

5 SEDIMENT QUALITY

This section discusses the quality of seabed sediment in the proposed placement site in the North Edinburgh channel and considers the impacts on sediment quality of introducing sediment from Princes Channel. Effects on water quality from the placement operation are considered in Section 6.

5.1 Existing Environment

The North Edinburgh Channel forms part of the dynamic system of channels and sandbanks in this part of the Outer Thames Estuary. The proposed placement site is 18km from the nearest coast and therefore is unlikely to be affected by anthropogenic inputs of contaminants, for example there are no long sea outfalls in the vicinity. Present day inputs may include waste from commercial and recreational vessels.

Historically, a waste disposal site was located in the Black Deep, approximately 9km to the north east of the placement site. Dredged material from the River Thames and its dock system (both capital and maintenance), and sewage sludge was placed at this site until its closure in the late 1960s (CEFAS, 1994, O'Donnell, 1976). In addition, a sewage sludge site was located in the Barrow Deep, approximately 12km to the north of the North Edinburgh Channel. This site received sewage sludge from 1967 to the late 1990s when the disposal of sewage sludge at sea was banned (CEFAS, 1994). As part of the monitoring of licensed disposal sites, CEFAS undertook a sediment sampling survey in 1992. This survey covered a wide area slightly to the north of the North Edinburgh Channel and found that the heavy metals associated with sewage sludge disposal had dispersed away from the disposal site to form part of the background load of metals in the sediments in the Thames Estuary (CEFAS, 1994). The metals data is summarised in Table 6. A survey of marine derived litter was carried out by CEFAS in 1992-3 and found that the sewage sludge sites in the Thames Estuary were in the top three most contaminated sites (CEFAS, 1994).

Table 6 CEFAS 1992 Sediment Quality Data

PARAMETER*	MINIMUM CONCENTRATION (mgkg ⁻¹)	MAXIMUM CONCENTRATION (mgkg ⁻¹)	MEAN CONCENTRATION (mgkg ⁻¹)
Lead	26	104	51.5
Zinc	78	225	126.3
Copper	25	107	45.6
Mercury	0.08	2.4	0.29

*Samples were taken from 48 locations.

As part of the baseline studies to characterise the North Edinburgh placement site, a sediment quality survey was undertaken (during the marine biological survey).

Sediments were taken from sites within the North Edinburgh Channel and at sites across a wider area. Only one of these sites is comparable with the earlier CEFAS samples. The samples were collected from surface sediments using a grab sampler and were analysed for a suite of parameters previously agreed with CEFAS and the EA (see Appendix D). The parameters included metals, organics and microbiological parameters, and were analysed in recognition of the status of the Thames estuary as designated Shellfish Waters. Particle size analysis (PSA) was also carried out. A summary of the sediment quality data is provided in Table 7 and the full report is available as Appendix E on the accompanying CD-ROM.

In addition, as part of the FEPA application, samples were collected from the North Edinburgh and Princes Channel and analysed by CEFAS but the results are not yet available from CEFAS.

Table 7 Sediment Quality in the North Edinburgh Channel and Adjacent Areas

PARAMETER*	MINIMUM CONCENTRATION (mgkg ⁻¹ dry wt)	MAXIMUM CONCENTRATION (mgkg ⁻¹ dry wt)	MEAN CONCENTRATION (mgkg ⁻¹ dry wt)
Lead (16 sites)	1	75	18.5
Zinc (16 sites)	6	160	44.4
Copper (4 sites)	2	5	3.5
Mercury	All below detection limit of 0.13mgkg ⁻¹		
Arsenic (16 sites)	4	73	23.7
Cadmium	All below detection limit of 0.7mgkg ⁻¹		
Nickel (16 sites)	2	56	10.4
Chromium	5	150	28
Silver (13 sites)	0	45	10.2
Tributyl Tin	One conc. of 40 µgkg ⁻¹ . Others below detection limit of <10µgkg ⁻¹		
PAHs	All below detection limits (see Appendix E).		
PCBs	All below detection limits (see Appendix E).		
Pesticides	All below detection limits (see Appendix E).		

