Dublin Port Company

Dumping at Sea Permit
Supporting Information
# DOCUMENT ISSUE RECORD

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**Supporting Information**

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1 Introduction

1.1 Background

Dublin Port is situated on the River Liffey which flows through the City of Dublin between the Great South Wall and North Bull Wall (Appendix A, Figure 1) before entering Dublin Bay. These breakwaters are fundamental to the existence of the commercial Port of Dublin.

The breakwaters channel the flow of the river, maintaining some of its velocity further into Dublin Bay than would occur naturally. This velocity is maintained sufficiently to carry substantial quantities of sediment that would have otherwise settled at the mouth of the river. However, some quantities do settle in the mouth of the river, and, coupled with coastal sediment transport processes and storm events, lead to deposition of material within and beyond the breakwaters. Further to the above, over time, dredged profiles collapse and are distorted by the movement of sediment as a result of ships propulsion.

In order to maintain the dredged profiles of navigable channels, berths and docks, and therefore safe usage of the port, Dublin Port Company (DPC) needs to carry out maintenance dredging. Regular maintenance dredging of the berths, basins and channels is carried out by a contractor. On the basis of past experience it is expected that dredging will be required at 18 month intervals to safely maintain the port for shipping traffic.

The standard depth of the berths to the East of the East Link Bridge varies between -6.5m and -11.3m below Lowest Astronomical Tide (LAT), which is 0.1m below Chart Datum at Dublin Port. The Fairway is the main channel through the port complex, running from the Talbot Memorial Bridge through the centre of the Port and out between the North Bull and Great South Wall (Appendix A, Figure 2). Seaward of the East Link Bridge the Fairway is maintained at a standard depth varying from -6.5m LAT to -7.8m LAT.

This document supports an application for a Dumping at Sea Permit for a 6-year maintenance dredging plan for the period from 2009-2014. The areas to which this application relates are shown in Appendix A, Figures 3, 4 and 5.

1.2 Historical Maintenance Dredging in Dublin Port

The Port of Dublin has been dredged for 300 years. The Dublin Port Committee marked a channel to the north of Ringsend in 1709. Dredging was achieved using 60 ton lighters, each with a 9 man crew. In 1812 a steam powered bucket dredger was used, dredging 1,000 tons per week.

In 1900 Kalis, a Dutch company, was the first dredging contractor employed to work in the port. The 750,000 tons dredged from the Fairway was used as reclamation material for the graving dock. The Port Authority maintained the channel with its own equipment until 1970.

LAT is defined as the lowest water level that is predicted to occur under any meteorological or astronomical condition.
Since 1970 commercial contractors have been engaged to carry out regular maintenance dredging campaigns in the Fairway, berths and basins.

In October 2000, a 5-year maintenance dredging plan was produced under the guidance of the OSPAR regulations. The permit associated with that plan was extended by one month in 2006 to allow essential maintenance to be carried out.

A sediment sampling programme was commissioned in 2006 with the intention of submitting an application for a further 5-year Dumping at Sea permit. The results of the sampling indicated that in general the chemical parameters tested were lower than that measured during testing for the previous plan. However, stricter environmental controls had been introduced in the intervening period, and as a result the dredge material required further investigation in relation to its suitability for disposal at sea. The result of the further investigation was that a small proportion of the dredge material, although suitable under previous controls, was no longer suitable for “unrestricted” dumping at sea.

In light of the above it was proposed to contain such “restricted” material during disposal with “unrestricted” material using a Level Bottom Capping (LBC) technique. As this was a locally untested method it was decided to apply it initially to a 1-year Dumping at Sea Permit application. Dredging in accordance with this 1-year plan was completed during the winter of 2007/08.

1.3 Environmental Policy

The DPC Environmental Management System (EMS) commenced in 2006 to ensure that activities within the port are conducted in accordance with environmental best practice.

"It is our policy to manage our obligations to the environment in a responsible manner and to take a sustainable approach to developing the port's business"

1.3.1 Ecoports Certification

DPC achieved the Ports Environmental Review System (PERS) certification in February 2008 from Ecoports, a network of ports and port related stakeholders sharing environmental experiences. PERS is based on internationally recognised professional best practice and defines a basic standard of good environmental practice for the port sector. The Ecoports foundation promotes the implementation of the European Sea Ports Organisation (ESPO) Code of Environmental Practice. PERS certification places DPC amongst the top European Ports providing a responsible and self-controlling approach to their environmental performance. Ecoports review this certification on biennial basis.

1.3.2 ISO 14001 Certification

In September 2008 DPC was awarded the internationally recognised environmental standard ISO 14001 certification for its activities, facilities and operations within the port estate. This award demonstrates DPC's positive and proactive commitment to the environment.

The DPC EMS and environmental practices are independently audited on a six monthly basis by Bureau Veritas. The last surveillance audit, which took place on
1st April 2009, demonstrated that the environmental management system is continuously being developed and maintained to provide ongoing improvements in applying environmental best practice and undertaking environmental initiatives.

