Appendix B Environmental Assessment of Proposed Dredging and Disposal Activities

PORT KEMBLA PORT CORPORATION

MPB3 AND EB4 DREDGING AND DISPOSAL OF MATERIAL TO THE OUTER HARBOUR

ENVIRONMENTAL ASSESSMENT

Issue No. 3
DECEMBER 2005

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1 INTRODUCTION

1.1 GENERAL

Port Kembla Port Corporation (PKPC) propose to undertake capital dredging at two sites within the Inner Harbour of Port Kembla and some maintenance dredging as part of port development works for the creation of two new berths.

Dredging is proposed in the Western Basin of the Inner Harbour associated with development of a new berth to be known as the Multi-Purpose Berth No 3 or MPB3 and in the Eastern Basin of the Inner Harbour associated with development of a new berth to be known as Eastern Basin No 4 or EB4 (refer **Figure 1.1**). At both sites, construction of the berth would be undertaken first followed by the dredging and disposal operations.

PKPC propose to dredge approximately 400,000 m^3 (insitu volume) of material at MPB3. The design dredge level for MPB3 is 12.3 m below Chart Datum (-12.3 m CD) within the berth pocket and - 11.75 m CD throughout the remainder of the dredge foot print. In addition, PKPC propose to dredge approximately 230,000 m^3 (insitu volume) of material at EB4. The dredging at EB4 would be undertaken in two stages. The design dredge level of Stage 1 is - 12.3 m CD and the design dredge level of Stage 2 is - 14.5 m CD.

Of the total dredging volume of 630,000 m^3, approximately 330,000 m^3 of material is proposed to be disposed of at sea and the remaining 300,000 m^3, considered unsuitable for sea disposal, is proposed to be disposed of within a reclamation area in the Outer Harbour (refer **Figure 1.1**).

Disposal of dredged material at sea requires a permit under the Environment Protection (Sea Dumping) Act 1981 from the Department of Environment and Heritage (DEH). A permit for the disposal of the material from MPB3 and EB4 at sea has recently been granted by DEH (refer **Appendix A**).

This Environmental Assessment Report has been prepared for the dredging and disposal operations within the Outer Harbour of Port Kembla in accordance with the Environmental Planning and Assessment Act, 1979 (EP&A Act) and the Environmental Planning and Assessment Regulation, 2000.

1.2 NEED FOR THE PROJECT

On 5 October 2003, the NSW Government announced the expiration of the Darling Harbour leases within Sydney Harbour as part of the NSW Ports Growth Plan. One of the aims of the plan involves the relocation of container and break-bulk trade from Sydney Harbour to Port Kembla. This would provide long term and continuing opportunities for PKPC to efficiently handle containers, break-bulk and general cargo thereby enhancing the economic efficiency of NSW ports overall and boosting the economy of the Illawarra Region.

In addition, on 10 October 2005, the NSW Premier announced that the Glebe Island car facility in Sydney would be closing early and that the trade would be relocating to Port Kembla.

As a result of the NSW Government's announcements and in accordance with PKPC's growth strategy, the existing Multi-Purpose Berth has recently been extended to accommodate two Panamax sized vessels and would handle the re-located cargo from Darling Harbour and the existing cargo from the Multi-Purpose Berth. The extension is referred to as the MPB130 extension.

The proposed MPB 3, adjacent to the Multi-Purpose Berth extension, would allow a total of three Panamax size vessels to be accommodated at the berth. EB4, the fourth berth, would be developed to ensure the accommodation of all trade relocated from Port Jackson.

1.3 AGENCY CONSULTATION

The required agency and community consultation regarding the dredging and disposal to the Outer Harbour has been undertaken as part of the proposed development of MBP3 and EB4. Key government agencies and organisations provided advice on the issues that should be addressed for the dredging and disposal operations. The main issues raised by the agencies and the location where these issues are addressed in this Environmental Assessment are summarised in **Appendix B.** In addition, a program of Commonwealth and State agency consultation was undertaken as part of the sea dumping permit application process.

In all, the following agencies have been consulted regarding the dredging and disposal operations:

- NSW Department of Planning
- Department of Environment and Conservation (DEC)
- NSW Fisheries
- NSW National Parks and Wildlife Service
- Waterways Authority
- NSW Roads and Traffic Authority
- Wollongong City Council
- Wollongong Fisherman's Co-operative (sea dumping permit)
- The Nature Conservative Council of NSW (sea dumping permit)
- Australian Maritime Safety Authority (sea dumping permit)
- National Native Title Tribunal (sea dumping permit)
- The Nature Conservation Council of NSW (sea dumping permit)
- NSW Aboriginal Land Council (sea dumping permit)
- Department of Lands (Nowra) (sea dumping permit)
- Australian Hydrographic Office (sea dumping permit)
- Australian Fisheries Management Authority (sea dumping permit)
- South East Trawl Fishing Industry Association (sea dumping permit)

A copy of all responses received is included in **Appendix B**.

1.4 COMMUNITY CONSULTATION

PKPC use the Port Kembla Pollution Committee and the Port Kembla Harbour Environment Group to keep the community informed about Port related activities and future development proposals. The Port Kembla Pollution Committee comprises representatives from various government agencies, community interest groups and representatives from PKPC. PKPC has provided written and verbal reports regarding the proposed dredging and disposal operations outlined in this Environmental Assessment to both the Port Kembla Pollution Committee and the Port Kembla Harbour Environment Group. No objections have been raised.

2 PLANNING CONTEXT AND APPROVALS

2.1 GENERAL

Environmental impact assessment is undertaken in NSW in accordance with the Environmental Planning and Assessment Act, 1979 (EP&A Act) and the Environmental Planning and Assessment Regulation, 2000. On 9 June 2005 the NSW Parliament passed the Environmental Planning and Assessment Amendment (Infrastructure and Other Planning Reform) Bill. The key component of the amendment was the insertion of a new Part 3A (Major Projects) into the EP&A Act.

The proposed berth development and associated dredging and disposal operations at Port Kembla has been determined to be a 'Major Project' under Part 3A of the EP&A Act. Part 3A consolidates the assessment and approval regime for all major projects previously addressed under Part 4 or Part 5 of the Act, removing the need for separate approvals.

The main steps in the approvals process under Part 3A are:

- preparation of the Environmental Assessment;
- lodgement, exhibition, consultation and review; and
- assessment and determination.

The consent authority for the proposed berth development and associated dredging and disposal operations at Port Kembla would be the Minister for Planning.

A more detailed description of the approvals process for the entire berth and terminal development project can be found in the SKM Environmental Assessment report (2005).

This report provides the Environmental Assessment for the dredging and disposal operations associated with the MPB3 and EB4 berth developments. The Director General's Environmental Assessment Requirements for the project are included in **Appendix C**.

2.2 LICENCES AND APPROVALS

2.2.1 Commonwealth Legislation

The Environment Protection and Biodiversity Conservation Act, 1999 (EPBC Act) aims to protect the environment and controls the environmental assessment and approvals process for matters of National Environmental Significance. The EPBC Act also regulates actions that affect Commonwealth land. Should the action proposed require approval under the EPBC Act, the proposal must be referred to the Commonwealth Environment Minister. Matters of national environmental significance identified in the Act are:

- World Heritage properties;
- national heritage places;
- Ramsar wetlands of international significance;

- threatened species and ecological communities;
- migratory species;
- commonwealth marine area; and,
- nuclear actions.

The proposed dredging and disposal operations are not considered to have any significant impacts on any of these matters. Approval under the EPBC Act is therefore not required.

2.2.2 NSW Legislation

The new Part 3A of the EP&A Act for assessment and approval of major projects is intended to provide a 'one assessment-one approval' process. Approval under Part 3A of the EP&A Act integrates the approvals under the following eight separate NSW acts:

- concurrence under Part 3 of the Coastal Protection Act;
- permits under the Fisheries Management Act;
- heritage and excavation approvals under the Heritage Act;
- cultural approvals under the National Parks and Wildlife Act;
- approvals to clear native vegetation under the Native Vegetation Act 2003;
- permits under Part 3A of the Rivers and Foreshores Improvement Act;
- bush fire safety authorities under the Rural Fires Act; and
- water use approvals, water management work approvals, and activity approvals under the Water Management Act.

The only approval subsequent to the Minister's approval that a proponent has to obtain, if relevant, is a licence under the Protection of the Environment Operations Act 1997.

Protection of the Environment Operations Act, 1997

The Protection of the Environment Operations Act, 1997 (POEO Act) is the primary Act regulating pollution control and waste disposal in NSW. The Act gives DEC the authority to issue licences and environment protection notices.

Under the POEO Act, dredging of more than 30,000m^3 per year is classified as a scheduled activity and an environmental protection licenses (EPL) is required. PKPC would therefore be required to submit an application to the DEC for the proposed dredging activity.

3 DESCRIPTION OF THE PROPOSAL

3.1 LOCATION

3.1.1 Dredge Areas

Port Kembla is located on the east coast of New South Wales approximately 90 km south of Sydney. The port is a man-made harbour comprising an Outer Harbour and an Inner Harbour connected by a channel. The Outer Harbour was formed by the construction of two stone breakwaters in 1898 and the Inner Harbour was formed by the dredging of Tom Thumb Lagoon in 1960 (Coffey , 2001).

PKPC propose to undertake capital dredging at two sites within the Inner Harbour and some maintenance dredging as part of port development works for the creation of two new berths (refer **Figure 1.1**). Capital dredging is proposed at MPB3 in the Western Basin of the Inner Harbour and at EB4 in the Eastern Basin of the Inner Harbour.

MPB3

MPB3 is located adjacent to the existing Mutli-Purpose Berth south of Tom Thumb Road (refer **Figure 3.1**). MPB3 comprises an onland and overwater dredge area. The western side of the area is bounded by the No. 2 Products Berth and the Roll on Roll off (Ro Ro) Berth.

The MPB3 site was originally Tom Thumb Lagoon which was dredged to create the Inner Harbour in the 1950s/60s. Deepening of the harbour from -11 m CD to -15 m CD was undertaken from 1972 to 1975.

In 1988, the Casting Basin for the Sydney Harbour Tunnel project was dredged. The majority of this material was placed north of Tom Thumb Rd (refer **Figure 1.1**). In 2000, PKPC and BHP used slag to reclaim the Casting Basin. The Casting Basin site which was dredged to -8.5m CD in 1988 was filled with blast furnace slag to +1.0 m CD.

The onland portion of MPB3 has had no use since the filling/restoration of the Casting Basin. Prior to construction of the Casting Basin it was an undeveloped area of the port.

EB4

EB4 is located adjacent to the Coal Berth and would replace the old Australian National Line (ANL) Roll-on Roll-off (Ro-Ro) Berth, situated south of Tom Thumb Road (refer **Figure 3.2**).

As described above, in the late 1950's and early 1960's, Tom Thumb Lagoon was dredged to create the Inner Harbour. In 1980 the Coal Loader berthing basin located in the Eastern Basin of the Inner Harbour and south of the proposed EB4 dredge footprint was dredged (refer **Figure 3.2**). In 1985 the Grain Terminal Berthing Basin located to the south west of the EB4 dredge footprint was dredged (refer **Figure 3.2**). The Grain Terminal has been operational since 1990.

The land adjacent to the EB4 dredge area was first developed in 1971 when the ANL Ro-Ro terminal was built and used to export steel product (mainly slabs) to Westernport in Victoria. This lasted until the mid 1980's. In 1993 the terminal was used as a Ro Ro service to Tasmania with most of the cargo being containerised. This service finished in 1994. No other ongoing activity on the site has occurred. The site is sometimes, but rarely, used for cargo storage.

Maintenance Dredge Areas
The most recent maintenance dredging of the Inner Harbour's shipping channels and berths being undertaken in conjunction with major capital dredging operations associated with the coal and grain terminals in the 1970's and 1980's. Proposed maintenance dredge areas would include berth boxes and areas of siltation on the edge of the navigation channels within the Inner Harbour.