*Samples were taken from 22 locations – where below detection limit or no value, average has been taken over remaining sites. Detection limits were set in accordance with Canadian ISQG values. Results are corrected for % organic carbon.

Particle size analysis carried out for each sample classifies the great majority of the samples as sand. Figure 8 shows the sediment characteristics across the survey area.

5.1.1 Sediment Quality Assessment

Currently, there are no published national guidelines for marine sediment quality. CEFAS (who are responsible for providing scientific advice to Defra on the sea disposal of dredged material) have internal guidelines for evaluating the results of sediment contamination testing. These internal CEFAS guidelines comprise two Action Levels

(AL), which are used as part of a weight-of-evidence approach to assessment on a case by case basis. In general terms, however, if contamination levels are below AL 1 then the materials are likely to be considered chemically 'clean'. Between AL 1 and 2, further testing may be required to identify any management techniques which may be required before sea disposal can be authorised and at levels above AL2, material may be considered too contaminated for sea disposal or require specialised dredging/disposal techniques.

An alternative or additional approach to assessing sediment quality is the use of the Interim Sediment Quality Guidelines (ISQGs) for the protection of marine aquatic ecosystems. The ISQGs have been acknowledged by English Nature as being appropriate for use in the UK given the lack of national standards. The ISQGs comprise two levels, the first (and lower level) being the ISQG, the level below which no effects would be expected on marine aquatic life. The second level is the Probable Effects Level (PEL) and sediments containing contamination at this level would be expected to cause effects in 50% of organisms. Between the two levels further assessment would be necessary to identify any necessary management actions in the same way as for CEFAS' Action Levels. As CEFAS Action Levels are unpublished and are based on wet weights, ISQG levels have been used as the first assessment in this report.

Metals

The sediment quality analysis demonstrated a variation between levels of metals that were at or below detection limits and levels that are above ISQG and PEL levels. Of particular note are the levels of arsenic, which are elevated above the ISQG at the majority of sites while levels at four sites are above the PEL. The maximum concentration of 75mgkg^{-1} is significantly greater than the PEL of 41.6mgkg^{-1} . Levels of lead and zinc at some sites are also elevated with concentrations between ISQG and PEL levels. Although arsenic was not analysed in the CEFAS survey in 1992, the lead and zinc levels are comparable with those recorded from that survey. This suggests that the previous use of the Black Deep and Barrow Deep disposal sites continues to effect sediments in the outer Thames Estuary.

There are no obvious spatial distribution patterns within the sample locations and the samples are representative of surface sediments only. However, the sediment is fine sand which has been observed to move considerably over relatively short periods and so there is the possibility for release by redistribution of older more contaminated material (PLA survey data, 2004). Elevated sediment concentrations are found in samples both in deeper water and on the drying banks leaving no indication of any distribution associated with dominant water movements.

Further, there is no clear association of elevated levels of contaminants with those samples with a higher fines content, for example, the highest zinc level is recorded at sample location 5 which comprises almost 100% sand. Site 5 also has high arsenic, chromium and nickel, although these elevated levels are in part a product of the standardisation technique applied to the data i.e. the low organic carbon levels at the site.

Tributyl Tin

The results for tributyl tin (a biocide and component of antifouling paints that is presently being phased out of use) showed that, with the exception of one sample, the levels in all samples were below the detection limit of $10\mu\text{gkg}^{-1}$. TBT was recorded at site 7 with a level of $40\mu\text{gkg}^{-1}$, but this was below the relevant guideline level and CEFAS advised that this isolated peak was not considered significant (EMU, 2004).

Non-Metallic Parameters

The majority of non-metallic parameters analysed for during the survey were found to be below the detection limit and therefore below the ISGC thresholds and CEFAS Action Levels. These included all pesticides and organic compounds with the exception of Total Petroleum Hydrocarbons (TPH) (EMU, 2004). Although TPH was recorded, levels were considered very low across the area and well below the CEFAS Action Level.

