples. Averaged data did not record any exceedances above the respective PEL values, where available for review.

No background data for the disposal site is available for review, therefore a comparison between sediment sample results and disposal site data cannot be made.

Further consideration of the potential risks associated with the proposed disposal is considered in the following sections.

2.5 Water Framework Directive Assessment

As outlined in the Water Framework Directive Assessment: estuarine and coastal waters, there are several key receptors which can be impacted upon including the following:

- Hydromorphology
- Biology – habitats
- Biology – fish
- Water quality
- Protected areas

Each of these points are considered in Table 2-1 below:

Table 2-1: Receptor Risk Assessment

Key Receptor	Brief Summary of Potential Effects on Receptor	Further Consideration Required?	Comment
Hydromorphology (Source Area and Disposal Site)	Morphological conditions, for example depth variation, the seabed and intertidal zone structure tidal patterns, for example dominant currents, freshwater flow and wave exposure	No	The areas proposed to be dredged are already subject to dredging and the proposed disposal site is within the intertidal zone. Sediment disposed in the intertidal zone is likely to be dispersed quickly by rising and falling tides. The practice of disposing of dredged material over the harbour wall has been agreed in the past due to the limited access to the harbour for dredging plant.
Biology - habitats	Included to assess potential impacts to sensitive/high value habitats.	Yes	The dredge site is adjacent to the Firth of Forth SPA/SSSI/Ramsar. The area is noted to be habitat for several bird species. This is considered further under 'Protected Areas' below.

Key Receptor	Brief Summary of Potential Effects on Receptor	Further Consideration Required?	Comment
Biology – fish	Consideration of fish both within the estuary and also potential effects on migratory fish in transit through the estuary.	No	Not considered to be a significant risk considering the dredge areas are part of the existing harbour area and require dredging to maintain its use. Sediment disposed in the intertidal zone is likely to be dispersed quickly by rising and falling tides. Averaged analytical data for the dredged sediments are below the PEL. Additionally, there is no estuary in close proximity to the site in which migratory fish would be migrating towards, and immediately out with the harbour and proposed disposal site is open sea with no obvious constraints
Water Quality	Consideration must be given to water quality when contaminants are present in exceedance of CEFAS RAL1.	Yes	Contaminants noted to exceed CEFAS RAL 1 within sediment samples for some metals and PAH species as well as hydrocarbons.
Protected Areas	If your activity is within 2km of any WFD protected area, include each identified area in your impact assessment. • special areas of conservation (SAC) • special protection areas (SPA) • shellfish waters • bathing waters • nutrient sensitive areas	Yes	The dredge site is located within Crail Harbour. The boundary of the Firth of Forth SPA/SSSI/Ramsar is immediately beyond the harbour wall. The proposed disposal site is within these protected/designated areas. Fife Council had a pre-consultation discussion regarding the proposed disposal route with Scottish Natural Heritage (SNH) in December 2019 in advance of the formal consulting exercise. SNH concluded that deposited sediments would “disperse quickly and not cause any lasting damage”. On this basis risks to the designations are considered to be low and short lived. The dredge and disposal sites are located within 500m of the Crail (Roome Bay) Bathing Waters. The dredge and adjacent disposal sites are not designated as shellfish water or within 2km of any designated shellfish water protected areas.

Source: Taken from https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters

2.6 Potential Risk to Water Quality and Marine Life

The potential risks to water quality and protected areas at both the dredge sites and disposal site are further considered as all other receptors have been screened out of the assessment (see Table 2-1).

2.6.1 Water Quality

The coastal classification of this area of water (Fife Ness to Elie) is reported as "good" in 2018 (SEPA) as detailed on Scotland's Environment (http://www.environment.scotland.gov.uk/).

Although there are contaminants of concern above the RAL 1 for various metals, PAHs and THC, it is considered that these levels will not contribute to an overall degradation of water quality as the potential for dilution in the Firth of Forth is very considerable. When the sediment results are reviewed on an averaged basis to assess the sediment mass as a whole body for disposal, then only concentration of copper exceeds the ERL, with a marginal exceedance of the ERL for mercury. All averaged results are below the PEL. On this basis, the risks from the sediment as a dredge mass are considered to be low, with the associated dilution potential providing further mitigation to potential risks. Additionally, the proposed dredge volume for disposal is considered to be small, so total source of potential contaminants is considered to be limited.

The key contaminants for impacting water quality are considered to be metals as these have the potential to dissolve/desorb from sorption sites, whereas the organic contaminants (PAHs have a greater affinity for the organic materials which they are bound to, and are more likely to remain strongly bound to the sediment, or if they become dissolved, quickly adsorbed onto organic matter within the water column or sediments. Saline water environments tend to help facilitate flocculation of suspended material which ultimately settles on the sea bed and helps control dissolved contaminant concentrations further.

