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Mr Matt Coetzee
Principal
URS Australia Pty. Ltd.
Level 3
116 Miller Street
NORTH SYDNEY NSW 2060

Telephone: 9762 8001
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Dear Mr Coetzee

**Proposed Expansion, Port Botany**
**Our Reference: S01/02520**

I refer to your letter, dated 4 December 2001, seeking the Director-General's requirements for the preparation of an Environmental Impact Statement (EIS) for the above proposal.

**Commonwealth *Environment Protection and Biodiversity Conservation Act 1999***

As you are aware, Environment Australia has declared the proposed expansion, and all associated construction and operation activities, to be a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and accredited the NSW assessment process.

This means that even though the proposed expansion will require Commonwealth approval, the assessment process will be undertaken in accordance with the relevant provisions in Part 4 of the *Environmental Planning and Assessment Act 1979* (the Act).

Environment Australia has provided its requirements for the EIS (see Attachment No. 2).

**Statutory Issues**

Attachment No. 1 outlines the statutory matters that must be included in any EIS under Clauses 71 and 72 of the Environmental Planning and Assessment Regulation 2000 (the Regulation).

**Specific Issues**

Under Clause 73(1) of the Regulation, the Director-General requires you to address the following specific issues in the EIS:

- **Description of the Proposal**: The EIS must include a detailed description of the proposal, clearly identifying those components of the proposal for which approval is being sought, and those components of the proposal that would be the subject of future development applications.

- **Strategic Justification**: The EIS must justify the need for the proposal, taking into account any relevant trends in international, national, and state trade, transport, and logistics; the forecast growth in sea-borne trade, and all the relevant State Government's strategic land use, transport, and environmental planning policy documents. This justification must also include a detailed assessment of the range of alternatives available in NSW to accommodate this forecast growth, demonstrating that the proposed expansion of Port Botany is the best alternative available.
- **Inquiry Recommendations**: The EIS must consider the proposal against the recommendations in the Healthy Rivers Commission's final report on the Independent Inquiry into the Georges River-Botany Bay System, and if necessary, justify any inconsistencies between the proposal and these recommendations.
- **Statutory Instruments**: Assess the proposal against the relevant provisions in *State Environmental Planning Policy No. 11 – Traffic Generating Developments*, *State Environmental Planning Policy No. 33 – Hazardous and Offensive Development*, *State Environmental Planning Policy No. 55 – Remediation of Land*, draft *State Environmental Planning Policy No. 66 – Integrated Land Use & Transport; Botany Local Environmental Plan 1995.*
- **Key Issues**: Assess the following potential impacts of the proposal during construction and operation, and describe what measures would be implemented to manage, mitigate, or off-set these potential impacts:
  (a) Traffic and transport, on land, water, and air, identifying any infrastructure upgrades that would be required to support the proposal;
  (b) Hydrological;
  (c) Fauna and flora, terrestrial and aquatic, particularly on critical habitats, threatened species, populations, or ecological communities;
  (d) Noise and vibration;
  (e) Soil and groundwater quality;
  (f) Surface water quality;
  (g) Air quality;
  (h) Hazards and risks: this assessment should:
    - Include a Preliminary Hazard Analysis of the proposal that has been prepared in accordance with Planning NSW's *Hazardous Industry Planning Advisory Paper No. 6: Guidelines for Hazard Analysis* and *Multilevel Risk Assessment Guidelines;*
    - Consider the potential impacts associated with storing and handling dangerous goods on-site, and transporting dangerous goods to and from the site; and
    - Demonstrate that the proposal is consistent with the *Port Botany Land Use Safety Study* (DUAP, 1996);
  (i) Visual;
  (j) Heritage;
  (k) Waste Management;
  (l) Utilities & services; and
  (m) Social and economic, particularly on the recreational use of the northern part of Botany Bay.

  This assessment must consider the potential cumulative impacts associated with this proposal and the proposed upgrade of Patrick's container terminal at Port Botany, and the ground access needs of Sydney Airport. This assessment must also include a detailed assessment of the potential off-site impacts of the proposal, particularly on the wider Botany Bay system, and the surrounding local government areas.
- **Environmental Management**: Describe how the environmental performance of the proposal would be monitored and managed during construction and future operations.

You should note that if the Development Application to which these requirements relate is not made within two years of the date of this letter, Clause 73(6) of the regulation requires you to consult further with the Director-General before lodging the application.

**State Significant Development Requirements**

For all State Significant Development proposals, the Director-General requires the Applicant to:

- Nominate a contact person (with telephone number) to answer public enquiries about the proposal;
- Consult with the community that is likely to be affected by the proposal. The DA must include a report indicating who was consulted, how the affected community was identified, what consultation methods were used, and what issues were raised by the community;
- Consult with the local Council;
- Provide the Department with an electronic copy of the Executive Summary of the EIS with the DA for exhibition on the Department's website; and
- Advise the Department of the relevant newspapers circulating in the area affected by the proposal.

**Integrated Development**

Under section 91 of the Act, development is only classified as "integrated development" if it requires certain approvals in addition to development consent before it may be carried out.

In your form A, you indicated that you proposal would require additional approvals from the Roads and Traffic Authority, Environment Protection Authority, NSW Fisheries, and the Waterways Authority. These approval bodies have provided the Department with their requirements for your EIS (see Attachment No. 3). You must address the requirements in your EIS.

If further integrated approvals are identified before you lodge the Development Application, you must conduct you own consultation with the relevant agencies, and you must address these requirements in your EIS.

When you lodge a DA for the proposal, you must include:

- At least on copy of the DA and supporting information for each of the integrated approval bodies; and
- Cheque for $250, made payable to each of the integrated approval bodies.

**Guidelines**

During the preparation of the EIS, you should consider the Department's EIS guideline on *Marinas & Related Facilities*.

**Consultation**

During the preparation of the EIS, you should consult with the relevant local, State, and Commonwealth government authorities, service providers and community groups, and address any issues they may raise in the EIS.

In addition to the integrated approval bodies, several agencies and groups have provided comments on the proposal, which you must take into consideration in your EIS (see Attachment 4).

If you have any enquiries about the above, please contact David Kitto 9762 8162.

Yours sincerely

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Sam Haddad
**Executive Director**
**Sustainable Development**

9.4.2002

# Attachment No. 1

**DEPARTMENT OF URBAN AFFAIRS AND PLANNING**

**Attachment No. 1**

# STATUTORY REQUIREMENTS FOR THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT UNDER PART 4 OF THE ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

In accordance with the *Environmental Planning and Assessment Act 1979* (the Act), an environmental impact statement (EIS) must meet the following requirements.

***Content of EIS***

Pursuant to Schedule 2 and clause 72 of the *Environmental Planning and Assessment Regulation 2000* (the Regulation), an EIS must include:

1. A summary of the environmental impact statement.
2. A statement of the objectives of the development or activity.
3. An analysis of any feasible alternatives to the carrying out of the development or activity, having regard to its objectives, including the consequences of not carrying out the development or activity.
4. An analysis of the development or activity, including:
   (a) a full description of the development or activity; and
   (b) a general description of the environment likely to be affected by the development or activity, together with a detailed description of those aspects of the environment that are likely to be significantly affected; and
   (c) the likely impact on the environment of the development or activity, and
   (d) a full description of the measures proposed to mitigate any adverse effects of the development or activity on the environment, and
   (e) a list of any approvals that must be obtained under any Act or law before the development or activity may be lawfully carried out.
5. A compilation, (in a single section of the environmental impact statement) of the measures referred to in item 4(d).
6. The reasons justifying the carrying out of the development or activity in the manner proposed, having regard to biophysical, economic and social considerations, including the following principles of ecologically sustainable development:
   (a) The precautionary principle - namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
   In the application of the precautionary principle, public and private decisions should be guided by:
      (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and
      (ii) an assessment of the risk-weighted consequences of various options,
   (b) Inter-generational equity - namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations,
   (c) Conservation of biological diversity and ecological integrity, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,
   (d) Improved valuation, pricing and incentive mechanisms, namely, that environmental factors should be included in the valuation of assets and services, such as:
      (i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,
      (ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,
      (iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

An environmental impact statement referred to in Section 78A(8) of the Act shall be prepared in written form. The prescribed form to accompany the environmental impact statement must comply with the requirements of clause 71 of the Regulation and be signed by the person who has prepared it.

Procedures for public exhibition of the EIS are set down in clauses 77 to 81 of the Regulation.

Attention is also drawn to clause 283 of the Regulation regarding false or misleading statements in EISs.

**Note**

If the development application to which the EIS relates is not made within 2 years from the date of issue of the Director-General's requirements, under clause 73(6) of the Regulation the proponent is required to reconsult with the Director-General.

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# Attachment No. 2

Environment Australia

Department of the Environment and Heritage

INFRASTRUCTURE DEVELOPMENT & ASSESSMENT
2 APR 2002

Mr David Kitto
Planning Officer
Development & Infrastructure Planning
Planning NSW
GPO BOX 3927
SYDNEY NSW 2001

Dear Mr Kitto

**PROPOSED EXPANSION OF PORT BOTANY – NSW DIRECTOR GENERAL'S EIS REQUIREMENTS**

I refer to your letter of 14 March 2002 requesting Environment Australia's EIS requirements for the proposed expansion of Port Botany.

The location of the proposed expansion is immediately north of the Towra Point Ramsar site. Any dredging activities within Botany Bay may affect the Ramsar site. The Towra Point Ramsar site is one of the few remaining areas of estuarine wetlands in the Sydney region and is an important migratory waterbird feeding and roosting site.

The proposed development is likely to result in:
- increased turbidity in Botany Bay;
- changes to salinity and an influx of marine water into brackish or freshwater environments;
- increased erosion by modifying wave dynamics in Botany Bay; and

As a result, it may also seriously affect the habitat of species dependent on the wetland. A number of listed migratory waterbird species have been identified as present in the vicinity of the proposed action

Accordingly, the following issues should be included in the guidelines for preparation of the EIS:
- determine the level of impact of construction and dredging of the port facility and associated infrastructure on the Ramsar site to the south;
- identify mitigation measures to reduce the impact of dredging activities on turbidity, salinity and wave dynamics in Botany Bay;
- determine the potential impacts of the proposed action on migratory waterbirds listed under the EPBC Act, including but not limited to, the following species:
- Pacific Golden Plover (*Pluvialis fulva*)
- Mongolian Plover (*Charadrius mongolus*)
- Ruddy Turnstone (*Arenaria interpres*)
- Eastern Curlew (*Numenius madagascariensis*)
- Latham's Snipe (*Gallinago hardwickii*)
- Painted Snipe (*Rostratula benghalensis*); and
- determine the level and type of use of the Penrhyn Estuary by listed migratory species.

The proposed action is located 400 m from Sydney (Kingsford Smith) Airport, which is on Commonwealth land. Operations at the expanded port will involve activities in close proximity to Sydney Airport's parallel runway. The proposal is likely to have impacts on the physical qualities and characteristics of the airport. These include impacts relating to light, noise, and dust and potentially increased numbers of birds in the airspace above the airport. In addition, the potential exists for changes to wave dynamics from dredging to adversely affect the breakwaters and shoreline of the third runway. Such impacts are impacts on the environment on Commonwealth land and should be addressed by the EIS.

Thank you for the opportunity to input into the NSW Director-General's EIS requirements.

Yours sincerely

Tim Kahn
Acting Assistant Secretary
Environment Assessment & Approvals Branch

27 March 2002

# Attachment No. 3

(3)

- 4 FEB 2002

Our Reference : SRF5400

NSW EPA

Sydney Region

Mr David Kitto
Planning NSW
20 Lee Street
SYDNEY NSW 2000

Dear Mr Kitto

**EIS Requirements for the Proposed Expansion of Port Botany**

I refer to your request dated 10 December 2001 for the Environment Protection Authority's (EPA) requirements for the preparation of an Environmental Impact Statement (EIS) in regard to the proposed expansion of Port Botany.

The EPA has considered the information provided and has identified the information it requires to issue its general terms of approval in Attachment 'A' to this letter. In this document, the EPA has identified that the area has significant ecological importance and its key information requirements for the proposal include:

1. A noise impact assessment report conducted in accordance with the *NSW Industrial Noise Policy* regarding any noise and vibration impacts associated with site activities and increased road and rail traffic serving the development;

2. An assessment of potential impacts on the bay from disturbance of potentially contaminated groundwater/soil/sediment during dredging and land reclamation;

3. An assessment of impacts due to potential changes in the bay wave and current patterns/energy and their significance on the bay;

4. An assessment of the potential impacts of the proposal on the whole of bay system, in the context of the recent Government decision on the Healthy Rivers Commission's *Final Report – Independent Inquiry into the Georges River – Botany Bay System, September 2001*;

5. Demonstration of adequate management systems for the on-site storage and transport of dangerous goods, including the transfer of dangerous goods between water, road and rail vessels in accordance with the *Road and Rail Transport (Dangerous Goods) Act 1997*; and

6. An effective stakeholder consultation program including an open and transparent community consultation program with public advertisement of the application.

Based on the information provided to the EPA, the applicant will require an environment protection licence under the *Protection of the Environment Operations Act (POEO Act) 1997.* The applicant will need to make a separate application to the EPA for this licence. The DA/EIS will need to clarify whether the proposed activities on the site will meet or exceed the threshold for any scheduled activity under Schedule 1 of the POEO Act, including Shipping Facilities, Dredging Works, Contaminated Soil Treatment Works and/or Chemical Storage Facilities.

It is requested that the EPA be provided with three (3) copies of the EIS. These documents should be lodged at our office located at Level 7, 79 George St Parramatta NSW 2150 or PO Box 668 Parramatta NSW 2124.

If you have any queries regarding this matter please contact Rachelle Amess on 9995 6815.

Yours sincerely

J Zurrer 31/1/02

**JO ZURRER**
<u>A/Manager Sydney Planning</u>

<u>Attachments</u>: A. EPA Directors Requirements for preparation of EIS.

Attachment A

# Environment Protection Authority

# EIS Requirements

# Proposed Expansion of Port Botany

## A. EXECUTIVE SUMMARY

The executive summary should include a brief discussion of the extent to which the proposal achieves identified environmental outcomes.

## B. THE PROPOSAL

### 1. Objectives of the proposal

- The objectives of the proposal should be clearly stated and refer to:
  - the size and type of operation, the nature of the activities to be carried out and the by-products and wastes produced;
  - a life cycle approach to the production, use, or disposal of products and/or waste materials;
  - the anticipated level of performance in meeting required environmental standards and cleaner production principles;
  - the staging and timing of the proposal and any plans for future expansion; and
  - the proposal's relationship to any other industry, facility, rail network and road network.

### 2. Description of the proposal

**General**

- Outline the proposed activities including:
  - defining the location, nature, timing and volume of road and rail traffic movements arising from the proposal
  - any potential pollutants being moved through and stored on the site, any points of discharge to the environment and their respective destinations (sewer, stormwater, atmosphere, recycling, landfill etc).
  - any life-cycle strategies for the proposed facility.
  - all steps and processes involved including, but not limited to: site preparation, soil and/or sediment extraction/excavation, soil and/or sediment handling/movement/storage, plant construction, soil and/or sediment drying/preparation, plant commissioning/operation/ decommissioning.

- the environmental "mass balance" for the process – quantify in-flow and out-flow of materials, any points of discharge to the environment and their respective destinations (sewer, stormwater, atmosphere, recycling, landfill etc.); and
- any life-cycle strategies for the products.

- Outline cleaner production actions, including:
  - measures to minimise waste (typically through addressing source reduction);
  - proposals for use or recycling of by-products;
  - proposed disposal methods for solid and liquid waste;
  - air management systems including all potential sources of air emissions, proposals to re-use or treat emissions, emission levels relative to relevant standards in regulations, discharge points;
  - water management system including all potential sources of water pollution, proposals for re-use, treatment etc., emission levels of any wastewater discharged, discharge points; and
  - soil contamination treatment and prevention systems.
- Outline construction works including:
  - actions to address existing soil and/or groundwater contamination;
  - any earthworks or site clearing; re-use and disposal of cleared material (including use of spoil on-site);
  - construction timetable and staging; hours of construction; proposed construction and decommissioning methods; and
  - environment protection measures, including noise mitigation measures, dust control measures and erosion and sediment control measures.

**Noise and vibration**

- Identify all noise sources from the development (including construction, operation and decommissioning phases). Detail all potentially noisy activities including ancillary activities such as transport of goods and raw materials.
- Specify the times of operation for all phases of the development and for all noise producing activities.
- Provide details of road alignment (include gradients, road surface, topography, bridges, culverts etc as appropriate), and land use along the proposed road and rail lines proposed to service the facility and measurement locations – diagrams should be to a scale sufficient to delineate individual residential blocks.

**Air**

- Identify all sources of air emissions from the development.
- Provide details of the project that are essential for predicting and assessing air impacts including:
  - the quantities and physico-chemical parameters (for example concentration, moisture content, bulk density, particle sizes etc.) of materials to be used, transported, produced or stored;
  - an outline of procedures for handling, transport, production and storage; and
  - the management of solid, liquid and gaseous waste streams with potential for significant air impacts.

## Water

- Provide details of the project relevant to any water impacts of the development such as drainage and/or dredging works and associated infrastructure; land-forming and excavations; working capacity of structures; and water resource requirements of the proposal.
- Outline site layout, demonstrating efforts to avoid proximity to water resources (especially for activities with significant potential impacts for example effluent ponds) and showing potential areas of modification of contours, drainage etc..
- Outline how total water cycle considerations are to be addressed showing total water balances for the development (with the objective of minimising demands and impacts on water resources). Include water requirements (quantity, quality and source(s)) and proposed storm and waste water disposal, including type, volumes, proposed treatment and management methods and re-use options.

## Waste and chemicals

Provide details of:

- the quantity and type of gaseous, liquid, non-liquid, chemicals and wastes (highlighting hazardous and dangerous materials) generated, handled, stored, processed or disposed of at the premises;
- procedures and management systems for the above substances at the proposed facility, including:
  - the transportation, assessment and handling of wastes, chemicals, dangerous materials or recovered materials arriving at or generated at the site;
  - any stockpiling of wastes or recovered materials at the site;
  - any waste processing related to the facility, including reuse, recycling, reprocessing (including composting) or treatment both on- and off-site;
  - the method for disposing of all wastes or recovered materials at the facility;
  - the emissions arising from the transport, handling, storage, processing and reprocessing of waste at the facility; and
  - the proposed controls for managing the environmental impacts of these activities, including incident management measures.
- spoil disposal with particular attention to:
  - the quantity of spoil material likely to be generated;
  - proposed strategies for the handling, stockpiling, reuse/recycling and disposal of spoil;
  - the need to maximise reuse of spoil material in the construction industry,
  - identification of the history of spoil material and whether there is any likelihood of contaminated material, and if so, measures for the management of any contaminated material; and
  - designation of transportation routes for transport of spoil.

## Ecologically Sustainable Development (ESD)

- Demonstrate that the planning process and any subsequent development incorporates objectives and mechanisms for achieving ESD, including:
  - an assessment of a range of options available for use of the resource, including the benefits of each option to future generations;
  - proper valuation and pricing of environmental resources; and

- identification of who will bear the environmental costs of the proposal.

### Rehabilitation

Outline considerations of site maintenance, and proposed plans for the final condition of the site (ensuring its suitability for future uses).

### Consideration of alternatives and justification for the proposal

- Consider the environmental consequences of adopting alternatives, including alternative:
  - sites and site layouts;
  - access modes and routes;
  - freight handling processes;
  - materials handling and production processes;
  - chemicals, waste and water management;
  - impact mitigation measures, particularly air quality and noise measures; and
  - energy sources.
- Selection of the preferred option should be justified in terms of:
  - ability to satisfy the objectives of the proposal;
  - relative environmental and other costs of each alternative;
  - acceptability of environmental impacts;
  - acceptability of any environmental risks or uncertainties, including assessment based on presumed normal operating mode and on the worst case situations;
  - reliability of proposed environmental impact mitigation measures; and
  - efficient use (including minimising re-use) of land, raw materials, energy and other resources.

## C. THE LOCATION

### General

- Provide an overview of the affected environment, to place the proposal in its local and regional environmental context including:
  - meteorological data (for example rainfall, temperature and evaporation, wind speed and direction);
  - topography (landform element, slope type, gradient and length);
  - surrounding land uses (potential synergies and conflicts);
  - geomorphology (rates of landform change and current erosion and deposition processes);
  - soil types and properties (including erodibility; engineering and structural properties; dispersibility; permeability; presence of acid sulfate soils and potential acid sulfate soils);
  - ecological information (water system habitat, vegetation, fauna);
  - availability of services and the accessibility of the site for passenger and freight transport.