Microbiological Parameters

Neither faecal Coliforms nor faecal Streptococci were detected across the study area. *Clostridium perfringens* was detected but levels were found to be low compared to other benthic surveys carried out in the vicinity of North Edinburgh Channel some of which surveys were specifically associated with sewage discharge (EMU, 2004).

5.2 Change in Sediment Quality in North Edinburgh Channel

5.2.1 Impact Description

The sediment quality in the North Edinburgh Channel reflects an area that has, in the past, been subject to inputs of anthropogenic contamination with levels of trace metals being elevated compared to natural background for an area such as the Thames Estuary (with no mineralisation or geological inputs). In order to ascertain the effects on sediment quality from the introduction of sand from Princes Channel, a detailed survey of sediment quality in Princes Channel was undertaken. A previous survey of sediment quality has found elevated levels of some metals in Princes Channel seabed sediments but no organic contamination. This survey was not considered to reflect the current situation given the Phase I dredge has been completed and the Phase II dredge will cover an increased area and depth.

The sediment quality survey comprised 43 vibrocores on three transects spaced 300m x 175m across the channel. Figure 12 shows the distribution of the vibrocores and the data is contained in Appendix F on the accompanying CD-ROM. Vibrocores were sunk to a depth of more than 4m, well below the maximum dredge level of 2m. At a representative selection of sites samples were taken from the surface sediments and at various depths throughout the sediment column and analysed for a suite of trace metals, organics, TBT

and microbiological parameters. The samples were divided into three groups; those provided to CEFAS for analysis, those analysed for all parameters (Suite A) and those analysed for metals only but at 0.5.m intervals throughout the sediment column (Suite B) Each sample was also analysed for particle size.

