

9 SEDIMENT QUALITY

1. The sediment quality of the marine environment is described on the basis of samples taken during the marine ecological surveys. The concentrations of a range of determinands were determined comprising metals, polychlorinated biphenyls (PCBs), organotins, petroleum hydrocarbons and polyaromatic hydrocarbons (PAHs).

2. The proposed development does not have the potential to impact on sediment quality but there is the potential for the development and, in particular, the capital dredging to cause the resuspension and subsequent redistribution of potential contaminants. This has potential implications for water quality and marine ecology and such implications are considered in the relevant sections of the ES dealing with these parameters.

9.1 EXISTING ENVIRONMENT

9.1.1 Introduction

1. As described in Section 3.1, at 10 of the stations sampled during the biological survey a further sample was taken for the determination of sediment chemistry. These stations were selected to cover those area where either the sediment contamination may be more likely (e.g. adjacent to the oil jetty) and in areas where the scheme would be expected to cause most disturbance to the sediment (e.g. in the proposed dredge areas).

2. Each of the 10 samples was analysed for a range of determinands, namely:

- Metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc);
- PCB congeners (28, 52, 101, 118, 138, 153, 180, 105, 156, 128 and 170);
- Dibutyl tin (DBT) and tributyl tin (TBT);
- Total petroleum hydrocarbons (C6-C30); and,
- A range of polyaromatic hydrocarbons (PAH) (naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene and benzo(g,h,i)perylene).

9.1.2 Results of sediment chemistry sampling

1. The raw data are presented in Appendix 3 and the data are summarised in Table 9.1.1 (metals, PCB congeners, DBT and TBT) and Table 9.1.2 (PAHs) which show the maximum, minimum and mean concentration of each determinand within the survey area.

Table 9.1.1 Summary of sediment chemistry data for metals, PCB congeners, DBT and TBT for marine sediments in the vicinity of the proposed development

Determinand	Concentration (mg.kg ⁻¹) (dry weight)		
		Minimum	Mean
Arsenic	30	10	20.2
Cadmium	<0.5	<0.5	<0.5
Chromium	40	<1	6.2
Copper	37	9.2	20.8
Lead	32	7.7	23.7
Mercury	<0.5	<0.5	<0.5
Nickel	29	9	23.1
Zinc	95	29	65.3
PCB congeners	<0.005	<0.005	<0.005
DBT	<0.02	<0.02	<0.02
TBT	<0.02	<0.02	<0.02

Table 9.1.2 Summary of sediment chemistry data for PAHs for marine sediments in the vicinity of the proposed development

Determinand	Concentration (µg.kg ⁻¹) (dry weight)		
	Maximum	Minimum	Mean
Naphthalene	90	40	58
Acenaphthylene	30	<20	21
Acenaphthene	20	<20	20
Fluorene	30	<20	21
Phenanthrene	210	50	104
Anthracene	290	20	71
Fluoranthene	2880	60	409
Pyrene	2430	40	351
Benzo(a)anthracene	1030	20	140
Chrysene	1890	10	286
Benzo(b)fluoranthene	1140	80	226
Benzo(k)fluoranthene	1490	60	256
Benzo(a)pyrene	1680	30	268
Indeno(1,2,3-cd)pyrene	860	<20	145
Dibenzo(a,h)anthracene	260	<20	51
Benzo(g,h,i)perylene	910	20	152

9.1.3 Assessment of marine sediment quality

Sediment quality guidelines

1. There are currently no published guidelines in the UK against which to assess the quality of marine sediments. In the absence of UK guidelines, there are a number of other guidelines published in other countries that can be used. Such guidelines should be used with caution and the findings treated as indicative because the guidelines are

developed specifically for the country in which they were developed and the species used in deriving the guidelines may have different sensitivities to those in the UK. The geology and environment of such countries may be very different from the UK and, therefore, the consideration of whether or not a given concentration of a particular determinand is acceptable or would give cause for environmental concern is location specific. However, the guidelines give an indication of the level of concern that may arise for a given concentration of a particular determinand.

