3 ENVIRONMENTAL CHARACTERISATION PROCESS

This section describes the legislation that is applicable to the placement of material at sea, the environmental scoping process and the environmental characterisation process.

3.1 Legislative Context

A number of pieces of national and European legislation are applicable to the placement of dredged material in the marine environment including the following:

- Food and Environment Protection Act, 1985.
- Conservation (Natural Habitats &c.) Regulations 1994;
- Countryside and Rights of Way Act (CRoW) 2000;
- Environmental Impact Assessment (EIA) Directive (97/11/EC);
- Shellfish Waters Directive (79/923/EEC); and
- Surface Waters (Dangerous Substances) (Classification) Regulations 1997 & 1998.

The Shellfish Waters Directive and the Surface Waters Regulations are soon to superseded by the Water Framework Directive and its implementing regulations.

3.1.1 Deposits At Sea

Placement of sand below mean high water springs is considered a deposit at sea, which is regulated by the Department for Environment, Food and Rural Affairs (Defra) under the Food and Environment Protection Act (FEPA) 1985. Under Section 5 of Part II a license is required for the disposal of dredged material at sea.

It is often the case that marine disposal takes place at existing licensed sites but there are examples of placement sites that have been licensed for short term or project-specific operations.

The PLA is proposing the recycling of sand within the estuary system and believes that this is more akin to using dredged material beneficially rather than disposing of it. However, the same licensing requirements apply to both beneficial placement and disposal in the marine environment.

3.1.2 Conservation (Natural Habitats &c.) Regulations 1994

These regulations transpose the 1992 EC Habitats Directive into legislation in England and Wales. There is a requirement to consider if a project is likely to have a significant effect on a designated European site and, if this is the case, to undertake an appropriate assessment to determine the effects of the project on the integrity of the site. In the UK, English Nature (EN) provides advice to government on the likely effects of projects on designated sites.

The CRoW Act contains similar provisions to the above Conservation Regulations in that it provides protection for conservation sites designated under national legislation.

3.1.3 EIA Directive and Implementing Regulations

The EIA Directive has been implemented for works in harbours through the Harbour Works (EIA) Regulations 1999. These regulations are operated by the DfT through the CPA consent process. However, there are currently no specific regulations that apply the EIA Directive to applications under FEPA, although these are in preparation. In the absence of such regulations, the PLA is preparing an environmental characterisation based on the requirements for the provision of environmental information in the FEPA.

3.1.4 Shellfish Waters Directive

The Shellfish Waters Directive (SWD) applies to coastal or brackish waters which need "protection or improvement in order to support shellfish (bivalve and gastropod molluscs) life and growth and thus to contribute to the high quality of shellfish products directly edible by man". The Directive sets water quality standards which must not be exceeded by pipeline discharges and defines sampling and monitoring requirements for compliance.

Part of the Thames Estuary is one of more than 100 designated Shellfish Waters in the UK (Figure 2). Others include Southampton Water and the Solent, the Humber Estuary, Liverpool Bay, Swansea Bay, Milford Haven and Morecambe Bay. Poole Harbour, Portsmouth Harbour and the Fal estuary, and many other areas of importance for port and recreational navigation also have designated waters.

Sea disposal activities are not subject to consideration under the Shellfish Water Directive although, during their scientific assessment of the proposals, CEFAS consider the effects on shellfish and the food chain.

3.1.5 Water Framework Directive

In December 2003, the EC Water Framework Directive was transposed into national law by means of the Water Environment (Water Framework Directive) (England and Wales) Regulations, 2003. These Regulations provide for the implementation process of the WFD from designation of all surface waters as water bodies to achieving good ecological status in 2015. Presently, there is little guidance on the application of the Regulations to existing activities such as disposal at sea. Further, the WFD is limited to activities within 1nm of the coast. Although boundary lines have not yet been seen the North Edinburgh Channel is certainly more than 1nm from the shoreline.

3.2 Environmental Characterisation

3.2.1 Scoping Study

An Environmental Scoping Report was prepared with the aim of identifying the key issues to be assessed during the characterisation process. The Report set out the existing environmental data and outlined the additional survey requirements (Appendix A on the accompanying CD-ROM). The Report was submitted to Defra as the Regulator and the relevant environmental consultees. Responses were received from the majority of consultees and any additional issues raised were taken forward as part of the characterisation process. Table 3 summaries the responses to the Scoping Report and the full responses are contained in Appendix B.

Table 3 Summary of Consultation Responses

CONSULTEE	SUMMARY OF RESPONSE
Defra	1. Discussion of choice of disposal site 2. Fisheries/shellfisheries, commercial fishing 3. Fate of dredged material 4. Future maintenance dredging 5. Sediment quality 6. Cumulative effects 7. Use of South Falls
KESFC	No comments on Scoping Report
Environment Agency	1. Post-disposal marine biological survey 2. Shellfishery assessment 3. Consideration of suspended solids
RYA	1. Notice to Mariners 2. Vessels marked
RSPB	1. Designated conservation sites & interest features 2. Disturbance to birds 3. Effects from sediment movement (smothering, erosion. accretion etc.) 4. Keep material within the system 5. Birds outside designated sites
English Nature	1. Welcomes retaining material within system 2. Consider placement/beneficial use options 3. Confirms issues in Scoping Report 4. *Sabellaria* reefs in benthic surveys 5. Possible future offshore sites

3.2.2 Existing Marine Surveys and Datasets

During the preparation for Phase I of the Princes Channel Development, the PLA carried out a number of surveys to provide information on the geological, physical, chemical and biological characteristics of the study area, focussing mainly on the Princes Channel area. These surveys are described briefly in Appendix C.

Following the Scoping Study, further surveys were carried out in the North Edinburgh Channel. Table 4 summaries these surveys and studies.