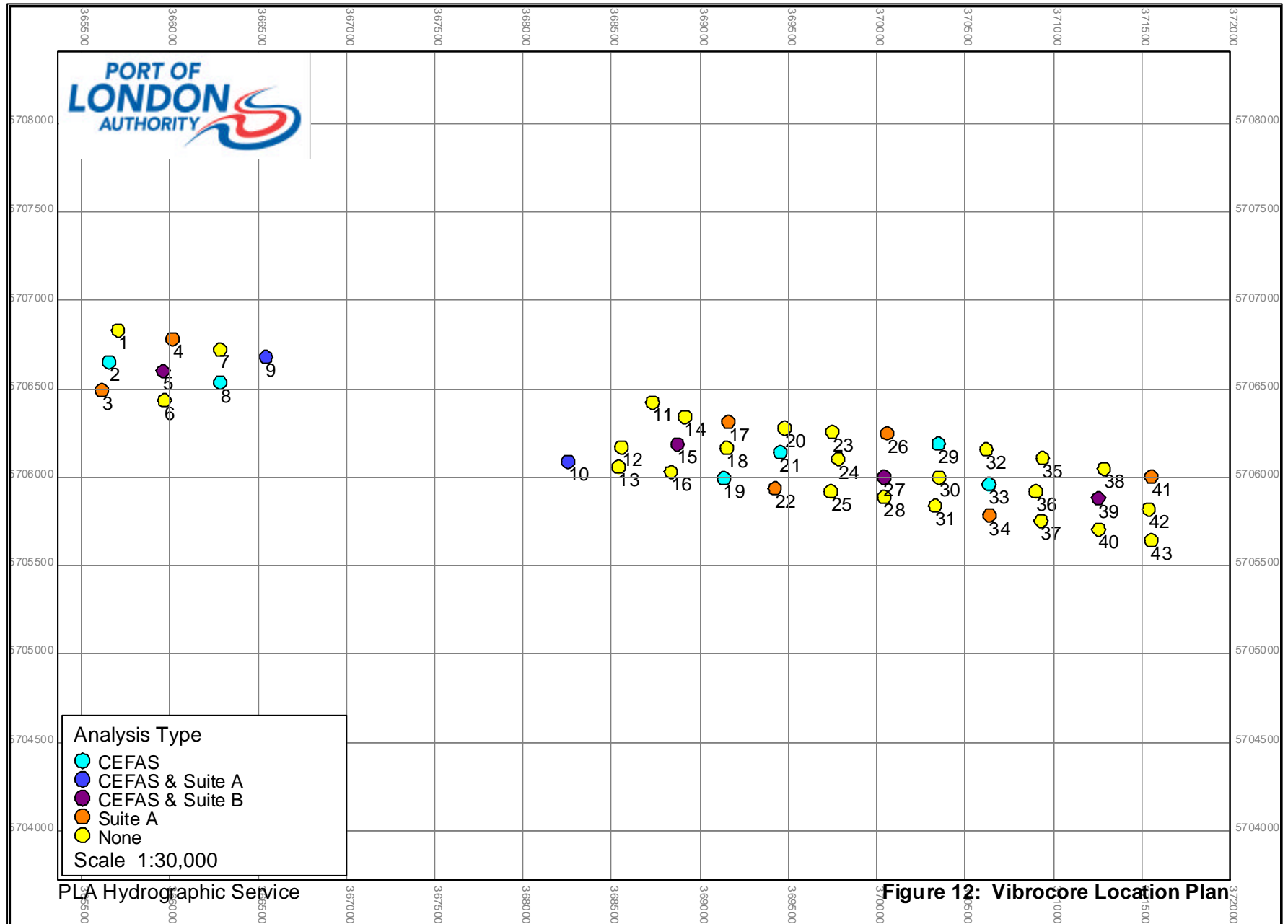


Figure 12: Vibrocore Location Plan

As with the samples from the North Edinburgh Channel, the Canadian ISQG levels were used as a guide to sediment quality. Analytical detection limits were set in accordance with these levels.

Microbiological Parameters

Samples were analysed for Clostridia, E Coli, faecal Streptococci and total coliforms. No microbiological parameters were recorded at any of the stations in either surface samples or at depths in the sediment column. The results from the Princes channel and North Edinburgh Channel are very similar with the exception that *Clostridium perfringens* was recorded at two sites in the North Edinburgh Channel at values slightly above the detection limit used for the Princes Channel analysis. It is considered that the proposed placement operation will have **no change** on the microbiological quality of the North Edinburgh channel.

Non-Metallic Parameters

As was found in the earlier survey, levels of organic parameters (PCBs, PAHs and pesticides) were very low with almost all parameters of concern undetectable. The full dataset can be found in Appendix F on the accompanying CD-ROM. The sediment in the North Edinburgh Channel also contains undetectable levels of organic parameters. It is therefore considered that there will be **no change** in the levels of organic parameters resulting from the placement of sand from Princes Channel at the proposed placement site in the North Edinburgh Channel.

Tributyl Tin

For the large majority of samples, TBT levels were found to be below the detection limit of $1 \mu\text{gkg}^{-1}$. TBT was recorded at a small number of samples but the levels were significantly below CEFAS Action Level of $100\mu\text{gkg}^{-1}$ (there is no ISQG level for TBT). The TBT levels are comparable with the levels of TBT recorded in the North Edinburgh Channel and it is therefore considered that there will be **no change** in the levels of TBT resulting from the placement of sand from Princes Channel at the proposed placement site in the North Edinburgh Channel.

Trace Metals

The metals data demonstrates the sediment quality throughout the Princes Channel area, both surface and through the sediment column is good with levels at or below the precautionary ISQG level. Table 8 provides a summary of the metals data for surface sediments.