1.4 Legislative Framework

The Government departmental responsibilities have recently changed as a result of ministerial changes. At the present time the Department of Agriculture, Fisheries and Food (DAFF) are responsible for Dumping at Sea Permit Applications, and this document has been prepared using the most up to date guidance available from the Department. Should the authorities change over the course of the 6-year plan, the reporting elements detailed will be forwarded to the relevant authority.

This document provides the information required for assessment of dredging and disposal operations under the current guidance (DCMNR, 1999; Cronin et al, 2006), taking account of the assessment criteria laid down under the OSPAR Convention as set out in the First Schedule to the Dumping at Sea Act, 1996. These criteria are:

- the availability, or otherwise, of suitable land-based alternative disposal options or there being other possible beneficial uses of the material (e.g. land reclamation, beach nourishment, etc.);
- the characteristics and composition of the material to be dumped;
- the characteristics of the dumping site and method of disposal;
- potential interference with other legitimate uses of the area including fisheries, aquaculture, areas of special scientific importance, areas of wildlife importance, recreation, navigation and shipping both from the dumping and dredging aspects of the proposed project;
- proper certification of the disposal vessel and crew; and

Note that the dredging and disposal will be carried out by a commercial contractor following competitive tender. On this basis information to confirm the proper certification of the disposal vessel and crew is not included within this document. Relevant details will be supplied following appointment of the contractor and in advance of the issue of the Dumping at Sea Permit and the commencement of works.
Characteristics and Composition of the Substance for Dumping

2.1 Form and Physical Properties

The sediment which is deposited within the port area is from the River Liffey and Dublin Bay. Sediment particles are carried down the River Liffey and drop out of suspension as the river widens and slows resulting in sediment being deposited in the Port area (deposition occurs from the North Bank light and beyond). The incoming tide has sufficient velocity to bring sediment in from the bay, consisting mainly of small particles (i.e. fine sands and silt). Tidal sediments affect all the berths and the Fairway out towards the Dublin Bay Buoy (refer to Admiralty Chart - Appendix A, Figure 2).

In order to categorise the nature of the sediments to be dredged, a granulometric survey (Appendix B) was carried out in 2006 for agreed sampling stations throughout the dredged area (Appendix A, Figure 3). The composition of the material is summarised in the following table:

Table 1: Composition of dredge material (as defined in Cronin et al, 2006 based on Folk scale)

<table>
<thead>
<tr>
<th>Material Category</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock / gravel (&gt;2mm)</td>
<td>2</td>
</tr>
<tr>
<td>Sand (62.5μm -2mm)</td>
<td>60</td>
</tr>
<tr>
<td>Silt (4μm-62.5μm)</td>
<td>32</td>
</tr>
<tr>
<td>Mud (&lt;4 μm)</td>
<td>6</td>
</tr>
</tbody>
</table>

As illustrated above, the majority of the sediments are fine sands, with varying amounts of silt across the area. An area of gravel material was identified at Sample Site 20 in Alexandra Basin East. It is anticipated that the composition and form of sediment surveyed in 2006 will remain representative of the composition of material to be dredged under this plan.

2.2 Chemical Properties

2.2.1 Assessment of Chemical Properties

In August 2006, in accordance with current guidance and in agreement with the Marine Institute, samples were also taken from the sample sites (Appendix A, Figure 3) to characterise the chemical nature of the sediments to be dredged. The results of the 2006 survey are shown in Appendix C (note that the sampling programme included an area upstream of the East Link Bridge for comparison purposes but it is not proposed to dredge that area under this application).

The definition of the areas proposed for dredging within the Port are outlined in Appendix A, Figure 4. The sediments within the proposed dredging area have been
assessed against the limits of suitability for dumping at sea (see Table 1.2 of the “Guidelines for the Assessment of Dredge Material for Disposal in Irish waters”\(^2\)).

The conclusion of the assessment was that a number of elevated results were identified in sediments upstream of a line between the western end of Berth 35 and the western end of Berth 41, which shall hereafter be referred to as “Area A” (see Figure 5). Area A includes a buffer zone downstream of the sample points with elevated levels of contaminants. Whilst the quality of material is below the upper thresholds for dumping at sea, the range of elevated contaminants identified caused concern and has been categorised as Class \(2^2\). Further testing was undertaken in September 2006, which confirmed the extent of contaminants within these sediments (Appendix C) and in light of this the Marine Institute deemed that material in Area A should not be subject to unrestricted dumping at sea.

Downstream of the line between the western end of Berth 35 and the western end of Berth 41, the assessment determined that the quality of the material was below the lower thresholds for dumping at sea and was categorised as Class \(1^2\). This material was considered suitable for unrestricted dumping at sea and the area in which this material prevails shall hereafter referred to as Area B (see Figure 5).