3.1.2 Disposal Area

Disposal operations for MPB3, EB4 and the maintenance dredge areas involved disposal of approximately 330,000 m^3 (insitu volume) of material to sea and reuse in the order of 300,000 m^3 (insitu volume) of material to a proposed reclamation area in the Outer Harbour (refer **Figure 1.1**).

A permit for the disposal of the material from MPB3 and EB4 at sea has recently been granted by DEH (refer **Appendix A**). An assessment of alternative disposal options for the dredged material was undertaken as part of the sea disposal permit application process. No available low-lying land around the port could be identified that could suitably accept the material. Land disposal of the material would use large areas of landfill. In addition, the cost of disposal to a landfill site would be prohibitive (in the range of $30-$40 million). Offshore disposal combined with reuse of material as part of the proposed reclamation area were considered to be the only viable disposal options.

The proposed reclamation area in the Outer Harbour is located between Jetty No. 6 and Jetty No. 3 in water depths between -3 m CD and -11 m CD (refer **Figure 3.3**). The area has been used previously for disposal of dredged material including:

- 120,000 m^3 of material in 1994 from dredging operations undertaken for the extension of the Multi-Purpose Berth as part of the ESSO Operations;
- 26,000 $m^3$of material in 1999 as part of modifications to the Inner Harbour Restoration Project; and
- 50,000 m^3 of material in 2005 as part of the recent MPB130 extension.

Prior to the above works, the water depth at the Outer Harbour disposal area increased rapidly from the shore to approximately -11 m CD (AWT 1999). Currently the depth of parts of the Outer Harbour between Jetty No. 6 and Jetty No. 3 is approximately -4 m CD (refer **Figure 3.3**).

3.2 DREDGING EXTENT, TYPE OF DREDGED MATERIAL AND DREDGING QUANTITY

3.2.1 Dredge Footprint

The proposed dredge footprint for MPB3 is shown in **Figure 3.1.** The design dredge level for MPB3 is -12.3 m CD within the berth pocket and -11.75 m CD throughout the remainder of the dredge foot print. The dredge footprint at MPB3 covers an onland and overwater area. The existing ground level of the onland portion of MPB3 is approximately 5 m CD. The bed level of the overwater portion of MPB3 is approximately - 6.5 m CD sloping to the design dredge level along the dredge footprint's southern boundary.

The proposed dredge footprint for EB4 is shown in **Figure 3.2**. The work would occur in two stages. Stage 1 would involve redevelopment of the existing terminal to accommodate vessels up to 200 m Length Overall (LOA). The Stage 1 design dredge depth is -12.3 m CD. Stage 2 would involve further development of the berth and terminal to accommodate Panamax class vessels. The Stage 2 design dredge level for EB4 is -14.5 m CD. The existing bed level of EB4 averages around -9 m CD sloping to the design dredge level along the southern boundary of the dredge footprint.

3.2.2 Type and Quantity of Material

The types of material to be dredged and disposed to the Outer Harbour are summarised below. Further details regarding the sediment quality, and cross sections showing the different material types, are included in **Section 4.1**.

The capital dredge material at EB4 for disposal in the Outer Harbour includes:

- very soft dark grey to black contaminated silty estuarine clay;
- sandy fill; and
- slag/gravel fill.

Where possible, the sandy fill and slag/gravel fill would be re-used in Port development works. If no options for reuse are available at the time of dredging, the material would be placed in the Outer Harbour reclamation area.

The capital dredge material at MPB3 for disposal in the Outer Harbour includes:

- slag crust;
- slag fill with associated sandwiched clay layers;
- sandy material (previous dredge material);
- slag fill; and,
- contaminated soft to firm estuarine clay.

It is proposed that in the order of 25,000 m^3 of slag fill from the former casting basin would be used to create a platform at MPB 3 for installation of the bulkhead wharf prior to the dredging operations. Following construction of the bulkhead wharf, the slag fill located in front of the bulkhead wharf would be removed during the dredging operations and disposed of to the Outer Harbour.

The maintenance dredge material comprises very soft dark grey to black contaminated silty estuarine clay.

The dredging quantities for each material type for each dredge area are summarised in **Table 3.1. Table 3.1** includes insitu volumes and volumes allowing for dredging tolerance[1] and bulking factors[2].

Table 3.1 Dredging quantities of each material type

MATERIAL	INSITU VOLUME (m^3)	INSITU VOLUME + TOLERANCE (m^3)	BULKED VOLUME (m^3)
EB4 Capital Dredging			
very soft dark grey to black contaminated silty estuarine clay	73,000	81,000	105,000
sandy fill	up to 35,000	35,500	up to 40,000
slag / gravel fill	up to 3,000	3,000	up to 3,000
MPB3 Capital Dredging			
slag crust	11,000	11,000	11000
slag / clay mix (sandwiched layers)	30,000	30,500	40,000
dredged sandy fill	28,000	29,000	33,000
slag fill[1]	53,000	54,500	54,500
contaminated soft to firm estuarine clay	22,000	36,000	47,000
very soft dark grey to black contaminated silty estuarine clay	33,000	41,000	53,000
Maintenance Dredge Material			
very soft dark grey to black contaminated silty estuarine clay	up to 50,000		up to 65 000

1. includes slag from the casting basin and slag used as fill to construct the platform for installation of the bulkhead

3.3 METHOD OF IDENTIFYING MATERIAL FOR DISPOSAL TO THE OUTER HARBOUR VERSUS SEA DISPOSAL

3.3.1 General

It is necessary to ensure that the material that has been determined to be unsuitable for sea disposal is in fact not taken to sea but rather is selectively dredged and disposed of to the Outer Harbour.

Two situations arise that have been considered in the development of the methodology to ensure the above:

[1] Dredging tolerance refers to the additional depth of dredging that occurs below the design level in order to ensure the design level is satisfied. It arises due to a number of factors including the dredging equipment, wave action, tidal action and the like.

[2] Bulking is the increase in the volume of a material that occurs after dredging, associated with the formation of additional voids in the material. The bulking factor is the ratio of the volume after dredging to the insitu volume.

- within the overwater portion of the dredge footprints at EB4 and MPB3 where contaminated very soft dark grey to black silty estuarine clays for disposal to the Outer Harbour overlie uncontaminated grey and mottled red-brown very stiff alluvium / residual clay and/or soft to hard sandstone for sea disposal;

- within the onland portion of MPB3 where contaminated dark grey soft to firm silty estuarine clays for disposal to the Outer Harbour overlie uncontaminated dark grey soft to firm silty estuarine clays for sea disposal, ie the contamination boundary has been found to lie within a single particular soil unit.

3.3.2 Overwater Portion at EB4 and MPB3

The very distinct physical differences between the overlying contaminated material and the underlying uncontaminated material (eg colour and consistency) in the overwater portion at EB4 and MPB3 means that the boundary would be readily identifiable in the field by the operator of the dredging plant[3] and by PKPC personnel involved in the supervision of the contract (by visual observation of the material being loaded into the barges).

Additional verification procedures to be employed by PKPC during the contract (i.e. in addition to visual observations) would involve simple physical testing such as probing and/or sampling of the seabed to confirm the existence of the very stiff material at the surface, before dredging and loading of material for sea disposal takes place.

In practice it can be expected that overdredging beyond the boundary between the contaminated and uncontaminated materials by an amount of about 300 mm vertically and 2 m in batters, ie dredging tolerance, would occur due to the proposed method of dredging, ie in order to remove the very soft contaminated material the contractor would dig out about 300 mm of the very stiff uncontaminated material.

3.3.3 Onland Portion of MPB3

Here the situation is different as the contamination boundary is located within similar material, i.e. there are no significant distinguishing colour or consistency differences above and below the boundary.

In this case, the following approach has been adopted:

- the reduced level of the boundary between the contaminated and uncontaminated material where available in boreholes and test pits has been entered into the digital terrain model (DTM) developed for the project[4];

[3] The method of dredging is expected to comprise a backhoe dredger or grab dredger, ie mechanical plant (refer below). The operator will be able to ‘feel’ the boundary because of the large difference in dredgeability of the two materials, which is related to their respective shear strengths.
[4] Note that the DTM includes all geotechnical information for the site, not just that information where contamination data exists, comprising in the case of MPB3 a total of some 29 BHs and 12 TPs in the onland portion of MPB3 alone.

- a design dredge level has been set conservatively based on the position of the contamination boundary in the onland area, as output from the DTM[5].

In practice, it can again be expected that overdredging beyond the nominated design dredge level by an amount of about 300 mm vertically and 2 m in batters would occur due to the proposed method of dredging. This would add further conservatism in ensuring only uncontaminated material is taken to sea.

3.4 METHOD OF REMOVAL, TRANSPORT AND DISPOSAL OF THE SEDIMENTS

3.4.1 Removal of Material

The method of removal of material would depend on a range of factors including access, method of disposal of material[6], and cost. While details of the methodology would ultimately be selected by the successful dredging contractor, it is possible to state based on experience and consultation with the dredging industry that the method would involve mechanical dredging equipment such as a backhoe dredger or grab dredger loading self-propelled hopper barges, operating 24 hours per day seven days per week.

Use of mechanical dredging equipment keeps the moisture content of the dredge material close to its insitu moisture content thereby maximising the solids content in the hopper barges and reducing cost.

Photo 3.1 shows a view of a grab dredger loading a self-propelled hopper barge in the recent MPB130 extension project. **Photo 3.2** is a close up view of the grab operating within a turbidity curtain.

A turbidity curtain would be employed in the proposed dredging at MPB3 and EB4 to mitigate against the migration of any fine sediments suspended in the water column by the dredging operations.

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[5] The design dredge level is set as the lower bound of the position of the contamination boundary in multiple cross-sections generated through the onland area.
[6] Note that two methods of disposal are proposed, unconfined sea disposal and disposal to the Outer Harbour, to be undertaken by a single dredging contractor. This report deals with the Outer Harbour disposal only.

Photo 3.1 Grab dredger loading a self-propelled hopper barge

Photo 3.2 Close up view of grab dredger operating within a turbidity curtain

3.4.2 Transport of Material

Material would be transported from the dredged areas at MPB3 and EB4 to the Outer Harbour disposal area in self-propelled hopper barges, as noted above. These barges would have a hopper capacity of 350 to 500 m^3 and a fully loaded draft of up to 3.5 m. It is likely that a minimum of two barges would be involved in the disposal operations to the Outer Harbour.

The operation of the self-propelled hopper barges would be in accordance with directions from the PKPC's Harbour Master and Vessel Traffic Information Centre, so that the transit of the barges does not impede shipping operations and movements.

3.4.3 Disposal of Material

The material would be disposed of within the Outer Harbour between No 6 Jetty and No 3 Jetty as shown in the disposal area drawings prepared by Maunsell and reproduced here are **Figures 3.3 and 3.4**.

The larger central disposal area features underwater containment bunds having a crest level at -4 m CD. These bunds would be constructed by the dredging contractor using uncrushed blast furnace slag previously stockpiled onshore in the Outer Harbour by PKPC. The dredging contractor would load the slag into the hopper barges, probably using a temporary loading jetty constructed for this purpose.

Construction of the slag bunds would be by bottom dumping. The contractor may use a 'location pontoon', kept in position by anchors, wires and winches, to control the bottom dumping operations thereby improving the accuracy of the bund construction and minimising the amount of slag required. The barges would work the tide to enable construction of the bunds and some of the final 'topping up' of the bunds may be undertaken using partly loaded barges in order to reduce daft.