2. For the purposes of this assessment, the Canadian interim sediment quality guidelines (ISQG) have been used for the assessment of the degree of sediment contamination. These guidelines were developed by the Canadian Council of Ministers of the Environment as broadly protective tools to support the functioning of healthy aquatic ecosystems (CCME, 2001). The guidelines have been developed based on research programmes that rely on field data that demonstrate associations between chemicals and biological effects and establish cause-effect relationships. At present, the marine ISQGs include threshold effect levels (TELs) and probable effect levels (PELs). It is likely that the TELs will be adopted as the ISQGs (CCME, 2001).

3. The ISQGs and PELs for those determinands tested for in the present survey are shown in Table 9.1.3. The table also includes incidences of adverse biological effects in the concentration ranges defined by the ISQGs and the PELs. The approach to identifying these was researched as an interpretative tool to relate ambient sediment quality data to the potential for adverse biological effects (Long *et al.*, 1995).

4. There are no ISQGs for the following determinands which were tested for:

- Nickel;
- Tributyl tin
- Dibutyl tin;
- Total petroleum hydrocarbons (C6-C30);
- Fluoranthene;
- Benzo(b)fluoranthene;
- Benzo(k)fluoranthene;
- Indeno(1,2,3-cd)anthracene;
- Dibenzo(a,h)perylene; and,
- Benzo(g,h,i)perylene.

Sediment quality within the proposed development area

5. The metal concentration of the samples taken from within the proposed dredging and reclamation areas is compared with the ISQG (TEL) for those determinands for which guidelines have been developed in Figure 9.1.1. The data for PCBs are not presented because the concentration of all PCBs in all samples was below the limit of detection and also the ISQG. A discussion of the relationship between PAHs and the ISQGs is provided below.

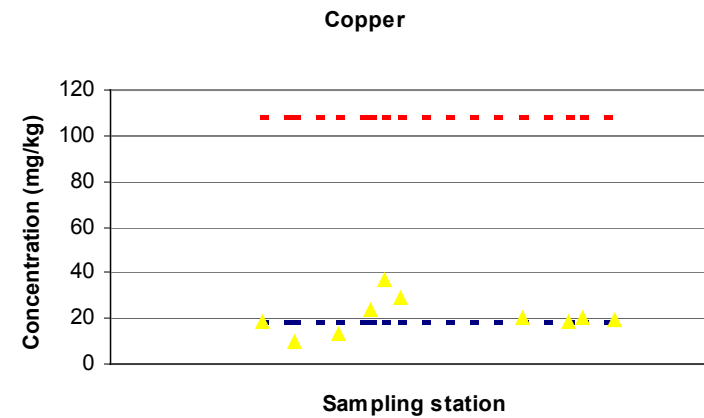
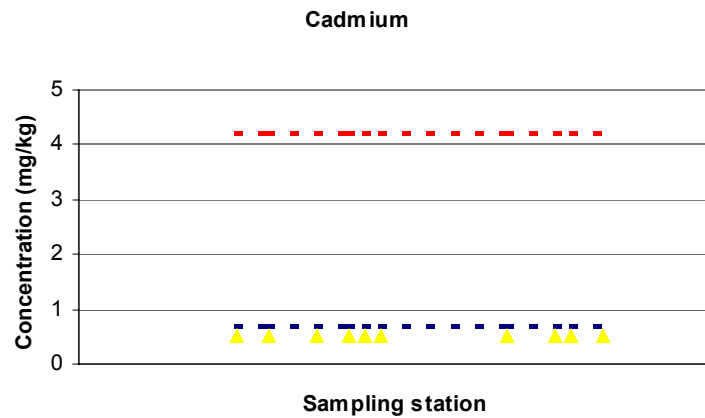
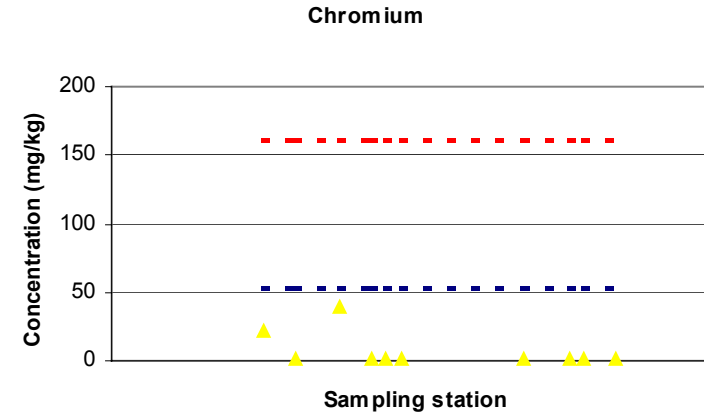
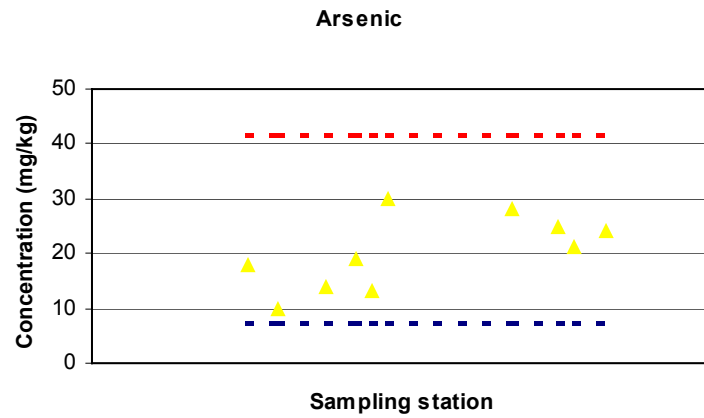