### 2.2.2 Further Assessment of Area A and Area B Delineation

As requested by the Marine Institute it is proposed that in parallel with this application further chemical testing is undertaken at locations which shall be in accordance with the requirements of the Marine Institute. This further testing shall allow reassessment of the delineation between Area A and Area B in recognition that sediment quality may differ from that sampled in 2006. If the sediment quality is found to differ, delineation shall be adjusted in consultation with, and with the agreement of, the Marine Institute. Following any adjustment of delineation between Area A and Area B, the volumes of restricted and unrestricted material shall be recalculated and revised volumes submitted to the Marine Institute. This sampling and testing is proposed to be undertaken prior to the 3\(^{rd}\) round of dredging in year 3 of this 6-year dredging plan. A copy of the sampling plan, as agreed with the Marine Institute, is included at Appendix D.

It is proposed that a granulometry survey shall be undertaken as part of the overall sampling strategy associated with this application to confirm this assumption and will subsequently be submitted to the Marine Licence Vetting Committee (MLVC).

In advance of the development of this 6-year dredging plan an additional round of sampling and testing was undertaken by DPC, during October 2008, at the locations previously identified with the Marine Institute and shown in Appendix D. The results of this testing, which are also included in Appendix D, identifies similar granulometry to the 2006 assessment. Chemical analysis of the 2008 sampling demonstrates a marked improvement from the level of contamination present in the 2006 samples. However, it is not envisaged that the delineation between Area A and Area B will reassessed until the results of the year 3 sampling, identified above, are assessed.

### 2.2.3 Assessment of Contaminant Sources

It is considered that given the extent of Area A and results of chemical analysis of sediment upstream of the East Link Bridge one source of potential contaminants to the port may be external sources upstream of the East Link Bridge. In order to

\(^2\)Marine Environment & Health Series No.24 2006.
assess this theory it is proposed, in consultation with the Marine Institute, that chemical testing of incoming suspended sediments upstream of the port is undertaken.

2.3 Biochemical Properties

There have been a number of localised biological investigations in Dublin Port, for example an investigation of the sediments in Alexandra Basin was undertaken in 2001/2002. In general, the sediments in the port are polychaete and oligochaete dominated muds and fine sands, which are typical of shallow water, intertidal muddy sediments in the inner part of Irish ports and are of widespread occurrence around the Irish coast.

2.4 Toxicity

In 2006 toxicological testing was undertaken, comprising two types of tests, of the sediments in Area A (see Appendix E). In the first test the organism *Vibrio fischeri* was used for assessing the acute effects and was exposed to the porewater from the sediments sampled, for periods of 5, 15 and 30 minutes and the percentage light inhibition was recorded. In an optimum population density, *Vibrio fischeri* will illuminate, and as such the percentage light inhibition indicates reduced population density (which can indicate mortality in the population). The results of these test indicate an initial reduction in luminescence at 5 minutes exposure (positive numbers) while the 15 and 30 minutes results (negative numbers) indicate a recovery of the population density. This shows some minimal acute toxicity of the pore water, though not of significant levels.

The second test used *Corophium volutator* which tests the effects on amphipods or sediment reworkers (i.e. marine organisms that process sediment). This test involves exposure to the sediment for a period of 10 days to record mortality. The results showed no significant mortality and recorded levels of less than 8%.

Area B is categorised Class 1 and therefore no additional toxicological analysis was deemed necessary.

At this juncture, it is not proposed to undertake further toxicological testing in relation to this application. Further toxicity testing will be undertaken in year 3 of this 6-year dredging plan. Seven of the silt samples collected for chemical analysis (see section 2.2.2 above) will also be subjected to toxicological testing. The locations of these seven samples have been agreed with the Marine Institute and are detailed in Appendix D.

2.5 Radiological Properties

In December 2006 samples were taken for radiological testing throughout the proposed dredge area, encompassing Area A and Area B (see Appendix F). The samples were analysed by the Radiological Protection Institute of Ireland (RPII) in early 2007 for the following range of isotopes:

- K – 40
- I – 131
- CS – 134
- Cs – 137
- Ra – 226
The results of the radiological tests confirm that the radiological properties of the material in both dredge areas are not of concern. It is assumed that there shall not be any significant change in the radiological properties from 2006 and as such it is not proposed to undertake further radiological testing in relation to this application.

2.6 Other Characteristics of the Substance or Material

It is understood that the material characteristics and properties identified above and proposed further testing is sufficient to allow the MLVC and Marine Institute to gauge the potential impact and ecological risk using a “weight of evidence” approach, based on the following considerations:

- Persistence (physical, chemical and biological)
- Accumulation and Biotransformation
- Chemical and Physical Changes of the Waste after Release
- Taints

2.7 Calculations of Predicted Volumes

The predicted dredge quantities have been calculated by comparison of the 2006 pre-dredge survey and 2007 post dredge bathymetric surveys using the MOSS software application, which calculates the difference in volume between two defined surfaces. In the calculation the dredged area has been split into a number of distinct regions (see Appendix A, Figure 3).

The volume that has been calculated is the difference between “cut” and “fill” volumes over the whole of a particular region, with “cut” and “fill” being associated with areas of bed level increase and decrease respectively. “Fill” volumes are attributable to those locations where ship propulsion causes accretion or where dredge slopes slip into the dredge pocket. The difference between “cut” and “fill” represents the net change in the volume of sediment within the port and in this case in the period of 2006 to 2007.