Placement of dredged material behind the slag bunds and within the two areas either side of the slag bunds would be by bottom dumping in accordance with a Dredged Material Placement Management Plan. This Plan would be prepared by the dredging contractor and included within the Environmental Management Plan (EMP) for the project. The Dredged Material Placement Management Plan would set out the proposed disposal operation in a systematic manner taking into account factors such as:

- various types of material to be disposed of and behaviour during transport and dumping
- the sequence of the removal of the material in the dredge area
- tidal conditions, particularly tidal range
- wave and wind conditions
- environmental controls, eg turbidity curtains, and their effect on disposal operations, eg the need for 'gates' in the curtain (refer below)
- management of 'high spots' in the disposal area (refer below)
- the mobility of the material following placement having regard to the wave and current conditions in the disposal area
- the relative staging of the dredging at MPB3 and EB4

It is proposed to fill the disposal areas to a crest level of about -3 m CD. This would involve the barges working the tides. To manage 'high spots', it may be necessary to utilise a sweep bar to spread the more problematic material such as the firm clays and slag that would not naturally 'flow' after dumping.

The disposal area would be surrounded by a turbidity curtain to prevent the migration of any fine suspended sediments. It would be necessary to incorporate a 'gate' in the curtain to allow the passage of the hopper barges. This gate would be pulled open and closed using a tug. **Photo 3.3** shows a turbidity curtain deployed in the Outer Harbour on a previous dredging and disposal contract[7].

Photo 3.3 Turbidity curtain deployed in the Outer Harbour

[7] Note that the dredger shown in this plate is a trailing suction hopper dredger

3.5 DURATION OF THE WORKS

Based on discussions with the dredging industry, the following estimated duration of the works would be expected:

- construction of temporary loading jetty, loading and placement of uncrushed blast furnace slag to form the underwater slag containment bunds — 10 weeks[8]
- dredging, transport and placement of material form MPB3 — 12 weeks
- dredging, transport and placement of material from EB4 — 9 weeks

[8] This construction duration could be shortened if, rather than construction of a loading jetty, Jetty No 6, say, is used for loading the hopper barges. In this case the duration of this overall activity would reduce to approximately 5 weeks.

4 ENVIRONMENTAL IMPACT ASSESSMENT AND MITIGATION MEASURES

4.1 SEDIMENTS

The sediment quality of the materials to be dredged and disposed to the Outer Harbour was assessed in 2004 as part of investigations to determine the suitability of the material for sea disposal. Samples were retrieved by a combination of vibrocoring, borehole drilling and test pit excavation in accordance with methods described in the DEH National Ocean Disposal Guidelines for Dredged Material (NODGDM). A description of the sediment quality of each material type to be dredged is provided below in **Section 4.1.1** and **4.1.2**.

The sediment quality of the maintenance dredge material has been investigated on behalf of PKPC by Douglas Partners (2002) and Patterson Britton & Partners (2003). The results of these investigations are described in **Section 4.1.3**.

The sediment quality at the Outer Harbour disposal area has also been determined specifically for this Environmental Assessment. It is discussed in **Section 4.1.4** and compared to the quality of the dredged sediments in **Section 4.1.5**. A full copy of the report on the sediment quality investigations for the Outer Harbour disposal area is included as **Appendix D**.

4.1.1 EB4

In April 2004, vibrocoring was undertaken to retrieve sediment samples from EB4. Long sections of the dredge footprint showing the different material types observed at EB4 have been prepared from the Digital Terrain Model (DTM) proposed for the project (refer **Figures 4.2** and **4.3**). **Figure 4.1** shows the location of each long section.

The sediment at EB4 generally comprised contaminated very soft dark grey to black silty estuarine clay overlying stiff alluvial/residual silty clay. The thickness of the very soft dark grey to black silty estuarine clay varied from 0.5 to 4 m with an average thickness of 1.5 m.

The results of sediment testing were compared to the sediment quality guidelines in the Australian and New Zealand Environment and Conservation Council / Agriculture and Resource Management Council of Australian and New Zealand (ANZECC & ARMCANZ), Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) (refer **Table 4.1**). These guidelines provide Low and High Interim Sediment Quality Guideline values (ISQG). Note that the ISQG Low and ISQG High values are equivalent to the screening level (SL) and maximum level (ML) values in the NODGDM (Environment Australia, 2002).

Contamination levels throughout the very soft dark grey to black silty estuarine clay layer generally increased with depth. Contamination levels of cadmium, chromium, copper, lead, mercury, nickel and TBT exceeded ISQG Low. Contamination levels of zinc and some PAH constituents exceeded ISQG High. The very soft dark grey to black silty

TABLE 4.1 EB4, Statistical Analysis of Laboratory Results & Comparison to Guideline Levels

	NODGDM		EB4 Harbour Samples							
			soft to firm silty estuarine clay				stiff alluvial / residual clay			
	SL	ML	n	mean	SD	95%UCL	n	mean	SD	95%UCL
Aluminium	--	--	38	13409	5355	15112	7	12564	5036	16295
Antimony	2	25	38	0.5	0.3	0.6	7	<0.5	0	--
Arsenic	20	70	38	12	5	14	6	4	4	8
cadmium	1.5	10.0	38	2.2	1.3	2.6	7	0.1	0.0	0.1
chromium	80	370	38	90	53	107	7	18	6	22
cobalt	--	--	38	8	4	9	7	6	4	9
copper	65	270	38	76	46	91	7	25	11	33
lead	50	220	38	160	105	193	7	12	2	14
manganese	--	--	38	359	167	412	7	115	98	188
mercury	0.15	1.00	38	0.24	0.14	0.28	7	0.01	0.01	0.02
nickel	21	52	38	19	8	22	7	10	4	13
selenium	--	--	38	1.2	0.7	1.4	7	0.8	0.7	1.3
silver	1.0	3.7	38	0.4	0.2	0.5	7	0.1	0.0	0.1
vanadium	--	--	38	59	23	66	7	48	18	62
zinc	200	410	38	977	759	1218	7	31	15	42
Naphthalene	0.16	2.10	38	5.86	11.34	9.47	7	<0.05	--	--
Acenaphthylene	0.044	0.640	38	0.550	1.696	1.089	7	<0.05	--	--
Acenaphthene	0.016	0.500	38	0.116	0.377	0.235	7	<0.05	--	--
Fluorene	0.019	0.540	38	0.480	1.524	0.965	7	<0.05	--	--
Phenanthrene	0.24	1.50	38	1.04	2.77	1.92	7	<0.05	--	--
Anthracene	0.085	1.100	38	0.710	2.776	1.592	7	<0.05	--	--
Fluoranthene	0.6	5.1	38	0.7	1.5	1.1	7	<0.05	--	--
Pyrene	0.665	2.600	38	0.744	1.785	1.312	7	<0.05	--	--
Benz(a)anthracene	0.261	1.600	38	0.296	0.616	0.492	7	<0.05	--	--
Chrysene	0.384	2.800	38	0.262	0.534	0.431	7	<0.05	--	--
Benzo(b)&(k)fluoranthene	--	--	38	0.51	1.10	0.86	7	<0.05	--	--
Benzo(a)pyrene	0.43	1.60	38	0.41	0.85	0.68	7	<0.05	--	--
Indeno(1,2,3-cd)pyrene	--	--	38	0.21	0.39	0.33	7	<0.05	--	--
Dibenz(ah)anthracene	0.063	0.260	38	0.083	0.145	0.129	7	<0.05	--	--
Benzo(ghi)perylene	--	--	38	0.25	0.51	0.41	7	<0.05	--	--
TOTAL PAH	4	45	38	12	24	20	7	<0.05	--	--
Organochlorine (OC) Pesticides	0.02 - 2.2 ug/kg	1 - 46 ug/kg	7	<1	--	--	2	<1	--	--
PCBs	23 ug/kg	--	7	0.46	0.63	0.51	2	<10	--	--
TPH C6 - C9	--	--	38	<25	--	--	7	<25	--	--
TPH C10 - C14	--	--	38	35	69	57	7	<50	--	--
TPH C15 - C28	--	--	38	171	445	313	7	<100	--	--
TPH C29 - C36	--	--	38	94	298	189	7	<100	--	--
TBT	5 ug/kg	70 ug/kg	38	3.3	13.6	7.7	7	0.4	0.5	0.8

1. Units are in mg/kg unless otherwise stated
2. All organics results have been normalised to 1% TOC. Normalisation is only appropriate over the TOC range 0.2-10%. Outside this range, the end values have been used.
3. Where results are below laboratory detection limits a value of half the laboratory detection limit has been used for the statistical analysis, **unless,** all results for a dataset were below the detection limit in which case the detection limit has been shown
4. > SL > ML
5. SL values are equivalent to the ANZECC ISQG Low values
6. ML values are equivalent to ANZECC ISQG High

estuarine clay was determined to be unsuitable for unconfined sea disposal. It is proposed that this material would be disposed of to the Outer Harbour reclamation area.

Testing of the stiff alluvial/residual silty clay confirmed it was uncontaminated (all analytes below ISQG Low or SL) and thus suitable for unconfined sea disposal.

4.1.2 MPB3

The proposed dredge footprint at MPB3 comprises an overwater and an onland portion. Vibrocoring was undertaken to retrieve samples from the overwater portion of MPB3. A combination of borehole drilling and test pit excavation was undertaken to retrieve samples from the onland portion of MPB3.

Long sections of the dredge footprint showing the different material types at MPB3 have been prepared using the DTM (refer **Figures 4.4 and 4.5**). **Figure 4.1** shows the location of each long section.

MPB3 – overwater

The sediment within the overwater portion of MPB3 generally comprised contaminated very soft dark grey to black silty estuarine clay overlying a stiff alluvial/residual silty clay. The thickness of the very soft dark grey to black silty estuarine clay varied from 0.5 to 3 m with an average thickness of 1.3 m.

Contamination levels throughout the very soft dark grey to black silty estuarine clay layer generally increased with depth. Contamination levels of cadmium, chromium, copper, lead, mercury and nickel exceeded ISQG Low. Contamination levels of zinc and some PAH constituents exceeded ISQG High. The very soft dark grey to black silty estuarine clay was determined to be contaminated and unsuitable for unconfined sea disposal. It is proposed that this material would be disposed of to the Outer Harbour reclamation area.

Testing of the stiff alluvial/residual silty clay confirmed it was uncontaminated (all analytes below ISQG Low or SL) and thus suitable for unconfined sea disposal.

Results of the chemical analysis are summarised in **Table 4.2**.

MPB3 – onland

The borehole drilling and test pit work showed that the following material types were located within the onland portion of MPB3, starting from the surface to the proposed depth of dredging (12.3 m below CD):

- slag fill;
- slag fill with associated sandwiched clay layers;
- sandy material (previous dredge material);
- soft to firm silty estuarine clay;
- stiff alluvium/residual silty clay; and,
- weathered rock (sandstone).