Table 4 North Edinburgh Surveys and Studies

SURVEY/WORK DESCRIPTION	COMMENT
Dredged material characterisation	Surface and depth samples were taken during a vibrocore survey and analysed for a suite of heavy metals, TBT and particle size.
Placement site seabed characterisation	Surface samples were collected and analysed for a suite of heavy metals, TBT, organics, pesticides and microbiological parameters.
Current profiling	ADCP survey on track shown in Figure 7.
Fate of deposited material	Process modelling of the dredging operations. Conventional sediment bed-load transport techniques to assess rate of movement along the bed. Dynamic plume modelling was originally proposed but was discounted due to lack of fines in the material to be placed.
Marine biological survey	Survey comprising grabs and trawl sampling to complement existing data. Survey covered area shown within red outline on Figure 14.
Morphological change	Desk study of existing literature.
Archaeological assessment	Assessment covered Thames Estuary and focussed on North Edinburgh Channel.
Ordnance	Desk study of existing literature.

3.2.3 Environmental Characterisation Process

The consultation responses, baseline surveys and data collection described above provided the inputs into the environmental characterisation process. The environmental characterisation comprised identification and evaluation of possible impacts, discussion of possible mitigation and/or monitoring requirements, and reporting. The results of the characterisation are set out in Sections 4-15 using, where appropriate, the following structure for each topic area:

- Existing Environment
- Impact Title
- Impact Description
- Mitigation Measures
- Residual Impact
- Impact Summary Table
- Monitoring Requirements

The characterisation process has considered the spatial and temporal extent of impacts and any potential in-combination and cumulative effects. Potential direct and indirect, permanent or temporary impacts have been assessed.

Significance Criteria
The significance of an impact upon a feature has been considered using the significance criteria (outlined in Table 5) as a guide. Significance levels may be adverse or beneficial.

Table 5 Environmental Significance Criteria

	MAGNITUDE (DIRECT/INDIRECT, GEOGRAPHIC EXTENT, TIMESCALE ETC)				
Value (including designations, rarity etc)		***High***	***Medium***	***Low***	***Very Low***
	High	Major	Major/moderate	Minor	Negligible
	Medium	Moderate	Moderate/minor	Minor	Negligible
	Low	Moderate	Minor	Negligible	Negligible

4 COASTAL PROCESSES

This section describes the existing environment in the outer Thames Estuary with emphasis on the North Edinburgh Channel area, details the sand placement process and discusses the likely changes on hydrodynamic parameters that may occur as a result of the placement operation.

4.1 Existing Environment

The North Edinburgh Channel is one of a number of dynamic channels in a complex sandbank system of the Outer Thames Estuary. It is thought that sand enters the outer estuary as sand ribbons and waves moving from the north east and joins the north western tip of the Long Sand. This sandbank feature is considered to control water movement in the outer Estuary and thus the movement of sand (pers. comm.. B D'Olier, 2004). The interaction of the tidal currents from the North Sea and the English Channel result in the sand being moved westwards through a series of deposition zones to the eventual deposition site on the Maplin Sands (pers. comm.. B D'Olier, 2004). It is reasonable to assume that the Outer Thames Estuary forms a single sedimentary system and the Princes Channel and the North Edinburgh Channel, being a few km apart, are part of this system. Studies of historical charts demonstrate that the forms of the various sandbanks have changed over time and the PLA's ongoing hydrographic surveys continue to find changes in depth and form. Within the context of these large scale movements, smaller scale changes are observed such as those in the North Edinburgh Channel.

4.1.1 North Edinburgh Channel

Bathymetry
Water depths in the proposed placement site in the North Edinburgh Channel vary from approximately 10m along the boundary of the site to more than 16m in the Channel centre. Beyond the site's boundaries depths gradually shallow up to the very shallow and in some places drying sandbanks. These depths are representative of low water conditions and at high water an additional 4.5m of water is available with the resulting depths being 14m to 20m. For the purposes of this assessment low water depths have been used.

Morphology
Bathymetric data relating to the North Edinburgh Channel can be found on PLA Chart 203MS, which was last subject to a full main survey in 1997. More recently a survey was carried out by PLA in 2004. These data show the channel to have moved some 220 metres eastwards between the two surveys as well as becoming considerably shallower overall. Rough computations, using the approximate channel geometries, indicate that a total of around 24 Mm^3 of sand would have to be eroded from a 4 km strip on the east side of the channel to allow this to happen (pers. comm. DRL, 2004). An equivalent, or possibly greater, amount of sand would have to be deposited on the west side of the channel to complete the geometrical shift and shoaling. It can be seen from these figures

that on average in excess of $6Mm^3$ of sand is moving annually to make these geomorphological changes. However, this is only the resultant, or residual, movement of material occurring over a 12-month period (pers. comm. DRL, 2004). In practice, the gross amount of material moved in any direction would probably be an order of magnitude higher than this. The proposed placement operation is assessed within this context. Figure 6 shows a comparison between surveys from 1997 and 2004 and it can be seen that over this period depth changes of 10m occurred in some places.

Tidal Currents

A survey of tidal currents was carried out in the North Edinburgh channel in February 2004 and a vessel-mounted ADCP was used to collect water velocity data along the four transects shown on Figure 7. The data was used to refine the existing mathematical model for the outer Thames Estuary and to inform an assessment of sand movement away from the placement site. In the deeper water in the centre of the Channel and towards the northern side of the Channel, peak water speeds are approximately $1ms^{-1}$ while in the shallow water speeds are in the range of $0.5ms^{-1}$ to $0.9ms^{-1}$. At one location in the deep water in the centre of the Channel the current speed reached $1.5ms^{-1}$ but this isolated reading is not considered representative (DRL, 2004).

Seabed Sediments

During the marine biological survey, sediment samples were taken at 22 locations and analysed for their constituent fractions of silt, sand and gravel. Figure 8 shows the sediment composition for the survey area.

All of the 22 locations comprise sand, the majority comprise between 95 and 100% sand. Gravel fractions are identified in only three samples, two are located in the deep water of the Knock Deep (samples 20 and 2) to the south of the Long Sand and the third (sample 13) is located on the Kentish Flats to the southeast of Princes Channel. Many of the samples contain a very small component of fine material with the greatest proportion in sample 15 in the Black Deep (near to the historic disposal site) and sample 2 in the Knock Deep.