Based on the assumption that 2006 to 2007 represents a typical year it is anticipated that over a 6 year period the dredge volume would be 6 times the change in volume in the period of 2006 to 2007. The calculation results are summarised in Table 2, Table 3 and Table 4 below:

**Table 2: Area A – Class 2 / Restricted Material Volumes**

<table>
<thead>
<tr>
<th>Area Code</th>
<th>Area Description</th>
<th>6 Year Dredge Volumes (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B007</td>
<td>River – Area A</td>
<td>35,461</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>35,461</td>
</tr>
</tbody>
</table>
Table 3: Area B – Class 1 / Un-Restricted Material Volumes

<table>
<thead>
<tr>
<th>Area Code</th>
<th>Area Description</th>
<th>6 Year Dredge Volumes (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B006</td>
<td>North Quay Extension</td>
<td>8,057</td>
</tr>
<tr>
<td>B008</td>
<td>Alexandra Basin East</td>
<td>50,617</td>
</tr>
<tr>
<td>B009</td>
<td>Oil Berths</td>
<td>81,522</td>
</tr>
<tr>
<td>B010</td>
<td>Ferryport</td>
<td>121,807</td>
</tr>
<tr>
<td>B011</td>
<td>River - Area B</td>
<td>743,358</td>
</tr>
<tr>
<td>B012</td>
<td>South Quays</td>
<td>59,863</td>
</tr>
<tr>
<td>B013</td>
<td>Sludge Jetty</td>
<td>0</td>
</tr>
<tr>
<td>B016</td>
<td>Bar West</td>
<td>0</td>
</tr>
<tr>
<td>B017</td>
<td>Bar East</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>1,065,224</td>
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</table>

Table 4: Volume Totals by Area

<table>
<thead>
<tr>
<th>Area Description</th>
<th>6 Year Dredge Volumes (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairway Total (Areas B007, B011, B016 &amp; B017)</td>
<td>778,819</td>
</tr>
<tr>
<td>Berth Total (Areas B006, B008, B009, B010, B012 &amp; B013)</td>
<td>321,866</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,100,685</td>
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In order to provide for atypical conditions such as storms or other factors that may result in higher levels of siltation than that calculated for the period 2006 to 2007, a contingency of 25% is proposed above the estimated 200,000m³ per annum of material. Dredging is expected to be undertaken at 18 monthly intervals, therefore it is estimated that 300,000m³ may be dredged in each operation, and that in any dredging operation the dredged volume may be up to 375,000m³ (inclusive of 25% contingency). The total volume of material to be dumped at sea over a six year period, including contingency and on the basis of 5 dredging operations is estimated to be 1,875,000m³.
3 Characteristics of Dumping Site

3.1 Location

It is proposed to dispose of the dredged material at the Burford Bank which is charted as a spoil ground on Admiralty Charts (see Appendix A). This site, which is in approximately 20m depth of water, has been in use since 1996 following the introduction of a new shipping separation scheme at that time. The area comprises approximately 212 hectares and is adjacent to the previous disposal site used from the 1960’s to 1996.

The area is bounded by the following co-ordinates:

- latitude 53°20.07’ North and longitude 06°03.00’ West,
- latitude 53°20.07’ North and longitude 06°01.82’ West,
- latitude 53°19.17’ North and longitude 06°01.82’ West,
- latitude 53°19.17’ North and longitude 06°02.71’ West,
- latitude 53°19.38’ North and longitude 06°03.00’ West.

3.2 Other Disposal Sites

There are no other disposal sites in the vicinity of Dublin Port or the Burford Bank site currently licenced. The nearest dumpsite is licensed to Drogheda a significant distance from Dublin Port and would be practically, financially and environmentally unviable to use for this operation.

3.3 Location in Relation to Other Areas

The nearest shellfishery area of importance is 12km from the site (*Nephrops norvegicus* - Dublin Bay Prawn / Langoustine).
4 Method of Deposit

4.1 Methods of Packaging and Containment

Recognising the slightly elevated levels of contaminants in the upstream material in Area A compared to the current threshold values, unconfined disposal of sediment at sea is not considered to be a suitable disposal option for this material. Therefore capping of this material is recommended.

The objective of capped in-water disposal is to isolate Class 2/Restricted material from the environment by capping the sediment with clean material – usually sand or other coarse material. The contaminated dredged material is placed on the level sea bed or within bottom depressions and clean material is then placed on top. Specific engineering principles are used in the design and placement of the cap to ensure that it successfully isolates the contaminants and stays in place. Caps are designed so that currents, waves, or burrowing sea bed creatures will not erode the protective layer over time (US EPA, 2006, ACE, 2006).

In order to provide the best environmental option, the dredged sediments from the uncontaminated area of the port (i.e. Area B) will be used as the capping material for the Class 2/Unrestricted material from Area A. It is anticipated that the Area B material will be suitable for the cap as it contains similar granulometry to the material at the dump site. This material will be deposited at the dumping site at 18 month intervals as part of the dredging operation and therefore no cap replenishment activities from other sources are expected to be required.