Figure 9.1.1 Comparison of metal concentrations of samples within the proposed reclamation and dredging area with Canadian ISQGs (- - - = PEL, - - - = ISQG, ▲ = survey data)

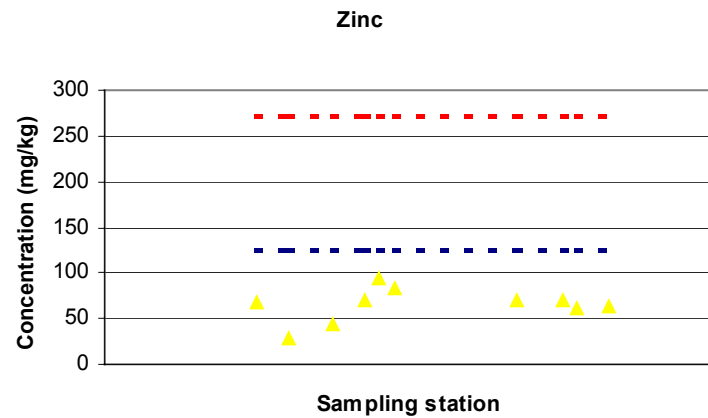
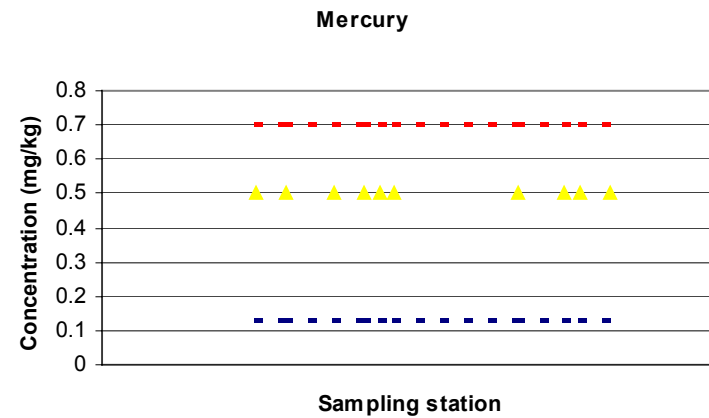
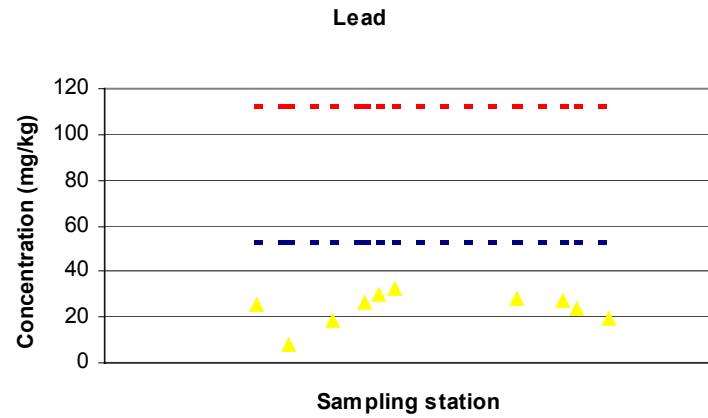