The five samples within the proposed placement site all have a sand content of greater than 90%. The seabed in the placement site and much of the surrounding area is described as heterogeneous, poorly sorted, mixed sediments with variables levels of silt and gravel fraction (EMU, 2004). On the western edge of the proposed placement site is a localised area of homogeneous moderate to well sorted sands (EMU, 2004).

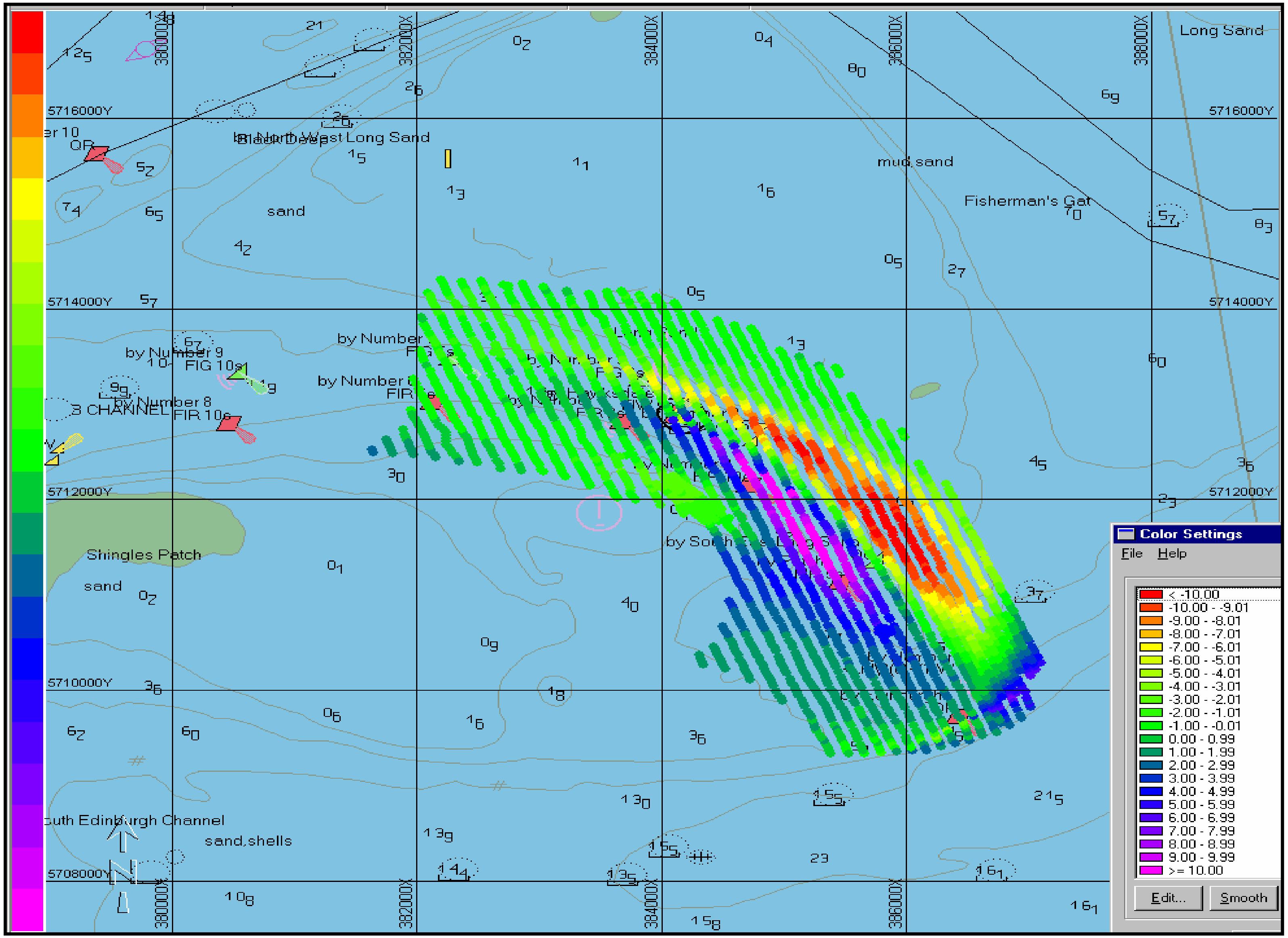

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Figure 6: Net Change in Sediment Movement in North Edinburgh Channel 1997 – 2004