The following discussion summarises the methods proposed for Level Bottom Capping (LBC) as the preferred option for restricted disposal of Class 2 sediments.

4.1.1 Level Bottom Capping (LBC)

4.1.1.1 General

The Level Bottom Capping (LBC) technique used by Dublin Port Company (DPC) for the 1-year plan in 2007 under Licence No.388 and has been successfully used around Europe and in the US. LBC is defined as the placement of contaminated material in a mounded configuration and the subsequent covering of the mound with clean sediment (Palermo et al, 1998) (US EPA, 2006).

Capped disposal for the isolation of contaminated sediment is practiced worldwide. In the UK, capped disposal has been used successfully by the Port of Tyne. Elsewhere in Europe this technique has been used in Norway, the Netherlands and Belgium (Zeman et al 1992). In the United States and Canada, capped disposal sites have been used successfully for over 20 years by the US Army Corps Engineers (US EPA, 2006, ACE, 2006).

This disposal option is more expensive than unconfined dumping at sea given the sequencing restrictions necessary to adequately control the placement of material. However, it is considered that this option represents the best practicable environmental option for dealing with material not suitable for unrestricted disposal arising from maintenance dredging at Dublin Port.
Laboratory tests and guidance have been developed to determine the thickness of capping sediment required to chemically isolate a Class 2 sediment from the overlying water column (Sturgis and Gunnison 1988). These tests also take into account the effects of bioturbating organisms (Brannon 1985). The minimum required cap thickness is considered to be the thickness required for chemical isolation plus that thickness of bioturbation associated with organisms likely to colonize the site in significant numbers (US EPA, 2006, ACE, 2006). For this plan a cap thickness of 0.46m (1.5ft) is considered sufficient (ACE, 2006) to account for bioturbation, settling and physical/chemical oxidation. This will also enhance the stability of the cap to protect it from natural and man made disturbances (US EPA, 2006, ACE, 2006).

The design of capping layers for heavily contaminated sediments usually incorporates a layer of clean silt to act as a chemical barrier underneath the cap of coarse material. In this instance, taking account of the properties of the sediments, it is considered sufficient to cap directly with the coarse material, without the incorporation of an additional chemical barrier. Any additional unrestricted dumping at sea operations on the Burford bank site of Class 1 sediments by other parties will assist the maintenance of the cap integrity.

4.1.1.2 Placing of Class 2 / Restricted Material

The Class 2/Restricted material, which must be dredged on the incoming tide, will be placed at slack water by a bottom dumping barge. Recent experience of a similar operation at the Port of Tyne in deeper water (approx 50m) resulted in a deposition area of 200m x 200m for surface deposition from a split barge.

The relationship between flow velocity and sediment transport is described by the Hjulstrøm Diagram (1939) and Shields Diagram (Shields, 1936, ASCE, 1975, Gessler 1971). These have been used together with standard values as quoted in Miller et al (1977) to describe the sediment transport characteristic of the deposited contaminated material.

The viability of the dumping operation was assessed from a sediment transport perspective by an additional current metering programme carried out between 14th February 2007 and 3rd March 2007 (Appendix G). Due to the prevailing tidal and storm conditions during this period it should be noted that the measured tidal currents are likely to be higher than those which might be considered representative of normal tidal conditions at the site. This assessment is therefore considered to be conservative.

The flood and ebb tidal currents move predominately in a South - North direction with peaks of 0.3m/s (flood tide) and 0.4m/s (ebb tide), measured at the sea bed. These peak flows occur over a 100 minute period of the tidal cycle (Appendix H). These results also indicate that the magnitude of the ebb tide is slightly stronger, which is likely to result in the net movement of any entrained material in a northerly direction.

The Class 2/Restricted material has an average grain size of 0.064mm (silt/fine material), therefore according to the Hjulstrøm curve the measured tidal velocities are sufficient to entrain sediment (i.e. the initial setting into motion of sediment on the seabed). However, the magnitudes of the tidal velocities are not considered strong enough to re-suspend the entrained sediment. This assessment is supported by the findings of the 1998 hydrodynamic modelling report (Appendix H).
A paper published in the Journal of Oceanography (Volume 37, Number 4 / November 1981) presents a relationship between the velocity of entrained sediment and tidal flow velocity. This paper suggests that entrained particles have a velocity of 1m/min when subjected to a flow velocity of 1.0m/s.

The average difference between the magnitude of the peak flood and ebb tidal velocities, during a neap tide is 0.1m/s and this occurs over a 100 minute period. Therefore adopting the above relationship, it is estimated that the net movement of contaminated material during one tidal cycle is 10m, in a northerly direction. With two tides per day, the net movement per day is 20m.

While it is proposed that capping will commence immediately on completion of placement of the Class 2 material (i.e. after 3.5 days) it is considered prudent to allow some contingency for operational difficulties, and therefore a 5 day period has been considered in this assessment. If 5 days pass between placing the Class 2/Restricted material and the capping layer, it is possible that the Class 2/Restricted material may migrate approximately 100m in a northerly direction.