Figure 9.1.1 (continued)

Table 9.1.3 Interim marine sediment quality guidelines (ISQGs)/threshold effect levels (TELs), probable effects levels (PELs) (dry weights) and incidence (%) of adverse biological effects in concentration ranges defined by these values

Substance	Units (dry sediment)	ISQG/TEL	PEL	Incidence (%≤ISQG)	Incidence (ISQG <%<PEL)	Incidence (%≥PEL)
METALS						
Arsenic	mg.kg ⁻¹	7.24	41.6	3	13	47
Cadmium	mg.kg ⁻¹	0.7	4.2	6	20	71
Chromium	mg.kg ⁻¹	52.3	160	4	15	53
Copper	mg.kg ⁻¹	18.7	108	9	22	56
Lead	mg.kg ⁻¹	30.2	112	6	26	58
Mercury	mg.kg ⁻¹	0.13	0.7	8	24	37
Zinc	mg.kg ⁻¹	124	271	4	27	65
PCBs						
Total PCBs	µg.kg ⁻¹	21.5	189	16	37	55
PAHs						
Acenaphthene	µg.kg ⁻¹	6.71	88.9	8	29	57
Acenaphthylene	µg.kg ⁻¹	5.87	128	7	14	51
Anthracene	µg.kg ⁻¹	46.9	245	9	20	75
Benz(a)anthracene	µg.kg ⁻¹	74.8	693	9	16	78
Benzo(a)pyrene	µg.kg ⁻¹	88.8	763	8	22	71
Chrysene	µg.kg ⁻¹	108	846	9	19	72
Dibenz(a,h)anthracene	µg.kg ⁻¹	6.22	135	16	12	65
Fluorene	µg.kg ⁻¹	21.2	144	12	20	70
Naphthalene	µg.kg ⁻¹	34.6	391	3	19	71
Phenanthrene	µg.kg ⁻¹	86.7	544	8	23	78
Pyrene	µg.kg ⁻¹	153	1398	7	19	83

Metals

6. It can be seen from Figure 9.1.1 that the concentration of chromium, cadmium, lead and zinc in all of the samples is below the ISQG. The data for mercury is inconclusive because the concentration of mercury in all of the samples was below the limit of detection of the instrumentation (0.5mg.kg⁻¹). Therefore, the concentration of mercury in the samples could be either between the ISQG and the PEL (at or below the maximum concentration shown in Figure 9.1.1), below the ISQG or samples could fall into either category. All of the samples had concentrations of arsenic that were between the ISQG and the PEL and the concentration of copper was mostly below the ISQG for this metal but a small number of samples had copper concentrations above the ISQG but well below the PEL.

Polyaromatic hydrocarbons

7. In most cases the concentration of the various PAHs is around the ISQG concentration although there are instances when the ISQG is exceeded in some samples. As was the case for mercury (discussed above) the data for acenaphthylene and acenaphthene are inconclusive because the concentration of these determinands is below the limit of detection of the instrumentation (20µg.kg⁻¹).

8. The concentration of total PAHs was found to be notably high (well in excess of the PEL) at sampling station 31, with the concentration at all other sampling stations being relatively consistent. Table 9.1.4 summarises the data for total PAHs at all of the sampling stations.