**Noise and vibration**

- Identify any noise sensitive locations likely to be affected by activities at the site, such as residential properties, schools, churches, and hospitals.
- Identify the land use zoning of the site and the immediate vicinity and the potentially affected areas.

  Note: *The noise assessment report should include a map of the locality showing any identified noise sensitive locations in relation to the site.*

**Air**

- Describe the topography and surrounding land uses. Provide details of the exact locations of dwellings, schools and hospitals. Where appropriate provide a perspective view of the study area such as the terrain file used in dispersion models.
- Describe surrounding buildings that may affect plume dispersion.
- Provide and analyse site representative data on the following meteorological parameters:
  - temperature and humidity;
  - rainfall, evaporation and cloud cover;
  - wind speed and direction;
  - atmospheric stability class;
  - mixing height (the height that emissions will be ultimately mixed in the atmosphere);
  - katabatic air drainage; and
  - air re-circulation.

**Water**

- Describe the catchment including proximity of the development to any waterways and provide an assessment of their sensitivity/significance from a public health, ecological and economic perspective.

**Soil and/or Sediment Contamination Issues**

- Provide details of site history and contamination investigations with regard to soil and/or sediment contamination in accordance with guidelines made or approved by the EPA under section 105 of the *Contaminated Land Management Act 1997*. Proposed earthworks and site uses should address soil, sediment and groundwater contamination consistent with the above guidelines, *SEPP55: Remediation of Land* and the 1988 DUAP/EPA *Managing Land Contamination: Planning Guidelines*.

## D. IDENTIFICATION AND PRIORITISATION OF ISSUES (SCOPING OF IMPACT ASSESSMENT)

- Provide an overview of the methodology used to identify and prioritise issues. The methodology should take into account:
  - relevant NSW government guidelines (see Section I of this document for available guidance materials);
  - industry guidelines;

- EISs for similar projects;
- relevant research and reference material;
- relevant preliminary studies or reports for the proposal; and
- consultation with stakeholders.

- Provide a summary of the outcomes of the process including:
  - all issues identified including local, regional and global impacts (for example increased/decreased greenhouse emissions);
  - justification for the level of analysis proposed (the capacity of the proposal to give rise to high concentrations of pollution compared with the ambient environment or environmental outcomes is an important factor in setting the level of assessment).

# E. THE ENVIRONMENTAL ISSUES

The potential impacts identified in the scoping study need to be assessed to determine their significance, particularly in terms of achieving environmental outcomes, and minimising environmental pollution.

## 1. <u>Describe baseline conditions</u>

### General

- Provide a description of existing environmental conditions for any potential impacts.

### Noise and vibration

- Determine the existing background ($L_{A90}$) and ambient ($L_{Aeq}$) noise levels in accordance with the EPA's NSW Industrial Noise Policy, January 2000.
- Determine the existing road traffic noise levels in accordance with the NSW Environmental Criteria for Road Traffic Noise, where road traffic noise impacts may occur.

  *Note: The noise impact assessment report should provide details of all monitoring of existing ambient noise levels including:*

  - *Details of equipment used for the measurements,*
  - *A brief description of where the equipment was positioned,*
  - *A statement justifying the choice of monitoring site, including the procedure used to choose the site, having regards to the definition of 'noise sensitive location(s)' and 'most affected location(s)' described in Section 3.1.2 of the NSW Industrial Noise Policy,*
  - *Details of the exact location of the monitoring site and a description of land uses in the surrounding areas,*
  - *A description of the dominant and background noise sources at the site,*
  - *Day, evening and night assessment background levels for each day of the monitoring period,*
  - *The final RBL value,*

- *Graphs of the measured noise levels for each day,*
- A record of the periods of affected data (due to adverse weather and extraneous noise), methods used to exclude invalid data and a statement indicating the need for any re-monitoring under Step 1 in Section B1.3 of the *NSW Industrial Noise Policy,*
- Determination of $L_{Aeq}$ noise levels from existing industry.

**Air**

- Provide a description of existing air quality and meteorology, using existing information and site representative ambient monitoring data in accordance with the 2001 EPA *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales.*

**Water**

- Describe existing surface water quality – an assessment needs to be undertaken for any water resource likely to be affected by the proposal and for all conditions (for example a wet weather sampling program is needed if runoff events may cause impacts).
- Provide historic river flow data where available for the catchment.
- Provide site drainage details and surface runoff yield.
- Describe the condition of the local catchment for example erosion levels, soils, vegetation cover, etc.
- Outline baseline groundwater information, including, but not restricted to, depth to watertable, flow direction and gradient, groundwater quality, reliance on groundwater by surrounding users and by the environment.

*Note: Methods of sampling and analysis need to conform with the EPA's Approved Methods for the Sampling and Analysis of Water Pollutants in NSW 1998 and analysis undertaken by accredited laboratories.*

## 2. <u>Assess environmental impacts</u>

**General**

- For any potential impacts relevant for the assessment of the proposal provide a detailed analysis of the impacts of the proposal on the environment including the cumulative impact of the proposal on the receiving environment given the existing situation especially where there are sensitive receivers.
- Describe the methodology used and the assumptions made in undertaking this analysis (including any modelling or monitoring undertaken) and indicate the level of confidence in both the predicted outcomes and the resilience of the environment to cope with the predicted impacts.
- The analysis should also make linkages between different areas of assessment where necessary to enable a full assessment of environmental impacts (for example assessment of impacts on air quality will often need to draw on the analysis of traffic, health, social and/or ecological systems impacts; etc.).
- The assessment needs to consider impacts at all phases of the project cycle including: exploration (if relevant or significant), construction, excavation, routine operation, start-up operations, upset operations and decommissioning (if relevant).

- The assessment should also consider impacts of the proposal on the whole of bay system, in the context of the recent Government decision on the Healthy Rivers Commission's *Final Report – Independent Inquiry into the Georges River – Botany Bay System, September 2001.*

**Noise and Vibration**

- Determine the project specific noise levels for the site. For each identified potentially affected receiver, this should include:
  - determination of the intrusive criterion for each identified potentially affected receiver;
  - selection and justification of the appropriate amenity category for each identified potentially affected receiver;
  - determination of the amenity criterion for each receiver; and
  - determination of the appropriate sleep disturbance limit.

*Note: Maximum noise levels during night-time period (10pm-7am) should be assessed to analyse possible affects on sleep. Where $L_{A1(1min)}$ noise levels from the site are less than 15 dB above the background $L_{A90}$ noise level, sleep disturbance impacts are unlikely. Where this is not the case, further analysis is required. Additional guidance is provided in Appendix B of the NSW Environmental Criteria for Road Traffic Noise.*

- Determine the noise levels arising from the additional train movements from the Port Botany site arising from the proposal in reference to the requirements of environment protection licence number 3142 held by the Rail Infrastructure Corporation.
- Determine expected noise level and noise character (for example tonality, impulsiveness, vibration, etc.) likely to be generated from noise sources during:
  - site establishment;
  - construction;
  - operational phases;
  - transport including traffic noise generated by the proposal; and
  - other services.

Note: *The noise impact assessment report should include noise source data for each source in 1/1 or 1/3 octave band frequencies including methods or references used to determine noise source levels.*

- Determine the noise and vibration levels likely to be received at the most sensitive locations (these may vary for different activities at each phase of the development). Potential impacts should be determined for any identified significant adverse meteorological conditions. Predicted noise levels under calm conditions may also aid in quantifying the extent of impact where this is not the most adverse condition.

Note: *The noise impact assessment should include:*
  - *A plan showing the assumed location of each noise source for each prediction scenario,*
  - *A list of the number and type of noise sources used in each prediction scenario to stimulate all potential significant operating conditions on the site,*
  - *Any assumptions made in the predictions in terms of source heights, directivity effects, shielding from topography, buildings or barriers, etc,*
  - *Methods used to predict noise impacts including identification of any noise models used,*
  - *Methods used to predict noise impacts including identification of any noise models used. Where modelling approaches other than the use of the ENM or SoundPlan computer models are adopted, the approach should be appropriately justified and validated,*

- *An assessment of appropriate weather conditions for the noise predictions including references to any weather data used to justify the assumed conditions,*
- *The predicted noise impacts from each noise source as well as the combined noise level for each prediction scenario under any identified significant adverse weather conditions as well as calm conditions where appropriate,*
- *Where a significant level of noise impact is likely to occur, noise contours for the key prediction scenarios should be derived,*
- *An assessment of the need to include modification factors as detailed in Section 4 of the NSW Industrial Noise Policy.*

- Discuss the findings from the predictive modelling and, where relevant noise criteria have not been met, recommend additional mitigation measures.

*Note: The noise impact assessment report should include details of any mitigation proposed including the attenuation that will be achieved and the revised noise impact predictions following mitigation.*

- Where relevant noise/vibration criteria cannot be met after application of all feasible and reasonable mitigation measures the residual level of noise impact needs to be quantified by identifying:
  - locations where the noise level exceeds the criteria and extent of exceedence;
  - numbers of people (or areas) affected;
  - times when criteria will be exceeded;
  - likely impact on activities (speech, sleep, relaxation, listening, etc.);
  - change on ambient conditions; and
  - the result of any community consultation or negotiated agreement.
- For the assessment of existing and future traffic noise, details of data for the road should be included such as assumed traffic volume; percentage heavy vehicles by time of day; and details of the calculation process. These details should be consistent with any traffic study carried out in the EIS.
- Where blasting is intended, the following details of the blast design should be included in the noise assessment:
  - bench height, burden spacing, spacing burden ratio;
  - blast hole diameter, inclination and spacing; and
  - type of explosive, maximum instantaneous charge, initiation, blast block size, blast frequency.

*Note: The noise impact assessment report should include noise source data for each source in 1/1 or 1/3 octave band frequencies including methods or references used to determine noise source levels.*

**Air**

- Provide a detailed air quality impact assessment conducted in accordance with the requirements of the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales.* The air quality impact assessment must include all the information specified in Section 10 of the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales.*

**Water**

- Identify and estimate quantity of all pollutants that may be introduced into the water cycle by source and discharge point including residual impacts after mitigation measures are implemented.

- Apply the ANZECC 2000 water quality guidelines to assess potential ecosystem impacts of contaminants in water.
- Describe the effects and significance of any pollutant loads on the receiving environment.
- Determine changes to hydrology (including drainage patterns, surface runoff yield, flow regimes, wetland hydrologic regimes and groundwater).
- Describe water quality impacts and their significance resulting from changes to hydrologic flow regimes (such as nutrient enrichment or turbidity resulting from changes in frequency and magnitude of stream flow).
- Describe changes to wave and current patterns/energy and their significance resulting from the development such as land-forming, excavations/dredging, working capacity of structures and water resource requirements of the proposal .
- Identify any potential impacts on quality, quantity and flow patterns of groundwater describing their source and significance.
- Identify any potential impacts on aquatic ecology including the distribution of seagrass communities and any options for wetland habitat replacement.
- Identify potential impacts associated with activities with potential to increase surface water and sediment runoff or to reduce runoff and sediment transport. Also consider possible impacts such as bed lowering, bank lowering, instream siltation, floodplain erosion and floodplain siltation.
- Identify impacts associated with the disturbance of acid sulfate soils and potential acid sulfate soils.
- Provide details of the project relevant to any water impacts of the development such as drainage works and associated infrastructure; land-forming, excavations/dredging; working capacity of structures; and water resource requirements of the proposal.
- Outline site layout, demonstrating efforts to avoid proximity to water resources (especially for activities with significant potential impacts) and showing potential areas of modification of contours, drainage etc.

*Note: The assessment of water quality impacts needs to be undertaken in a total catchment management context to provide a wide perspective on development impacts, in particular cumulative impacts.*

**Soil, Groundwater and Sediment Contamination Issues**

- Identify any likely impacts resulting from the construction or operation of the proposal, including dredging and land reclamation – this should include the likelihood of:
  - moving, handling, stockpiling, drying and transporting contaminated soil and/or sediment;
  - disturbing any existing contaminated soil and/or sediment;
  - contamination of soil and/or sediment by operation of the activity;
  - subsidence or instability;
  - soil erosion;
  - disturbing acid sulfate or potential acid sulfate soils.

**Waste and chemicals**

Provide details of:

- the adequacy of proposed measures to minimise natural resource consumption and minimise impacts from the handling, transporting, storage, processing and reprocessing of waste and/or chemicals (including dangerous and/or hazardous substances).
- the quantity and type of liquid and non-liquid waste, chemicals, dangerous materials or recovered materials generated, handled, processed or disposed of at the premises in accordance with the EPA's *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes 1999.*
- Procedures and management systems for the above substances at the proposed facility, including:
  - the transportation, assessment, classification and handling of waste, chemicals, dangerous materials or recovered materials arriving at or generated at the site;
  - any stockpiling of wastes or recovered materials at the site;
  - any waste processing related to the facility, including reuse, recycling, reprocessing (including composting) or treatment both on- and off-site;
  - the method for disposing of all wastes or recovered materials at the facility;
  - the emissions arising from the handling, storage, processing and reprocessing of waste at the facility; and
  - the proposed controls for managing the environmental impacts of these activities.
- spoil disposal with particular attention to:
  - the quantity of spoil material likely to be generated;
  - proposed strategies for the handling, stockpiling, reuse/recycling and disposal of spoil;
  - the need to maximise reuse of spoil material in the construction industry;
  - identification of the history of spoil material and whether there is any likelihood of contaminated material, and if so, measures for the management of any contaminated material; and
  - designation of transportation routes for transport of spoil.

**Ecological Sustainable Development (ESD)**

- Identify gaps in information and data relevant to significant impacts of the proposal and any actions proposed to fill those information gaps so as to enable development of appropriate management and mitigation measures.

**Cumulative impacts**

- Identify the extent that the receiving environment is already stressed by existing development and background levels of emissions to which this proposal will contribute.
- Assess the impact of the proposal against the long term air, noise and water quality objectives for the area or region.
- Identify infrastructure requirements flowing from the proposal (for example water and sewerage services, transport infrastructure upgrades).
- Assess likely impacts from such additional infrastructure and measures reasonably available to the proponent to contain such requirements or mitigate their impacts (for example travel demand management strategies).

## 3. Management and mitigation of environmental impacts

### General

- Use environmental impacts as key criteria in selecting between alternative designs and technologies, and to avoid options having the highest environmental impacts.
- Describe any mitigation measures and management options proposed to minimise identified environmental impacts associated with the proposal including an assessment of their effectiveness and reliability and any residual impacts after these measures are implemented and how they are to be monitored.
- Outline any proposed approach (such as an Environmental Management Plan) that will demonstrate how commitments made in the EIS will be implemented and reported. Areas that should be described include, but are not limited to:
  - operational procedures to manage environmental impacts;
  - monitoring procedures;
  - training programs;
  - community consultation;
  - complaint mechanisms including site contacts;
  - strategies to use monitoring information to improve performance; and
  - strategies to achieve acceptable environmental impacts and to respond in event of exceedences.

### Noise and vibration

- Determine the most appropriate noise mitigation measures and expected noise reduction including noise controls and management of impacts for construction, operational (including traffic noise impacts) and decommissioning noise. This will include selecting quiet equipment and construction methods, noise barriers or acoustic screens, location of stockpiles, temporary offices, compounds and vehicle routes, scheduling of activities, etc. and proposing a monitoring and reporting program.
- For traffic noise impacts, provide a description of the ameliorative measures considered (if required), reasons for inclusion or exclusion, and procedures for calculation of noise levels including ameliorative measures. Also include, where necessary, a discussion of any potential problems associated with the proposed ameliorative measures, such as overshadowing effects from barriers. Appropriate ameliorative measures may include:
  - use of alternative transportation modes, alternative routes, or other methods of avoiding the new road usage
  - control of traffic (for example limiting times of access or speed limitations)
  - resurfacing of the road using a quiet surface
  - use of (additional) noise barriers or bunds
  - treatment of the facade to reduce internal noise levels in buildings where the night-time criterion is a major concern
  - more stringent limits for noise emission from vehicles (that is, using specially designed "quiet" trucks and/or trucks to use air bag suspension)
  - driver education
  - appropriate truck routes
  - limit usage of exhaust breaks
  - use of premium mufflers on trucks

- reducing speed limits for trucks
- ongoing community liaison and monitoring of complaints phasing in the increased road use.

**Air**

- Outline specifications of pollution control equipment (including manufacturer's performance guarantees where available) and management protocols including monitoring and reporting for both point and fugitive emissions. Where possible, this should include cleaner production processes.

**Water**

- Outline stormwater management to control pollutants at the source and contain them within the site. Also describe measures for maintaining and monitoring any stormwater controls.
- Outline erosion and sediment control measures directed at minimising disturbance of land, minimising water flow through the site and filtering, trapping or detaining sediment. Also include measures to maintain and monitor controls as well as rehabilitation strategies.
- Describe waste water treatment measures that are appropriate to the type and volume of waste water and are based on a hierarchy of avoiding generation of waste water; capturing all contaminated water (including stormwater and dredging waste water) on the site; reusing/recycling waste water; and treating/monitoring/reporting any unavoidable discharge from the site to meet specified water quality requirements in accordance with the Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* and the NSW Government's *Water Quality and River Flow Interim Environmental Objectives 1999.*
- Outline pollution control measures relating to storage of materials, possibility of accidental spills (for example preparation of contingency plans), appropriate disposal methods, and generation of leachate.
- Describe hydrological impact mitigation measures including:
  - minimising runoff;
  - minimising reductions or modifications to flow regimes; and
  - avoiding modifications to groundwater.
- Describe groundwater impact mitigation measures including:
  - retention of native vegetation and revegetation;
  - artificial recharge;
  - providing surface storage with impervious linings; and
  - monitoring program.
- Describe geomorphological mitigation measures including:
  - erosion and sediment controls;
  - minimising in stream works;
  - treating existing accelerated erosion and deposition;

- monitoring program.

- Describe any trade-off or off-set measures to be instigated in the event that the proposal is approved.

**Waste and chemicals**

- Outline measures to minimise the consumption of natural resources.
- Outline measures to avoid the generation of waste and promote the re-use and recycling and reprocessing of any waste.
- Outline measures to support any approved regional or industry waste plans.

**Soil and sediment issues**

- Describe and assess the effectiveness or adequacy of any soil and/or sediment management and mitigation measures during construction and operation of the proposal including:
  - erosion and sediment control measures; and
  - proposals for site remediation – see *Managing Land Contamination, Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Authority 1998), guidelines made or approved by the EPA under section 105 of the *Contaminated Land Management Act 1997* and the EPA's *Assessing and Managing Acid Sulfate Soils 1995* (note that this is only methodology accepted by the EPA).

**Community consultation**

- Outline proposed community consultation procedures. This should include an open and transparent community consultation program, including prominent public advertisement of the application.

## F. COMPILATION OF MITIGATION MEASURES

- Outline how the proposal and its environmental protection measures would be implemented and managed in an integrated manner so as to demonstrate that the proposal is capable of complying with statutory obligations under EPA licences (for example outline of an environmental management plan).

- The mitigation strategy should include the environmental management and cleaner production principles which would include two sections, one setting out the program for managing the proposal and the other outlining the monitoring program with a feedback loop to the management program.

## G. JUSTIFICATION FOR THE PROPOSAL

- Reasons should be included which justify undertaking the proposal in the manner proposed, having regard to the potential environmental impacts.

## H. LIST OF APPROVALS AND LICENCES

- Identify all approvals and licences required under environment protection legislation including details of all scheduled activities, types of ancillary activities and types of discharges (to air, land, water). This should include identification of any construction and/or operations phase licence(s) required under any provisions of Schedule 1 of the Protection of the Environment Operations Act and in particular, but not limiting to, whether the proposed activities on the site will meet or exceed the threshold for the following activities:
  - Chemical storage facilities;
  - Contaminated soil treatment works;
  - Dredging works;
  - Shipping facilities.

## I. AVAILABLE GUIDANCE MATERIALS

### Relevant legislation administered by the EPA

- The *Protection of the Environment Operations (POEO) Act 1997* sets out the broad allocation of responsibilities under the Act between the EPA, local councils and other public authorities. The activities listed in Schedule 1 to the Act (broadly, activities with potentially significant environmental impacts) require a licence. Licences can control the air, noise, water and waste impacts of an activity.