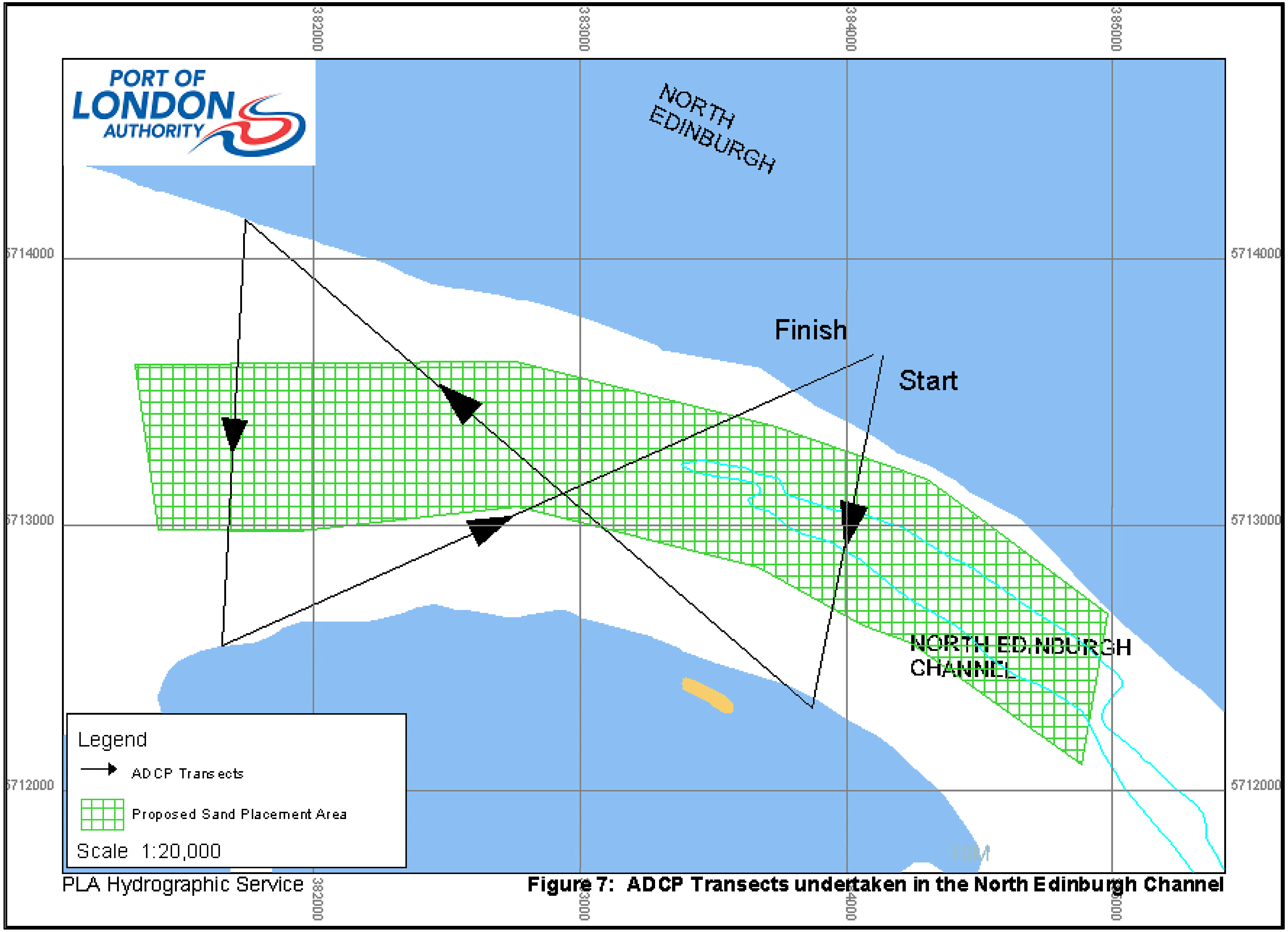

Figure 7: ADCP Transects undertaken in the North Edinburgh Channel

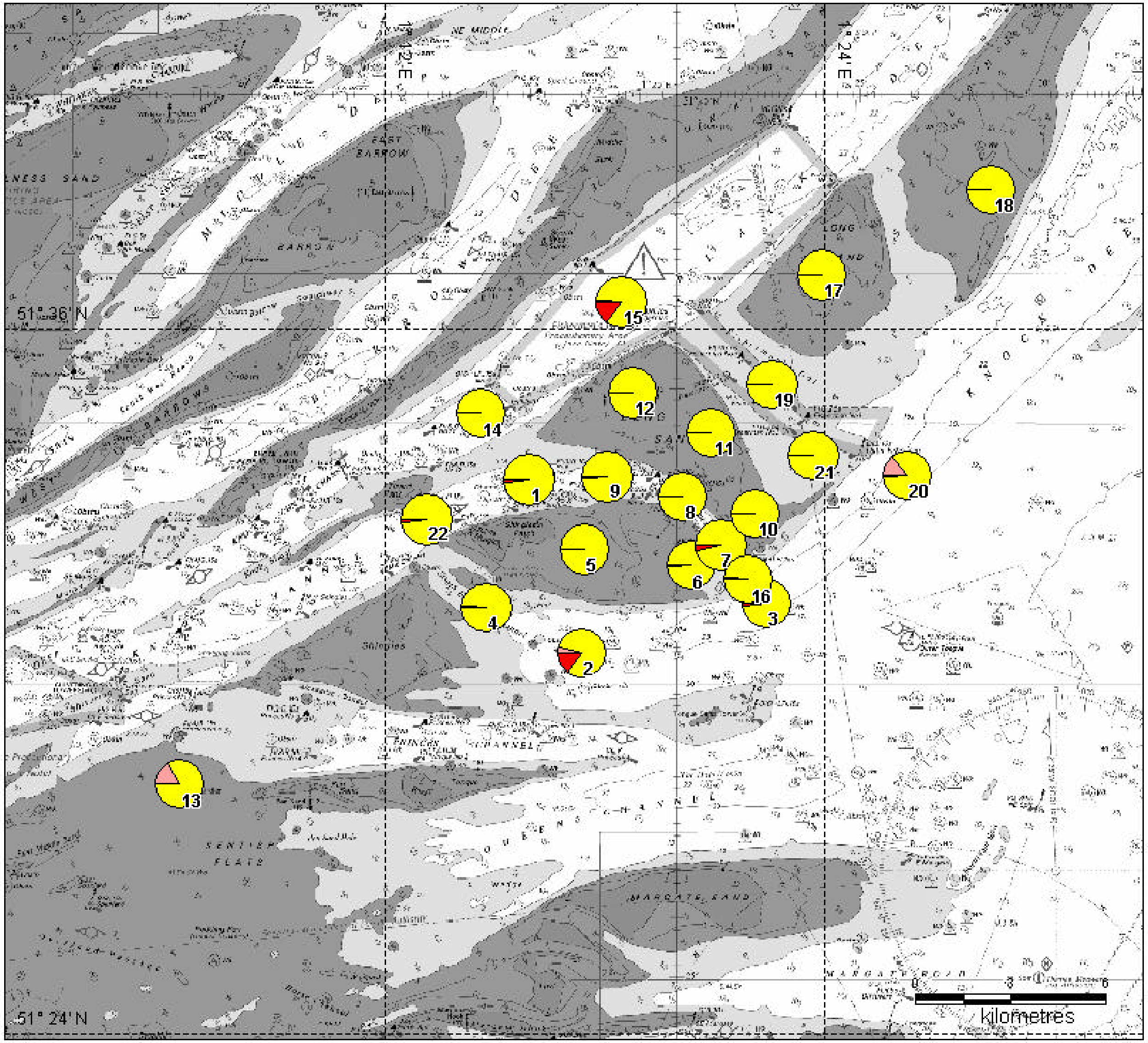

Figure 8:
Surface Sediment Characteristics

Key

Sediment Characteristics

- Gravel
- Sand
- Fines

Based on Emu 2004

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4.1.2 South Falls Disposal Site