Taking account of this, it is proposed that the material either be placed in a “line” formation, no greater than 100m long with dumping commencing at the south end. Allowing for a further 100m northwards migration, the deposition area is estimated as 100m x 300m, giving an average thickness of 0.5m.

Using a bottom dumping barge the material can be placed in an area under 200m x 200m, but this should be covered with cap as soon as possible to prevent dispersion or migration of sediments.

**4.1.1.3 Placement of Capping (Class 1/ Unrestricted) Material**

Following placement of the Class 2/Restricted material. At least, 20,000m$^3$ of subsequent cap material will be placed directly from the surface, in order to promote mixing of the sediments in the water column. Placed in a “line” the formation will provide a thickness of 0.53m over a 150m x 250m area completely covering the Class 2 material, and any that has entrained sediments, with sufficient cap material. The additional material from the remainder of the maintenance dredging operation will then be deposited at the site, giving additional cap coverage and erosion resistance.

**4.1.1.4 Assessment of Effectiveness of LBC at the Burford Bank**

As conditioned in the previous 1-year Dumping at Sea Application, prior to commencing the 2007 dumping at sea operation, a biological, chemical and Sediment Profile Imaging (SPI) survey was carried out (see Appendix I), repeating some of the survey stations from the 1995 survey of the previous dumpsite and control sites (See Appendix J). SPI is a high-resolution, wire deployed imaging system used to observe spatial and temporal biological activity on and below the sediment water interface. This technique has been recommended by the Marine Institute to assess the cap material. SPI provides a rapid reconnaissance technique for mapping habitat quality on the soft seafloor.

Results for the above pre-dump Burford Bank survey, carried out in October 2007, showed good levels of biological diversity and initial analysis shows rating of ‘Good and ‘High’ versus the Water Framework Directive AMBI (AZTI Marine Benthic Index, Borja et al 2000), indicating good recovery. A Species list from these surveys is included at Appendix J.
A bathymetric survey of the dumpsite was undertaken, as required under the conditions of the previous 1-year Dumping at Sea Application, approximately one month after all dredge operations were completed looking at the profile of the site following disposal (see Appendix K).

4.1.2 Sea Disposal

Irrespective of any unforeseen difficulties which may arise with the disposal of the Class 2 material from Area A and the LBC method currently proposed for consideration for this material, the Area B (Class 1) material is considered to remain suitable for unrestricted dumping at sea on the Burford Bank site, as undertaken in previous dredging campaigns. This material is proposed to be deposited by bottom dumping barge and ideally should be carried out at periods of low tidal flow (slack water) to minimise dispersal.

4.2 Rate of Disposal

The dredge and disposal methodology is based on the use of a trailer suction dredger using bottom dumping. The exact details of the vessel to be used will be dependent on the outcome of a tendering process for a dredging contractor and the availability of their plant.

As detailed the dredging operation shall be divided between Area A and Area B, commencing with Area A. The total volume of material from Area A is estimated to be approximately 36,000m$^3$ over 6 years (see Table 2). Dredging is likely to occur at 18 month intervals and it is therefore estimated that the volumes of Class 2 material would be approximately 10,000m$^3$ per dredge operation. This includes a buffer area around the Class 2/Restricted material to be dredged.

It is proposed that Class 1/Unrestricted material from Area B shall be used as capping material for the Class 2/Restricted, Area A material.

4.3 Initial Dilution, Dispersal, Horizontal Transport & Vertical Mixing Characteristics

The methodologies described above seek to minimise any anticipated dilution of the sediments in the water column. The material to be capped will be dredged on the flood tide so that any contaminants released into the water column during the dredging operation are transported upstream to an already contaminated area rather than downstream.

Placing of contaminated material shall be at slack water by bottom dumping. Analysis contained in Appendix L shows that over 92% of the material is expected to be on the bottom within 8 minutes and 97% within 16 minutes of release, hence minimising dilution and dispersion.

4.4 Water Characteristics

The three main rivers discharging to Dublin Bay are the Liffey, the Tolka and the Dodder. The Dodder discharges to the Liffey. The rivers Camac and Poddle as well as the Royal Canal and the Grand Canal also discharge to the Liffey. The Santry River discharges into Dublin Bay at the causeway to North Bull Island. Organic pollution in the rivers is monitored on a regular basis. The Liffey is described as
moderately polluted, the Camac as seriously polluted, and the Dodder and Tolka as moderately polluted (GDSDS, 2006).

Within the port, water quality data for the period January 2003 to December 2004 was obtained from Dublin City Council (DCC) for Ocean Pier. Given the industrialised nature of the Port, the incoming waters and the characteristics of the bed sediments, these results indicate reasonable water quality, albeit with some degree of nutrient enrichment and sporadic elevated coliform counts.

Within Dublin Bay there are continuous discharges including effluent from water treatment works which serve approximately 70% of the population of Dublin, smaller outfalls and contaminants carried down in the rivers and streams. Other sources of pollution that may affect water quality in the bay and sediment quality are dredge spoil disposal, litter, chronic spillages of small amounts of oil, ores and other toxic substances and diffuse sources. Since 1999 there has been no dumping of sewage sludge at sea.