- The Road and Rail Transport (Dangerous Goods) Act 1997 regulates the transport of dangerous goods (other than explosives) by road and rail as part of a national scheme for road transport. It substantively re-enacts the Commonwealth's *Road Transport Reform (Dangerous Goods) Act 1995.*

### Guidelines made by the EPA

- The EPA's *NSW Industrial Noise Policy 2000* provides the framework and process for deriving noise limit conditions for consents and licences that will enable the EPA to regulate premises.

- The waste guidelines also provide for a process to assess and classify wastes that are not already classified under Schedule 1 (Part 3) of the *Protection of the Environment Operations Act (POEO Act) 1997.* In this regard, you attention is directed to Technical Appendices 1 and 2 of the Waste Guidelines.

- The EPA's *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW 1998* sets out the sampling and analysis methods to be used to test for the presence or concentration of matter in water.

- The EPA's *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW 2001* lists the methods to be used and provide guidance for the modelling and assessment of air pollutants from stationary sources in NSW for statutory purposes.

- The EPA's *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW 1998* sets out the sampling and analysis methods to be used to test for the concentration air pollutants.

- The EPA's draft policy *Assessment and Management of Odour from Stationary Sources in NSW* outlines the legislation that applies to odour assessment and management and recommends a policy framework for dealing with odour issues.

**Guidelines approved and/or used by the EPA**

- Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* and the NSW Government's *Water Quality and River Flow Interim Environmental Objectives1999*, provide a framework for water quality management.

- The Department of Housing's *Managing Urban Stormwater: Soils and Construction 1998* describes techniques for soil and water management of construction activities.

- In August 1998 the NSW Government released the Acid Sulfate Soils Manual. This 'all of government' approach to the issue was prepared by the interdepartmental Acid Sulfate Soils Management Advisory Committee. The manual covers the following topics:
  - Planning guidelines
  - Assessment guidelines
  - Management guidelines
  - Laboratory methods guidelines
  - Drainage guidelines
  - Groundwater guidelines
  - Management plan guidelines
  - Industry guidelines

(13)

Waterways

Our Reference: 02//00001
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**MARITIME PROPERTY & ASSETS DIVISION**
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Level 11, Maritime Trade Towers
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4 February 2002

Mr Gordon Kirkby
A/Assistant Director
Development and Infrastructure Assessment
Planning NSW
GPO Box 3927
Sydney NSW 2001

-5 FEB 2002

Facsimile 9762 8703

Dear Mr Kirkby

**SYDNEY PORTS CORPORATION — PROPOSED EXPANSION OF PORT BOTANY, BOTANY BAY**

Thank you for your letter of 20 December 2001 seeking the Waterways Authority's issues in relation to the preparation of an environmental impact statement (EIS) for the above project.

It is noted that the proposed development is State Significant Development for the purposes of Part 4 of the *Environmental Planning and Assessment Act 1979*.

The Waterways Authority is by law the successor of the Maritime Services Board and of the Marine Ministerial Holding Corporation (MMHC). Assets now owned by the Waterways Authority include the seabed of Botany Bay and adjacent foreshore land such as Northern Foreshore Beach (immediately seaward of Foreshore Drive) and west of Penrhyn Road. In addition, the Chief Executive of the Waterways Authority is the delegate of the Minister for Transport in exercising his functions under the *Maritime Services Act 1935* and the *Rivers and Foreshores Improvement Act 1948*.

Please be advised that the proposed works will require the following approvals from the Waterways Authority:

1. Approval under the *Maritime Services Act 1935* (in particular, section 13T and section 13TA),
2. Permit under Part 3A of the *Rivers and Foreshores Improvement Act 1948, and*
3. Prior to lodgement of the development application, consent as land owner for the lodgement of the DA.

From the Authority's perspective, the following information should be covered in an EIS for the proposed development:

1. Historical context for the development of Port Botany and justification for the proposed extension in terms of current and future requirements and trends in international commercial shipping. The EIS should take into account the

proposed expansion of the Patrick's Terminal at Port Botany and address potential operational impacts at the Port of Sydney.

2. Details of the size of vessels anticipated including overall length (metres), beam (metres), Gross Registered Tonnes (GRT) and Deadweight Tonnes (DWT). Such details should include the maximum size vessel as well as the range of vessels.

3. A full description of works proposed including reclamation, dredging, works on adjacent foreshore land and replacement of the existing public boat ramp.

4. Details of proposed dredging should include:

   (a) Purpose of the proposed dredging including details of the likely maximum number and types of berths,

   (b) Proposed extent and depth of dredging and existing depth of water,

   (c) Quantity of material to be dredged,

   (d) Type of material to be dredged including the extent of soil sampling on which the analysis is based,

   (e) Likelihood of disturbing contaminated sediments and acid sulphate potential,

   (f) Proposed method of dredging and proposed method of spoil removal and spoil disposal including equipment, size and location of any pipelines, and any dewatering operations. Any assumptions made with regard to removal methods should be stated together with any alternative removal methods which may need to be employed, and

   (g) Any likely interference with existing port, recreational boating or other waterway uses.

5. Details of reclamation including:

   (a) Submerged and on-shore land affected,

   (b) Quantity of material to be deposited,

   (c) Source(s) of material, and

   (d) Characteristics of material and suitability for purpose.

6. The establishment of a replacement public boat ramp in a suitable location as part of the port expansion proposal, in light of the unavoidable removal of the existing boat ramp off Penrhyn Road. The EIS should include plans of the proposed boat ramp facility, assess potential impacts, and discuss timing in relation to the overall port expansion works. The boat ramp facility it to be of at least equal standard to the current facility.

7. Details of any temporary structures, berthing facilities, platforms etc. needed to allow staging of the development works.

8. Plans and other drawings showing:

   (a) The location, extent and depth of the proposed dredging (all depths should be to Fort Denison Datum),

   (b) The location of the toe and top of all battered or retained banks together with an average slope and extent of those banks,

(c) Current depth contours and proposed depth contours of the areas to be affected,

(d) Any redistribution of material within the dredged area,

(e) Details of the proposed disposal areas, including current and proposed contours, details of current features at the sites, details of all proposed containment and dewatering structures as well as any temporary works,

(f) Likely berth locations and wharf structures adjacent to the dredged area,

(g) The location of the replacement public boat ramp and associated works, and

(h) Locations of marine and terrestrial vegetation, aquatic and animal habitats etc. likely to be affected (directly or indirectly) by the proposed works during construction and operation.

9. A detailed analysis of the potential effects on coastal processes/ hydrodynamics within Botany Bay. Of particular concern are the potential effects on foreshore stability around Botany Bay including implications for current and proposed coastal protection works such as at Lady Robinsons Beach and Towra Point. The EIS should include details of studies undertaken and level of certainty of predictions.

10. The method, timing and staging of construction including dredging rates and contingencies such as range of weather conditions necessitating the temporary cessation of operations.

11. Describe the stormwater and water quality controls to be adopted for the operation of the facility to ensure minimised adverse water quality impacts on Botany Bay or adjacent foreshore habitats.

12. The effect on existing stormwater drainage into Botany Bay including the Mill Stream Diversion Channel and mitigating measures.

13. Discussion of the general impacts on navigation and recreational boating and proposed mitigating/management measures both during the construction phase and when in operation.

14. Consideration of any potential effects on the surrounding area such as structural damage, vibration, noise, etc. arising from the proposed dredging.

15. A detailed framework for an Environmental Management Plan for the development including:

(a) Staging of the proposal, site management and sediment and erosion control measures,

(b) Location, type and scale of associated works such as temporary structures, stockpiles, access roads and related activities. Outline the proposed treatment of these sites,

(c) Measures for the mitigation of potential adverse impacts on the environment during and post construction, and

(d) Contingency plans and emergency response plans.

16. Identify any proposed monitoring and maintenance programme for the dredged channel, bank stability etc during and post construction and short- and long-term.

17. Describe the vegetation to be removed or impacted by the proposed development and details of any landscaping to be carried out. It is desirable that landscaping be comprised of locally indigenous species which represent the original plant communities which would have been found in the Botany Bay area.

If you have any further questions regarding this matter please contact Persephone Rougellis on telephone 9364 2176.

Yours sincerely,

David Morton
**A/General Manager**

(19)

NSW Fisheries

1 7 JAN 2002

Our ref: BB2-04-001
Your ref: S01/02520

15 January 2002

Mr Gordon Kirkby
A/ Assistant Director
Department of Urban Affairs and Planning
GPO Box 3927
SYDNEY NSW 2001

Dear Mr Kirkby

**Re: Proposed Expansion of Port Botany**

Thank you for your letter requesting EIS requirements from NSW Fisheries for the proposal cited above.

This proposal will have major impacts on the aquatic environment and therefore the EIS must consider the range of issues outlined below to ensure the impacts are mitigated wherever possible, adequate compensation is proposed to avoid a net loss of habitat, and that indirect impacts are also explored and factored into the cost of the works. Overall this Department encourages holistic treatment of Botany Bay for both the natural and the built environment to ensure that existing and planned protection and mitigation works in other areas of the Bay are still functional. This policy is in line with the findings of the *Independent Inquiry into the Georges River-Botany Bay System* by the Healthy Rivers Commission.

There are two parts to this letter. The first section outlines information that is specific to this proposal, the second section outlines our general EIS requirements and expands on some of the points in the first section.

***Particularly for this proposal the following must be considered within the EIS:***

These works will require the following approvals/permits from NSW Fisheries:

- A permit to harm marine vegetation,
- An approval for dredging and reclamation,
- An approval to block fish passage, and
- If underwater explosive work is necessary, an approval for the use of explosives.

The alternatives need to be explored further and then compared with the Port Botany proposal that includes the costings of any secondary works necessary to protect the remainder of Botany Bay from the extensive reclamation proposed. An alternative that does not involve such extensive reclamation should be seriously explored.

Direct issues:

1. Dredging and reclamation work proposed.
2. Contaminated sediment remobilisation and disposal/use of spoil within reclamation.
3. Impact on water quality, particularly turbidity.

4. Impact on marine vegetation, including seagrasses, mangroves, macroalgae and saltmarsh:
   - Any proposed transplantation of seagrass must include suitable areas for receipt of seagrass and methods of secondary compensation if transplants fail.
   - The impacts on marine vegetation left in situ such as altered wave refraction and other changes in water movement, container movement, moorings and traffic from the new boat ramp.
5. Impact on other aquatic habitats, eg rocky reefs, sand flats
6. Impact on fish and invertebrate populations.
7. Impact on fish passage, including in the immediate vicinity, into the Mill ponds and Penrhyn estuary catchment.
8. Impact on aquatic threatened species.
9. Impact on fishing, both recreational and commercial including the proposal for a Recreational Fishing Area within Botany Bay. Community consultation with recreational fishers/clubs, commercial fishers and conservation groups will be necessary.
10. Possible methods of compensation for loss of fish habitat, eg reopening Botany Wetlands to saltwater intrusion, Cooks River rehabilitation.
11. Stormwater.
12. Impacts on groundwater.
13. Options/impacts for Penrhyn estuary/catchment.
14. An environmental management plan is necessary.
15. Maximising the use of rail rather than road transport.
16. Impact of ballast water, hull fouling and the increased risk of introducing noxious species.

Indirect issues:

- Predicted refraction of wave energy on to other sections of the Bay, particularly Towra Point aquatic and terrestrial environments, and the predicted impacts, including on seagrasses.
- Alteration of currents and other coastal processes within the Bay.
- The impact of proposed protection works, eg for terrestrial nature reserves, beaches or the built environment, on the aquatic environment.

***The information listed below is our general requirements.***

**Definitions**

The definitions given below are relevant to these requirements:

***Fish*** means any part of marine, estuarine or freshwater fish or other aquatic animal life at any stage of their life history (whether alive or dead). Fish include oysters and other aquatic molluscs, crustaceans, echinoderms and beachworms and other aquatic polychaetes.

***Marine vegetation*** means any species of plant that at any time in its life must inhabit water (other than fresh water).

***Waters*** refers to all waters including tidal waters to the Astronomical High Tide Level (AHTL) as well as flowing streams, irregularly flowing streams, gullies, rivers, lakes, coastal lagoons, wetlands and other forms of natural or man made water bodies on both private and public land.

**Useful Information**
To help you in the preparation of an EIS, the publication "*Guidelines for the Assessment of Aquatic Ecology in EIA*" (Draft 1998) produced by the Department for Urban Affairs and Planning may prove useful in outlining appropriate procedures and methodologies for conducting aquatic surveys.

**Matters to be Addressed**

1. **General Requirements**

The EIS must include the information outlined below:
A topographic map of the locality at a scale of 1:25 000 should be provided. This map should detail the location of all component parts of the proposal, any areas locally significant for threatened species (such as aquatic reserves), and areas of high human activity (such as townships, regional centres and major roads).

A recent aerial photograph (preferably colour) of the locality (or reproduction of such a photograph) should be provided, if possible. This aerial photograph should clearly show the subject site and indicate the scale of the photograph.

**GENERAL REQUIREMENTS**

- Area which may be affected either directly or indirectly by the development or activity should be identified and shown on an appropriately scaled map (and aerial photographs).
- All waterbodies and waterways within .the proposed area of development are to be identified.
- Description of aquatic vegetation, snags, gravel beds and any other protected, threatened or dominant habitats should be presented.
- Area, density and species composition should be included and mapped.
- Identification of recognised recreational and commercial fishing grounds, aquaculture farms and/or other waterways users.
- Presented maps or plans
- Description of proposal and study area
- Details of the location of all component parts of the proposal, including any auxiliary infrastructure, timetable for construction of the proposal with details of various phases of construction
- Size of the area affected
- Aspects of the management of the proposal, both during construction and after completion, which relate to impact minimisation eg Environment Management Plans
- Plan of study area
- Locations and types of landuses present
- Locations of streams and other waterbodies
- Land tenure details for all land parcels
- For each freshwater body identified on the plan, the plan should include, either by annotation or by an accompanying table, hydrological and stream morphology information such as: flow characteristics, including any seasonal variations, bed substrate, and bed width
- For each marine or estuarine area identified on the plan, the plan should include, either by annotation or by an accompanying table, hydrological and stream morphology information such as: tidal characteristics, bed substrate, and depth contours

**DREDGING AND RECLAMATION ACTIVITIES**

- Purpose of works
- Type(s) of marine vegetation in the vicinity of the proposed works
- Distance of adjacent marine vegetation from the outer boundary of the proposed works
- Method of dredging to be used
- Duration of dredging works
- Time of dredging works
- Dimension of area to be dredged
- Depth of dredging activities
- Nature of sediment to be dredged, including Acid Sulphate Soil
- Method of marking area subject to works
- Environmental safeguards to be used during and after works
- Measures for minimising harm to fish habitat under the proposal
- Spoil type and source location for reclamation activities
- Method of disposal of dredge material
- Location and duration of spoil stockpiling, if planned
- Volume of material to be extracted or placed as fill

**ACTIVITIES THAT DAMAGE MARINE VEGETATION**

- Type of marine vegetation to be harmed
- Amount of marine vegetation to be harmed, map distribution of marine vegetation
- Reasons for harming marine vegetation
- Methods of harming marine vegetation
- Construction details
- Duration of works/activities
- Measures for minimising harm to marine vegetation under the proposal
- Environmental measures to be employed, if necessary
- Method and location of transplanting activities or disposal of marine vegetation

**ACTIVITIES THAT BLOCK FISH PASSAGE**

- Type of activity eg works in a stream that change flow or morphological characteristics
- Length of time fish passage is to be restricted
- Timing of proposed restriction
- Remediation works

**THREATENED SPECIES**

- Threatened aquatic species assessment (Part 5C, EP&A Act 1979)
- Eight-Part Test
- Consultation with NSW Fisheries immediately the Eight-Part Test is completed and prior to the EIS being finalised.

2. **Initial assessment**

A list of threatened species, endangered populations and endangered ecological communities must be provided. In determining these species, consideration must be given to the habitat types present within the study area, recent records of threatened species in the locality and the known distributions of these species.

In describing the locality in the vicinity of the proposal, discussion must be provided in regard to the previous land and water uses and the effect of these on the proposed site. Relevant historical events may include land clearing, agricultural activities, water abstraction/diversion, dredging, de-snagging, reclamation, siltation, commercial and recreational activities.

A description of habitat including such components as stream morphology, in-stream and riparian vegetation, water quality and flow characteristics, bed morphology, vegetation (both aquatic and adjacent terrestrial), water quality and tide/flow characteristics must be given. The condition of the habitat within the area must be described and discussed, including the presence and prevalence of introduced species. A description of the habitat requirements of threatened species likely to occur in the study area must be provided.

In defining the proposal area, discussion must be provided in regard to possible indirect effects of the proposal on species/habitats in the area surrounding the subject site: for example, through altered hydrological regimes, soil erosion or pollution. The study area must extend downstream and/or upstream as far as is necessary to take all potential impacts into account.

**Please Note:** Persons undertaking aquatic surveys may be required to hold or obtain appropriate permits or licences under relevant legislation. For example:

*Fisheries Management Act 1994*

- Permit to take fish or marine vegetation for research or other authorised purposes (Section 37)
- Licence to harm threatened (aquatic) species, and/or damage the habitat of a threatened species (Section 220ZW).

*Animal Research Act* 1985:

- Animal Research Authority to undertake fauna surveys.

It is recommend that, prior to any field survey activities taking place, those persons proposing to undertake those activities give consideration to their obligation to obtain appropriate permits or licences which may be required in the specific context of the proposed survey activities.

3. **Assessment of likely impacts**

The EIS must:

- describe and discuss significant habitat areas within the study area;
- outline the habitat requirements of threatened species likely to occur in the study area;
- indicate the location, nature and extent of habitat removal or modification which may result from the proposed action;
- discuss the potential impact of the modification or removal of habitat;
- identify and discuss any potential for the proposal to introduce barriers to the movement of fish species; and
- describe and discuss any other potential impacts of the proposal on fish species or their habitat.

For all species likely to have their lifecycle patterns disrupted by the proposal to the extent that individuals will cease to occupy any location within the subject site, the EIS must describe and discuss other locally occurring populations of such species. The relative significance of this location for these species in the general locality must be discussed in terms of the extent, security and viability of remaining habitat in the locality.

**4. Ameliorative measures**

The EIS must consider how the proposal has been or may be modified and managed to conserve fisheries habitat on the subject site and in the study area.

In discussing alternatives to the proposal, and the measures proposed to mitigate any effects of the proposal, consideration must be given to developing long term management strategies to protect areas within the study area which are of particular importance for fish species. This may include proposals to restore or improve habitat.

Any proposed pre-construction monitoring plans or on-going monitoring of the effectiveness of the mitigation measures must be outlined in detail, including the objectives of the monitoring program, method of monitoring, reporting framework, duration and frequency.

In the event of a request for concurrence or consultation of the Director of NSW Fisheries, one (1) copy of the EIS should be provided to NSW Fisheries in order for the request to be processed.

It should be noted that NSW Fisheries has no regulatory or statutory role to review draft EISs unless they are accompanied by or are requested as part of a licence application under Part 7A of the FM Act. However, NSW Fisheries is available to provide advice to consent and determining authorities regarding Fisheries' opinion as to whether the requirements have been met if requested, pending the availability of resources and other statutory priorities.

Should you require any further information on these requirements please contact me on 9492 9401.

Yours sincerely

LESLEY DIVER
**Conservation Manager – Sydney Region**

(16)

R T A

Roads and Traffic Authority
www.rta.nsw.gov.au

Sydney Client Services

83 Flushcombe Road
Blacktown NSW 2148
Telephone 131 782
Facsimile (02) 9831 0155
PO Box 558
Blacktown NSW 2148
DX 8120 Blacktown

Our Reference: 51.5314
Your Reference: S01/02520
Contact: Tricia Zapanta-Mostyn
Telephone: 9672 2577
Friday 18 January 2002

22 JAN 2002

Department of Planning
Development and Infrastructure Assessment
GPO Box 3927
**SYDNEY NSW 2001**

Attention: Gordon Kirby

Dear Mr Kirby

## PROPOSED EXPANSION OF PORT BOTANY - REQUEST FOR EIS REQUIREMENTS

Further to your letter of 20 December 2001 in relation to the above matter, the following information is submitted for your consideration.