TABLE 4.2 MPB3, Statistical Analysis of Laboratory Results & Comparison to Guideline Levels

			MPB3 Harbour Samples								MPB3 Onland Samples																							
	NODGDM		soft to firm silty estuarine clay				stiff alluvium / residual clay				slag fill				clay fill layers				sandy dredged material				upper portion of soft to firm silty estuarine clay (3.9-6.5m below surface)				soft to firm silty estuarine clay (6.5-8.5m below surface)				stiff alluvium / residual clay			
	SL	ML	n	mean	SD	95%UCL	n	mean	SD	95%UCL	n	mean	SD	95%UCL	n	mean	SD	95%UCL	n	mean	SD	95%UCL	n	mean	SD	95%UCL	n	mean	SD	95%UCL	n	mean	SD	95%UCL
Aluminium	--	--	44	15210	4402	16511	3	8247		9356	15	15051	9776	19998	12	10572	4706	13235	6	1737	1278	2759	14	11899	6238	15167	10	19578	6013	23305	14	12817	4187	15010
Antimony	2	25	44	0.9	0.5	1.1	3	<0.5	--	--	15	<0.5	--	--	12	<0.5	--	--	6	<0.5	--	--	14	0.9	0.5	1.2	10	<0.5	--	--	14	<0.5	--	--
Arsenic	20	70	44	16	6	18	3	2		4	15	3	2	4	12	6	5	9	6	3	1	4	14	12	4	14	10	16	3	18	14	12	12	18
cadmium	1.5	10.0	44	3.6	3.2	4.6	3	<0.1	--	--	15	0.13	0.14	0.20	12	0.25	0.08	0.34	6	--	--	--	14	0.8	0.6	1.1	10	<0.1	--	--	14	<0.1	--	--
chromium	80	370	44	254	188	309	3	15		19	15	250	235	369	12	48	108	109	6	3	2	4	14	75	68	111	10	21	5	24	14	17	7	21
cobalt	--	--	44	12	3	13	3	2		4	15	3	1	3	12	4	3	6	6	1	0	1	14	9	4	12	10	12	4	15	14	3	2	4
copper	65	270	44	80	36	91	3	20		33	15	19	19	29	12	15	8	19	6	2	1	3	14	32	16	40	10	23	8	28	14	12	5	14
lead	50	220	44	260	203	320	3	9		11	15	17	16	25	12	19	16	27	6	10	7	16	14	196	177	289	10	14	3	16	14	11	8	15
manganese	--	--	44	825	595	1001	3	19		33	15	10640	8996	15193	12	1936	5218	4888	6	64	40	95	14	893	731	1276	10	360	139	446	14	36	102	90
mercury	0.15	1.00	44	0.44	0.32	0.53	3	0.01		0.03	15	<0.01	--	--	12	0.02	0.01	0.03	6	<0.01	--	--	14	0.08	0.07	0.11	10	0.02	0.01	0.03	14	0.01	0.01	0.02
nickel	21	52	44	33	11	36	3	6		11	15	15	13	21	12	9	6	12	6	2	1	3	14	22	13	29	10	16	5	19	14	4	3	6
selenium	--	--	44	1.9	1.2	2.3	3	<0.5	--	--	15	<0.5	--	--	12	<0.5	--	--	6	<0.5	--	--	14	0.7	0.7	1.1	10	<0.5	--	--	14	<0.5	--	--
silver	1.0	3.7	44	0.6	0.4	0.7	3	<0.1	--	--	15	0.09	0.08	0	12	0.14	0.04	0.18	6	<0.1	--	--	14	0.59	0.54	0.87	10	<0.1	--	--	14	<0.1	--	--
vanadium	--	--	44	89	92	117	3	32		48	15	2489	2309	3658	12	412	1163	1070	6	7	2	8	14	47	21	59	10	72	14	81	14	59	33	76
zinc	200	410	44	1848	1482	2286	3	55		109	15	148	145	221	12	103	98	158	6	61	51	102	14	1450	1300	2131	10	55	23	69	14	16	11	22
Naphthalene	0.16	2.10	44	13.72	14.92	18.13	3	<0.05	--	--	15	0.18	0.13	0.25	12	0.34	0.33	0.52	6	0.21	0.10	0.30	14	2.11	2.88	3.62	10	0.04	0.04	0.06	14	<0.05	--	--
Acenaphthylene	0.044	0.640	44	0.317	0.285	0.401	3	<0.05	--	--	15	0.02	0.04	0.040	12	0.04	0.04	0.056	6	0.04	0.08	0.106	14	0.42	0.61	0.743	10	<0.05	--	--	14	<0.05	--	--
Acenaphthene	0.016	0.500	44	0.093	0.096	0.122	3	<0.05	--	--	15	0.010	0.016	0.019	12	0.007	0.006	0.011	6	0.008	0.007	0.013	14	0.074	0.084	0.117	10	<0.05	--	--	14	<0.05	--	--
Fluorene	0.019	0.540	44	0.559	0.560	0.724	3	<0.05	--	--	15	0.017	0.021	0.027	12	0.022	0.030	0.039	6	0.033	0.069	0.088	14	0.328	0.491	0.585	10	<0.05	--	--	14	<0.05	--	--
Phenanthrene	0.24	1.50	44	2.09	2.79	2.91	3	<0.05	--	--	15	0.202	0.249	0.328	12	0.143	0.102	0.201	6	0.241	0.439	0.593	14	0.980	1.447	1.738	10	<0.05	--	--	14	<0.05	--	--
Anthracene	0.085	1.100	44	0.711	2.706	1.511	3	<0.05	--	--	15	0.03	0.03	0.05	12	0.03	0.03	0.05	6	0.07	0.13	0.17	14	0.36	0.53	0.64	10	<0.05	--	--	14	<0.05	--	--
Fluoranthene	0.6	5.1	44	1.5	1.9	2.1	3	<0.05	--	--	15	0.215	0.282	0.358	12	0.181	0.151	0.266	6	0.373	0.693	0.928	14	1.573	2.559	2.914	10	<0.05	--	--	14	<0.05	--	--
Pyrene	0.665	2.600	44	1.345	1.500	1.788	3	<0.05	--	--	15	0.2	0.3	0.3	12	0.2	0.1	0.3	6	0.3	0.6	0.7	14	1.5	2.5	2.9	10	<0.05	--	--	14	<0.05	--	--
Benz(a)anthracene	0.261	1.600	44	0.487	0.533	0.644	3	<0.05	--	--	15	0.097	0.099	0.147	12	0.095	0.083	0.142	6	0.237	0.475	0.617	14	1.043	1.708	1.937	10	<0.05	--	--	14	<0.05	--	--
Chrysene	0.384	2.800	44	0.444	0.476	0.585	3	<0.05	--	--	15	0.092	0.084	0.135	12	0.096	0.082	0.142	6	0.119	0.180	0.263	14	0.576	0.974	1.087	10	<0.05	--	--	14	<0.05	--	--
Benzo(b)&(k)fluoranthene	--	--	44	1.06	1.17	1.41	3	<0.05	--	--	15	0.191	0.196	0.290	12	0.240	0.238	0.375	6	0.306	0.606	0.790	14	1.714	2.975	3.272	10	<0.05	--	--	14	<0.05	--	--
Benzo(a)pyrene	0.43	1.60	44	0.76	0.82	1.00	3	<0.05	--	--	15	0.10	0.11	0.15	12	0.17	0.18	0.27	6	0.19	0.44	0.55	14	1.05	1.87	2.03	10	<0.05	--	--	14	<0.05	--	--
Indeno(1,2,3-cd)pyrene	--	--	44	0.37	0.38	0.48	3	<0.05	--	--	15	0.07	0.07	0.10	12	0.13	0.14	0.21	6	0.12	0.29	0.35	14	0.60	1.11	1.18	10	<0.05	--	--	14	<0.05	--	--
Dibenz(ah)anthracene	0.063	0.260	44	0.110	0.099	0.139	3	<0.05	--	--	15	0.01	0.01	0.01	12	0.04	0.05	0.07	6	0.02	0.03	0.04	14	0.23	0.47	0.48	10	<0.05	--	--	14	<0.05	--	--
Benzo(ghi)perylene	--	--	44	0.40	0.39	0.52	3	<0.05	--	--	15	0.038	0.042	0.059	12	0.101	0.104	0.160	6	0.094	0.217	0.267	14	0.471	0.808	0.894	10	<0.05	--	--	14	<0.05	--	--
TOTAL PAH	4	45	44	24	24	31	3	<0.05	--	--	15	1	1	2	12	2	2	3	6	2	4	6	14	13	21	24	10	0.31	0.24	0.46	14	<0.05	--	--
Organochlorine (OC) Pesticides	0.02 - 2.2 ug/kg	1 - 46 ug/kg	10	<1	--	--	2	<1	--	--	--	--	--	--	--	--	--	--		--	--	--	4	<1	--	--	2	<1	--	--	5	<1	--	--
PCBs	23 ug/kg	--	10	6.8	4.3	9.5	2	<10	--	--	--	--	--	--	--	--	--	--		--	--	--	4	<10	--	--	2	<10	--	--	5	<10	--	--
TPH C6 - C9	--	--	44	<25	--	--	3	<25	--	--	15	<25	--	--	12	<25	--	--	6	<25	--	--	14	<25	--	--	10	<25	--	--	14	<25	--	--
TPH C10 - C14	--	--	44	25	13	29	3	<50	--	--	15	430	710	789	12	<50	--	--	6	<50	--	--	14	232	261	403	10	<50	--	--	14	<50	--	--
TPH C15 - C28	--	--	44	156	145	199	3	<100	--	--	15	<100	--	--	12	<100	--	--	6	<100	--	--	14	<100	--	--	10	<100	--	--	14	<100	--	--
TPH C29 - C36	--	--	44	64	87	90	3	<100	--	--	15	<100	--	--	12	<100	--	--	6	<100	--	--	14	<100	--	--	10	<100	--	--	14	<100	--	--
TBT	5 ug/kg	70 ug/kg	44	0.7	1.3	1.1	3	<0.5	--	--	5	0.32	0.15	0.44	7	<0.5	--	--	3	<0.5	--	--	7	<0.5	--	--	10	<0.5	--	--	14	<0.5	--	--

1. Units are in mg/kg unless otherwise stated
2. All organics results have been normalised to 1% TOC. Normalisation is only appropriate over the TOC range 0.2-10%. Outside this range, the end values have been used.
3. Where results are below laboratory detection limits a value of half the laboratory detection limit has been used for the statistical analysis, **unless,** all results for a dataset were below the detection limit in which case the detection limit has been
4. > SL >ML
5. SL values are equivalent to the ANZECC ISQG Low values
6. ML values are equivalent to ANZECC ISQG High

Results of the chemical analysis of each material type are described below and summarised in **Table 4.2**.

<u>Slag</u>
Sampling and testing of the slag showed levels of chromium and some individual PAH constituents exceeded ISQG Low. Ecotoxicological testing of the slag indicated it was not suitable for unconfined sea disposal. However, it is considered likely that the slag did not pass the sea disposal toxicity testing due to physical properties such as grainsize and lack of food for the aquatic test organisms rather than due to the elevated levels of chromium and PAHs. Nevertheless, it is proposed that this material would be disposed of to the Outer Harbour reclamation area.

<u>Sandy clay and clayey sand fill layers</u>
As for the slag material, sampling and testing of the sandy clay and clayey sand fill showed levels of chromium and some individual PAH constituents exceeded SL. Ecotoxicological testing of the material indicated it was not suitable for unconfined sea disposal. However, it is considered likely that the material also did not pass the sea disposal toxicity testing due to physical properties such as grainsize and lack of food for the test aquatic organisms rather than due to the elevated levels of chromium and PAHs. Nevertheless, it is proposed that this material would be disposed of to the Outer Harbour reclamation area.

<u>Sandy material (previous dredge material)</u>
Sampling and testing of the sandy dredge material showed levels of some individual PAH constituents and total PAHs exceeded ISQG Low. Ecotoxicological testing of the sandy material indicated it was not suitable for unconfined sea disposal. As above, it is considered likely that the material also did not pass the sea disposal toxicity testing due to physical properties such as grainsize. Nevertheless, it is proposed that this material would be disposed of to the Outer Harbour reclamation area.

<u>Soft to firm silty estuarine clays</u>
Elevated levels of chromium, nickel, zinc, TPHs and PAHs above ISQG Low were observed in the upper 1 to 2 m of the estuarine material. In addition, levels of lead were above ISQG High. Further testing showed the possible cause of toxicity was mixed contaminants and therefore the upper 1 to 2 m of the estuarine material is not suitable for unconfined sea disposal. It is proposed that this material would be disposed of to the Outer Harbour reclamation area.

The results showed that no contamination of the soft to firm silty estuarine clays was detected below 6.3 m below the ground surface (all analytes below ISQG Low) and the material is suitable for unconfined sea disposal.

<u>Stiff alluvium/residual silty clay</u>
Testing of the stiff alluvial/residual silty clay confirmed it was uncontaminated (all analytes below ISQG Low) and thus suitable for unconfined sea disposal.