Table 8 Metal Levels in Princes Channel Surface Sediments

PARAMETER	MINIMUM CONCENTRATION (mgkg ⁻¹ dry wt)	MAXIMUM CONCENTRATION (mgkg ⁻¹ dry wt)
Arsenic	7.1	36.7
Cadmium	<0.1	<0.1
Chromium	9.7	15
Lead	3.3	18
Mercury	<0.1	<0.1
Copper	1.2	5.8
Nickel	23.3	27.3
Zinc	8.8	29.5
Silver	<0.1	<0.1

There are two exceptions to the general low levels noted above; as follows:

1. Arsenic levels are considered slightly elevated at most sites in surface samples. The concentrations decrease with depth to what could be described as background at depths of greater than 2.5m (~4.5mgkg⁻¹). Although slightly elevated above the ISQG, the majority of concentrations are well below the relevant PEL value of 41.6 mgkg⁻¹ with a mean concentration of 11.4mgkg⁻¹.

At five sites (comprising six samples) concentrations of arsenic of more than 25mgkg⁻¹ have been recorded. Figure 13 shows the sites and the arsenic concentrations. In all but one of the sites the arsenic is contained in the first 60cm of sediment. The exception is site 3 where arsenic increases with depth from 17.3 mgkg⁻¹ at the surface to 26 mgkg⁻¹ at approximately 2m depth. A review of the associated particle size data indicates that there is no correlation between the higher levels and the finer sediments. In fact, the reverse appears to be the case with the coarser samples containing the higher arsenic levels. The unpublished CEFAS Action Levels for disposal of dredged material at sea are 10mgkg⁻¹ (AL1) and 25-50mgkg⁻¹ (AL2) (CEFAS, 2000). These levels are wet weight and using 50% as an approximate conversion to dry weight gives 20mgkg⁻¹ (AL1) and 50-100mgkg⁻¹ (AL2). Given that the arsenic concentrations for the majority of the samples are below AL1, these few elevated levels are not considered significant.

2. Site 39 (see Figure 12) shows a slight elevation of chromium, nickel, zinc and cadmium relative to all the other sites. Whilst the difference is of interest, the concentrations remain below their relevant ISQG levels.

In general the metals content in the North Edinburgh Channel sediments are significantly higher than the concentrations in Princes Channel. Table 9 compares the maximum and mean concentrations for each metal. Given that the particle size data suggests that the seabed sediments are physically similar, it is likely that the difference relates to the relative proximity of North Edinburgh Channel to the disused sewage sludge disposal sites.

Table 9 Comparison of Summary Metals data for Princes and North Edinburgh Channels

PARAMETER	MINIMUM CONC (mgkg ⁻¹ dry wt) NORTH EDINBURGH	MINIMUM CONC (mgkg ⁻¹ dry wt) PRINCES CHANNEL	MAXIMUM CONC (mgkg ⁻¹ dry wt) NORTH EDINBURGH	MAXIMUM CONC (mgkg ⁻¹ dry wt) PRINCES CHANNEL
Arsenic	4	7.1	73	36.7
Cadmium	<0.7	<0.1	<0.7	<0.1
Chromium	5	9.7	150	15
Lead	1	3.3	75	18
Mercury	<0.13	<0.1	<0.13	<0.1
Copper	2	1.2	5	5.8
Nickel	2	23.3	56	27.3
Zinc	6	8.8	160	29.5
Silver	0	<0.1	45	<0.1