The RTA would like to see the following issues addressed in an EIS for the subject site:

1. A Traffic and Transport Study should be prepared for the proposed Port Botany expansion site that takes into account the following issues:

   - The proposed means of vehicular access to/from the site. If direct vehicular access is sought via Foreshore Road, a concept plan showing proposed management arrangements such as traffic signal design should be prepared in consultation with the RTA. Consultation regarding vehicular access arrangements via Foreshore Road should be determined in the early stage of this proposal and prior to the exhibition of the EIS/Development Application for the Port Botany expansion site. This assessment should also include a cost estimate of work and funding/maintenance responsibilities. The RTA advises that it will not incur the cost of any traffic works required as a result of the Ports expansion.

   - Identification of alternative vehicular access arrangements in the event the proposed direct vehicular access or traffic signal construction on Foreshore Road is not viable.

   - An assessment of existing and future level of service on Foreshore Road in the event of traffic signal construction or an alternative traffic management measure for the Port Botany expansion site. The cumulative impact of providing direct vehicular access to the proposed new boat ramp facility as well as the existing traffic signal operation of Penryhn Road/Foreshore Road/Botany Road should be investigated.

- Identification of truck storage areas within the subject site, taking into account the RTA's intention to maintain No Stopping areas along Foreshore Road. The design of the road system within the site should include appropriate truck storage areas.

- Details of the anticipated haulage route of trucks through the metropolitan and local road network.

- Identification of likely peak traffic movements generated by the development and the potential increase in the level and type of traffic associated with the proposal as well as an assessment of the cumulative traffic generation of this development with surrounding developments and its impact on surrounding intersections.

- An assessment of the likely impact of truck traffic on nearby residential areas.

- Consideration of the need for the preparation of a local area traffic management plan.

- An assessment of the potential increase in toxicity levels of loads transported on arterial and local roads and consequently, the preparation of an incident management strategy for accidents, if appropriate.

- An assessment of the car parking provisions for employees and visitors of the facility.

2. Preparation of a Plan of Management during the construction phase of the Port Botany expansion site incorporating the traffic and transport issues mentioned above.

Please refer further queries to Tricia Zapanta-Mostyn on 672 2577.

Yours faithfully

Charles Wiafe
**Manager, Landuse Development**
**Transport Planning Unit, Sydney Client Services Branch**

# Attachment No. 4

20

NSW NATIONAL PARKS AND WILDLIFE SERVICE

ABN 30 841 387 271

Mr Gordon Kirkby
A/Assistant Director
Development and Infrastructure Assessment
PlanningNSW
GPO Box 3927
SYDNEY NSW 2001

Dear Mr Kirkby

**RE: Proposed expansion of Port Botany**

Thank you for your letter received on 24 December 2002 in which you consulted with the NSW National Parks and Wildlife Service (NPWS) on the above proposal.

It is understood that the proposal involves the provision of 2 kilometers of additional wharf space, with the terminal created by infilling and a ship manoeuvring basin created by dredging.

The NPWS has statutory responsibility for the protection and care of native flora, native fauna and Aboriginal sites, and for managing NPWS estate. Accordingly the NPWS has an interest in ensuring that potential impacts on these attributes are appropriately assessed in the EIS and SIS.

As this proposal is "State significant', it is understood that the Minister for Planning will be the consent authority under Part IV of the *Environmental Planning and Assessment (EP&A) Act*.

As the Minister for Planning will be the consent authority, the Minister for the Environment will have an advisory role should threatened species, populations or ecological communities be significantly impacted by the proposal. On 31 October 1997, the NPWS issued Director-General's requirements for a SIS for the then proposed expansion of Port Botany. It is advised that if it is concluded that the present proposal is likely to significantly impact to threatened species, populations or ecological communities, new Director-General's requirements for a SIS should be sought from the NPW Director-General.

The NPWS may be an approval body if Consent to Destroy an aboriginal site is required under Section 90 of the *National Parks and Wildlife Act*, pursuant to the IDA provisions of Part IV of the *EP&A Act*.

Attached are general guidelines for Environmental Impact Assessment and Aboriginal Heritage Impact Assessment. Impacts of particular concern, which should be identified in the preliminary stages of the assessment process, include the impact of the proposal on:

- the habitat of species protected under the *TSC Act*, particularly waders;
- Aboriginal archaeological sites and areas of significance to the Aboriginal community;
- Towra Spit and areas of NPWS estate within the southern portion of Botany Bay.

43 Bridge Street
PO Box 1967
Hurstville NSW
2220 Australia
Tel: (02) 9585 6444
Fax: (02) 9585 6555
www.npws.nsw.gov.au

To adequately understand and assess the impact of the proposal on these matters it is suggested that a "whole of Botany Bay approach" be adopted. Hydrological assessment should be undertaken to identify, throughout Botany Bay, the likely impacts caused by the proposed dredging and associated wave refraction.

The EIS should also assess the regional importance of the Penrhyn Inlet area for threatened species and migratory waders. If the assessment process identifies that the area is regionally significant, and that that proposal will have a significant impact on those values, the EIS will need to consider mitigative strategies and other options for securing equivalent habitat values for the effected species.

If you have any questions regarding this advice, please contact Elise Stocker, Conservation Planning Officer on (02) 9585 6575.

Yours sincerely

Lou Ewins 21/1/02

Lou Ewins
**Manager, Conservation Planning Unit**
**Conservation Programs and Planning Division**
**Central Directorate**

NSW NATIONAL PARKS AND WILDLIFE SERVICE

# GENERAL GUIDELINES FOR IMPACT ASSESSMENT

The National Parks and Wildlife Service (NPWS) has an interest in the potential impacts of proposals on the following:

- areas of native vegetation;
- areas of potential value as habitat for native fauna;
- sites and places of Aboriginal cultural heritage, including areas of archaeological potential; and
- land dedicated under the *National Parks and Wildlife Act 1974* (*NP&W Act*).

If these attributes are anticipated to be present in your study area and / or likely to be impacted, it is recommended that assessments by a suitably qualified person be undertaken to determine the extent of impact. The NPWS suggests that the following basic details be included in the assessments:

- the qualifications and experience of the person undertaking the work; and
- a detailed description of survey methodology including survey design, sampling methods, weather conditions, time and duration of surveys and location of any survey sites and transect lines.

Specific issues that are recommended to be addressed by the assessments are detailed below.

## General information

- description of the proposal and the way in which the environment will be modified;
- map(s) placing the proposal in a regional and local setting;
- applicability of Local Environmental Plans, Regional Environmental Plans and State Planning Policies to the proposal;
- information on the current and past land uses of the site and that of the surrounding area; and

- appropriately scaled maps which identify the location and extent of any areas of native vegetation and fauna habitat and Aboriginal cultural heritage value in relation to the area of proposed development.

## Impacts

- prediction of the likely impact of the proposal on land dedicated under the *NP&W Act*;
- prediction of the likely impacts of the proposal on areas and items of natural significance, such as native vegetation and fauna habitat, and on Aboriginal heritage sites and areas of cultural significance. This should include consideration of any off-site impacts; and
- assessment of measures available to minimise the impact of the proposal on these attributes, including potential conservation options, alternative development options and monitoring programs, if appropriate.

## Native flora, fauna and threatened species

The following information is considered necessary to assess the potential impact of a proposal:

- detailed description and mapping of all vegetation communities in the study area;
- identification of any vegetation communities or plant species which are of local, regional or state conservation significance (including threatened species, populations, ecological communities or critical habitat listed under the *Threatened Species Conservation (TSC) Act*). The criteria for establishing significance should be documented;
- description of known or expected fauna assemblages within the study area;
- identification of fauna habitat likely to be of local, regional or state significance (including habitat of threatened species, populations, ecological communities or critical habitat listed under the *TSC Act*);
- identification of habitat corridors and linkages between areas of remnant native vegetation which may assist faunal movement through the area and an assessment of the conservation significance of these; and
- prediction of the likely impact of the proposal on the above attributes (quantification of the extent of impact where practical).

In addition to these general requirements, there are specific requirements relating to the assessment of a proposal and its potential impact on threatened species, populations, ecological communities, their habitats and critical habitat.

The provisions of the *TSC Act* and related provisions of the *Environmental Planning & Assessment Act* should be considered when undertaking the assessment of a proposal. In addition to the *TSC Act* itself, further information on the provisions of the

*TSC Act* may be obtained from the Department of Urban Affairs and Planning Circular No. A13 (12 December 1995). The NPWS has also produced Information Circulars on the *TSC Act* which may be obtained by contacting the NPWS Information Centre on (02) 9585 6333.

Concurrence provisions

Where a consent authority determines that a proposal is likely to have a significant effect on threatened species or their habitats, a species impact statement (SIS) must be prepared in accordance with the requirements of the Director-General of the National Parks and Wildlife Service. If, after considering the SIS, a consent authority intends to grant approval to a proposal that will have a significant effect on threatened species or their habitats then the concurrence of the NPWS is required. If the Minister for Urban Affairs and Planning is the consent authority the concurrence of the NPWS is not required, but consultation must occur with the Minister for the Environment before development consent is granted.

The process and timeframes for development applications that require concurrence are detailed in Division 2 of the *Environmental Planning and Assessment Regulation 1998*.

## Aboriginal heritage

General issues

For the purposes of these guidelines Aboriginal heritage is considered to include "relics" and places of significance to Aboriginal communities.

Under the *NPW Act*, a 'relic' is defined as any deposit, object or material evidence (not being a handicraft made for sale) relating to indigenous and non-European habitation of the area that comprises NSW, being habitation both prior to and concurrent with the occupation of that area by persons of European extraction, and includes Aboriginal remains (as defined within the meaning of the *NPW Act*). Relics are confined to physical evidence. Aboriginal 'relics' are commonly referred to as Aboriginal sites.

An "Aboriginal place" is a place which has been declared so by the Minister for the Environment because he or she believes that the place is or was of special significance to Aboriginal culture. It may or may not contain physical relics.

It should also be noted that there are places in the landscape which have particular meaning for Aboriginal people, for example, spiritual areas or natural mythological areas. Although these areas are not protected under the *NPW Act*, unless they contain physical remains of Aboriginal occupation or have been declared an 'Aboriginal place', it is recommended that the potential impact of proposals on such places also be considered in the assessment process.

## Assessment process

It is recommended that an assessment be conducted of the Aboriginal cultural values of the study area if the proposal involves disturbance to substantially unmodified ground surfaces. If the study area is considered to have archaeological potential or cultural significance then it is recommended that a survey and assessment be undertaken in accordance with NPWS guidelines. These guidelines are contained in the NPWS' publication "Aboriginal Cultural Heritage: Standards and Guidelines", which may be purchased by contacting the NPWS' Cultural Heritage Conservation Division on (02) 9585 6571.

Should any Aboriginal archaeological sites be present in the study area, you should consider the requirements of the *NP&W Act* with regard to Aboriginal relics. Under s90 of the *NP&W Act* it is an offence to knowingly damage or destroy relics without the prior permission of the Director-General of the NPWS.

In assessing Aboriginal heritage values, consideration should also be given to whether the study area is likely to contain places of cultural significance to the Aboriginal community. It should be noted that places of cultural significance to the Aboriginal community are not limited to archaeological sites. An assessment of cultural significance should involve consultation with community representatives and if necessary, documentary research to establish whether there are any places of traditional or historic significance to the Aboriginal community.

## Integrated Development Assessment

Under recent amendments to the *EP&A Act*, a range of approvals and licences issued by various agencies have been integrated with the development approval process. Section 91 of the *Environmental Planning and Assessment Amendment Act 1997* lists the approvals of agencies which are included in the integrated development assessment (IDA) process.

This includes Section 90 approvals under the *NP&W Act* regarding consent to knowingly destroy, deface or damage or knowingly cause or permit the destruction or defacement of or damage to an Aboriginal relic or Aboriginal place. Where a relic or an Aboriginal place is known to occur on land prior to the lodgement of a development application, and the development proposal will damage, deface or destroy the relic or Aboriginal place, thereby requiring a consent to destroy from the Director-General of the NPWS, the NPWS will become an approval body.

It should be noted that where a relic or Aboriginal place is found to occur on land after a development application is lodged, separate NPWS approval will still be required under Section 90 of the *NP&W Act.*

The NPWS has prepared detailed guidelines to assist councils and applicants in the IDA process (copies available upon request). The guidelines outline the role of the

NPWS in the IDA process and describe the information that needs to be submitted in an integrated development application. In summary, two types of information are required:

- Aboriginal cultural heritage assessment which involves consultation with the Aboriginal community groups. The NPWS is committed to working in partnership with the Aboriginal community groups in the management of Aboriginal sites and requires community assessment of any Aboriginal site management; and
- Archaeological assessment which involves the assessment of Aboriginal sites and their management based on archaeological heritage criteria.

Environmental impact statements

Where an environmental impact statement (EIS) is required to be prepared for an integrated development, the Director-General of the Department of Urban Affairs and Planning (DUAP) must request each approval body to provide their requirements in relation to the EIS. If the approval body does not provide those requirements within 14 days then the Director-General of DUAP must inform the applicant and the applicant must consult with the approval body to obtain its requirements for the EIS.

If an EIS is to be prepared for an integrated development that involves a Section 90 approval under the *NP&W Act*, the NPWS will be requested to provide its requirements for the EIS. In this situation, the NPWS requirements for the EIS are the same as for any IDA proposal that requires a Section 90 approval under the *NP&W Act*. These requirements are detailed in the attached guidelines.

## Databases

The NPWS has two GIS databases which may provide information of use to you if you proceed to undertake further assessment. These are:

- Atlas listing of fauna and flora records in NSW;
- Aboriginal Sites register.

The material from these databases is available upon written application and the receipt of the appropriate fee. If you are interested in obtaining access to the Atlas database, please contact the Data Licensing Officer, GIS Division, on (02) 9585-6684. Records from the Aboriginal Sites register may be obtained upon written application to the Registrar, Cultural Heritage Conservation Division, on (02) 9585-6471.

## Further Information

For further information please contact:

Manager, Conservation Planning Unit
Conservation Programs and Planning Division
Central Directorate
NPWS
PO Box 1967 — Ph - (02) 9585 6674
Hurstville NSW 2220 — Fax - (02) 9585 6442

# NSW NATIONAL PARKS AND WILDLIFE SERVICE

## ABORIGINAL CULTURAL HERITAGE AND THE INTEGRATED DEVELOPMENT ASSESSMENT PROCESS

## INFORMATION FOR LOCAL COUNCILS

Updated 20 February 2001

The NPWS recommends that the following information be read in conjunction with the "Guide to section 79C' prepared by the Department of Urban Affairs and Planning, which outlines Council's obligation to consider Aboriginal heritage issues in determining a development application.

The NPWS has a statutory responsibility for the identification, management and conservation of Aboriginal heritage under the *National Parks and Wildlife Act 1974.* The NPWS acknowledges that it is Aboriginal people who should determine the cultural significance of Aboriginal heritage, and the NPWS has a strong commitment to working in partnership with Aboriginal people to manage and conserve Aboriginal cultural heritage. The NPWS recognises that Aboriginal cultural heritage includes both traditional and contemporary associations of Aboriginal people with the environment as well as physical sites.

Aboriginal heritage issues should be addressed upfront as part of the planning process undertaken for developments, and prior to lodgement of a development application. The NPWS requires that options for conserving Aboriginal relics within development footprints be fully explored in discussion with the Aboriginal community as part of the development assessment process. Impacts on Aboriginal relics should only be considered where there are no viable alternatives. The NPWS will require a clear demonstration that alternatives to site destruction have been fully explored.



NSW National Parks and Wildlife Service
43 Bridge Street, Hurstville NSW PO Box 1967, Hurstville NSW 2220
Telephone (02) 9585 6444 Facsimile (02) 9585 6555
Internet Email: info@npws.nsw.gov.au

## When is the NPWS an approval body in the IDA process ?

The NPWS is an approval body in the IDA process when a development will impact on an Aboriginal relic or Aboriginal place, thereby requiring a consent to destroy from the Director-General of the National Parks and Wildlife Service. Threatened species, populations and/or ecological communities do not trigger the IDA process as the *Environmental Planning & Assessment (EP&A) Act 1979* and *Threatened Species Conservation Act 1995* eliminated the need for separate licensing or approvals in relation to these issues.

The NPWS is an approval body for a development application under the IDA process when:

1) A 'relic' is known to exist on the land to which the DA applies; and/or the land to which the DA applies is an Aboriginal place, immediately before the DA is made (as per s.91 (2)(a-b), *EP&A Amendment Act 1997);* AND

2) The development proposal will destroy, deface or damage an Aboriginal 'relic' or Aboriginal place, and a consent to destroy from the Director-General of the National Parks and Wildlife Service will be required, as per section 90 of the *National Parks and Wildlife (NPW) Act 1974* (note damage to an Aboriginal relic or place may be direct damage or result from indirect impacts).

   Under the *NPW Act,* a 'relic' is defined as any deposit, object or material evidence (not being a handicraft made for sale) relating to indigenous and non-European habitation of the area that comprises NSW, being habitation both prior to and concurrent with the occupation of that area by persons of European extraction, and includes Aboriginal remains (as defined within the meaning of the NPW Act). Relics are confined to physical evidence.

   Aboriginal 'relics' are commonly referred to as Aboriginal sites.

   An "Aboriginal place" is a place which has been declared so by the Minister for the Environment because he or she believes that the place is or was of special significance to Aboriginal culture. It may or may not contain physical relics.

It should be noted that *the NPW Act* does not provide protection for spiritual areas or natural mythological areas that have no physical remains of Aboriginal occupation, unless they have been declared an 'Aboriginal place'.

For the purposes of the IDA process, the NPWS considers that an Aboriginal site ('relic') may be considered to be 'known' if:

- It is registered on the NPWS Aboriginal Sites Register; and/or
- It is an Aboriginal site known to the Aboriginal community; and/or
- It is located during surveys (eg: archaeological, anthropological) or test excavations conducted prior to lodgement of the DA.

## How to obtain information about known Aboriginal sites

In order to obtain information about the location of known sites it is necessary to:

- Consult with Aboriginal community groups to identify the location of Aboriginal sites. The community groups may be aware of Aboriginal sites that have not been registered with NPWS.
- Contact the Aboriginal Sites Registrar at NPWS and request a site search to obtain a listing of registered sites. The Register only includes those Aboriginal sites which have been reported to NPWS. **Attachment 1** provides general information on the Aboriginal Sites Register, and a site search request form.
- Undertake an assessment of the known Aboriginal site/s and/or undertake survey of the subject land to locate Aboriginal sites. Test excavations may be required as part of this investigation to verify the location, extent and/or geomorphic context of Aboriginal sites. Such excavations need to be undertaken **before** the DA is submitted. A permit is required from NPWS for such investigation and if all information is attached to the application the processing time is approximately 8 weeks.

## How to find out whether land contains a gazetted Aboriginal place

An Aboriginal place may be considered known if it has been declared by the Minister, and gazetted. Information on whether a proposed development site contains an Aboriginal place may be obtained by contacting the NPWS Aboriginal Sites Register (refer **Attachment 1**).

## Information required by the NPWS to provide general terms of approval

In responding to requests for general terms of approval under the IDA process, the NPWS requires the same level of information to make an 'in-principle' decision as to whether to issue its general terms of approval as it would require to make a decision on the subsequent Section 90 consent application. In order for the NPWS to be in a position to provide its general terms of approval, all issues regarding conservation and site management need to be resolved upfront.

The NPWS does not require that a Section 90 consent application be submitted with the Integrated Development Application. The NPWS will issue its general terms of approval to the consent authority, and these terms of approval are incorporated into the development consent. Once the development consent is granted, the proponent has up to three years to apply to the NPWS for a Section 90 consent. The NPWS is then bound to issue the Section 90 consent in accordance with the development consent conditions.

In providing general terms of approval, the NPWS will require some administrative information from Council and information on the development proposal and Aboriginal heritage values of the relic and/or Aboriginal place from the applicant, as follows:

## 1.0 ADMINISTRATIVE INFORMATION REQUIRED FROM COUNCIL

1.1 A clear indication from Council that the development application is being assessed under the integrated development assessment (IDA) process and therefore will, or is likely to require subsequent approvals from the NPWS with respect to Aboriginal heritage. Where possible, Council should include the reasons why it has reached this conclusion. If Council is unsure whether a subsequent approval from the NPWS is required, it is suggested that Council seek advice from the NPWS.

1.2 A clear statement from Council as to whether Council also wishes the NPWS to provide advice on flora, fauna and threatened species values and/or potential impacts on adjoining NPWS reserves with respect to the development proposal.