The nearest existing marine disposal site is South Falls, located some 55km from Princes Channel. This site has been in use for many years and receives both capital and maintenance dredged material. The site is located in water depths of approximately 40m and is subject to tidal currents of approximately $1ms^{-1}$ (Defra GIS, 2004). Given the strength of the tidal currents it is probable that dispersive material and fine sand will be transported away from the site in the form of plumes and bedload transport. Larger material (gravel, rocks, clay etc.) would remain at the site and be subject to winnowing and erosion over time. The seabed is described as fine sand however it is also likely to contain debris from capital dredging operations and may not be a smooth sandy seabed.

The site is presently used for the disposal of maintenance dredged silts and sands from the River Medway with a total permitted quantity 280,000 tonnes (approximately $147,500m^3$). One operator on the Thames uses the site on a periodic basis (about once every three years) for coarse sand that cannot be moved by water injection dredging, and the quantity can be up to 70,000 tonnes (approximately $40,000m^3$). In 1993/4 the Port of Ramsgate was licensed to dispose of up to 700,000 tonnes of capital material and in 2000 and 2001, Medway Port Authority held a licence for up to 800,000 tonnes of material from its channel deepening project (Defra Public Register, 2004).

4.2 The Sand Placement Operation

The placement operation will occur from a stationary trailer dredger in a series of pre-defined placement cells and the actual placement operation by bottom discharge will occur within approximately one minute (out of a round trip time of three hours). The assessment of effects on coastal processes is based on placement of the entire $2.5Mm^3$ on a continuous basis. In such an operation, approximately $210,000m^3$ would be placed at the site each week over a 12 week period. In practise this is very unlikely to occur given the PLA's commitment to find beneficial use for the majority of the dredged material.

The processes which operate during disposal by bottom-discharge from barges or trailer dredgers can be divided into three phases (Bokuniewicz *et al.*, 1978); convective descent, impact (or dynamic collapse) and passive diffusion.

On release, the material descends rapidly as a well-defined turbulent jet at a speed far in excess of the settling velocity of the component soil particles. During descent, the material is diluted due to axial spreading of the jet and entrainment of ambient water. The degree of dilution is largely a function of the geometry of the dumping situation. It increases as the water depth increases and as the speed of discharge from the vessel decreases.

A proportion of the material is stripped from the descending jet to form a passive sediment plume in the water column. Depending on the water depth and hydrodynamic conditions at the dump site, the suspended material may be transported considerable distances by water currents. The amount of material stripped from the jet will be greater in deep water than in shallow water but for this operation would be in the region of 3%. The size of barge or dredger bottom-openings through which the material is discharged is also a factor. In percentage terms, stripping losses will generally decrease as the size of the discharging vessel increases.

In very deep water, the dilution eventually reaches the stage where dynamic collapse occurs; the density of the jet is reduced to a density similar to that of the surrounding seawater and the material becomes subject to passive advection and diffusion. Unless very small vessels are used, and discharge speeds are slow, dynamic collapse is unlikely to occur in water depths of less than 100 metres. Instead, the dumped material will impact the seabed at speed and spread radially from the impact point as a density current, eventually coming to rest, assuming a level seabed, when all of the kinetic energy has been dissipated through frictio n.

4.3 Changes to Bathymetry

4.3.1 Effect description

As Port Authority the PLA is concerned to ensure that the placement operation does not compromise the future use of the North Edinburgh or other channels in the vicinity because further natural bathymetric changes may allow these channels to be re-opened. The site has been chosen to reflect an area with depths of greater than -10mCD at low tide.

The placement operation will result in a number of individual mounds of sand distributed over the seabed. If the total quantity of 2.5Mm^3 is distributed evenly over the disposal area, a mound of 1.25m would be formed. In practice, following each placement operation, the sand will impact on the seabed and spread laterally under its own momentum and gravity (DRL, 2004). Assuming a medium sized dredger (4-8,000m3 hopper capacity) each placement will initially form a mound of approximately 2m in height. Slumping and reworking by tidal currents would reduce the mounds to approximately 1.5m. The remaining sand would then form part of the seabed for uptake in bedload sediment transport (see Section 4.6).

The result of the placement of 2.5Mm^3 in the placement site would result in a depth reduction of 1.5m following initial slumping and levelling off.

4.3.2 Mitigation

To ensure the navigational constraint of -10mCD is maintained, it is proposed that placement activities are restricted to water depths of -12mCD or greater. Figure 9 shows the revised placement area.

The significance of the effect for other environmental features is discussed in the relevant section.