4.1.3 Maintenance Dredge Material

The maintenance dredge material generally comprised contaminated very soft dark grey to black silty estuarine clay. Recent sediment sampling of the material was conducted by Douglas Partners (2002) and Patterson Britton & Partners (2003). The chemical analysis of these results are summarised in **Table 4.3**.

Contamination levels of cadmium, chromium, copper, mercury, nickel TBT and total PAH exceeded ISQG Low. Contamination levels of zinc and some PAH constituents exceeded ISQG High. The maintenance dredged material is considered contaminated and unsuitable for unconfined sea disposal. It is proposed that this material would be disposed of to the Outer Harbour reclamation area.

4.1.4 Outer Harbour Reclamation Area

Sediment sampling and analysis was undertaken during August 2005 at the proposed Outer Harbour reclamation area to assess the potential impacts of disposal of dredged material. Details of the sediment quality investigation are included in **Appendix D**. Samples were recovered from 12 locations (refer **Figure 4.6**). Chemical testing of each sediment sample included:

- moisture content;
- total organic carbon (TOC);
- a suite of metals (Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, Zn, Mn, Co, V, Se);
- total petroleum hydrocarbons (TPH);
- benzene, toluene, ethylbenzene and xylenes (BTEX);
- polychlorinated biphenyls (PCBs);
- organotins; and,
- polycyclic aromatic hydrocarbons (PAHs).

The sediments at the Outer Harbour disposal area comprised very soft dark grey to black silty clay.

The results of the chemical analysis of the sediment and comparison to guidelines are summarised in **Table 4.4**. The results show that the contamination levels of arsenic, cadmium, chromium, nickel, TBT and total PAH all exceed ISQG Low. Contamination levels of copper, lead, mercury, silver, zinc and naphthalene exceed ISQG High.

4.1.5 Comparison of proposed dredged material to Outer Harbour sediments

Comparison of the sediment quality results for the proposed dredge material to the sediment quality results at the Outer Harbour disposal area indicates that, for the majority of contaminants, the contamination levels at the Outer Harbour are similar to, or higher than, the proposed dredged material. In particular levels of arsenic, copper, lead, mercury, silver and TBT are higher in the sediments at the Outer Harbour than in the proposed dredge material. However, the very soft dark grey to black silty estuarine clay located at MPB3 contained higher levels of chromium, zinc and PAHs than the Outer Harbour sediments.

TABLE 4.3 Maintenance Dredge Material, Statistical Analysis of Laboratory Results & Comparison to Guideline Levels

	DP 2002				PBP 2003				NODGDM	
Contaminant	**n**	**mean**	**SD**	**95% UCL**	**n**	**mean**	**SD**	**95% UCL**	**SL**	**ML**
Metals & Metalloids										
Aluminium	--	--	--	--	20	2762	10.4	2767		
Antimony	43	--	--	below detection	--	--	--	--	2	25
Arsenic	43	14.5	4.4	15.7	20	19.1	2.7	20.2	20	70
Barium	43	87.3	37.7	96.9	--	--	--	--		
Cadmium	43	1.4	1.3	1.74	20	1.76	0.94	2.16	1.5	10
Chromium	43	90.5	49.8	103.3	20	116	52.1	22.3	80	370
Copper	43	141.6	58	156.4	20	208	48.7	228.5	65	270
Iron	43	57421	29229	64918	20	18695	281.9	18816	--	--
Lead	43	191.1	268.3	225	20	209	37.5	225	50	220
Mercury	43	0.33	0.15	0.37	--	--	--	--	0.15	1
Molybdenum	43	1.12	1.64	1.34	--	--	--	--		
Nickel	43	20	6	21	20	21.4	3.1	22.7	21	52
Silver	43	--	--	below detection	20	0.56	0.08	0.6	1	3.7
Zinc	43	736	319	818	20	1065	578	1312	200	410
Manganese	43	868	2222	1057	20	690	178.3	765.9	--	--
Cobalt	43	9.8	2.5	10.4	20	16.77	1.4	17.4	--	--
Vanadium	43	66	18	71	--	--	--	--	--	--
Selenium	43	2.9	4.5	3.32	--	--	--	--	--	--
Polychlorinated Biphenyls										
Individual PCBs	--	--	--	--	20	<0.01	--	--	--	--
Total PCBs	--	--	--	--	20	0.03	0.1	0.08	0.023	--
Organotins										
Monobutyltin (µgSn/kg)	43	4.7	13.4	4.4	--	--	--	--	--	--
Dibutyltin (µgSn/kg)	43	4.1	8.9	4.4	--	--	--	--	--	--
Tributyltin (µgSn/kg)	43	6.8	10.8	11.1	--	--	--	--	5	70
Polycyclic Aromatic Hydrocarbons[2]										
Naphthalene	43	2.49	2.08	3.02	20	1.16	0.9	1.5	0.16	2.1
Acenaphthylene	43	0.21	0.12	0.24	20	0.14	0.1	0.2	0.044	0.64
Acenaphthene	43	0.07	0.04	0.08	20	0.07	0.1	0.1	0.016	0.5
Fluorene	43	0.22	0.11	0.25	20	0.15	0.1	0.2	0.019	0.54
Phenanthrene	43	1.06	2.87	1.02	20	0.42	0.2	0.5	0.24	1.5
Anthracene	43	0.23	0.11	0.26	20	0.17	0.1	0.2	0.085	1.1
Fluoranthene	43	0.68	0.32	0.76	20	0.57	0.4	0.8	0.6	5.1
Pyrene	43	0.65	0.31	0.73	20	0.55	0.4	0.7	0.665	2.6
Benzon(a)anthracene	43	0.37	0.17	0.42	20	0.26	0.2	0.3	0.261	1.6
Chrysene	43	0.37	0.17	0.41	20	0.27	0.1	0.3	0.384	2.8
Benzo(b)fluoranthene	43	0.58	0.29	0.66	--	--	--	--	--	--
Benzo(k)fluoranthene	43	0.21	0.11	0.24	--	--	--	--	--	--
Benko(b)&(k)fluoranthene	--	--	--	--	20	0.65	0.4	0.8	--	--
Benzo(a)pyrene	43	0.47	0.24	0.53	20	0.31	0.2	0.4	0.43	1.6
Indeno(1,2,3-cd)pyrene	43	0.44	0.21	0.49	20	0.26	0.2	0.3	--	--
Dibenz(ah)anthracene	43	0.07	0.04	0.08	20	0.1	0.1	0.1	0.063	0.26
Benzo(g,h,i)perylene	43	0.34	0.16	0.38	20	0.29	0.2	0.4	0.59	
Total PAHs	43	8.39	6.2	9.98	20	5.38	3.3	6.8	14.68	
Total Phenolics	43	--	--	below detection	--	--	--	--		
Total Phosphorus	43	450	343	538	--	--	--	--		
Total Cyanide	43	2.2	1.4	2.6	--	--	--	--		

1. Units are in mg/kg unless otherwise stated
2. All organics results have been normalised to 1% TOC. Normalisation is only appropriate over the TOC
3. Where results are below laboratory detection limits a value of half the laboratory detection limit has
4. > SL > ML
5. SL values are equivalent to the ANZECC ISQG Low values
6. ML values are equivalent to ANZECC ISQG High

TABLE 4.4 Outer Habour Disposal Area, Statistical Analysis of Laboratory Results & Comparison to Guideline Levels

Contaminant	Sample ID															NODGDM	
	SOH-1	SOH-2	SOH-3	SOH-4	SOH-5	SOH-6	SOH-7	SOH-8	4E	6E	8E	9E	mean	SD	95% UCL	ML	ML
Antimony	0.4	0.7	0.6	<0.1	0.7	2	3.3	3.3	2.2	0.9	0.2	<0.1	0.97	1.06	1.4	2	25
Arsenic	15	20	27	12	20	79	95	140	60	29	4.1	11	36	37	52	20	70
Cadmium	0.2	0.2	0.1	2.6	0.7	1.8	4.6	6.5	1.1	1.3	0.6	3.6	1.4	1.9	6	1.5	10
Chromium	18	22	21	130	88	140	74	120	95	63	35	220	66	60	91	80	370
Copper	260	310	55	130	260	1400	4000	4100	450	290	27	85	696	1303	49800	65	270
Lead	70	73	76	110	150	550	800	1500	500	170	29	160	265	386	2956	50	220
Mercury	0.09	0.07	0.06	0.52	0.26	1.8	0.23	3.8	1.1	0.7	0.11	2.5	0.68	1.07	4	0.15	1
Nickel	4.9	6.6	7.9	27	18	42	37	66	20	15	8.1	23	18	17	25	21	52
Silver	0.1	0.1	<0.1	0.4	0.5	3.6	8.2	14	1.2	0.8	0.1	0.5	1.76	3.76	13	1	3.7
Zinc	220	280	380	760	620	1600	1500	2400	1400	550	220	1500	757	669	1040	200	410
Manganese	110	170	110	990	420	500	280	350	450	260	580	610	315	253	422	--	--
Cobalt	2.9	4.3	2.8	13	9.9	13	14	18	13	12	4.8	13	7.8	5.6	10	--	--
Vanadium	28	38	26	140	84	110	77	100	91	72	130	67	63	41	81	--	--
Selenium	1	2.6	1.3	5.4	4.7	13	31	35	6.5	3.9	1.6	6.7	6.9	10.4	22	--	--
TRH C6 – C9	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	--	--	--	--
TRH C10 – C14	<10	<10	<10	55	22	21	15	88	27	<10	11	98	24	30	52	--	--
TRH C15 – C28	<50	<50	<50	880	330	470	510	890	890	170	190	1200	357	402	532	--	--
TRH C29 – C36	<50	<50	<50	540	260	390	370	460	<50	130	150	900	243	263	358	--	--
Individual OC Pesticides	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	--	--	--
Benzene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.2	0.11	0.03	0.12	--	--
Toluene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.2	0.3	0.12	0.05	0.14	--	--
Ethyl benzene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	--	--	--	--
m+p xylenes	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	--	--	--	--
o-xylene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	--	--	--	--
Total BTEX	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	--	--	--	--
Total PCBs	<0.0005	<0.0005	<0.0005	<0.025	<0.025	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.025	<0.025	--	--	0.023	--
Tributyltin (µgSn/kg)	27.4	40	15	2.9	10	5.9	10.6	15.9	0.1	0.1	12.2	4.1	12.2	11.18	17.5	5	70
Naphthalene	1.59	0.87	0.19	3.95	4.2	1.3	1	0.59	1.44	0.79	3.78	6.18	1.29	1.83	2.78	0.16	2.1
1-Methylnaphthalene	0.08	0.05	nd	0.12	0.15	0.06	0.05	0.03	0.07	0.04	0.14	0.17	0.08	0.05	0.1	--	--
2-Methylnaphthalene	0.19	0.1	0.04	0.32	0.4	0.15	0.12	0.07	0.15	0.08	0.37	0.5	0.19	0.15	0.26	--	--
Acenaphthylene	0.35	0.15	0.04	0.55	0.6	0.19	0.15	0.08	0.26	0.12	0.67	0.82	0.3	0.26	0.42	0.044	0.64
Acenaphthene	0.05	0.04	nd	0.11	0.13	0.04	0.03	0.02	0.04	0.02	0.13	0.14	0.06	0.05	0.09	0.016	0.5
Fluorene	0.2	0.09	nd	0.39	0.34	0.1	0.07	0.05	0.12	0.06	0.4	0.38	0.18	0.15	0.25	0.019	0.54
Phenanthrene	1.15	0.47	0.1	1.89	1.85	0.74	0.49	0.31	0.78	0.35	2.35	2	0.94	0.77	1.3	0.24	1.5
Anthracene	0.36	0.15	0.04	0.76	0.65	0.24	0.15	0.1	0.36	0.11	0.97	0.68	0.34	0.3	0.48	0.085	1.1
Fluoranthene	1.3	0.6	0.11	2.18	1.6	0.78	0.48	0.38	0.92	0.46	3.37	1.97	1.06	0.93	1.5	0.6	5.1
Pyrene	1.11	0.53	0.11	2.47	1.5	0.67	0.37	0.34	0.94	0.39	2.55	2.15	0.98	0.85	1.38	0.665	2.6
Benzo(a)anthracene	0.63	0.31	0.05	1.26	1.3	0.41	0.18	0.15	0.28	0.17	1.33	0.88	0.52	0.47	0.74	0.261	1.6
Chrysene	0.59	0.29	0.05	1.45	1.5	0.48	0.22	0.18	0.39	0.17	1.63	0.94	0.59	0.56	0.85	0.384	2.8
Benzo(b)&(k)fluoranthene	1.3	0.73	0.13	2.89	2.6	0.74	0.46	0.34	0.61	0.37	2.96	1.94	1.14	1.02	1.62	--	--
Benzo(a)pyrene	0.59	0.33	0.07	1.84	1.7	0.44	0.27	0.19	0.36	0.18	1.84	1.26	0.68	0.67	0.99	0.43	1.6
Indeno(1,2,3-cd)pyrene	0.18	0.11	nd	1	0.95	0.22	0.14	0.08	0.12	0.11	0.79	0.65	0.34	0.36	0.52	--	--
Dibenz(ah)anthracene	0.06	0.03	nd	0.26	0.26	0.06	0.04	0.02	0.03	0.03	0.21	0.15	0.1	0.1	0.15	0.063	0.26
Benzo(g,h,i)perylene	0.19	0.11	nd	1.11	1.1	0.25	0.16	0.09	0.13	0.13	0.82	0.79	0.39	0.41	0.59	--	--
Coronene	nd	nd	nd	0.87	0.55	0.13	nd	nd	0.06	0.06	0.39	0.5	0.36	0.3	0.58	--	--
Benzo(e)pyrene	0.44	0.28	0.06	1.34	1.2	0.34	0.19	0.15	0.28	0.13	1.33	0.94	0.5	0.48	0.73	--	--
Total PAHs	10.37	5.23	0.95	24.74	22.5	7.41	4.59	3.13	7.22	3.79	25.51	22.94	10.33	9.24	14.68	4	45