1.3 A clear statement of the time frames for comment, including:

- The date of receipt of the DA; and
- The date that general terms of approval must be back with Council (assuming that no additional information is required).

1.4 A list of other approval bodies to which the integrated development application has been referred.

1.5 A fee of $250 will be charged by the NPWS to process the application. This fee should be paid by cheque, made out to the National Parks and Wildlife Service, and must be attached to the application. If the cheque is not attached to the application, the NPWS will return the development application immediately upon receipt, and will not process the application until the fee is paid, in accordance with Schedule 1, Part 9, Division 1 (103)(3).

The $250 fee is solely for processing of the application. The applicant may be required to pay additional fees to the NPWS, such as a fee for obtaining a site search of the NPWS Aboriginal Sites Register, and a fee for processing an application for consent to destroy an Aboriginal site.

## 2.0 INFORMATION ON THE DEVELOPMENT AND ABORIGINAL CULTURAL HERITAGE

The NPWS requires two types of information from the applicant:

- Aboriginal cultural heritage assessment which involves consultation with the Aboriginal community groups. The NPWS is committed to working in partnership with the Aboriginal community groups in the management of Aboriginal sites and requires community assessment of any Aboriginal site management.
- Archaeological assessment which involves the assessment of Aboriginal sites and their management based on archaeological heritage criteria.

Council should give the applicant the NPWS's "Information for applicants' document to assist applicants in preparing their integrated development application. When Council refers a DA to the NPWS, Council should ensure the completeness of the applicant's information according to the requirements outlined below.

A flowchart is shown in **Attachment 2** that outlines the process for assessing the Aboriginal heritage values of an area to enable a decision to be made as to whether a development application will be an integrated development application for Aboriginal sites. It is essential that the outcomes of the Aboriginal cultural assessment and the technical assessment are integrated.

## 2.1 Aboriginal Cultural Heritage Assessment

Aboriginal sites can be the physical remains of Aboriginal occupation of an area or alternatively, an area that has particular meaning for Aboriginal people, for example, spiritual areas or natural mythological areas. It is important to consider that Aboriginal heritage is not only valuable to Aboriginal people but also to those people who are interested in learning from the early inhabitants of Australia. Proposed developments that alter landscapes can impact on these various types of Aboriginal sites.

Assessment of the cultural values of Aboriginal sites and places to the Aboriginal community is an important part of the assessment process, and the Aboriginal Cultural Heritage Assessment report (discussed below) is required by the NPWS in order for it to consider whether to issue general terms of approval.

### 2.1.1 Aboriginal Community Group/s Consultation

Applicants should contact (as early as possible) local Aboriginal community groups, including Local Aboriginal Land Councils, any known Tribal Elders Corporations and Native Title Claimants to ensure that proper consultation processes are carried out. Local Aboriginal community groups will require time to consider a proposal and to discuss any issues with its members, and sufficient time must be allowed for this to occur.

The purpose of Aboriginal participation in the assessment process is:

- To notify the local Aboriginal people in sufficient detail and in a timely manner about activities or developments which may impact on Aboriginal heritage, so that their concerns and possible options for action can be identified on a fully informed basis;
- To ensure that Aboriginal people who hold cultural knowledge, including native title holders or applications, are able to contribute to the assessment process in ways that are culturally acceptable to them;
- To identify locations and cultural values of Aboriginal sites and places of significance to the Aboriginal community that may be affected by the proposal so that potential impacts can be avoided wherever possible; and
- To identify whether there are culturally acceptable mitigative measures when impacts are considered to be unavoidable by the applicant.

It is essential that applicants provide NPWS with documentation from the Aboriginal community groups regarding their views and recommendations for actions.

The Environmental Planning and Assessment Regulation 2000 (cl. 111) allows 46 days (from the date of DA lodgement with the consent authority) for the Director-General of the National Parks and Wildlife to undertake any further Aboriginal community consultation, if the

Director-General of the NPW considers that such consultation is required before the Director-General can make a decision concerning the general terms of approval, and consultation commences within 25 days after the date on which the DA is forwarded to the Director-General.

### 2.1.2 Aboriginal Cultural Heritage Assessment Report

The report should contain:

1. Information on the nature, timing and location of consultation, including the identification of individuals and/or groups consulted and copies of any correspondence from those individuals and/or groups;
2. A statement of the Aboriginal community group/s understanding of the values of the known Aboriginal site/s and/or Aboriginal place located on the development site. This may include social, spiritual, historic, and archaeological values.
3. A statement of the Aboriginal community groups response to the development and their recommendations (if any) for mitigation of impacts and/or conservation of known Aboriginal sites and/or Aboriginal place/s.

The results of this assessment must be integrated with the technical (archaeological) assessment and provide the basis for the final assessment of Aboriginal heritage values and recommendations for management options. The NPWS will also require a clear demonstration in the development application of how the proponent proposes to address any issues which have been raised as part of the Aboriginal cultural assessment, and whether this is acceptable to the Aboriginal community.

To obtain a list of Land Councils and Native Title claimants contact:

**NSW State Aboriginal Land Council**
PO Box W125
PARRAMATTA NSW 2150
Ph: (02) 9689 4444

**Department of Aboriginal Affairs**
Level 5, 83 Clarence Street
SYDNEY NSW 2000
Ph: (02) 9290 8700

## 2.2 Archaeological Assessment

The NPWS requires the information summarised below to evaluate reports on the assessment of Aboriginal sites. Further detail on this is located in the NPWS' *"Aboriginal Cultural Heritage Standards and Guidelines Kit" 1997*, which sets out NPWS requirements for reporting on Aboriginal sites and assessments (refer **Attachment 3** for information on this kit). The assessment of individual Aboriginal sites and the development of management strategies may not require that all of the categories under the following list of information requirements are addressed, however, their relevance needs to be considered for each proposal.

The assessment of Aboriginal sites should be directed towards their conservation and protection. While the *NPW Act* provides for the destruction of sites, this option should always be considered as a last option and must be well supported.

2.2.1 Locational Context:

- description of location of study
- legislative context
- cadastral context (eg: Lot, DP)
- identification of any associated Aboriginal cultural heritage studies undertaken in the study area

2.2.2 Description of Development Impact

- type of development
- extent of direct impacts
- extent of potential indirect impacts (eg: run-off, increased visitation)
- flexibility of project design
- staging and how this might effect present or future management decisions

2.2.3 Assessment Context

- the brief for the work being undertaken for this particular project
- objectives of the assessment

2.2.4 Archaeological Context

- targeted review of known archaeology of region and previous work in the study area to identify range of expected archaeological evidence relative to the project and landscape
- type/s of Aboriginal sites
- **synthesis** and **evaluation** of this information to identify archaeological issues. This will provide the basis for defining the archaeological assessment and management context relevant to this study, and the development of appropriate management options, with protection/conservation being the primary consideration. It should be noted that a summary of previous work is not adequate.

2.2.5 Landscape Context

- description of landscape classification and land units being used for the study (at the different levels of landscape, landscape unit, landform, topographic unit)
- identification of any paleo-features
- assessment of how the landscape context and previous land surface change is relevant to the study
- assessment of how the landscape relates to models of site location and archaeology (as per synthesis above), and development of a framework for assessing the sites and landscapes within the study area
- identification of areas of archaeological sensitivity

The landscape analysis may need to include a geomorphic study to ensure that significant features are identified and considered in the overall assessment (e.g.: paleofeatures with the potential to include older sites).

2.2.6 Condition of Landsurface

- identify previous land surface impacts across the study area, with the view to assessing whether sites may be buried such as campsites, burials, and the integrity of the landsurface in those locations
- description of ground surface conditions and supporting tabulated data (for surveys)
- assessment of how the landsurface conditions have revealed, concealed, destroyed, impacted on or preserved archaeological evidence and how this relates to archaeological potential, the condition of Aboriginal sites and the geomorphology in these contexts

2.2.7 Methodology for Investigation

- description of input from the Aboriginal community to the method proposed for undertaking the study
- the proposed field methodology, such as type of sampling strategies and survey coverage (this should be targeted to the objectives of the study)
- description of the scope and method of recording and analysis by which the objectives of the study will be achieved
- the method whereby a clear and supportable significance assessment will be undertaken a supportable rationale for any proposed test excavations
- the program of work
- rationale for any variation in the methods adopted
- test excavation methodology, if relevant

2.2.8 Survey Coverage Data

- description of survey coverage and the effectiveness of that coverage for detecting potentially buried Aboriginal sites (this needs to be fully described and evaluated within the context of the objectives and the study plan. Specific methods are detailed in the NPWS Standards & Guidelines Kit)

2.2.9 Analysis and Reporting

- detailed Aboriginal site description/s including tabulated data summarising site content and any analysis, as per the NPWS Guidelines
- comprehensive evaluation of the study results (for potentially buried archaeological deposits this includes incorporating the information on archaeological potential and the reliability of survey coverage)
- results of test excavations, if relevant

Diagrams and photos are considered to be an essential component of archaeological reporting.

2.2.10 Archaeological Significance Assessment

- the significance criteria and attributes used for the assessment need to be fully supported by the information presented on the archaeological and landscape context of the site/s (e.g.: representativeness, items and landscape elements considered to be rare, information potential, social/historical values). The criteria for assessment need to be measurable.

2.2.11 Conclusions of the Study

- evaluation of potential impacts on known Aboriginal sites and areas of
- archaeological sensitivity and potential (if relevant)
- establish clear relationship between significance assessment and impacts
- consideration of cumulative impact of development on comparable sites and landscapes at both a local and regional level
- consideration of various management options, **specifically identification of conservation options**, including on-site conservation and compensatory areas (for larger scale projects)
- description of mitigation works required for specific sites to be impact on

2.2.12 Management Options

- recommendations for conservation and other management options based on the results of the archaeological report and discussions with the land owner / manager and the Aboriginal community group/s
- incorporation of management options from Aboriginal community group/s where these relate to the management options being proposed for sites or places

The following maps are required as a minimum (more detailed specifications are set out in the NPWS Guidelines). Mapping should be at the same scale throughout the report.

- location of study area (1:25,000 map series where available, more detailed maps are useful additions)
- development layout if known, flexible components of design if applicable
- locations of previous survey undertaken and sites recorded (referred to in text)
- (for surveys) survey coverage data showing location and extent of different methods used
- land units and topographic information used
- land surface history highlighting the location and boundaries of the disturbed and intact deposits
- Aboriginal site locations

A comprehensive glossary of terms used should also be provided.

## What happens if an Aboriginal site is found on the land after a development application is lodged or a development consent is granted ?

It is possible that an 'unknown' Aboriginal site could be identified on the land subsequent to the grant of development consent by Council or DUAP. The NPWS strongly advises that an adequate assessment of Aboriginal heritage values of the land be carried out prior to lodgement of the DA, so that this situation does not arise. However, in the event that this does occur, all works on or adjacent to the Aboriginal site must cease, and the applicant must seek a consent to destroy the relic from the Director-General of NPWS. A development consent granted under the *EP&A Amendment Act* does not equate to a Section 90 consent issued under the *NPW Act*. A consent to destroy an Aboriginal site must be granted pursuant to the *NPW Act* before an Aboriginal site or Aboriginal place can be destroyed. Failure to obtain this consent may result in prosecution.

## Further Information

The National Parks and Wildlife Service has a Cultural Heritage Division which manages Aboriginal heritage. The Division includes 4 geographic units which deal with on- and off-park conservation planning and assessment issues. These boundaries are shown on **Attachment 4.**

For further information on these requirements, please contact the Aboriginal Heritage Unit in your area:

Manager, Central Aboriginal Heritage Unit
Cultural Heritage Division
NSW National Parks and Wildlife Service
PO Box 1967
**HURSTVILLE NSW 2040**

Ph: (02) 9585 6674
Fax: (02) 9595 6442

Manager, Northern Aboriginal Heritage Unit
Cultural Heritage Division
NSW National Parks and Wildlife Service
Locked Bag 914
**COFFS HARBOUR NSW 2450**

Ph: (02) 6659 8245
Fax: (02) 6651 6187

Manager, Southern Aboriginal Heritage Unit
Cultural Heritage Division
NSW National Parks and Wildlife Service
PO Box 2115
**QUEANBEYAN NSW 2620**

Ph: (02) 6298 9736
Fax: (02) 6298 4281

Manager, Western Aboriginal Heritage Unit
Cultural Heritage Division
NSW National Parks and Wildlife Service
PO Box 1007
**DUBBO NSW 2830**

Ph: (02) 6883 5345
Fax: (02) 6884 9382

ATTACHMENT 1

*THE ABORIGINAL SITES REGISTER OF NSW*
**GENERAL INFORMATION**

The National Parks and Wildlife Service maintains the Aboriginal Sites Register of NSW. The Register includes a computer database and site recording cards for all recorded Aboriginal sites in NSW, in addition to a database index of archaeological reports and a library of these reports. Information from the Register may be made available for a variety of uses.

***What information is available?***

Information relating to recorded Aboriginal sites in a particular area may be made available upon request. The information is generally available in the form of a standard report from the Register database. This report lists all recorded sites within and/or surrounding the area of interest, with each record including the site identifying number, site type, site location and Australian Map Grid co-ordinates, date of recording and the name of the recorder of the site.

If the area of interest is particularly large (e.g.. a river catchment), a Data Licence Agreement may be required. This agreement is a legal contract document between the Director-General of the National Parks and Wildlife Service and a named client, and is designed to ensure that any data supplied under the agreement is used appropriately.

In some cases, written support from the relevant Local Aboriginal Land Council may be required before information can be provided from the Register.

***How is the data provided?***

Site information will generally be provided as a standard computer print out, however, digital computer formats on disk may be available for specific purposes.

***Is there a charge for data?***

The cost for supply of a standard report is $30 per search area. An urgent database search may be conducted for $60. More complex reports may incur an additional charge.

In particular circumstances there may be no charge for a report (e.g.. for Aboriginal Land Councils, research purposes etc.). The waiving of any charge requires discussion with the Aboriginal Sites Registrar.

There is no charge imposed for a Data Licence Agreement, however, any data supplied under a Licence Agreement will generally be charged at the current "cost of transfer".

*Are there any limitations in the data?*

**It is essential to note that a report from the Register does not represent a comprehensive list of all Aboriginal sites in a specified area. A report lists recorded sites only. In any given area there may be a number of undiscovered and/or unrecorded sites.** As a result of this limitation, and the fact that all Aboriginal sites are protected under NSW legislation, the NPWS may recommend that a survey for Aboriginal sites is conducted where development is proposed.

Locational details are recorded as grid references. It is important to note that there *may* be errors in these recordings. If accurate site locations are required it may be necessary to confirm the locations on the ground.

If the information provided is to be used for ongoing purposes, it is recommended that regular updates are obtained as new records are continually being added to the database.

*How to obtain Aboriginal sites data*

To obtain information about recorded Aboriginal sites, a written request should be forwarded to the Aboriginal Sites Registrar (a request form is available if required). All requests must include;

- Company/organisation name (if applicable)
- Contact name, phone number and address details
- Purpose for which the information is required
- Copy of a topographic map with the area of interest clearly marked
- A cheque for $30 per search area, made out to the NPWS (unless other arrangements have been made with the Registrar)

Applications should be forwarded to:

**The Aboriginal Sites Registrar**
**Cultural Heritage Division**
**NPWS**
**PO Box 1967**
**Hurstville, NSW 2220.** **or fax (02) 9585 6466**

*Further information*

For further information about the Aboriginal Sites Register, please contact the Aboriginal Sites Registrar (02 9585 6471, fax 02 9585 6466).

# ATTACHMENT 2

**PROCESS**

1. **Development proposal.**

2. **Investigative studies and assessments. This could include: Aboriginal heritage, flora and fauna, hydrology, air, noise, social / economic etc.**

3. **For Aboriginal heritage, information is required about:**

4. **Information sources:**
   ***NB: Test excavations may be required. This requires a permit from NPWS, allow 8 weeks for processing.***

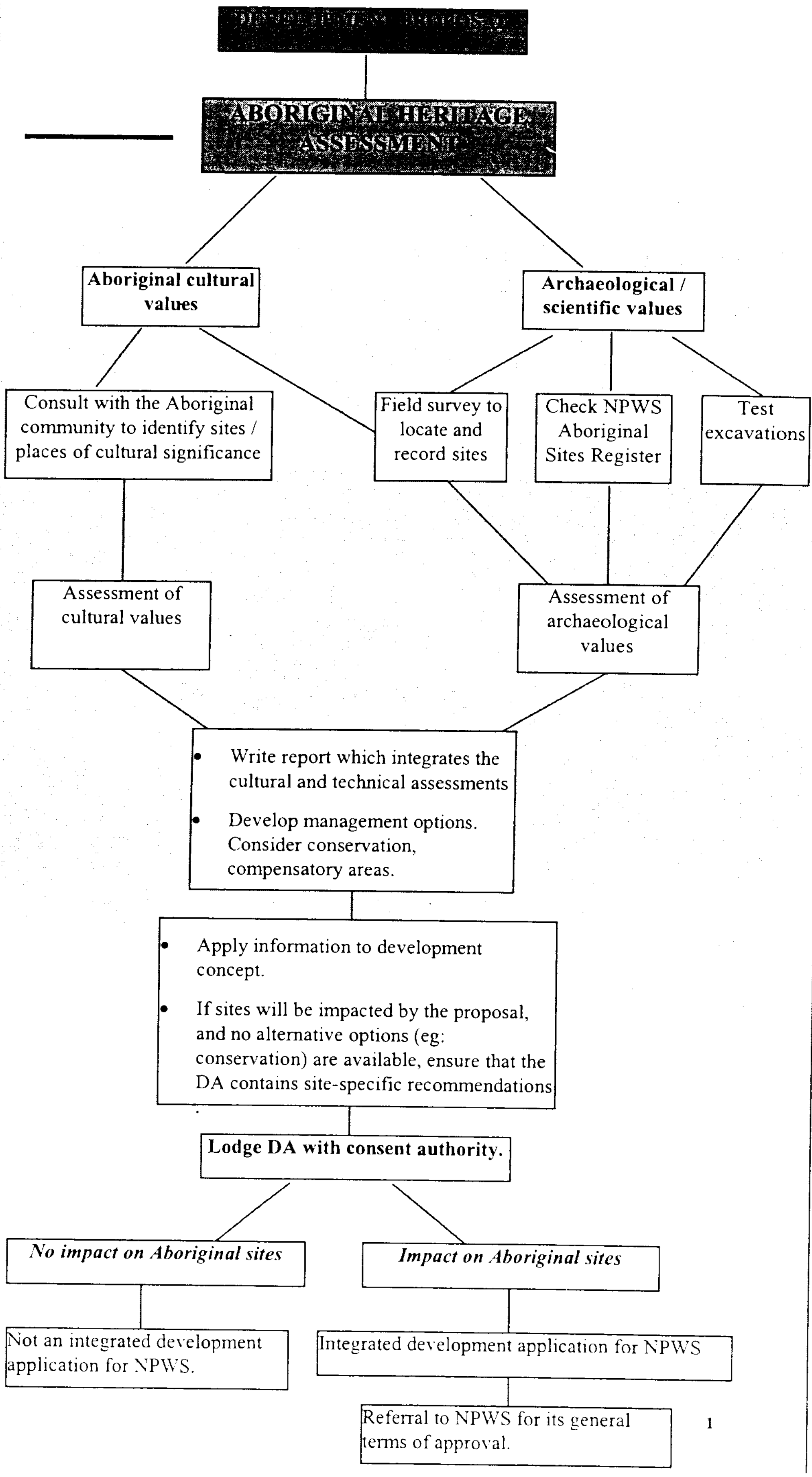
5. **Undertake assessment**

6. **Prepare report and recommend management options.**

7. **Apply this and information from other assessments to development concept and finalise development proposal. Avoiding impact on sites is the preferred strategy.**

8. **Lodgement of DA with consent authority**

9. **DA is an IDA if development will impact on Aboriginal sites.**



ATTACHMENT 3

# *Aboriginal Cultural Heritage*
# Standards and Guidelines Kit

comprising

***Guidelines for Aboriginal Consultants***

These *Guidelines* aim to clarify for Aboriginal consultants the type of reporting required for heritage assessments. The *Guidelines* reflect the Service's commitment to partnership with Aboriginal stakeholders in protecting and managing Aboriginal cultural heritage.

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***Standards Manual for Archaeological Practice in Aboriginal Heritage Management***

The *Standards Manual* sets out current best practices in this diverse and developing field. The *Manual* encourages archaeological methodology to be relevant to the management context. It has been developed in partnership with the professional community and will be supplemented by regular updates.