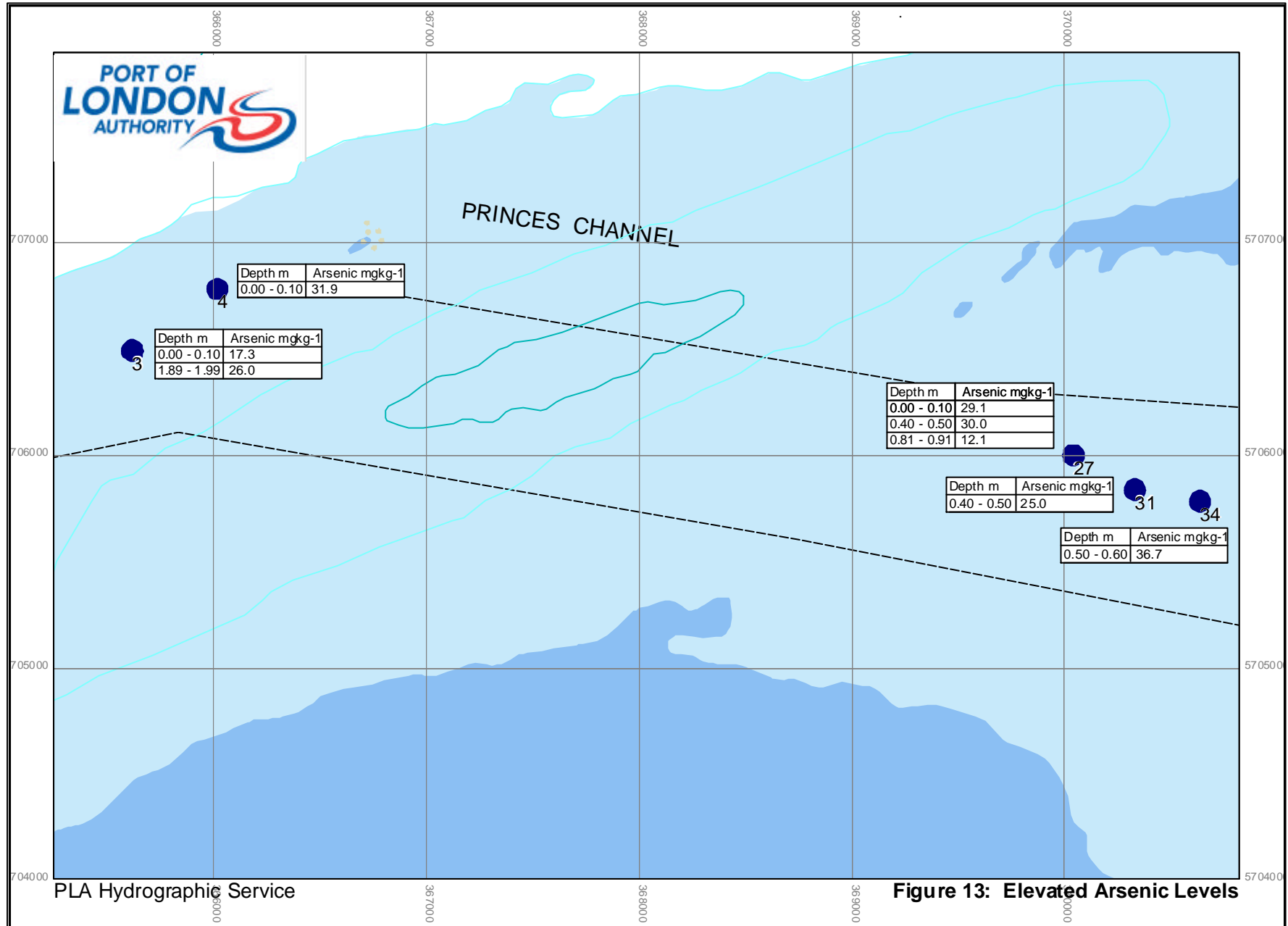
The placement of sand from Princes Channel into the North Edinburgh Channel will have the effect of improving sediment quality at the placement site. This improvement is considered to be of **minor beneficial significance**.

5.2.2 Mitigation

No mitigation is required

5.2.3 Residual Impact

The residual impact for change in sediment quality at the North Edinburgh Channel placement site is **minor beneficial significance**.



5.3 Summary of Potential Impacts

Table 10 summarises the predicted potential impacts, any mitigation measures and the residual impact.

Table 10 Summary of Potential Impacts on Sediment Quality

IMPACT TITLE	SIGNIFICANCE LEVEL	MITIGATION	RESIDUAL IMPACT
Change in sediment quality in North Edinburgh Channel	Microbiology: no change Non-Metallic: no change TBT: no change Trace Metals: minor beneficial	None required	None None None Minor beneficial

No cumulative impacts are on sediment quality are predicted.