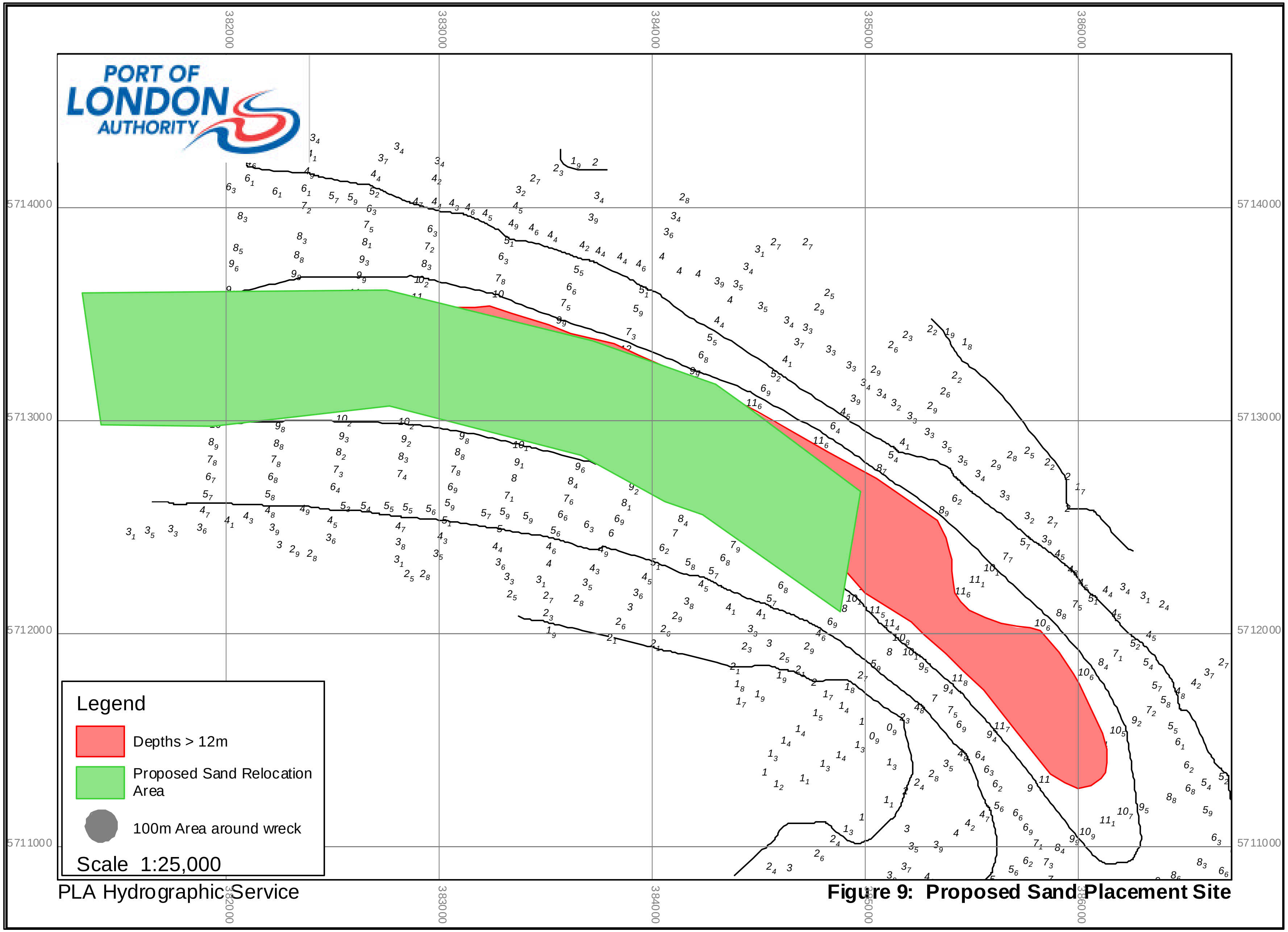

Figure 9: Proposed Sand Placement Site

4.4 Changes to Current Speed

4.4.1 Effect Description

Changes to water depths can result in changes to current speeds and subsequently sedimentation and erosion patterns. It is important to be aware that the North Edinburgh Channel is frequently subject to dramatic depths changes caused both by extreme events and the ongoing migration of the channel. For example, the eastwards movement described in Section 4.1 would have involved depth changes of up to 10 metres at any individual point. It can be concluded, therefore, that the North Edinburgh Channel is subject to changes in current speeds as a result of natural processes.

The reduction in depth of between 1.5 and 2m would result in an increase in local tidal current speeds of up to 25% across each mound of sand. At peak tidal flows this could result in localised increases in water speed of up to $0.25ms^{-1}$ (DRL, 2004). The effect of this increase will be enhanced erosion over the mounds and the dispersal of the sand into the sediment transport processes (see Section 4.6). Increases in tidal currents are predicted to remain local to each individual mound and will not affect current speeds outside of the immediate vicinity. As each mound decreases, the increase in current speed will also decrease, therefore, the 25% increase is considered a maximum short-lived effect. It should be noted that these predictions are based on low tide depths and the additional 4.5m at high tide will result in lower current speed increases. Assuming the worst case scenario of placement of $2.5Mm^3$ of sand, in the large scale outer Thames Estuary, no significant change to tidal flows or the sediment regime is predicted.

4.4.2 Mitigation

Given the above, consideration has been given to designing the placement methodology to have the least effect on current speed. It is therefore proposed to carry out placement along longitudinal strips parallel to the current flow. This will ensure that there are no blocking effects to current speeds across the channel, however, this will have the effect of slower dispersal of the sand away from the placement site.

The significance of these effects for environmental features are considered in Sections 5 to 16.

4.5 Changes to Wave Action

The wave climate local to the sand placement site has been derived using HR Wallingford's HINDWAVE and TELURAY models. The local conditions at the site are dependent on swell waves (generated in the North Sea) and wind sea waves generated within the Outer Thames Estuary by local wind action. In this case, HINDWAVE was run (with over 15 years of wind data) in order to predict the locally generated waves and TELURAY used to transform waves generated in the North Sea to the North Edinburgh Channel taking account of the modification to the offshore spectra resulting from refraction and shoaling. The dominant factor in the vicinity of the North Edinburgh channel relates to the large surrounding drying banks which limit the height of the waves by depth induced breaking. In this context, the very local change in depth within the deposition area is such as to have a negligible impact on wave height distribution.