•

***Guidelines for Archaeological Survey Reporting***

These *Guidelines* set out in detail the requirements of NPWS for survey reports submitted by archaeologists. The object is to enhance the comparability of survey reports as well as to promote transparency and predictability in the industry by making clear the needs and expectations of NPWS as the reviewing agency.

•

***Guidelines for Aboriginal Heritage Impact Assessment in the Exploration & Mining Industries***

These *Guidelines* provide industry-specific advice to applicants of exploration and mining ventures. They were prepared by NPWS in co-operation with the NSW Minerals Council and the NSW Department of Mineral resources.

To obtain a copy of this valuable kit please send a cheque for $70 made out to NPWS to:
Cultural Heritage Division, NPWS, PO Box 1967, Hurstville NSW 2220
Enquires to:
Denis Byrne (02)9585 6571 *denis.byrne@npws.nsw.gov.au*
Anthony English (02)9585 6464 *anthony.english@npws.nsw.gov.au*

(14)

*Your Ref: S01/02520*
*Our Ref: ERM01/01254*

LAND & WATER CONSERVATION

7 January 2002

Director
Development and Infrastructure Assessment
Department of Urban Affairs and Planning
GPO Box 3927
SYDNEY NSW 2001

Attention: Gordon Kirkby

Dear Sir,

**Re: EIS Requirements.**
**Proposed Expansion of Port Botany**

Thank you for your letter dated 20 December 2001, seeking this Departments comments and requirements for the above-proposed EIS.

The Department of Land and Water Conservation (DLWC) is responsible for managing the soil, water and vegetation resources in New South Wales.
The vision of the Department is to facilitate *clean, healthy and productive catchments for the twenty-first century*. As part of this vision, the Department advocates the principles of ecologically sustainable development, and intra and intergenerational equity.

The Departments comments are broad in nature to cover a variety of circumstances. Some of these comments may not be fully relevant to your proposal.

As part of the preparation of the EIS you will need to demonstrate how this proposal will meet the requirements of the various Acts and Policies within this letter.

## Integrated Development

Any development proposal that requires a **3A permit under the *Rivers and Foreshores Improvement Act (1948)***, or a **water license under the *Water Act (1912)***, for either surface water or ground water extraction, will be an Integrated Development. In these instances, the Department is an Approval Body for the Consent Authority (either Council or the Minister for Urban Affairs and Planning).

If the proposal falls under Pt 5 of the EPA Act (1979), then the proposal will not be an Integrated Development. However it is strongly suggested that all potential Departmental concerns for the issuing of a permit are addressed in the EIS and treated similar to an Integrated Development, to avoid possible future delays and changes to the proposal.

## Rivers and Foreshores Improvement Act (1948).

For this proposal, the Department and Waterways Authority are both responsible for administering the Rivers and Foreshores Improvement (R&FI) Act (1948) for different areas of the site.

If there is any creek, drain, channel (artificial or natural), depression, etc. which conveys water, or there is a foreshore, a Part 3A Permit may be required from the Department under the Act to:

(1) **Excavate** or remove material from the bank, shore or bed of any stream, estuary or lake, or land that is not more than 40 metres from the top of the bank or shore of protected waters (measured

horizontally from the top of the bank or shore). "**Protected waters**" as defined under section 22A of the Act means a river, lake into or from which a river flows, coastal lake or lagoon (including any permanent or temporary channel between a coastal lake or lagoon and the sea).

(2) **Build erosion control works** and other **structures** in a river, estuary or lake.

(3) **Place any fill material** in a river, estuary or lake.

When assessing developments that require a Part 3A permit under the R&FI Act, the Department will consider whether the proposal is consistent with State Government policy, including the NSW State Rivers and Estuaries Policy. A condition of consent to a Part 3A permit may include the establishment of a native vegetation riparian zone along a "river". The Department is unlikely to issue a Part 3A Permit for works that degrade watercourses and their environment.

It is the Departments aim that an adequate native vegetation riparian zone be kept or established on either side of any "river" or wetland area. A minimum native vegetation riparian zone of 20 meters, from the top of the bank is generally required, however a greater width may be required, depending upon the site and the surrounding area.

On-line or in-stream water quality structures such as water quality ponds, trash racks and gross pollutant traps (GPT's) are strongly discouraged, as they will affect the continuity and corridor function of streams and result in the loss of riparian vegetation and habitat.

The channelisation, piping and/or relocation of streams and the construction of on-line or in-stream structures and culverts for stream road crossings are also strongly discouraged. Developments that propose such actions must have the necessary approval of DLWC and are unlikely to receive support

Works that are undertaken by Public Authorities (not including business ventures such as state-owned corporations or commercial undertakings), or works on Crown Land, do not require a 3A permit prior to commencing works. However, all works undertaken still need to comply with Government policy, and if it is deemed that they could degrade the protected lands of the watercourse, the Department can require works to cease and issue a remedial notice to repair any damage.

Please note that the definition of a "river" in the Rivers and Foreshores Improvement Act is different to the definition in the Water Act and must be considered separately.

## NSW State Rivers and Estuaries Policy - General.

The NSW Government has a policy to encourage sustainable development of the natural resources of the State's rivers, estuaries, wetlands and adjacent riverine plains. This is to reduce and where possible halt;

- declining water quality,
- loss of riparian vegetation,
- damage to river banks and channels,
- loss of biodiversity, and
- declining natural flood mitigation;

and to encourage projects and activities which will restore the quality of the river and estuarine systems such as;

- rehabilitating remnant habitats,
- re-establishing vegetation buffer zones adjacent to streams and wetlands,
- restoring wetland areas,
- rehabilitating of estuarine foreshores, and
- ensuring adequate streamflows to maintain aquatic and wetland habitats.

This includes ensuring the construction of any wetland or detention structure off-line, so as not to degrade the functions of that natural resource.

## NSW Wetlands Policy - General

The NSW Government has a policy to encourage projects and activities, which will restore the quality of the States wetlands. The following principles will be applied in reviewing any proposal,

- Water regimes needed to maintain or restore the physical, chemical and biological processes of wetlands will have formal recognition in water allocation and management plans.
- Land use and management practices that maintain or rehabilitate wetland habitats and processes will be encouraged.
- New developments will require allowances for suitable water distribution to and from wetlands.
- Water entering natural wetlands will be of sufficient quality so as not to degrade the wetlands.
- The construction of purpose-built wetlands on the site of viable natural ones will be discouraged.
- Natural wetlands should not be destroyed, but when social or economic imperatives require it, compensation through the rehabilitation or construction of a wetland will be required.
- Degraded wetlands and their habitats and processes will be actively rehabilitated as far as is practical.
- Wetlands of regional or national significance will be conserved, and
- The adoption of a stewardship ethos and co-operative action between land and water owners and managers, government authorities, non-government agencies and the general community is necessary for effective wetland management.

## NSW Estuary Management Policy - General

The NSW Government recognises the ecological, social and economic importance of the State's estuaries and is concerned about the long-term consequences of their accelerating degradation. The general goal of the policy is to achieve an integrated, balanced, responsible and ecologically sustainable use of the State's estuaries.

As such, proposals within the State's estuaries should ensure:

- The proposal will not adversely impact the physical processes operating within the estuary, for example:
  - a reduction in the existing tidal prism as a result of reclamation may affect an estuary's flushing and water quality characteristics and
  - any associated retaining wall construction may result in erosion of adjacent properties and destruction of foreshore flora and fauna
- Intertidal and aquatic flora and fauna are adequately protected
- Potential impacts on water quality during construction and operational phases are appropriately mitigated
- Conflict with other estuary users and uses are minimised
- The visual impact of potential development is assessed, for example, the length of jetties, the extent of foreshore walls, the form and colour of structures, the degree of land clearing, etc.
- The cumulative impact of a proposal is considered in terms of its contribution to overall habitat loss and disturbance, water quality degradation, alienation of intertidal areas, increase in boat traffic in the area etc.
- Consistency with Estuary Management Plans where they exist.

## Ground Water License Issues - general.

The Water Act states that all works connected to a source of underground water and used for water supply, waste disposal, or any other commercial or industrial purpose, must be licensed. A work includes any of the following: bore, well, excavation, shaft trench, collector system, spearpoint, artesian bore temporary dewatering of construction sites, or variations on these basic structures. The term bore is used throughout this section to describe any of the above works.

When there has been an artificial improvement work carried out on a natural spring and it is used for water supply, a licence is also required. A natural spring where there has been no improvement of the original feature does not require a licence.

Licences are issued for a commercial, industrial etc purposes. There is a requirement to fit a meter and report water usage to the Department.. Licences are subject to distance conditions as follows:
a) At least 200 metres from a property boundary.
b) At least 400 metres from the nearest irrigation bore.
c) At least 500 metres from a town water supply bore.
d) At least 40 metres from the bank of a river or defined creek.

Exemptions are sometimes possible for small properties and where practical considerations lead neighbours to agree on more closely spaced bores.
In assessing the groundwater license, the Department will consider if the proposal is consistent with The NSW Groundwater Policy Framework Document.

Any dewatering a development site in order to lower the local water table to permit the construction of subsurface areas eg. a basement level underground carpark etc. is also a licensable work under Part V of the Water Act.. Temporary dewatering may be authorised provided there are no adverse environmental or resource management impacts associated with the proposal.. Permanent dewatering, however, is considered to be unsustainable and accordingly will NOT be APPROVED.

## Ground Water Issues – specific

Details of the proposal are required, including design, layout, pumping and storage capacities, volumes of water to be extracted all associated earthworks and infrastructure works etc. Also to be included are environmental management reports such as water quality assessments (particularly in urban areas, and areas of known or suspected contaminated groundwater locations), a hydrogeological report showing the impacts on the groundwater and other users of the water, a fauna and flora report, a geotechnical report for salinity or acid sulfate soils etc.

The proposal's site is in an area of known shallow ground water, which may also be contaminated. The large amount of fill may impead shallow ground water flows and cause rising of the groundwater off-site, which could adversely impact upon other existing developments. This problem has already occurred in the area from previous filling in the area.
Dredging of the bay is likely to intersect with potentially contaminated groundwater. This may have cause expose the bay to different and more contamination. Further, it may cause instability of any cut batter of the dredged area.

The EIS will need to demonstrate the commercial, environmental benefits and sustainability of the proposal as it relates to the groundwater resource of the area.

There will be separate fees, including an application fee and other charges based on the capacity of the work, the purpose, or the area to be irrigated. The water license is also subject to annual charges as determined by IPART
The bore licence must be obtained prior to construction of the any licensable works you must supply the name of the licensed driller before work commences.

For further information contact, Mr Dan McKibbin, Regional Hydrogeologist, phone number 9895 7875.

## The NSW Groundwater Policy Framework Document - General

The NSW Government recognises the need to manage the State's groundwater resources so that they can sustain environmental, social and economic uses for the people of NSW.
It is to encourage the ecological sustainable management of the groundwater resources so as to:

- Slow and halt, or reverse any degradation of groundwater resources.
- Ensure long term sustainability of the systems ecological support characteristics.
- Maintain the full range of beneficial uses of these resources.
- Maximise economic benefit to the Region, State and nation.

The following principles will be applied to any proposal:

- An ethos for the ecologically sustainable management of groundwater resources to be encouraged in all agencies, communities and individuals that own, manage or use these resources, and its practical application facilitated.
- Non-sustainable resource uses to be phases out.
- Significant environmental and/or social values dependent on groundwater to be accorded special protection.
- Environmentally degrading processes and practices to be replaced with more efficient and ecologically sustainable alternatives.
- Where possible, environmentally degraded areas to be rehabilitated and their ecosystem support functions restored.
- Where appropriate, the management of surface and groundwater resources should be integrated.
- Groundwater management should be adaptive, to account for both increasing understanding of resource dynamics and changing community attitudes and needs.
- Groundwater management should be integrated with the wider environmental and resource management framework, and also with other policies, dealing with human activities and land use, such as urban development, agriculture, industry, mining, energy, transport and tourism.

The proponent will need to demonstrate how this strategy will be met.

## NSW Biodiversity Strategy

The NSW Government has a strategy for protecting the native biodiversity of NSW and for maintaining ecological processes and systems. The following principles will be applied in reviewing any proposal;

- Ensuring that the proposal does not decrease native biodiversity of either individual species or communities of the site or area.
- Ensuring that the proposal is not part of any threatening process to the native biodiversity of the site or area.
- Determining if the proponent has been guided by the precautionary principle to show careful evaluation to avoid, wherever possible, serious or irreversible damage to native biodiversity, through an assessment of risk-weighted consequences of various options.

The proponent will need to demonstrate how this strategy will be met.

## Crown Land Matters - General

Matters the proponent needs to consider when undertaking development adjoining Crown land include;

- Overland flows, including stormwater should not be concentrated or diverted from their natural flowline.
- Roofwater shall not be discharged directly onto Crown land.
- The velocity and volume of stormwater flows to Crown land must be no greater than those before the proposed development.
- Any stormwater control structure must be designed and constructed in accordance with, *Managing urban Stormwater, Soils and Construction*. NSW Dept of Housing, 3 Ed. (1998).
- Any excavation or fill is to be contained entirely on the proponents' property and shall not jeopardise the longevity of any vegetation on Crown land. Where fill is proposed adjoining the common boundary it shall be properly drained and retained or battered back and revegetated to prevent the escape of any material onto Crown land.

- Access to any part of the proponents property is not to be over Crown Land. Should the proponent wish to construct a Crown road, permission in writing must first be obtained from the Department.
- Any fire reduction zone that is required by a development, that adjoins Crown land is to be completely within that development boundary.
- Any other matters that may adversely impact upon the Crown land.

## Crown Land- Major Public Authority Projects

Where Crown lands or Crown reserves are considered to be needed, as part of a major project, the land should be acquired using the provisions of the **Land Acquisition (Just Terms Compensation) Act 1991.**
Where tunnelling or deep excavation are to be undertaken as part of the project, a close examination of all the titles of the lands affected by the proposal is required. The titles for lands in some instances are restricted in depth. The lands below this depth restriction are considered to be Crown lands and as such compensation for the acquisition of these lands are payable.

## Sydney Regional Coastal Management Strategy

The proposal will need to be consistent with the aims and objectives of this Strategy. The local council should be able to give details of this strategy, as it relates to your location.

## State Government's Coastline Hazard Policy

This refers to development proposals along beachfront areas within the Sydney urban area.
Any proposed development should consider the State Government's Coastline Hazard Policy as outlined in the Coastline Management Manual (1990). The primary objective of the Coastline Hazard Policy is to reduce the impact of coastal hazards on individual owners and occupiers of land and to reduce private and public losses resulting from such hazards. Consideration should be given, therefore, to the impacts of coastline hazards on the proposed development and the impact of the proposed development on the coastal environment.

The Coastline Hazard Policy also requires other planning factors, such as social, economic, recreational, aesthetic and ecological issues, be weighed along with coastline hazard considerations and beach amenity requirements, when making decisions regarding coastal development. Implementation of the Policy objectives is best achieved through the development of balanced, long-term coastline management plans that address all relevant planning factors.

## Coastal Protection Act 1979

This refer to proposals within the offshore component of the coastal zone extending three nautical miles seaward from the open coast low water mark
The Minister for Land and Water Conservation's concurrence pursuant to the Coastal Protection (Non-local Government Areas) Regulation 1994 under the Coastal Protection Act 1979 is required for the project. The Regulation applies to coastal land not within a local government area and not subject to an environmental planning instrument viz. the low water mark to the State's 3 nautical mile limit.

The procedure for seeking the Minister's concurrence is set out in Section 40 of the Coastal Protection Act. In assessing the application the Minister can only have regard to the matters described in Section 44. Matters for consideration in this instance are whether the subject proposal may adversely affect or be adversely affected by the behaviour of the sea or may adversely affect any beach, dune or seabed. It is necessary for the application to be accompanied by a sufficiently detailed description of the proposal to enable the assessment to be carried out.

## Soil Conservation Act (1938)

The Soil Conservation Act (1938) and amendments provides for the conservation of soil and farm water resources and for the mitigation of erosion within NSW. Any land use activity that disturbs a vegetative ground cover creates an erosion hazard, which requires measures to minimise environmental degradation.

In relation to soil erosion, sedimentation and land degradation in general the Department advises that the EIS should address at least, but not be limited to the following issues:-

- ⇒ topography
- ⇒ landform
- ⇒ soil type
- ⇒ soil erodibility
- ⇒ site capability
- ⇒ potential for salinity problems.
- ⇒ acid sulfate and potential acid sulfate soils
- ⇒ vegetation management
- ⇒ erosion and sediment control strategy including techniques

## Acid Sulfate Soils.

Deposited NSW coastal soils that are within one metre sea level (AHD) have a high potential to be affected by acid sulfate soil (PASS) materials.
If the site is within five metres AHD anywhere east of the Blue Mountains, a soil survey and soil analysis program should be conducted by the proponent to determine the potential, and extent of the problem. The EIS will need to provide the Consent Authority with a management plan illustrating how they will treat the material, if this soil will be disturbed.

The Department recommends that the level of assessment and details within the acid sulfate management plan are consistent with the NSW Government guidelines regarding Assessing and Managing Acid Sulfate soils from the *Acid Sulfate Soil Manual*, Department of Urban Affairs and Planning. (1998)

## Erosion and Sediment control Plan

An integrated site development plan needs to be prepared, incorporating an Erosion and Sediment Control Plan, for the EIS. This plan shall cover the life of the proposed site extension, rehabilitation and closure, and ensure that the site land is stabilised to standards of the *Managing Urban Stormwater, Soils and Construction*. NSW Dept of Housing,, 1998, 3 Ed, and Consent Authority (which ever is the greater). The plan at the EIS stage should be detailed enough to enable any reviewer to determine that the concepts for control are sound and practical. The sizes and location of control works should be according to design and the accepted policies, and the revegetation/ landscape plan will enhance the native vegetation biodiversity of the site. It is expected that the following detail will be made available upon request, if required. This same detail is what will be required before the Construction Certificate stage.

- ⇒ Soils investigation to determine erosion and sediment control design
- ⇒ Details on proposed erosion control practices
- ⇒ Details on proposed sediment and pollution control practices
- ⇒ Discharge calculations for diversionary works
- ⇒ Design specifications for banks and sediment basins
- ⇒ Detailed rehabilitation practices including selection of tree, shrub and cover crop species and implementation method
- ⇒ Maintenance and monitoring program for sediment and pollution control structures
- ⇒ Assessment of off-site impacts for surface flow from the development
- ⇒ Rehabilitation proposal for existing erosion on or adjacent to the site

- ⇒ Plans at suitable scale and with diagrams and notation clearly displayed
- ⇒ Details of development works for sequence and staging
- ⇒ Location of critical areas (water bodies, drainage lines, unstable slopes, rock outcrops, hard cover areas, flood plains and wet areas).
- ⇒ Location of all earthworks including roads, areas of cut and fill or land regrading
- ⇒ Diversion of uncontaminated up-site runoff areas to be disturbed
- ⇒ Existing and final contours
- ⇒ Revegetation program

## Vegetation - Endangered Ecological Communities

If there is any native vegetation upon, or could be affected by the proposed development site\s, the proponent must check that there is no other Endangered Ecological Communities. There have been several recently listed, and an up to date listing, details of potential location, and description should be obtained from National Parks and Wildlife.

## Vegetation - Native vegetation establishment near native vegetation areas.

The Department recommends that developments integrate an endemic native revegetation program. This is to minimise or prevent potential environmental weeds spreading into any existing nearby native vegetation areas and to minimise the fragmentation of any native vegetation by the development.

## Vegetation - Native plant enhancement.

The Department recommends that developments, where applicable, integrate a bush regeneration program within the development. This is to minimise the on and off-site environmental weed invasion potential and enhance any native vegetation.

I trust the above comments will be useful in the preparation of the EIS. The Department will require three full copies of the EIS to be sent to Greg Brady, Environmental Review Co-ordinator, at the address supplied. Should you have any questions please contact Greg Brady on (02) 9895 7441.

Yours sincerely,

for
Marwan El-Chamy
Resource Access Manager
Sydney/South Coast Region

(17)

NSW
Heritage
Office

18 JAN 2002

Contact: Anne Mackay
Telephone: (02) 9849 9569
mackaya@heritage.nsw.gov.au
File: S90/05826
Our Ref: HRL 15360
Your Ref: S01/02520

Mr Gordon Kirkby
A/Assistant Director
Development and Infrastructure Assessment
planningNSW
GPO Box 3927
Sydney NSW 2001

Dear Mr Kirkby,

**Re: Proposed Expansion of Port Botany**

I refer to your letter of 20 December 2001 requesting comments on heritage requirements for the preparation of an Environmental Impact Statement (EIS) for the above project. The NSW Heritage Office has not yet received a background paper on this proposal.