1. Units are in mg/kg unless otherwise stated
2. All organics results have been normalised to 1% TOC. Normalisation is only appropriate over the TOC range 0.2-10%. Outside this range, the end values have been used.
3. Where results are below laboratory detection limits a value of half the laboratory detection limit has been used for the statistical analysis, **unless,** all results for a dataset were below the detection
4. > SL > ML
5. SL values are equivalent to the ANZECC ISQG Low values
6. ML values are equivalent to ANZECC ISQG High

The results indicate that placement of the dredged material at the Outer Harbour disposal area is unlikely to cause a risk of further significant level of contamination in the Outer Harbour as the sediments already contain similar concentrations of most contaminants. Any biota inhabiting the proposed disposal area would already be exposed to a range of contaminants (refer **Section 4.2**).

Dredging and disposal operations typically result in the creation of turbidity. As most contaminants are adsorbed on fine particles, the mobilised contaminated sediment would be controlled by use of turbidity curtains at the dredge and disposal areas (refer **Section 3.4**). Contaminated sediments in the Port are regularly mobilised by ship movements (approximately 1200 ship movements per year). It is therefore considered unlikely that the suspension of contaminated sediments due to the dredging and disposal operations would cause adverse impacts as contaminated harbour sediments are already disturbed and mobilised on a daily basis by shipping movements and the turbidity curtains deployed during dredging and disposal operations would not be removed until the turbidity from these causes had reduced to background levels.

In the longer term, the Outer Harbour disposal area is proposed to be reclaimed. The contaminated sediments placed in this areae would then be permanently contained and capped. Removal of the material from the dredge areas and containment in the reclamation area would result in an overall improvement in the sediment quality in the Port.

4.1.6 Acid Sulfate Soils

Sampling and testing of the sediment at MPB3 and EB4 for acid sulfate soils (ASS) indicated that the estuarine material located within the harbour at EB4 and MPB3 and within the onland portion of MPB3 are potential acid sulfate soils[9]. However, as the sediments are to be disposed of below water at the Outer Harbour disposal area, the material would not oxidise and create actual acid sulfate soils[10] and generate acidic leachate. Disposal of ASS underwater is a recommended management strategy. It is noted that the material would be exposed to air during transport from the dredge areas to the disposal area. However the material would be in a moist condition and the transport would only be for a short duration.

No significant impacts on the environment are considered likely due to acid sulfate soils.

4.1.7 Potential Impacts from the use of slag at the Outer Harbour disposal area

Slag from within the onland portion of MPB3 is proposed to be disposed of to the Outer Harbour disposal area. In addition, it is proposed to construct the containment bunds at the Outer Harbour disposal area using uncrushed blast furnace slag.

Blast furnace (BF) slag is a by-product of the blast furnace operation where limestone and coke are used to melt and segregate the iron from other minerals in the iron ore by forming a molten slag. The molten slag is either cooled by water quenching resulting in

[9] Potential acid sulfate soils are soils which contain iron sulfide material which have not been exposed to air and oxidised.
[10] Actual acid sulfate soils are soils containing highly acidic soil horizons or layers resulting from the aeration of soil materials that are rich in sulfides, primarily iron sulfide.

"granulated slag" or more commonly allowed to cool in pits exposed to the atmosphere resulting in "air cooled" blast furnace slag.

BF Slag has been used in Port Kembla as part of the Inner Harbour Restorations Project and for reclamation of the berth back-up area as part of the recent MPB130 extension. These recent projects had environmental controls in place which were subject to review and monitoring by relevant agencies. No long term adverse impacts were observed due to the use of slag at these sites. Slag materials have also been widely used for aggregate in concrete, as ballast and as fill across Australia and overseas for the following activities (Golder Associates, 1994):

- breakwall construction in shoreline stabilisation;
- soil stabilisation in low lying areas;
- causeway construction;
- surface pavement materials for roads and carparks;
- railway embankment fill;
- filter in wastewater treatment;
- filter material in fish hatcheries; and
- fertilisers in soil conditioning.

Large quantities of BF slag (30 million tonnes since 1928) have been used as fill throughout the Illawarra and other areas with few complaints about pollution or likely pollution of waters. There have been no proven incidents of damage to the environment by BF slag products (Golder Associates, 1994).

A study of the chemical characteristics and ecotoxicity of experimentally generated leachate from unbound rock BF slag produced by BHP Steel at its Port Kembla facility was undertaken by Golder Associates Pty Ltd (1994). The chemical composition of slag generated is dependent on the ingredients of the slag producing process. The slag is composed primarily of aluminium, calcium, magnesium and silica minerals (Golder Associates, 1994).

The results of the Golder Associates investigations indicated that the use of rock BF slag in uncemented emplacements has a low degree of risk of causing an unacceptable impact to the environment, based on both column leaching and TCLP test results.

The production of leachate has been found to be dependent on the slag surface area that is in contact with water. Water moving through slag would maximise leachate production. Sirman (1985) indicates that slag placed in an aqueous environment would cement itself within six months, significantly reducing the surface area exposed to potential leaching.

On the basis of the above, the potential for contamination of the surrounding environment as a result of the placement of uncrushed BF slag in the Outer Harbour is expected to be low.

4.2 AQUATIC ECOLOGY

An assessment of the aquatic ecology at EB4 and MPB3 was undertaken by Eco Logical Australia Pty Ltd (ELA) in July 2004. The study also based some of its findings on a 2001 study conducted by the Centre for Research on Introduced Marine Pests (CRIMP). ELA has also undertaken an ecological assessment for the disposal of the dredge material in the Outer Harbour. A full copy of the reports by ELA is provided in **Appendix E**.

4.2.1 EB4 and MPB3 Dredge Areas

Aquatic Flora
The main findings of the ELA aquatic flora study for EB4 and MPB3 are as follows:

- no seagrass or macroalgae was observed during inspections carried out for the ELA (2004) study, or in the CRIMP (2001) study;
- the habitat was not considered suitable for seagrass or macroalgae due to the high turbidity (low photic depths); and,
- low levels of *Alexandrium ‘catenella* type’ cysts have been found in all sediments. It is not clear whether or not the cysts observed were from a species that can cause toxic blooms. However, there is no evidence of a toxic bloom occurring in Port Kembla harbour to date (CRIMP, 2001).

Aquatic fauna
The main findings of the ELA aquatic fauna study for EB4 and MPB3 are as follows:

- the fish in the Inner Harbour are estuarine in nature;
- there are no known records of threatened fish species listed under the Fisheries Management Act (FM Act) within Port Kembla Inner Harbour;
- pest species which occur at or close to the dredge area include Hydrozoans, Polychaetes, hull-fouling barnacles, Malacostracan species, Ascidian, 3 fish and up to 16 Bryozoans species; and,
- fish pest species are mobile animals and dredging works is unlikely to spread these animals to regions that they could not reach by normal movements.

4.2.2 Outer Harbour Reclamation Area

Aquatic Flora
A total of 27 macroalgae species have previously been found in the Outer Harbour (CRIMP, 2001), although this study focused on locating introduced, rather than native, species. Within the proposed disposal area, a total of 2 species were recorded. A further 9 species were found from pile scraping samples taken at either Jetty No. 3 or Jetty No. 6 in the Outer Harbour.

Seagrass was entered in Table 4.2.2 of CRIMP (2001) as being found in a pile scraping sample from the Outer Harbour at No. 6 Jetty. This result would appear questionable, however, as seagrass is not known to grow on pile substrates.

An examination of Port Kembla Harbour underwater video for the presence of seagrasses was undertaken by Eco Logical Australia Pty Ltd (ELA) in May 2003. A full copy of the report by ELA is included in **Appendix E**.

The underwater video found no seagrass or macroalgae at the disposal area. The Outer Harbour reclamation area is not considered to be suitable for seagrass or macroalgae because of the following limiting factors:

- the fine sediment on the bed of the harbour is not a suitable substrate;
- lack of light at the depths proposed for disposal; and,
- high turbidity evident at the disposal area.

No cryptogenic or introduced macroalgae have been found in Port Kembla Harbour. As noted above, low levels of *Alexandrium* '*catenella* type' cysts (a dinoflagellate from the kingdom Protista) have been found in all sediments at low levels (CRIMP, 2001). Cysts from the species *A. catenella* can become toxic blooms when disturbed. Blooms are usually less than 4 weeks in length, normally occurring between the months of December and April in southern Australia (CRIMP, 2001). These toxic blooms can accumulate in shellfish and cause Paralytic Shellfish Poisoning (PSP) in humans. There is no evidence of a toxic bloom occurring in Port Kembla harbour to date (CRIMP, 2001).

Aquatic Fauna
There are 87 species of fish known to occur in both the Inner and Outer Harbours of Port Kembla (MSE & CEC 1991, appendix 2). None of these species are threatened fish species listed under the FM Act.

The black cod (Epinephelus daemelii) is known to occur along the coast of New South Wales. Coastal rock pools and rocky shores in estuaries are important habitat for small and large juveniles respectively (NSW Fisheries 2002). It is considered unlikely that the disposal area would be important habitat for the black cod because the species has not been observed within Port Kembla Harbour (MSE & CEC 1991), and habitat in the study area is considered unsuitable. Whilst rock revetments do occur in the study area, juveniles of the black cod are not known to utilise this habitat, instead they appear to prefer crevices under a large overhanging rock lip. Juveniles are considered to possibly use the entrance breakwaters (pers. comm. Allan Lugg, 19/7/04).

No benthos fauna listed under the FM Act are known to exist within Port Kembla. The benthos habitat in the disposal area consists of fine silty materials (ELA, 2003), which are common in Port Kembla.