4.6 Changes to Sediment Transport Patterns

4.6.1 Effect description

The introduction of sand to the North Edinburgh Channel will increase the amount of sand available for onward sediment transport. As noted in Section 4.4 the initial effect of the placement will be to increase sediment transport processes local to each placement mound. This will result in increased erosion of the mounds with deposition of sand into the hollows between each mound until a more level seabed is achieved and sediment transport patterns return to those existing at present (DRL, 2004). Evolution of the North Edinburgh Channel is considered to be driven primarily by extreme events, i.e. storm action, and the placement of this material is considered to mimicking a smaller storm event.

It is not predicted that there will be any increased erosion of the adjacent sandbanks, rather the changes will be restricted to the locality of the placement site, which is approximately 360m from the 2m contour.

4.7 Fate of the Placed Sand

The material proposed for placement into the North Edinburgh Channel is fine sand and has very similar characteristics to the existing seabed material. Although the seabed material in the Princes Channel has a higher *in situ* fines content, use of DRL's Dredging Process model predicts that much of this material will be dispersed into the immediate area during the dredging process. The fines content of the material remaining in the hopper of the dredger is comparable to the fines content of the North Edinburgh seabed sediment. Figure 10 shows the relative properties of the two; dredged material and the seabed sediment at the placement site.

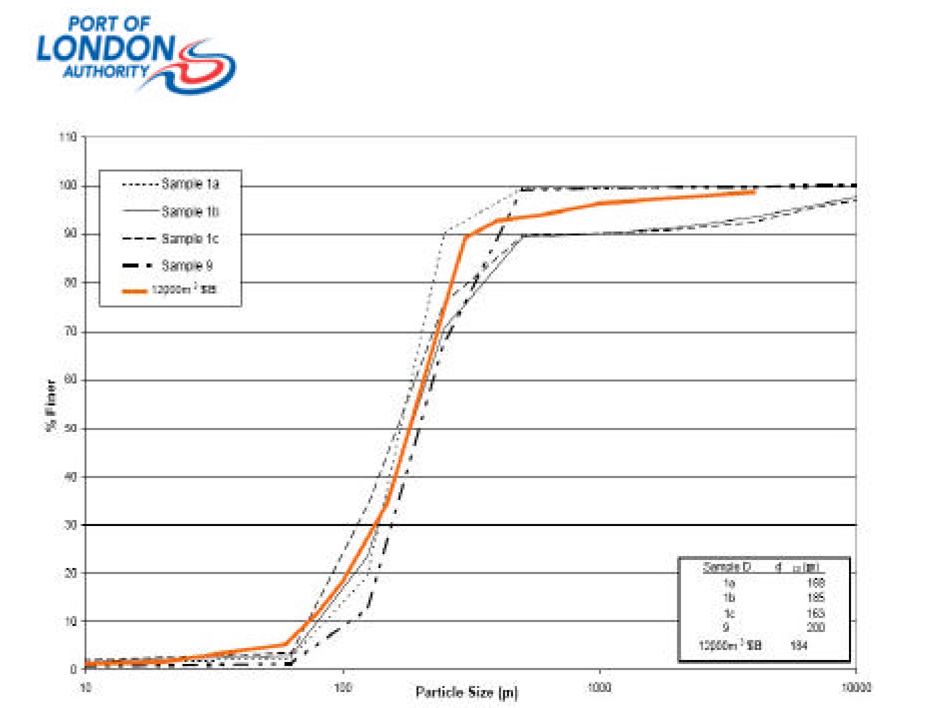

Figure 10: Physical Properties of Seabed Sediment

It is likely that there will be a small proportion of London Clay in one section of the Princes Channel dredge area. This area has been identified from the vibrocore survey and, if encountered, permission would be sought to dispose of this clay to South Falls, the existing marine disposal site for capital material.

Apart from the clay, given the similarity in properties, it can be predicted that the two sediments will behave in a similar way when subjected to tidal currents and wave action. The approach taken to assess the mobility of the sand involves calculations of shear stress required to initiate movement in the North Edinburgh Channel. The calculations found that the shear stress required to initiate movement ranged from a current speed of $0.38ms^{-1}$ to $0.43ms^{-1}$. Assuming that the current speed varies sinusoidally with the tide, with a peak speed of $1ms^{-1}$ (from ADCP data), it can be see that the shear stress will be exceeded for between 75% and 72% of the tidal cycle (DRL, 2004). The peak water speed could mobilise sand grains up to a diameter of 2.5-3mm, therefore, even the coarser sand will be mobilised on a spring tide.

Assessment of the eventual fate of placed material is notoriously complicated as many factors affect bedload movement, such as currents, storm surges, storm waves and swell, strong winds etc. The placed material will be mobilised for the majority of each tidal cycle and will be transported in the direction of the tidal flow. On the flood tide the material will move towards the inner estuary for a distance of a few km, over slack water the sand will be deposited on the seabed before being picked up again as speeds increase on the ebb. Material that is moved initially on the flood is expected to move up and down over a number of tides before being deposited in a lower estuary depositional environment, on a sandbank or coastal fringes.

In the North Edinburgh Channel, the ebb tide is dominant and sand will be transported further distances to the east, moving over the bank at the eastern end of the Channel and fanning out into the deeper water of the Knock Channel. Figure 6 indicates shows the most dynamic part of the channel and the initial placement operations will be targeted in this area. The deposited sand will act as the top mobile layer and will move in place of the sand that was previously forming the seabed surface. The placement operation will not, therefore, cause a significant increase in the material being transported out of the North Edinburgh Channel on each tide as the original seabed material would be buried and, therefore, not available for transport.

4.8 Comparison with South Falls

The South Falls disposal site has received a maximum of 800,000 tonnes in an annual period and only on three or four occasions. Ongoing use of the site is relatively small scale and amounts so to 2-300,000 tonnes per year. The capacity of the site to receive 2.5Mm^3 (equivalent to approximately 4.75M tonnes) of sand on a continuous basis has not, therefore, previously been assessed. It is probable, however, that the period of deposition would be more than double that for placement at North Edinburgh due to the significantly increased cycle time from Princes Channel to South Falls. A period of 30 weeks is thus more likely.