The EIS heritage assessment should address the following issues:

- The heritage significance of the site and any impacts the development may have upon this significance should be assessed. This assessment should include natural areas and places of Aboriginal, historic or archaeological significance. It should also include a consideration of wider heritage impacts in the area surrounding the site.
- The Heritage Council maintains the State Heritage Inventory which lists some items protected under the Heritage Act, 1977 and other statutory instruments. This register can be accessed through the Heritage Office home page on the internet (http:/www.heritage.nsw.gov.au), or can be searched by Heritage Office staff by request. You should consult lists maintained by the NSW National Parks and Wildlife Service, the National Trust, the Australian Heritage Commission and the local council in order to identify any identified items of heritage significance in the area affected by the proposal. You should be aware however, that these lists are constantly evolving and that items with potential heritage significance may not yet be listed.
- Non-Aboriginal heritage items within the area affected by the proposal are should be identified by field survey. This should include any buildings, works, relics (including relics underwater), trees or places of non-Aboriginal heritage significance. A statement of significance and an assessment of the impact of the proposal on the heritage significance of these items should be undertaken. Any policies to conserve their heritage significance should be identified. This assessment should be undertaken in accordance with the guidelines in the NSW

Heritage Manual. The field survey and assessment must be undertaken by a qualified practitioner/consultant with historic sites experience.

- If any items listed on the State Heritage Register are identified and will be impacted by the proposal, an Integrated Development Approval under the *NSW Environment, Planning and Protection Act, 1979* may be required from the Heritage Council. A full Heritage Impact Statement and where necessary a detailed Archaeological Assessment and Research design should be provided for these items.

- The relics provisions in the Heritage Act require an excavation permit to be obtained from the Heritage Council prior to commencement of works if disturbance to a site with known or potential archaeological relics is proposed. If any unexpected archaeological relics are uncovered during the course of work excavation should cease and an excavation permit obtained.

- If approval is required under the Heritage Act due to the listing of an item or place on the State Heritage Register, or being subject to an Interim Heritage Order, the Heritage Council's approval must be sought prior to an approval being issued by the consent authority under the Environmental Planning and Assessment Act (except where application relates to Integrated Development). In accordance with section 67 of the Heritage Act, an approval given by a consent authority in these cases before the Heritage Council's determination of the application has been notified to the consent authority, is void.

- The proposal should have regard to any impacts on places, items or relics of significance to Aboriginal people. Where it is likely that the project will impact on Aboriginal heritage, adequate community consultation should take place regarding the assessment of significance, likely impacts and management/mitigation measures. For guidelines regarding the assessment of Aboriginal sites, please contact the NSW National Parks and Wildlife Service on 9858 6444.

The Heritage Office would be happy to review any further documentation that may address any likely heritage impacts. If you have any questions, please do not hesitate to contact Anne Mackay on 9849 9569.

Yours sincerely,

Susan Macdonald

Susan Macdonald
**Principal Heritage Officer**

14·1·02

(4)

NEW SOUTH WALES **DEPARTMENT OF TRANSPORT**

DIRECTOR GENERAL

227 ELIZABETH STREET
SYDNEY NSW
GPO BOX 1620
SYDNEY 2001
AUSTRALIA

Ms Sue Holliday
Director General
Planning NSW
GPO Box 3927
Sydney NSW 2001

- 1 FEB 2002

Attention: Mr Gordon Kirkby

**Your reference: S01/02520**

Dear Ms ~~Holliday~~ Sue,

I refer to your letter referenced S01/02520 requesting Transport NSW input into the Director General's requirements for the EIS on the proposed new third container terminal expansion at Port Botany.

Transport NSW has a number of comments in respect of the overall project and considers that there are a number of key land transport and associated matters which should be addressed in the EIS.

There needs to be a comprehensive analysis of the road/rail mode shares and the transport infrastructure and operational management required both at the Port, and across the Sydney metropolitan area to support an integrated transport solution for an eventual 2.5 to 3 million TEU operation at Port Botany. Specific issues to be considered include:

- An integrated road and rail strategic plan which takes into account container movements and locations;
- The broad impacts of freight movements generated by the port, including air, noise and amenity;
- Development of principles for land use planning to manage container freight transport efficiency and impacts.

The proponent will need to work closely with both the Roads and Traffic Authority (RTA) and Rail Infrastructure Corporation (RIC)/State Rail Authority (SRA) to substantiate the capability of the transport networks. In particular the need for rail freight to use allocated paths and mix with passenger services across the Sydney rail network requires that the operational management concept for rail must be developed in consultation with the rail agencies.

To ensure that the transport outcomes are consistent with the strategic goals of the NSW Government, I propose that Transport NSW, RIC, SRA and the RTA be consulted as a reference group in relation to the detailed scoping of the transport related components of the EIS, and then on a regular basis throughout the EIS process.

In relation to the terminal area, the EIS should include a Masterplan which deals with the integrated development of the proposed site, including its relationship with the transport infrastructure of the existing Patrick and P&O terminals.

The EIS study must be predicated on the assumption that a 2.5 to 3 million TEU integrated facility at Port Botany will almost certainly necessitate 24 hour, 365-day operation, both at the site and across the transport network and remote intermodal terminals that will support the operation. The impacts arising from that level of operation must be addressed.

I note that both the RTA and RIC have been asked to provide comment in relation to the Director General's requirement for the EIS, and would expect that detailed transport matters be addressed by these agencies in their responses.

The impact of the growth in vessel size and the subsequent larger number of container transfers per ship call should also be taken into account in terms of the terminal layout and operation.

On the marine side, the issues will predominantly focus upon the direct impacts of the proposed dredging and land reclamation required for the new berth facility. Additionally, Transport NSW would like to see an environmental assessment made of the impact of increasing ship sizes and their movements within Botany Bay. However, Transport NSW considers that other agencies have more expertise to comment on the detailed requirements for the marine environment.

The proponent should take into account findings and recommendations of the Healthy Rivers Commission 'Independent Inquiry to the Georges River – Botany Bay System' within the EIS process.

Should you wish to discuss or clarify any matters, please contact Mr Jim Glasson, Director, Ports and Freight on 9268 2258.

Yours sincerely,

John Rogan

**John Rogan**
**Acting Director General**

29 January 2003

[redacted]

**RAIL** INFRASTRUCTURE
CORPORATION

11 January 2002

Access Division
Level 15
55 Market Street
GPO Box 47
Sydney NSW 2001

Telephone 02 9224 3000
Facsimile 02 9224 3991

Mr Gordon Kirby
A/Assistant Director
Development and Infrastructure Assessment
Department of Urban Affairs and Planning
Level 4
20 Lee St
SYDNEY NSW 2000

Dear Mr Kirby

**Subject:** PROPOSED EXPANSION OF PORT BOTANY

I refer to your letter S01/02520.

RIC has discussed the Sydney Ports Corporation (SPC) requirements for the EIS for the Expansion of Port Botany with SPC officers and is in general agreement.

RIC has proposed to SPC that in Form A Section 2, Describe the land to which the proposal relates: that the description area needs to be expanded to enable balloon loop rail lines to be developed as part of the basic generic infrastructure requirements of the terminal operator. These loops would connect with the Botany Line in Banksmeadow.

This change would require variations to Section 3. Summarise the proposal (eg purpose, components, size, employment). The first sentence on top of page 2 would read:

"An inter-modal rail facility would be established within the new terminal area by expanding the existing Botany Line into both existing Patrick and CTAL terminals by balloon loops to the line. This would create the opportunity for increased ..."

All other requirements would remain the same.

Yours sincerely

Gausden

Tony Gausden
Freight Operations Manager

CC to: Barrie Turner, Manager Town Planning, Sydney Ports Corporation

[redacted]

5

**RAIL**INFRASTRUCTURE
CORPORATION

Level 15, 55 Market St
Sydney NSW 2000
GPO Box 47 Sydney
NSW 2001 Australia

Telephone (02) 9224 3123
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29 JAN 2002

21st January 2002

Mr Gordon Kirby
A/Assistant Director
Development and Infrastructure Assessment
Department of Urban Affairs & Planning
Level 4
20 Lee Street
SYDNEY NSW 2000

Dear Mr Kirby,

**Re: PROPOSED EXPANSION OF PORT BOTANY**

I refer to the letter of 11th January, 2002 from Tony Gausden of RIC concerning requirements for the EIS for the Expansion of Port Botany.

RIC has held a further meeting with Sydney Ports Corporation (SPC) and Department of Transport (DOT) to explore the options for providing adequate rail capacity to the expanded port operations at Botany, including:-

- Balloon loops
- 60-80 TEU trains handled by locomotives utilising distributed power technology
- grade separation
- operating rules.

RIC, SPC and DOT are working collaboratively to identify the best rail configuration, taking account of broader rail network capacity issues. Accordingly it would be appreciated if the requirements for the EIS reflected the need for a broadly based investigation of other options in addition to balloon loops, that will enable rail to achieve a 40% share of container traffic (i.e. 1 million TEU's by rail per annum).

Yours sincerely,

**GLEN DAWE**
**General Manager Access**

Cc: Barry Turner
Manager Town Planning
Sydney Ports Corporation

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D01/02923

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2 1 DEC 2001
DUAP EXECUTIVE UNIT

(7)

HEALTHY RIVERS COMMISSION
Level 18, 15 Castlereagh Street
SYDNEY NSW 2000
Tel. (02) 9231 2977
Fax. (02) 9232 5973
Website: www.hrc.nsw.gov.au

20 December 2001

INFRASTRUCTURE ASSESSMENT
RECEIVED
0 2 JAN 2002

Ms Sue Holliday
Director General
Planning NSW
GPO Box 3927
Sydney NSW 2001

Dear Sue,

I refer to the Sydney Port Corporation proposal for expansion of Port Botany and its request for Director's Requirements related to the preparation of an Environmental Impact Statement.

The Commission attended the planning focus meeting on 18 December 2001 and I am prompted to write to you in relation to three issues. Firstly, the context in which this assessment should be made pursuant to the recent Government decision on the Commission's Georges River – Botany Bay Report. Secondly, technical matters drawn to the Commission's attention during that Inquiry and which could, with advantage, be addressed as part of the assessment. Thirdly, the possibility of sharing the Commission's extensive data-base for the Corporation's required consultation processes.

The port proposal presents a unique opportunity and catalyst to contribute to the implementation of the decision-making framework for the bay, decided by Cabinet on 12 November (Cabinet Minute 206-2001) which is to provide the following.

- Recognition by State planning strategies of the bay as a discrete ecosystem, which will be managed from a whole of bay perspective.
- The strategic context within which whole of bay goals can be formulated, better informed decisions taken, stakeholder input included; and any necessary trade-offs identified.
- A conflict resolution mechanism for competing interests, which involves all relevant stakeholders – the three levels of government and their agencies, business, transport interests and the community.
- Independent science to inform decision making on a whole of bay perspective. (The University of NSW is keen to broker that role.)

The Government's decision on assessment of significant proposals in and around the bay is premised on the establishment of the above decision-making framework. It requires comprehensive assessment of the impacts of specific proposals on the whole bay system (including assessment of cumulative impacts on the hydrology, geomorphology and biology of the bay). Clearly the port proposal should be assessed within that context. That view underpinned the Commission's recommendations which were endorsed by Government.

I also believe that the interests of the Sydney Ports Corporation would be better advanced through this process, which would then help structure the EIS process. Additionally, some of the conflicts, trade-offs and wide-ranging interests and concerns could be explored in ways that would better inform the EIS process.

The Director's Requirements in respect of the port proposal are, as I understand it, a State planning strategy and so should, in my view, be used to give effect to the Government decision for the management of Botany Bay. To assist further in the preparation of your Director's Requirements, attached is a list of technical issues that were drawn to the Commission's attention during its Georges River Botany Bay Inquiry. I would be happy to explore ways of sharing the Commission's extensive stakeholder list and interests known to the Commission.

Consideration of the port expansion provides both an opportunity and the catalyst for implementation of the Government decision about clarifying and strengthening the arrangements for natural resource and environmental management, including marine policy, in Botany Bay and surrounds. The decision, in my view, calls for particular attention to be paid to the exercise of operational, transport and commercial responsibilities as described in Recommendation BM 2 of the Commission's Report.

As always, I would be pleased to discuss this issue further. Your officers can also contact Paula Douglas, who led the Commission's Georges River – Botany Bay Inquiry.

Yours sincerely,

Kind regards. All the best for 2002.

Peter J Crawford

Peter J Crawford
**Commissioner**

Cc: Ms Lisa Corbyn, Mr Brian Gilligan

HEALTHY RIVERS COMMISSION
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3 January 2002

Mr Gordon Kirkby
planningNSW
GPO Box 3927
Sydney NSW 2001

Your Ref: SO1/02520

Dear Gordon,

Thank you for your letter dated 20 December 2001 inviting me to send you the Commission's views on the Director's Requirements for the EIS on the proposed expansion of Port Botany.

Those views and relevant technical information are contained in a letter from Commissioner Peter Crawford to Sue Holliday, also dated 20 December 2001, copy attached for your information. That letter should be taken as the formal response to yours referenced above.

Please do not hesitate to contact me on 9225 2305 if you require further assistance on this matter.

Yours sincerely,

Paula Douglas
Georges River – Botany Bay Inquiry Manager

Encl.

## Technical issues for consideration in the preparation of Director's Requirements for the Port Botany expansion proposal.

1. Loss of public space and amenity. The Commission found strong community and council opposition to any further loss of foreshore. Whilst the current configuration of Penrhyn estuary and Foreshore Beach is largely a human construct, the entire northern shoreline comprised sandy shoals before major port and airport construction (air photographs are available to verify).

2. Loss of the last remaining and significant habitat on the northern side of the bay. The Commission was advised that Penrhyn estuary provides important habitat for migratory species of birds and many wader species. The adjacent shoals support seagrass and habitat for juvenile fish and provide foraging areas for the birds.

3. Particular attention should be paid to the loss of that foraging area on the sustainability of Little Terns in the bay. The Commission was told that these endangered migratory birds are dependent on the shallows at the proposed site for foraging/feeding to build up condition required prior to nesting on the southern shores. Geoff Ross of the National Parks and Wildlife Service, who has an ongoing monitoring program at that site, can provide more details. Some of that seagrass was transplanted into the area as compensation for areas lost through airport construction. (NSW Fisheries holds relevant information.) The appropriateness of such compensation measures for one development being negated by another needs to be assessed.

4. Clearly the above significant losses are unlikely to be avoided if the port Botany expansion proceeds. An independent and strategic assessment of the need to expand at Botany *vis a vis* Newcastle and/or Kembla would seem warranted prior to a decision being made to alienate a further 2km of foreshore and 70 hectares of bay.

5. Changes to wave and current patterns/energy as a result of dredging, reclamation and hard stand areas, and their impact on sediment/sand transport and resultant shorelines around the entire bay.

6. The secondary impact of any measures proposed to mitigate (5). Dr Peter Cowell of the Coastal Studies Unit of the University of Sydney prepared an independent report for the Commission and may be able to provide further details to the Ports Corporation.

7. The impact of (5) and (6) on aquatic and terrestrial ecosystems in and around the bay including benthic organisms, seagrasses, fish, salt marsh, mangroves, migratory birds and other waders.

8. If the boat ramp is proposed to be relocated to the western end of Foreshore Beach, together with a concentration of recreational activities, the suitability of water quality will need to be assessed. Sydney Water's Sewer Overflow EIS indicated that the canal draining Mill Pond is a conduit for the 5$^{th}$ worst sewer overflow in the Sydney metropolitan area. Given the relatively poor flushing characteristics of that part of the bay, the western end of Foreshore Beach is prone to high levels of faecal coliforms. Sydney Water would be able to provide more details.

9. Further to the public health issues in (8), there may also be safety hazards associated with small vessels passing between the airport runway and large container ships at the proposed berth, especially given the depths of water that would be involved post dredging.

10. Changes to the levels and flow patterns of groundwater in the vicinity of the proposed site, and the resultant impacts on stormwater flows, flooding and the potential for contaminated groundwater to reach the surface thus creating a public health hazard in the Botany municipality. Should dredging breach the groundwater table, contaminants may reach the bay and have further impacts on bay ecology. DLWC has undertaken a study of this groundwater and would be able to provide more details, contacts are Dan McKibbon and Giselle Howard.

11. Identification of trade-offs and offsets in the event that the proposal is approved. The Commission has identified a number of ecologically important areas around the bay. Such offsets could therefore include, but not be limited to, the following.

    - Rehabilitation of the degraded areas of the Rockdale wetland corridor, which the Government has decided should be protected.

    - Enhancement of the flow characteristics of the Botany swamps (Sydney Water has prepared a detailed management plan and could provide advice in this regard.)

    - Enhancement of the wading bird habitat on the southern shores, including in Woodlands Bay which is habitat to the threatened Taren Point Shorebird Community.

    - Independent studies of sand movement on the southern shores to inform the best means to protect important habitats on Towra Point and Towra Spit Island.

    - Independent studies of sand movement at the mouth of the Georges River and the relationship between the Kurnell/Towra sand bodies, those on Taylors Bar and their interrelationships with Lady Robinsons Beach. Dr Peter Cowell has detailed recommendations in his report available from the Commission.

9

**From:** "Field, Ray" <Ray.Field@dotars.gov.au>
**To:** "'david.kitto@planning.nsw.gov.au'" <david.kitto@p...
**Date:** Wed, Jan 30, 2002 4:10 pm
**Subject:** PROPOSED EXPANSION OF PORT BOTANY

Dear Mr Kitto

I refer to Mr Kirkby's letter, reference S01/02520, relating to the Director-General's requirements for the above mentioned proposal.

The requirements of the Commonwealth Department of Transport and Regional Services relate to the protected airspace for Sydney Airport. The requirements are as follows:

"In accordance with the Airports Act 1996, Part 12 (Airspace Protection) and the Airports (Protection of Airspace) Regulations under Part 12, any aspect of the proposal which would, if carried out, result in a penetration of the prescribed airspace for Sydney Airport, must have the approval of the Department before it can proceed. In making a decision, the Department would have regard to the impacts of the development on the safety,efficiency and regularity of current or future air transport operations into and out of Sydney Airport."

Yours sincerely
Ray Field

Ray Field
A/g Director
Airport Planning (Commercial)

ph (02) 6274 7930 fax (02) 6274 6101
email ray.field@dotrs.gov.au

**CC:** "Foster, Kym" <Kym.Foster@g5dtcbr0ms02.dotars.gov....

(11)

CIVIL AVIATION
SAFETY AUTHORITY
AUSTRALIA

13 FEB 2002

Our Ref: 01/13325
Your Ref:S01/02520

Mr Gordon Kirby
A/Assistant Director
Department of Urban Affairs and Planning
Development and Infrastructure Assessment
GPO Box 3927
Sydney NSW 2001

Dear Mr Kirkby,

**Proposed Expansion of Port Botany**

I apologise for the delay in responding to your letter dated 20/12/01 requesting the Civil Aviation Safety Authority (CASA) requirements for the EIS.

Some of the issues raised by Sydney Airport Corporations Limited (SACL) at the Planning Focus Meeting held on the 18th December 2001 embrace the issues of concern to CASA. The issues that CASA would be concerned with relative to Sydney (KS) Airport are:

- hazardous objects, both permanent and transient;
- bird hazard management;
- dangerous lights; and
- interference to navigational aids and radar.

CASA confers with SACL and Airservices Australia to ensure that they have been consulted in relation to a development proposal, which therefore leads to CASA not having to have any direct involvement. However it maybe necessary for CASA to be involved at a later date if the advice provided to SACL and AsA is not followed and is then deemed to breach the Civil Aviation Regulations.