The key risk is considered to be an increase in turbidity/suspended solids during the disposal activity, although this is likely to cause localised degradation in water quality, it is considered that this will be a short term event.

The sediment material is dominated by sand (51%), and silt and clay size (30%) fractions based on the data provided.

Clay and silt have the potential to suspend for longer within the water column due to their smaller size and density than sand. Suspension and dispersion can be minimised depending on dredging technique to maximise the benefits of the cohesive nature of the silts and clays. Given that it is proposed that the material is to be deposited over the sea wall, it will likely fall as large clumps rather than as a slurry through the water column, therefore minimising suspended solids.

On this basis, the associated risk with degradation of water quality directly associated with the proposed disposal is considered to be low i.e. unlikely to cause a significant adverse effect on the overall water quality or have an adverse effect upon marine life.

2.6.2 Protected Areas – Bathing Waters

The site is approximately 500m west of the Crail (Roome Bay) Bathing Water. As noted in Section 2.6.1, there is a potential risk to water quality, primarily from an increase in turbidity/suspended solids while the disposed sediment is being dispersed from the intertidal zone. However, the risk to water quality and therefore risk to bathing water is considered to be low, based factors including the large dilution potential of the Firth of Forth. In addition, the risk is further minimised by the proposed timing of the dredge and disposal. The dredge is likely to be undertaken before the bathing season commences (Bathing season runs from 1st June to 15th September).

2.7 Conclusions and Recommendations

A review of available information has highlighted that several chemical contaminants exceed RAL 1. When the sediment mass is considered as a whole (averaged data), RAL 1 is exceeded only for copper, PAH and THC. Further assessment of averaged concentrations against the PEL (where available) noted no exceedances.

Following a review of available information and an assessment of risk against key receptors, a low risk is noted to all key receptors from the dredging activity.

The proposed disposal method is to deposit dredged material over the harbour wall on to the intertidal zone for dispersal by rising/falling tides, in line with previous practice and historical arrangements. The disposal is concluded to pose a low risk to hydromorphology, habitats, fish and water quality and protected/designated sites.

REFERENCES

Marine Scotland (2017). *Pre-DredgeSampling Guidance Version 2*: Scottish Government.

Marine Scotland (2015). *Guidance for Marine Licence Applicants Version 2*: Scottish Government.

APPENDICES

A SUMMARY TABLES

Summary Table A

Sampling Results Incorporated with BPEO Assessment (mg/kg)

						Crail Harbour									
	AL1	AL2	BAC	ERL	PEL	Sample A	Sample B	Sample C	Sample D	AVERAGE	No. Exceed RAL 1	No. Exceed RAL 2	No.Exceed BAC?	No. Exceed ERL	No. Exceed PEL?
Source			CSEMP	CSEMP	Canada										
Arsenic	20	70	25		41.6	6.09	3.4	7.7	8.51	6.41	0	0	0	-	0
Cadmium	0.4	4	0.31	1.2	4.2	0.12	0.31	0.24	0.25	0.23	0	0	0	0	0
Chromium	50	370	81	81	160	26	77.2	41.8	55	50.00	2	0	0	0	0
Copper	30	300	27	34	108	9.2	28.8	132	27.7	49.41	1	0	3	1	1
Mercury	0.25	1.5	0.07	0.15	0.7	0.05	0.32	0.15	0.12	0.16	1	0	3	1	0
Nickel	30	150	36	-	-	11.2	53.9	19.3	25.7	27.53	1	0	1	N/A	N/A
Lead	50	400	38	47	112	22.1	43.7	31.5	29	31.68	0	0	1	0	0
Zinc	130	600	122	150	271	41	101	122	130	98.38	1	0	1	0	0
Napthalene	0.1		0.08	0.16	0.391	0.0448	0.0494	0.0179	0.0428	0.04	0	-	0	0	0
Acenaphthylene	0.1				0.128	0.00661	0.13	0.00811	0.014	0.04	1	-	N/A	N/A	1
Acenaphthene	0.1				0.0889	0.0082	0.0161	0.00674	0.00865	0.01	0	-	N/A	N/A	0
Fluorene	0.1				0.144	0.0194	0.0353	0.0103	0.0173	0.02	0	-	N/A	N/A	0
Phenanthrene	0.1		0.032	0.24	0.544	0.115	0.44	0.102	0.0817	0.18	3	-	4	1	0
Anthracene	0.1		0.05	0.085	0.245	0.0459	0.123	0.0311	0.0266	0.06	1	-	1	1	0
Fluoranthene	0.1		0.039	0.6	1.494	0.297	0.772	0.189	0.0923	0.34	3	-	4	1	0
Pyrene	0.1		0.024	0.665	1.398	0.222	0.707	0.177	0.0891	0.30	3	-	4	1	0
Benzo(a)anthracene	0.1		0.016	0.261	0.693	0.118	0.275	0.0698	0.034	0.12	2	-	4	1	0
Chrysene	0.1		0.02	0.384	0.846	0.0957	0.282	0.0701	0.0309	0.12	1	-	4	0	0
Benzo(b)fluoranthene	0.1		-	-	-	0.145	0.425	0.0951	0.0611	0.18	2	-	N/A	N/A	N/A
Benzo(k)fluoranthene	0.1		-	-	-	0.0425	0.125	0.0303	0.0134	0.05	1	-	N/A	N/A	N/A
Benzo(a)pyrene	0.1		0.03	0.384	0.763	0.113	0.337	0.0734	0.0369	0.14	2	-	4	0	0
Indeno(1,2,3cd)pyrene	0.1		0.103	0.24	-	0.0452	0.175	0.0376	0.0216	0.07	1	-	1	0	N/A
Benzo(ghi)perylene	0.1		0.08	0.085	-	0.0564	0.213	0.053	0.0313	0.09	1	-	1	1	N/A
Dibenzo(a,h)anthracene	0.01		-	-	0.135	0.02	0.0554	0.0134	0.00762	0.02	0	-	N/A	N/A	0
TPH	100		-	-	-	56.6	160	102	130	112.15	3	-	N/A	N/A	N/A
PCBs	0.02	0.18	-	-	0.189	0.0059	0.0013	0.0013	0.0013	0.0025	0	0	N/A	N/A	0
TBT	0.1	0.5	-	-	-	0.002	0.00548	0.0105	0.00647	0.0061	0	0	N/A	N/A	N/A