Table 9.1.4 The concentration of total PAHs at each sampling station

Concentration total PAHs ($\mu\text{g.kg}^{-1}$) (dry weight)									
10	12	15	17	18	19	27	30	31	33
1590	1360	420	960	1440	1320	1170	1340	15190	600

9. As shown on Figure 6.1.2, station 31 is within the proposed area of dredging to the west of the existing approach channel. Therefore, an extensive area of high concentration of total PAHs in this area would give cause for concern given that the sediment within this area would be disturbed and the potential for adverse biological effect due to release of PAHs into the water column would be relatively high.

10. In order to investigate the extent of the elevated concentration of PAHs further analyses were undertaken. The aim of this was to identify the level of concern presented by the data from this station. A very localised 'hot spot' of PAHs (such as may arise if there had been a localised spillage of oil or if the sample happened to contain a fragment of tar from a coated submarine cable) would be of less concern than if the contaminated area was more widespread.

11. The first stage was to re-test another portion of sediment from sampling station 31. The result from this re-test gave a total PAH concentration of $11570\mu\text{g.kg}^{-1}$; although this concentration is lower than the initial result it is still considerably greater than all the other samples.

12. Given the above result, further samples were taken to identify the extent of the potential elevated concentration and, hence, to better define the potential for adverse biological effect and the level of concern. Nine further samples were taken; these samples were located to the north, south, east and west of site 31 with 4 samples approximately 20m distant and four samples 50m distant from site 31. Station 31 itself was also re-sampled.

13. The raw data from the additional PAH sampling at station 31 and from the 4 sites located 20m distant from station 31 is presented in Appendix 3 and summarised below in Table 9.1.5

Table 9.1.5 The concentration of total PAHs from additional sampling stations at and around sampling station 31

Concentration total PAHs ($\mu\text{g.kg}^{-1}$) (dry weight)				
31	31A	31B	31C	31D
170	420	310	250	160

14. Comparison of the data presented in Tables 9.1.4 and 9.1.5 shows that the concentration of total PAH's from the additional sampling at and around station 31

(ranging from 160 to 420 $\mu\text{g.kg}^{-1}$) is considerably lower than the result of the initial sampling at this station (15190 $\mu\text{g.kg}^{-1}$). Furthermore, the data from the additional sampling is comparable to or, in the majority of cases, lower than the concentration measured initially at all of the sites throughout the survey area. This suggests that the initial high concentration of total PAH's is very localised and is likely to be due to a particle of PAH containing material being present in the initial sampling (e.g. from the coating of an underwater cable). In view of the findings of the sampling reported above it is considered unnecessary to analyse the 4 additional samples located 50m distant from station 31.

9.2 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

9.2.1 Potential change in sediment quality due to the construction works

1. The dredging works would remove the surface sedimentary material down to a depth where geological material (London clay) would be exposed at the surface. Given this, the sediment that would be exposed due to dredging would have a lower level of contamination than under the existing situation. In this respect, the construction works can be considered to improve the quality of the surface sediment and, therefore, an impact of **minor beneficial significance** is predicted.
2. In the future, the exposed clay would experience a degree of siltation due to the settlement of material entering or leaving the estuary system.

Mitigation and residual impact

3. No mitigation measures are required and the residual impact is of **minor beneficial significance**.

9.3 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

9.3.1 Potential change in sediment quality

1. During the operational phase, there would be no change to the existing situation in terms of inputs of pollutants to the environment. Furthermore, there is no significant change to the existing pattern of erosion and accretion of sediments. As a result, there would be **no impact** on sediment quality during the operational phase as a result of the proposed development. It should be noted that at present the DSM Bakery Ingredients outfall discharges solids with a high organic content which, with the outfall in its present position, appear to accumulate around the outfall. The relocation of this outfall to the new quay face would result in the discharge being mixed into the berth. This would be removed by maintenance dredging and, therefore, no significant build up would be expected.

Mitigation and residual impact

2. No mitigation measures are required and there would be **no residual impact** on sediment quality.