The water quality in Dublin Bay has been assessed for several years and is improving.

The dredging operations have previously not reported any issues with water quality. The dredging operator is subject to Standard Operating Procedure under the Dublin Port Environmental Management System.

4.5 Bottom Characteristics

4.5.1 Hydrodynamics of the Site

Several studies of the current and the previous adjacent disposal site used until 1996 are available to inform the assessment of the hydrodynamics of the disposal site, see Appendices G and H.

The site is predominately sand with low silt levels in approximately 20m depth of water. Recent bathymetric survey of the disposal site (refer to Appendix M), indicates a regular slope from 15m on the eastern edge to 24m on the western edge of the site.

A current meter survey was commissioned by DPC in 2007 in order to provide additional information on the bed currents at the dumpsite (refer to Appendix G).

4.5.2 Biology of the Site

A benthic impact study undertaken in 1995 by the Fisheries Research Centre for the previous Burford Bank Dumpsite (refer to Appendix J) provides some information on the benthic communities within the current dumpsite, as well as providing information on the adjacent area.

The biology of the site indicates a clean sand community with numbers of nuculidae and tellins, showing a healthy bivalve, featherworm and brittlestar community. This community would be expected to re-colonise the site following future dumping operations. All locations surveyed during the study showed this community. These species recorded are sensitive to smothering, however, the lack of recorded impact confirms that the area is not permanently or adversely affected by disposal. The biology showed similarities with surrounding communities, with any differentiation being attributed to differences in the underlying sediments. The only slightly
different community was located to the north of the current / previous disposal sites, where there is a less dynamic environment and finer sands present, which is reflected in the biology. It is anticipated that there is a fast recovery rate from each operation, and that dumping activities undertaken to date have therefore been sustainable.

4.6 Dumpsite Use

Dublin Port used the Burford Bank dumpsite for capped disposal in January 2008. This site has been used by DPC for dumping at sea disposal since 1996.

In addition to the above, the site is used by other parties, such as Dublin City Council and Dun Laoghaire Harbour. Dublin City Council used the site in September 2007 for the dumping of 2,200 tons of material from the Macken Bridge works. Previous licence information for the use of the site is available via the former Department of Communications, Energy and Natural Resources website (www.dcenr.ie).
5.1 Interference with Socio-economic Aspects

The site is an existing dredge spoil disposal site, in operation in its current location since 1996 (and at an adjacent location since the 1960s) with no reported ecological or socio-economically negative interactions.

5.1.1 Fisheries Spawning, Recruitment and Nursery

Figures 6-8 in Appendix A show the dredge spoil disposal site and the generalised areas of commercial fish spawning and nurseries (Coull et al 1996, updated by CEFAS). The only species with possible interactions in the western Irish Sea which could include the dump site are Cod spawning and nursery grounds and Sprat nurseries. This site has been operational since 1996 (and the adjacent site before that). To date there have been no reported impacts from the disposal site on fisheries. There is no available beam trawl data to characterise the fish usage of the site, however, as the area has been closed to shipping for a number of years it may act as a refuge area.

5.1.2 Sport and Commercial Fishing Areas

Waters in the vicinity of the disposal site are heavily used by commercial and private shipping. The disposal site is charted as a spoil ground and an area to be avoided due to the vessel traffic separation lanes in the bay. Therefore it is highly unlikely that the area will be used for commercial or recreational fishing. No interactions or conflicts have been reported associated with the disposal site.

5.1.3 Aquaculture

There are no aquaculture sites reported in the vicinity of the disposal site. The nearest shellfishery area of importance is 12km from the site (*Nephrops norvegicus*).

5.1.4 Amenity Areas

The disposal site is a significant distance offshore and not adjacent to any amenity sites. The dredge area is within the commercial Dublin Port and the dredge areas are not in the immediate vicinity of amenity areas.

5.1.5 Exploitable Resources

The disposal site consists of fine sands and gravels. At present there are no active marine aggregate licences in Ireland.

5.1.6 Archaeology

An archaeological survey (1999) of the dredge area concluded that there are no features of interest in the dumping site (see Appendix N).
5.1.7 Areas of Special Scientific Interest or Wildlife Importance / Preservation

The dredge and dumping areas are outside and protected areas (Appendix A, Figure 9). Dublin Bay does contain a number of designated conservation sites including Special Areas of Conservation (SAC) as designated under the EU Habitats Directive (92/43/EEC) and Special Protection Areas (SPA) as designated under the EU Birds Directive (79/409/EEC). While the littoral habitats, flora and fauna in particular make up part of many of these conservation sites, they are not necessarily the primary reason for their designation. Particularly with regard to SPAs, the reason for designation is the important bird flocks that utilise the areas. The birds utilise the sandflats for feeding and as such the infauna and Zostera species are important. There are a number of protected species present in Dublin Bay, both associated with the conservation sites and other areas. Bull Island is also designated as a UNESCO Biosphere area.