4.2.3 Impact Assessment

Seagrass beds
The dredging and disposal areas are unlikely to be seagrass habitat. There are no records of seagrass within the Inner Harbour, and only one isolated record from the Outer Harbour, which appears to be dubious as it was noted as coming from a pile scraping. No impacts on seagrass are expected from the dredging and disposal operations.

Macroalgae
No macroalage were observed at the dredge areas. The number and diversity of macroalgae in the proposed disposal area is low, and the fine silt substrates are not ideal habitat. It is anticipated macroalage present would be lost during the disposal operations. There may also be impacts on macroalgae present on rock revetments, and jetty pylons, in the vicinity of the disposal area. However, as the macroalgae species detected (CRIMP, 2001) are not significant species, no significant long term impact upon macroalgae is anticipated.

Dinoflagellate cysts
Low densities of dinoflagellate cysts were observed in the very soft harbour clays at the dredge areas. It is currently unknown if the cysts include species that can cause toxic blooms (CRIMP 2001). There are treatments to kill cysts, such as heating to 40-50˚C, or using hydrogen peroxide, but these are not viable for large volumes of material. The overall risk of adverse impacts is considered to be low. However, it is recommended that the contaminated very soft dark grey to black silty estuarine clays (fine harbour sediments) are placed in the disposal area first, and are covered by other material. This recommendation would be addressed as part of development of the Dredged Material Placement Management Plan (refer **Section 3.4.3**).

However, given the potential for a high level of detrimental harm to both humans and the environment due to toxic blooms, monitoring for dinoflagellates as part of the proposed water quality monitoring program would be undertaken.

Aquatic communities in the sediment at the disposal area
It is anticipated that the aquatic communities in the disposal area would be lost due to smothering by sediment disposal. No significant marine vegetation or aquatic communities are known to be present, hence these impacts are not expected to be significant. Recolonisation of species is likely to occur over the long term.

Fish and their habitat
Fish are generally mobile, and thus individuals are likely to disperse during dredging and disposal operations, except for those captured within the turbidity curtain at the dredge and disposal area. No threatened fish species are known to occur, and the aquatic habitats which would be affected, soft sediment substrates, are common in Port Kembla. No fish breeding areas or nursery areas are known to be present. Impacts on fish and their habitats are therefore not considered to be significant.

Spread of marine pest species
A variety of pest species have been documented in both the Inner and Outer Harbours (CRIMP, 2001). The risk of transferring pest species is considered low as it is likely most organisms in the sediments being transferred would be smothered. In addition, the dredging and disposal areas are in close proximity.

Shoreline aquatic habitat
There may be some impacts on aquatic habitats in proximity to the proposed disposal area, particularly the deposition of fine sediments on the shoreline or rock revetments. However

as there has been previous disposal of dredged material in these areas and a history of industrial use, it is not anticipated that these impacts would be significant.

4.3 WATER QUALITY

Port Kembla comprises the Outer Harbour and the Inner Harbour. The Inner Harbour is a highly modified estuary. The main freshwater source is Allans Creek which discharges into the western end of the Inner Harbour. This water is a mixture of the freshwater from the catchment and the plant cooling water from the Integrated Steelworks of up to 950 ML/day. The water forms a plume of about 8-12 °C above ambient temperature and because it is less dense, it flows over the cooler seawater in the harbour (SKM, 2004).

Discharges from the Western Drain carrying urban runoff from Wollongong enter the Port at the Eastern Basin (SKM, 2004).

Allans Creek and the Western Drain carry fine sediments, organic particulates and some dissolved nutrients (eg. nitrates, phosphates) into the Inner Harbour (SKM, 2004). Around several thousand tonnes of sediments from urban and industrial runoff flow into the Inner Harbour each year. These sediments generally flocculate and settle out near the mouth of the creeks (SKM, 2004).

Other sources of contaminants are small quantities of metals and organic chemicals from the catchment and the industries surrounding the Harbour. The contaminants from BlueScope Steel have significantly reduced as a result of process improvements and wastewater purification measures (SKM, 2004).

In 2002, Marnie Philips, an Honours thesis student at Wollongong University, undertook an assessment of Port Kembla's water quality monitoring and assessment program in accordance with the guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)

This study involved the application of the guidelines for the protection of aquatic ecosystems in Port Kembla Harbour, identification of trigger values for further investigation of water and sediments, and development of a future long-term monitoring program.

The study indicated that Port Kembla Harbour was a measurably degraded aquatic ecosystem characterised by considerable anthropogenic inputs of metals, with the most significant external sources being effluent from surrounding industries, urban runoff from Allans Creek and municipal effluent from the Western Drain.

A long-term monitoring program was developed for the harbour in accordance with ANZECC & ARMCANZ (2000) based on the need for more rigorous data collection, a determination of whether trigger values are currently being met, and to assess compliance with guidelines for the protection of aquatic ecosystems.

The water quality monitoring program for Port Kembla Harbour and two reference sites at Wollongong Harbour and Shellharbour developed by Philips (2002) has been ongoing since December 2002. The monitoring program is coordinated by the Port Kembla Harbour Environment Group under the supervision of the University of Wollongong Department of Environmental Sciences and tests a number of parameters. **Figure 4.7** shows the water quality sampling locations and lists the parameters collected by each contributing organisation.

The parameters tested include:

- metals;
- total suspended solids;
- turbidity;
- pH;
- nutrients; and
- total suspended solids.

The water quality monitoring has found aluminium to be consistently above the ANZECC 95% trigger value. The observations indicated that runoff is probably the main source of aluminium and that high concentrations of aluminium are not a localised Port Kembla presence. Manganese, cadmium, tin, lead and arsenic were found to exceed the ANZECC 95% trigger value on some occasions.

Turbidity in the Port is considered to be moderate, with an average of 1.63 NTU (minimum of 0.72 NTU, maximum of 2.50 NTU from 10 sampling dates), and with secchi depths averaging 4.37m (minimum of 2.0m, maximum of 9.0m from 48 sampling dates) (Port Kembla Harbour Environment Group, 2003).

4.3.1 Mitigation Measures during dredging and disposal operations

Dredging and disposal operations can result in the creation of turbidity. As most contaminants are adsorbed on fine particles, control of turbidity is an effective measure to mitigate against water quality impacts caused by the re-suspension of contaminated material. In addition to water quality impacts, turbid plumes can also cause smothering of benthic organisms and reduce light penetration which may impact on phytoplankton populations.

It is proposed to mitigate the effect of turbidity through use of turbidity curtains at the dredging and disposal areas. As described in **Section 3.4**, turbidity curtains would be installed around the dredge areas and around the Outer Harbour disposal area to confine any suspended fine sediments.

Currently ship movements in the port, approximately 1200 movements per year, result in the disturbance of the contaminated harbour bed sediments causing regular suspension of sediments and turbid plumes (refer **Photo 4.1**). It is therefore considered unlikely that the dredging and disposal operations would have an impact on the water quality in the Port due to increased turbidity levels or re suspension of contaminated sediments.

Photo 4.1 Turbid plumes generated by ship movements within the Inner Harbour

In the longer term, it is possible that the proposed dredging, placement of the dredged material in the Outer Harbour and eventual reclamation of the area would result in an improvement in the water quality in Port Kembla due to the removal and containment of a large quantity of contaminated material.

Although it is considered unlikely that the dredging and disposal operations would have an impact on the water quality in the Port, a program of water quality monitoring is proposed to assess the effectiveness of the turbidity curtains and assess any short or long term impacts on water quality.

It is proposed that the existing water quality monitoring program, developed in accordance with the ANZECC & ARMCANZ (2000) guidelines and coordinated by the Port Kembla Harbour Environment group be employed with daily turbidity monitoring extended to include sites 1, 2, 4, 5 and 8 (refer **Figure 4.7**). In addition, the timing of nutrient and metals sampling and analysis would be coordinated to ensure sampling was undertake prior to, during, and after the dredging and disposal activities.

4.4 NOISE

A noise assessment of the proposed dredging and disposal operations was undertaken by Sinclair Knight Merz (SKM). The main findings of the assessment are described below. A full copy of the report by SKM is provided in **Appendix F**.

4.4.1 Acoustic Environment

The noise environment in the urban residential area to the north and north-west of the Port was assessed using unattended noise-monitoring for a nominal two week period. The monitoring was undertaken at 10 Swan Street and 392 Kiera Street Wollongong, between

Thursday 6 May and Friday 21 May 2004 (inclusive). The noise-monitoring locations were selected as being representative of the wider residential area most likely to be influenced by the proposed dredging activities.

It was observed that each of the residential locations would be influenced from distant traffic as well as general industry noise from the Wollongong industrial area to the south. Analysis of the data from the noise loggers indicated that the measured background $L_{A90,15minute}$ noise levels at the two residential monitoring locations were very similar even though they are separated by a substantial distance. This is indicative of the influence from a distant source such as broader industrial noise.

To categorise the range in the ambient day to day noise levels, the Department of Environment and Conservation (DEC) recommends that for large projects, a minimum of one week of ambient noise monitoring be undertaken. The DEC categorises a 24 hour period into the following three assessment periods:

Day – 7:00 am to 6:00 pm
Evening – 6:00 pm to 10:00 pm; and
Night – 10:00 pm to 7:00 am

A summary of the measured levels is included in **Appendix F.**

The L_{Aeq} levels for each site were also determined for the day, evening and night periods and are presented in **Table 4.5.**

Table 4.5 Summary of L_{Aeq} noise monitoring all sites

Assessment Period	10 Swan Street	392 Kiera Street
Day	53.8 dB (A)	57.8 dB (A)
Evening	52.5 dB (A)	54.2 dB (A)
Night	50.9 dB (A)	51.3 dB (A)

Attended noise surveys were also conducted at six locations on Wednesday 9 June 2004 between the hours of 12:15am and 3:05am to validate the noise logger results and subjectively determine the noise sources in the area. The measurement locations encompassed both Port and residential areas including 10 Swan Street and 392 Kiera Street, Wollongong. The night-time measured background $L_{A90,\ 15minute}$ noise levels at the two residential locations i.e. 45.2 dB(A) and 44.6 dB(A) respectively, were very similar to levels previously recorded during the unattended survey. Furthermore, the night-time background levels were controlled by distant industrial noise from the general direction of the Port.

4.4.2 Construction Noise Emission Objectives

Noise from construction activity in NSW should be assessed under the guidelines detailed in Chapter 171 of the 1994 Environmental Noise Control Manual (DEC).

Daytime noise levels of around 45 dB(A) to 48 dB(A) are currently experienced at the residential properties surrounding the site. Taking 45 dB(A) as the lower typical daytime level, DEC recommends that the $L_{A10(15\ minute)}$ noise levels arising from the dredging and disposal activities and measured in the general vicinity of any noise sensitive premises should not exceed:

- Background plus 20 dB(A) - For a cumulative period of noise exposure not exceeding 4 weeks, hence the construction noise should not exceed 65 dB(A).
- Background plus 10 dB(A) - For a cumulative period of noise exposure between 4 weeks and 26 weeks, hence the construction noise should not exceed 55 dB(A).
- Background plus 5 dB(A) - For a cumulative period of exposure greater than 26 weeks, hence the construction noise should not exceed 50 dB(A).

Where night time construction activities are proposed, inaudibility would be approximately equal to background minus 10 dB(A). At the nearest residences the night time background noise level ($L_{A90\ 10^{th}\ percentile}$) is approximately 45 dB(A). Therefore the night time criteria for dredging activities would be approximately 35 dB(A).

Sleep Disturbance Criteria
Noise emissions that may cause sleep disturbance are assessed under Chapter 19-3 of the 1994 Environmental Noise Control Manual, *Noise Quality Objectives, Special Considerations, Sleep Arousal Level.*

The main requirements for residential receiving areas are:

- Night-time – from 10 pm to 7 am the L_{A1} noise level of any specific noise source should not exceed the L_{A90} background noise level by more than 15 dB(A) when measured outside the bedroom window.