Note: Underlined Values are < LOD

PEL Data Source: http://ceqg-rcqe.ccme.ca/en/index.html#void

Summary Table B

Crail Harbour Average Concentrations

All units in mg/kg

	AL1	AL2	BAC	<ERL	PEL	Dredge Average	Exceed AL1?	Exceed AL2?	Exceed BAC?	Exceed ERL ?	Exceed PEL?
Source			CSEMP	CSEMP	Canada						
Arsenic	20	70	25	-	41.6	6.4	No	No	No	N/A	No
Cadmium	0.4	4	0.31	1.2	4.2	0.2	No	No	No	No	No
Chromium	50	370	81	81	160	50.0	No	No	No	No	No
Copper	30	300	27	34	108	49.4	Yes	No	Yes	Yes	No
Mercury	0.25	1.5	0.07	0.15	0.7	0.2	No	No	Yes	Yes	No
Nickel	30	150	36	-	-	27.5	No	No	No	N/A	N/A
Lead	50	400	38	47	112	31.7	No	No	No	No	No
Zinc	130	600	122	150	271	98.4	No	No	No	No	No
					-						
Napthalene	0.1	-	0.08	0.16	0.319	0.04	No	N/A	No	No	No
Acenaphthylene	0.1	-	-	-	0.128	0.04	No	N/A	N/A	N/A	No
Acenaphthene	0.1	-	-	-	0.0889	0.01	No	N/A	N/A	N/A	No
Fluorene	0.1	-	-	-	0.144	0.02	No	N/A	N/A	N/A	No
Phenanthrene	0.1	-	0.032	0.24	0.544	0.18	Yes	N/A	Yes	No	No
Anthracene	0.1	-	0.05	0.085	0.245	0.06	No	N/A	Yes	No	No
Fluoranthene	0.1	-	0.039	0.6	1.494	0.34	Yes	N/A	Yes	No	No
Pyrene	0.1	-	0.024	0.665	1.398	0.30	Yes	N/A	Yes	No	No
Benzo(a)anthracene	0.1	-	0.016	0.261	0.693	0.12	Yes	N/A	Yes	No	No
Chrysene	0.1	-	0.02	0.384	0.846	0.12	Yes	N/A	Yes	No	No
Benzo(b)fluoranthene	0.1	-	-	-	-	0.18	Yes	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene	0.1	-	-	-	-	0.05	No	N/A	N/A	N/A	N/A
Benzo(a)pyrene	0.1	-	0.03	0.384	0.763	0.14	Yes	N/A	Yes	No	No
Indeno(1,2,3cd)pyrene	0.1	-	0.103	0.24	-	0.07	No	N/A	No	No	N/A
Benzo(ghi)perylene	0.1	-	0.08	0.085	-	0.09	No	N/A	Yes	Yes	N/A
Dibenzo(a,h)anthracene	0.01	-	-	-	0.135	0.02	Yes	N/A	N/A	N/A	No
PCBs	0.02	0.18	-	-	0.189	0.002	No	No	N/A	N/A	No
TBT	0.1	0.5	-	-	-	0.0061	No	No	N/A	N/A	N/A