5.1.8 Shipping Lanes

Dublin Port is the largest and busiest shipping port in the country and as such the approaches and channels must be maintained for safe navigation of the 17,000 shipping movements per year. The disposal site is within an avoidance area between the shipping lanes and approaches to Dublin and Dun Laoghaire ports.

5.1.9 Shipwrecks

There are no recorded shipwrecks in the areas to be dredged or the disposal site nor are there any listed in the International Hydrographic Organization (IHO) Wrecks Register. An Archaeological Survey of the Dredge Area was carried out in 1999, refer to Appendix N for details.

5.1.10 Engineering uses of the Sea such as Undersea Cables, Pipelines etc

There are no pipelines or other engineering uses recorded on the site (Appendix A, Figure 10).

5.2 Results of the Irish National Seabed Survey (INSS)

Dublin Bay was not surveyed under the INSS programme. The INFOMAR (Marine Institute website: www.marine.ie) programme will survey the area during its current programme (2007-2013).
6 Alternative land based methods of treatment

6.1 Disposal to Landfill

Disposal of dredged material to landfill is possible where suitably licensed sites have capacity and are deemed suitable for the required categories of material. There are significant economic costs and environmental risks associated with bringing dredged material ashore, dewatering and transporting to landfill. Landfill is the lowest priority in the waste hierarchy. Since Ireland’s first waste policy document, “Changing Our Ways” (1998), one of the key priorities for waste management has been to reduce the reliance on landfill in accordance with the Landfill Directive.

In this case, the material for disposal comprises a significant water content due to the method of dredging. While the material could be loaded directly into road tankers for transport, the receiving landfill site would require the material to be dewatered prior to acceptance. As a minimum, a dewatering operation based on draining in a lagoon, or the use of filter presses, centrifuges or similar technology, would therefore be required.

In addition to the above, the quantity of material for disposal is significant and therefore the option of onshore disposal is not considered to be practicable or of a reasonable cost. Landfill or the exporting waste for landfill is the least favourable environmental option.

6.2 Beneficial Re-Use

Due to the silt content of the material a proportion of it is deemed unsuitable for certain engineering or construction activities within projects. The physical properties of the material to be dredged and the dredging operation, which adds significant quantities of water to the sediment as part of the dredging process, are such that beneficial re-use (e.g. in reclamation) would require a significant additional processing operation (e.g. separation of silt fractions, dewatering and improvement of the engineering properties by mixing with coarser material or the addition of cement).

Current constraints within the Port prevent the storage and processing of dredged material at this time, however DPC is keen to pursue re-use options wherever possible. It is likely that future projects within the Port will have a requirement for infill material and it is possible that a viable and cost-effective processing option may be developed.
Summary

Dublin Port Company has a current requirement to undertake maintenance dredging in order to maintain depths in the Fairway and at the berths and basins for navigational safety. In order to ensure the best practical environmental option, a repeat of the level bottom capping technique used in 2007/2008 is proposed. Maintenance dredging will be carried out at 18 month intervals.

It is anticipated that sampling will confirm that much of the material in Dublin Port is suitable for unrestricted dumping at sea and that this material should be permitted to be disposed of on the Burford Bank. Dredging at 18 month intervals will allow safe navigation to be maintained within the port.

Chemical testing on the material to be dredged, undertaken during 2006 and 2008, indicated that while there is a general reduction in the levels of contamination present, several parameters recorded values between the new lower and upper guidance values published in the “Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters” (Cronin et al, 2006). In order to comply with current best practice and these improved environmental thresholds, a proportion of the sediment with elevated levels will be disposed of in a contained manner. A sampling programme will be carried out in year 3 of this 6-year dredging plan in order to confirm the delineation of the Class 1/Class 2 areas identified in the 2006 survey.

This assessment has concluded that the best practicable environmental option for the disposal of the contaminated material is by capped sub-aquatic disposal at the existing dumpsite at Burford Bank. This methodology is based on the provision of cap material to mimic the existing bed material at the dumpsite. A detailed assessment of this option is presented herein to demonstrate that the methodology is appropriate, and to provide information on the likely associated environmental impacts. This method was approved for the previous disposal at sea licence.

It is considered that this methodology offers an environmentally responsible and pragmatic solution to the requirement for maintenance dredging at Dublin Port over the next six years.
References


6) Cronin, McGovern, McMahon, Boelens, 2006, Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters, Marine Institute, Galway


8) DCMNR, Dumping of dredge spoil at sea, Guidelines for applicants, 20th August, 1999

9) DCMNR, Foreshore License, Guidelines for applicants, 20th August, 1999


18) GDSDS, 2006, Greater Dublin Strategic Drainage Study, Phase 1, Fingal County Council


29) Palermo; Clausner, Rollings; Williams; & Myers; Guidance for Subaqueous Dredged Material Capping ARMY ENGINEER, US Pentagon, Report A327843


Thickness for Capping Subaqueous Dredged Material Deposits," Technical Note EEDP-0109, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.


Appendix I  Pre-Dredging Sediment Assessment - Burford Bank, Dublin, November 2008
Appendix K  Post dredge Dumpsite Bathymetry, 2008
Appendix L  Previous Burford Bank Site Characterisation, 1995