Based on the L_{A90} noise levels measured at the nearby residential locations, the L_{A1} sleep arousal criterion is 60 dB(A).

4.4.3 Noise Predictions

The acoustic modelling predictions were conducted using the CONCAWE algorithms as implemented within the SoundPLAN suite of noise prediction programs. In determining sound power levels for the dredging equipment, information was sourced from SKM's acoustic database. This information does not necessarily reflect the ultimate choice of dredging equipment by the contractor but would serve as a close approximation of expected noise emissions from the proposed works.

Dredging and Disposal
The dredger used for dredging and disposal operations is expected to be a grab dredger or backhoe dredger. A grab dredger has an estimated sound power level (for a typical unit) of 118 dB(A). A backhoe dredger would be expected to have a similar sound power level. Noise from dredging activities would be constant in nature and are not likely to exhibit impulsive or sporadically noisy emission levels. The estimated noise level at the nearest residences due to emissions from dredging operations alone is shown in **Table 4.6**.

Table 4.6 Calculated Noise Levels During Dredging

Location of Receiver	Approx. Distance from Proposed Works (m)	L_{A10} Noise Level
Kiera and Swan Street	Approx. 1700m	30 dB (A)

Based on these predicted values, construction noise impacts from the dredging works would not exceed the DEC noise criteria at the nearest residences and are likely to be inaudible at these locations.

Sleep Disturbance Predictions
The $L_{A,MAX}$ and L_{A10} calculated noise levels are not expected to vary by more than 10 dB(A) as the result of operations.

Based on the predicted L_{A10} level of 30 dB(A) for operations at the nearest residences the maximum predicted level arising from dredging operations is 40 dB(A) which is 20 dB(A) below the recommended sleep disturbance criteria. Because the L_{Amax} was used instead of the traditional L_{A1} the predicted level sleep disturbance impacts would be slightly conservative.

The results of the noise impact assessment indicate that there are no adverse noise impacts anticipated as the result of the proposed dredging activities within the Inner Harbour of Port Kembla.

4.5 HYDRODYNAMICS AND SEDIMENT MOBILITY

An assessment of the effect of a previous reclamation proposal within the Outer Harbour on currents and long and short term wave climates was undertaken by the Sydney Ports Corporation and Lawson and Treloar in 1999. A copy of this assessment is included in **Appendix G**. The findings of this assessment are relevant as they may be used to evaluate the impact of the proposed Outer Harbour disposal of dredged material from MPB3 and EB4 on currents and wave climate in the Outer Harbour[11]. The findings in relation to the previous reclamation proposal were as follows:

- current speeds in the Outer Harbour are low and the proposed reclamation is not expected to have any significant effect on current speeds and patterns outside the proposed reclamation area; and

- the impacts on short waves and long waves will be acceptable.

[11] The proposed disposal of dredged material from MPB3 and EB4 would result in a sub aqueous surface at about -3m CD rather than a reclamation that extends above water level. Accordingly, use of the results from the previous reclamation proposal (which occupied a similar area in the Outer Harbour and was also quite extensive in plan) to assess the impact of the dredged material disposal is quite conservative

It follows that the proposed disposal of dredged material from MPB3 and EB4 in the Outer Harbour would not have any significant impact on currents and long and short wave climate.

More recently, Lawson and Treloar has assessed the stability under wave action of dredged material and uncrushed blast furnace slag in the Outer Harbour as part of the design of the current Outer Harbour disposal area. A copy of the Lawson and Treloar letter report is included in **Appendix G**. This report has shown that:

- the uncrushed blast furnace slag comprising the underwater containment bunds would be stable in wave conditions up to 25 year ARI (Average Recurrence Interval); and,

- sandy sediments and soft clays are susceptible to movement in wave conditions of less than 1 year ARI.

The results of the Lawson and Treloar stability assessment would be used to assist in preparation of the Dredged Material Placement Management Plan (refer **Section 3.4.3**)and may dictate disposal of the more mobile sediments such as the soft clays and sands at the base of the disposal area, to be covered by more stable materials. This would also be of benefit to aquatic ecology having regard to the contaminated very soft dark grey to black silty estuarine clays (refer **Section 4.2.3**).

4.6 IMPACT ON NAVIGATION

Movements of the self-propelled hopper barges between the dredge areas at MPB3 and EB4 and the disposal area would be coordinated by PKPC. All barge movements would be undertaken in accordance with protocols and rules of the PKPC Vessel Traffic Centre. The dredging contract would include a clause stipulating the requirements of the dredging contractor regarding shipping movements.

It would be the responsibility of the dredging contractor to maintain regular contact with the PKPC's Harbour Master. The contractor would be required to undertake the dredging and disposal so that the activities do not impede shipping operations and movements at any time. The contractor would be given at least 6 hours notice of the arrival of ships to the Eastern and Western Basin.

The contractor would be responsible for providing and maintaining buoys, moorings and fastenings necessary to secure the floating plant and also marking buoys, piles, and lights as may be deemed necessary by the Harbour Master to warn vessels of the existence of the works and plant.

Adherence by the dredging contractor to directions from the Harbour Master and the protocols and rules of the Vessel Traffic Centre should result in the dredging and disposal operations having minimal impact on navigation in the port. It is noted that dredging activities in the Inner Harbour and disposal activities in the Outer Harbour have been previously carried out.

4.7 AIR QUALITY

Port Kembla is one of the largest industrial areas in Australia. The heavy industry of the area causes significant emissions. As a result, air quality in the area is regularly monitored by both private industry, DEC and other regulatory authorities.

The proposed dredging and disposal activities generally involve material with high water content. In addition, the material is proposed to be disposed of underwater. Consequently, the activities would not result in significant dust emissions.

The sediments within the onland above water portion of MPB3 are also not expected to result in significant dust emission. However, if dredging operations are being undertaken in windy conditions, the sediments would be kept moist using water carts to suppress dust.

Some odour may be generated as a result of the dredging however impacts would be short term. The community is not expected to be significantly affected by the odour because of the following (SKM 2005):

- the distance to the closest residences is at least one kilometre;
- the dredged sediment would only be exposed to the atmosphere during its storage in the hopper barges before its disposal in the Outer Harbour. The duration of exposure would be short term; and,
- the surrounding industrial development already comprises various odour generating activities.

4.8 HERITAGE

The proposed dredge and disposal areas have been previously disturbed and it is unlikely that any indigenous or heritage sites would be present.

A search of local, state and national heritage listing was undertaken. No heritage sites were found in the proposed dredge and disposal areas in the following registers:

- Schedule 1 of the Wollongong Local Environmental Plan 1990;
- Heritage Listings of the NSW Heritage Office;
- Register of the National Estate; and,
- National Trust Register.

However, if an indigenous or heritage item is discovered during dredging, all work would cease and advice would be sought from National Parks and Wildlife Services (a part of DEC).

4.9 VISUAL QUALITY AND LANDSCAPE CHARACTER

Given the surrounding industrial activities, no significant visual impact is expected from the dredging and disposal activities. The alteration to the landscape is generally below the water and would not affect the appearance of the site. The dredging of the onland portion of MPB involves a conversion of land area to water area. The dredging represents only a 0.1% increase in water area of the Port. In addition, the distance to the closest residential area is at least one kilometre and hence the proposed activities would not result in any visual impact to these residents.

4.10 CHECKLIST OF ENVIRONMENTAL IMPACTS

It is noted that under Clause 228(2) of the Environmental Planning and Assessment Regulation 2000, there are certain factors which must be taken into account when assessing the impact of an activity on the environment.

The factors from Clause 228(2) for assessing impacts are listed in **Table 4.7** and have been used as a checklist of the environmental impacts for the proposed dredging in the Inner Harbour and disposal to the Outer Harbour.

Table 4.7 Factors for environmental assessment as required in Clause 228(2) of the Environmental Planning and Assessment Regulation 2000.

Factors	Comment
(a) any environmental impact on a community;	No impact is expected on the surrounding community.
(b) a transformation of a locality;	No transformation of a locality is required.
(c) any environmental impact on the ecosystems of the locality;	As discussed in **Section 4**, the proposed dredging and disposal is not expected to have any long term impacts on the ecosystems of the locality. Mitigation measures are proposed to protect surrounding aquatic ecology and water quality.
(d) any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality;	No reduction of the environmental quality of the locality is expected. The Inner and Outer Harbour are already highly disturbed environments.
(e) any effect upon a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations;	The proposed dredging and disposal areas contain no known heritage sites.
(f) any impact on the habitat of protected fauna (within the meaning of the National Parks and Wildlife Act 1974);	The proposed dredging and disposal areas are not known to have any habitat of protected fauna.
(g) any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air;	No species of animal or plant (including seagrass/macroalgae) is expected to be endangered by the proposed activities.
(h) any long-term effects on the environment;	No long term effect on the environment is expected.
(i) any degradation of the quality of the environment;	No significant degradation of the quality of the environment is expected. The Inner and Outer Harbour are highly disturbed environments. Mitigation measures would be employed to ensure no significant degradation of the environment.
(j) any risk to the safety of the environment;	No risk to the safety of the environment is expected. As noted in **Section 4.7** Adherence by the dredging contractor to directions from the Harbour Master and the protocols and rules of the Vessel Traffic Centre should result in the dredging and disposal operations having minimal impact on navigation in the port.
(k) any reduction in the range of beneficial uses of the environment;	No reduction in the range of beneficial uses of the environment is expected. Disposal of the dredged material is proposed at a future reclamation area.
(l) any pollution of the environment;	As discussed in **Section 4**, the proposed dredging and disposal is not expected to result in long term pollution of the environment. Mitigation measures are proposed to ensure pollution is restricted to short term localised effects contained at the dredging and disposal areas by the use of turbidity curtains.
(m) any environmental problems associated with the disposal of waste;	The proposed activities involve disposal of dredged material to the Outer Harbour. No long term environmental problems are expected associated with the disposal of the material.
(n) any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply; and,	No significant demand on the use of resources in short supply is expected.
(o) any cumulative environmental effect with other existing or likely future activities.	In the longer term, the Outer Harbour disposal area is proposed to be reclaimed. The contaminated sediments placed in this area would be permanently contained and capped. Removal of the material and containment in the reclamation area would result in an overall improvement in the sediment quality in the Port.

5 PROPOSED MITIGATION

An Environmental Management Plan (EMP) would be prepared by the successful dredging contractor. The EMP would include measures proposed to mitigate any adverse impacts of the proposed dredging and disposal activities and the proposed monitoring described below:

- a turbidity curtain would be employed around the proposed dredging at MPB3 and EB4 to mitigate against the migration of any fine sediments suspended in the water column by the dredging operations
- a turbidity curtain would be employed around the proposed disposal area to mitigate against the migration of any fine sediments suspended in the water column by the disposal operations
- the existing water quality monitoring program, developed in accordance with the ANZECC & ARMCANZ (2000) guidelines and coordinated by the Port Kembla Harbour Environment Group would be expanded to include daily turbidity monitoring at additional sites
- monitoring for dinoflagellates and for evidence of toxic blooms would be undertaken as part of the proposed water quality monitoring program
- a Dredged Material Placement Management Plan would be developed. The Dredged Material Placement Management Plan would set out the proposed disposal operation in a systematic manner taking into account factors described in **Section 3.4.3** such as types of material, mobility of material, wave and wind climate, and aquatic ecology recommendations
- the dredging contractor would be responsible for providing and maintaining buoys, moorings and fastenings necessary to secure the floating plant, and for providing marking buoys, piles, and lights as may be deemed necessary by the Harbour Master to warn vessels of the existence of the works and plant
- the dredging contractor would be required to adhere to directions from the Harbour Master and the protocols and rules of the Vessel Traffic Centre
- if dredging operations are being undertaken in windy conditions, dust suppression measures would be employed for the above water portion of MPB3
- if an indigenous or heritage item is discovered during dredging, all work would cease and advice would be sought from the NSW National Parks and Wildlife Service

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