South Falls, with water depths of up to 40m clearly has the bathymetric capacity to receive the sediment, however, it is not in a sandbank system such as the Thames Estuary, rather it is in an area of deep water with no obvious sources of mobile sand. The current speeds at the South Falls site are similar to North Edinburgh. However, the influences of surges, storms and waves etc. at this depth are greatly reduced and thus most movement that occurs will be in the dominant current directions, which are 032° and 209º. The result of the deposition of this quantity of sand at South Falls over the given timescale would be to provide an increased quantity of mobile sand for onward transport. The assessment of the likely significance of this effect on marine biology, fisheries and fishing activity is considered in Sections 7, 8 and 12 respectively.

4.9 Summary of Potential Effects

The assessment of impacts on the environmental features in Sections 5 to 16 is based on the following effects on coastal processes:

- 2.5Mm^3 placed over a 12 week period (the “worst-case scenario”);
- Local increase in current speeds around each disposal mound;
- Sediment properties of placed material are equivalent to existing seabed material;
- Sediment will move away from the site as bedload transport in place of existing seabed sediment;
- There will be no obvious disposal plume due to low fines content; and
- There is no predicted change to wave action.

4.10 Monitoring

The rate of movement of placed material away from the site will be monitored by weekly bathymetric surveys during the placement operation. The surveys will extend away from the placement site in the direction of the tidal cycle to provide information on any local accumulations of material. A pre-placement survey will be undertaken and this, along with existing survey data, will form the baseline situation. Following the completion of the placement operations, monthly survey will be undertaken for a period of six months with further surveys undertaken on a six month basis until the site is considered have returned to its former regime. Figure 11 shows the proposed bathymetric survey area.

4.11 Sand Placement Management Plan

A Sand Placement Management Plan will be prepared for the dredging contractor to ensure that the placement operation is carried out in accordance with the assessment. The placement site will be divided into a grid with a series of cells, approximately 100m x 100m. Sand placement will occur cell by cell in longitudinal strips parallel with the tidal flow.

Environmental mitigation measures will also be contained within the plan as will monitoring requirements.

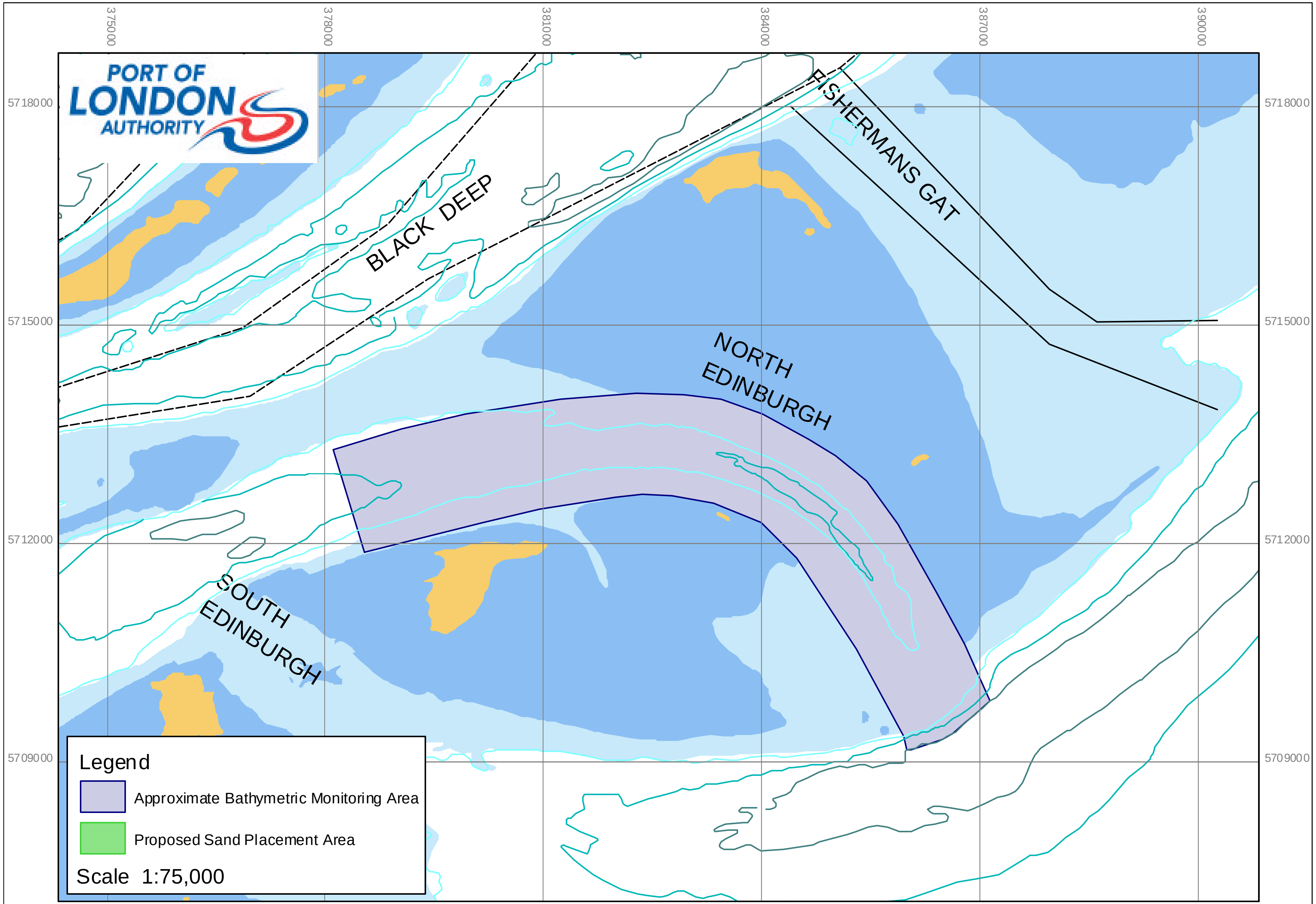

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Figure 11: Approximate Bathymetric Monitoring Area