Yours faithfully,

Kevin Dyer
District Aerodrome Inspector
SYDNEY

6th February 2002

P.O. Box CP57, CONDELL PARK NSW 2200. Telephone (02) 9780 3058 Facsimile (02) 9780 3045
Email: Dyer_K@casa.gov.au

AUSTRALIAN AIR TRAFFIC CONTROL

AIRSERVICES AUSTRALIA
SYDNEY OPERATIONS
Commercial Operations Group
PO Box 211 Mascot NSW 1460 • Phone: 02 9556 6842 • Fax: 02 9556 6500

-7 FEB 2002

Mr Gordon Kirkby
A/ Assistant Director
Development and Infrastructure Assessment
Planning NSW
GPO Box 3297
SYDNEY NSW 2001

5 February, 2002

Your ref: S01/02520 of 20 Dec 2001

Dear Mr Kirkby

**RE: PROPOSED EXPANSION OF PORT BOTANY**

The following is Airservices Australia (Sydney Operations) response to your request for specific issues in the Director-General's requirements for the Environmental Impact Statement for the proposed expansion of Port Botany by the Sydney Ports Corporation:

**1. Maintenance of Independent Airport Operations**

1.1 The EIS shall recognise that Airservices Australia will not support such development which would restrict the operations of Sydney Airport, in all weather conditions, by day or night, due to 'safety, efficiency and regularity' obligations, or any such action which may pre-dispose a flow on effect that would impinge on the operation of the Long Term Operating Plan (LTOP).

**2. No Penetration of Prescribed Airspace and Obstacle Limitation Surfaces (OLS)**

2.1 The EIS shall assess the impact of the proposed expansion on prescribed airspace as determined in accordance with *ICAO Annex 14*, *ICAO DOC 8168 Procedures for Air Navigation - Operations Vol II*, and relevant Commonwealth Legislation of the *Airports Act 1996* and the *Airports (Protection of Airspace) Regulations*, to the extent that penetration of such airspaces may compromise the independent operation of Sydney Airport and the Long Term Operating Plan. In such circumstances, the Commonwealth *Environment Protection and Biodiversity Act 1999* shall need to be addressed by the EIS.

2.2 The EIS shall take into account of current and future container shipping that may be able to utilise the port through all modes of operation including:

- Berthing and departure procedures;
- Tidal effects;
- Loading/unloading height differentiation; and
- Crane operations, including locations and maximum operating and non-operating heights (Airservices support the use of low height shuttle boom cranes that would not penetrate the OLS in any mode)

## 3. Transportation

3.1 Airservices understands that Rail Infrastructure Corporation (RIC) is proposing an upgrade and duplication of the current Sydenham - Botany Railway. Whilst not necessarily within the scope of the Port Botany Expansion EIS, Airservices has reservation regarding this expansion if it is likely to effect the Precision Approach OLS associated with Runway 25. Penetration of this surface could lead to the requirement of a displaced threshold, negating Runway 25's use as an Instrument runway and consequently affect the operation of air transportation and the LTOP. Airservices request that the status of the RIC expansion be confirmed.

3.2 Related to 3.1 is the expansion or alteration to major roads, bridges and flyovers that may be required or projected to be required as a result of the Port expansion, insofar as such works may also affect the prescribed airspaces. The EIS shall need to assess and report on this issue.

## 4. No Effect on Aviation Navigational Equipment and Communications

4.1 The EIS shall assess the impact of the Port botany Expansion on Airservices electronic navigational equipment, which may be made susceptible to shielding, reflection and interference. These include, but are not limited to:

- Terminal Approach Radar
- Precision Radar Monitor
- Very High Frequency Omni Directional Range (VOR)
- Distance Measuring Equipment
- Instrument Landing System (installed all runways)
- Very High Frequency (VHF) Air/Ground/Air Communications

4.2 The EIS shall assess the impact on future new generation navigational aids and procedures, which will include the use of ground based augmentation satellite systems.

Should you require further information, please Contact Terminal And Procedures Specialist Peter Close on 02 9556 6626, fax 9556 6802 or email peter.close@airservices.gov.au

Yours faithfully,

Susan Smith
Aerodrome Control Services Manager
SACL Customer Relations Manager

(8)

Sydney Airport

File No.: 01-01885 and 20.00827

25 January 2002

Mr Gordon Kirkby
A/Assistant Director, Development and Infrastructure Assessment
planningNSW
GPO Box 3927
SYDNEY NSW 2001

**FACSIMILE 02 9762 8703**

Sydney Airports
Corporation Limited
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Dear Mr Kirkby

**PROPOSED EXPANSION OF PORT BOTANY – SYDNEY PORTS CORPORATION**

I refer to your letter dated 20 December 2001, regarding the proposed expansion of Port Botany by the Sydney Ports Corporation, requesting a summary of specific issues for inclusion in the Director-General's requirements for the Environmental Impact Statement (EIS).

Sydney Airports Corporation Limited (SACL) issues are detailed below. These were presented to the Planning Focus Meeting held on 18 December 2001 and should be assessed fully in the EIS.

**Maintenance of Independent Airport Operations**

- The EIS shall recognise that SACL will not support any development which restricts the operations of the Airport, especially in regards to Runway 16L/34R - due to 'safety, efficiency and regularity' obligations and the need to preserve the Long Term Operating Plan for Sydney Airport and Associated Airspace (LTOP). The Federal Government mandated noise sharing under LTOP cannot be jeopardised, nor can the longer term value of Sydney Airport in the lead-up to a sale process.
- SACL wishes to preserve (for future owners) the use of 16L/34R for flexible future aircraft operations, and the Port Botany Expansion must not prejudice this option.

**Penetration of Prescribed Airspace/Transient Obstacles**

- The EIS must assess the impact of the Port Botany Expansion on prescribed airspace (which comprises Obstacle Limitation Surfaces and PANS-OPS) to ensure that the proposal is fully compatible with safe and efficient operation of Sydney Airport. Details of these surfaces have been provided to Sydney Ports for their planning purposes,
- Commonwealth aviation legislation/standards will need to be clarified regarding the status/definition of a transient obstacle arising from shipping operations,

- Legislation covering this issue is the *Airports Act 1996* and the *Airports (Protection of Airspace) Regulations*,
- Assessment of the new generation of large container ships, the size/height of the ship, the projected shipping leads into the Port and the extent of intrusion (including margins for error) into 16L/34R surfaces,
- Assessment of the maximum operational height of the range of proposed crane types, with an emphasis on low height shuttle boom cranes,
- The double stacking of container trains may penetrate the Runway 25 approach surfaces. The Rail Infrastructure Corporation (RIC) is proposing to upgrade and duplicate the current Sydenham-Botany Goods Railway, the height and alignment of which will determine the extent of the penetration if any. A more intensive use of the railway will increase the incidence of 'penetration', which may require a reassessment of its 'transience',
- Sydney Ports is to confirm that the Sydenham-Botany Goods Railway upgrade project by Rail Infrastructure Corporation (RIC) is being handled separately from this EIS. SACL is currently engaging with RIC and has a range of issues requiring resolution. SACL views the Port Expansion and the railway upgrade as linked, given RIC's role as a major service provider with a key freight logistics role, and they should be considered holistically in the EIS given the assumption on transport modal split and the efficiency of Port Botany.

**Precision Radar Monitor (PRM)/Navaids**
- The impact of the Port Botany Expansion on Airservices Australia's Precision Radar Monitor and navigational aids (including distortion potential) and associated aircraft operations are to be assessed,
- The EIS shall assess the impact of Port Botany Expansion on future, new-generation navigational aids and operational procedures.

**Research Overseas Port/Airport Relationships**
- The EIS should research the impacts on airports where there are port facilities in close proximity, and examine opportunities to ensure that the airport is not impacted. This may through the use of innovative operational procedures and infrastructure such as new/alternative cranes, use of port 'curfew' hours etc.

**Bird Management/Boat Ramp Relocation**
- The impact of birds on Sydney Airport is an ongoing risk which needs to be closely assessed due to operational safety issues,
- The Port Botany Expansion and the proposed boat ramp may increase the hazard to Sydney Airport, as it will alter the flight path of birds, which is generally to/from the west. As birds generally congregate at the boat ramp and the Port to feed on fishing refuse and roost, bird migration would increase the risk of bird strike,
- Sydney Ports would need to (re)investigate other locations/alternatives (including deletion) for a boat ramp,
- Bird attraction minimisation measures would need to be investigated by Sydney Ports in reduce the incidence of bird attraction to Port Botany.

**Road Transport**

- The EIS should establish current baseline traffic conditions, including an analysis of key intersections and projected performance given current rates of vehicular growth and additional Port Botany traffic, key traffic route identification, including origin-destination study of vehicular traffic,
- Assess the traffic generation potential of the Port Botany Expansion and the proposed modal split for rail and road container distribution,
- Assessment and Integration with any current RIC and/or RTA road proposals and concepts in the vicinity of the subregion, including integration into the existing road networks and capacity enhancement/connection opportunities with concepts such as the Marrickville Truck Tunnel, the St. Peters Industrial Route, Foreshore Drive flyover, and General Holmes Drive/Mill Pond Road Intersection,
- Any such road study should also integrate with current and future ground access needs for Sydney Airport.

**Other Options/Sites**

- Sydney Ports will need to provide a clear analysis of assessed alternative options,with lesser potential airport impacts,
- Options discounted in earlier assessments would need to be subjected to analysis again given the breadth of additional (aviation) issues raised by other agencies and in other forums.

**Other Issues**

- The Port Botany Expansion Proposal is considerably further to the west to that proposed during the Third Runway EIS, the effect of which requires additional dredging in Botany Bay for a new basin,
- The effects of Botany Bay dredging and the revised Expansion proposal in terms of any prejudicial hydrodynamic impacts on the Third Runway structure will require assessment,
- Overall hydrodynamic changes due to the Port Botany Expansion should be assessed as SACL and other agencies are implementing Third Runway agreed arrangements for the protection of Botany Bay. These would need consideration in the light of any changes to impacts on the Bay,
- Interface with Patrick's current proposal and EIS,
- Lighting shall meet the *Rules and Practices for Aerodromes – Lighting in the Vicinity of Aerodromes, Advice to Designers* requirements,
- The EIS and Development Application (DA) propose an envelope approach to the port operator and above-ground fixtures. The EIS must recommend that pre-defined development guidelines are produced which reflect the constraints of the site, as identified by the EIS and included in the DA, to ensure consistency of any future port development by third parties, with the EIS.

Sydney Ports Corporation and SACL have agreed on a direct dialogue framework to assist with resolution of key issues. This dialogue also involves the Department of Transport and Regional Services (as prescribed airspace regulator), the Civil Aviation Safety Authority, Airservices Australia and Qantas.

Thank you for the opportunity to input into the EIS process. Should planningNSW require further information, please contact SACL's Planning Analyst Joseph Chan on 02 9667 6423.

Yours sincerely

Karl Mezgailis
Master Planning and Environment Manager

cc:

Bob Stephens, Assistant Director Sydney Region East,

John Hayes, General Manager Property and Planning, Sydney Ports

Susan Smith, Aerodrome Control Services Manager Manager, AsA

Kevin Dyer, CASA

Bill Bourke, Qantas

Kym Foster, DoTRS

SACL
Chris Falvey
Greg Russell

(18)



**SUBMISSION ON**

# Director's Requirements for Port Botany Expansion EIS

## Introduction

SSROC is a voluntary association of the 11 local councils of Southern Sydney. It was established to assist Councils achieve common approaches to problem solving, to identify and address issues of regional concern, and provide a focus for inter-Council actions. The 11 councils forming SSROC collectively represent over 1 million residents.

In late 1999 SSROC obtained federal funding for the 'Botany Bay Program', as part of the national Coast and Clean Seas Program. The Program commenced in May 2000, with the main objective being to prepare a framework for the integrated planning of the Botany Bay catchment. The final report of the Program is to be launched in the coming weeks.

This submission has therefore been compiled from SSROC's extensive experience in matters surrounding Bay management and in consultation with staff from member councils.

We believe the following issues should be considered for inclusion in the Director's requirements for the EIS for the Port Botany expansion.

## 1. Alternatives

Alternatives include not only those available in Botany Bay but those available elsewhere – including Port Kembla and Newcastle. There is a need to be satisfied that other alternatives have been thoroughly investigated and that reasons for rejection of these are sound.

Alternatives within the Bay would include the 'do nothing' option; increasing the throughput of freight by management rather than structural change; introduction of more efficient technology/labour.

The wider issue of national port development policy is also relevant: is it consistent with the national interest for Port Botany to become the country's major container terminal, for example?

## 2. Port–Airport Relationships

The EIS needs to consider the implications of port expansion for airport operations, safety, security, hazard risk; can an enlarged sea port coexist in immediate proximity to an international airport which is itself likely to see increases in operational activity in the next decade? Is not this relationship so intimate that it brings with it a risk of a massive disaster at some future time?

## 3. Cumulative Impacts

These would include not only those associated with the port itself but also those generated by the additional industrial growth in the immediate locality (encouraged further by port expansion) and increases in airport traffic. These cannot sensibly be separated from each other. Cumulative impacts need to be addressed having regard to the wider Bay environment – not simply the Port site and its immediate environs. There is a need to consider the impact on local residents, bearing in mind that the area has changed dramatically since the last major expansion.

## 4. Retrospective Impact Assessment

The Corporation ought to be required to evaluate current operations in the context of impacts which were projected when the last major port works were undertaken: ie. were earlier projections and predictions correct? If not, why not?

## 5. Stormwater

Additional hardstanding, buildings and machinery will greatly increase the area of impervious surface and volume of run-off. How will this be managed? How will pollutants be handled? What action will be taken to prevent additional pollutant loadings entering Bay waters?

## 6. Global Warming

Will the proposed design take into account the possibility of sea level rise?

## 7. Public Access To Waterway – The Bay Trail Concept

Will design make any provision for public access to the foreshore for pedestrians, cyclists? Can design incorporate a segment of a future Botany Bay Trail (as proposed in The Tide is Turning, the report of the Botany Bay Program)?

## 8. Source Of Landfill Material

All such sources should be described; materials analysed and precautions for dealing with possible pollutants spelled out.

## 9. Ecological Impacts

The concerns raised by the Healthy Rivers Commission at the planning focus meeting need to be taken into account.

Both acute and chronic effects on ecological communities of vibration associated with construction activities, potential pollution from contaminated fill and potential risks from expanded port operation, need to be considered.

## 10. Marine Pest Management

The elevated potential for introduction of marine pests in both ballast water and on the hulls of vessels needs to be considered. It is currently possible for any ship to moor in the port irrespective of the number of potential pests growing on its hull. A comprehensive suite of practical management options to ameliorate these impacts should be detailed, including any successful attempts from overseas. New legislation may be required for example, that all vessels entering Australia must undergo a quarantine inspection.

## 11. Offsets For Environmental Damage

What is Port Corporation's proposal for offering compensatory offsets to counter loss, damage or destruction of public waterway surface, public amenities and species loss/damage? Of particular concern is the proposed elimination of Foreshore Beach, the only remaining beach in the Botany Bay Local Government Area.

## 12. Security Of Retaining Structures

The construction methods and particularly methods to contain sediment while dredging and during land reclamation need to be detailed, along with emergency procedures. The consequences of accidental mishap/breaching of retaining walls/bunds during ongoing port operations should also be spelled out

There is a need for an overall detailed risk analysis and recommendations for risk amelioration for both construction and operation phases.

## 13. Navigation

Proposed port expansion may create hazards for recreational users of the bay, including fishers, sailors, surfers. The EIS should describe measures for dealing with a worst case scenario: eg a container freighter coming aground in a storm on an incoming king tide.

## 14. Light Pollution

Twenty-four hour operations will require extensive lighting installation for security and operational purposes. Impacts of these facilities on local residential amenity, the airport and nearby astronomical observatories at The Rocks and Como need to be assessed.

## 15. Traffic and Transport

The impact of increased truck movements from the port all the way to their proposed destination needs to be analysed, particularly in the light of the proposed 24 hour operation. Potential impacts to the community include: noise (costs associated with additional insulation, costs associated with council needing to amend noise policies, loss of outdoor amenity), vibration (costs associated with increased stress levels, geological studies to assess long-term impact on structures), pollution, pedestrian safety and amenity and long-term Council road maintenance costs.

Efforts to encourage the significant number of additional employees to reduce car commuting must not be ignored.

Whilst it is undoubtedly better in terms of fuel use and greenhouse impacts, to transport freight by rail, there are nevertheless many factors which must be taken into account as a result of this rail movement, including noise and vibration impacts. There is also the loss of productivity impact on communities through which the trains pass as residents must wait at intersections (the RTA has formulae for these calculations).

## 16. Submarine Cables And Pipelines Across Bay

How will the port expansion affect these facilities?

## 17. Tourism – Special Aquatic Events – Bay Festivals

How will port expansion affect the planning and execution of aquatic events and celebrations in the northern sector of the Bay?

## 18. Visual Impacts

Need to explain and assess the visual impacts of the proposed Port expansion- scale, bulk, lighting etc in terms of its visibility from vantage points beyond the immediate Council areas, eg: elevated areas of Marrickville and neighbouring Council areas.

## 19. Hydrological Impacts

Issues of particular concern include: pile driving, dredging, sand draft from fill and dredge (which was a major problem during construction of the first port) and effects on the Bay floor of vibration associated with construction activities. Calculations from the third runway EIS were very inaccurate, as it turned out, in relation to sand movement along Lady Robinson's beach. Care in choosing accurate modelling methodology needs to be demonstrated.

There is a need to take into account the issues raised by Fisheries at the planning focus meeting, particularly in relation to dredging and reclamation.

## 20. Broader Planning Framework Considerations

The very detailed recommendations of the Healthy Rivers Commission report of its Inquiry into the Georges River and Botany Bay system need to be considered.

The proposal needs to be assessed in the context of the new planning framework announced by Minister Debus on 14 November 2001 and of PlanFirst arrangements.

There is a need to take into account the Marrickville Truck Tunnel proposal (to run from Parramatta Road to Canal Road) and the Cross-City Tunnel proposal.

What other proposals are currently on the table for bikeways, GreenWeb Sydney, and expansion of the CityRail network? Will the port expansion prevent these initiatives? There should be a requirement for any port expansion not to preclude the development of these more important initiatives.

What are the Ports Corporations' plans should further expansion be required after 2025?

(18) cont.

**From:** Juanita Higgs <jh@ssroc.nsw.gov.au>
**To:** <gordon.kirkby@planning.nsw.gov.au>
**Date:** Mon, Jan 21, 2002 10:55 am
**Subject:** FW: Introducing pests to Port Botany

Dear Gordon,
In reference to a point on pest introduction, raised in the SSROC submission for the D-G's requirements for Port Botany expansion, please see the following email from a marine biologist at James Cook Uni. If possible, it would also be good if these references could be passed on to the eventual EIS authors.
Regards, Juanita
--
Juanita Higgs
Regional Projects Manager
Southern Sydney Regional Organisation of Councils

Ph: 02 9317 2811
Fax: 02 9669 2112
Email: jh@ssroc.nsw.gov.au

Check out our website at: www.ssroc.nsw.gov.au

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From: "Oliver Floerl" <Oliver.Floerl@jcu.edu.au>
Date: Mon, 21 Jan 2002 07:46:26 +1000
To: "Juanita Higgs" <jh@ssroc.nsw.gov.au>
Subject: Re: Introducing pests to Port Botany

Dear Juanita,

thanks for your email - I'm glad you liked the article. I'll try and go through your email bit by bit.
> Do you have any info on pest introduction via container ships?

Species introductions by hull fouling is a grey area - everybody knows it has happened and still is happening - whenever there are ecological surveys undertaken in ports they find plenty of organisms, including exotic ones, on the hulls (or in amongst organisms on the hull - gobies, for example) or in the sea chests. So, there are countless records, but little research has been done on it compared to ballast water. In the case of ballast water, *everything* has been looked at: the scope of the problem, possible solutions (filtration/heat/de-oxygenation), and the effectiveness of these solutions. The result has been that managerial and public awareness have been raised, and that a mandatory ballast treatment protocol has been introduced by AQIS. Hull fouling is a much older problem, but not much has been done - people thought that because we've got antifouling paints the matter is dealt with. It isn't. Paints work less well in the tropics than in the temperates, and if they're not renewed they don't work at all.

Sorry about all the blurb....that happens when you get me started. I am attaching a list of references to the bottom of the email. Most of them might be of interest for your EIS. The CSIRO/CRIMP report is availabe from the CSIRO for $40 I think (easy to find on the web - type "CRIMP" into www.google.com and you should be there). It does not incorporate sampling of ship hulls but has extensive introduced species lists for Port Phillip Bay and estimates the likely introduction vectors for each species - hull fouling gets ~70%. The Thresher (1999) paper is a diluted version of it. The Cranfield et al. report from NZ is also very informative, and that report and the James & Hayden (2000) report can be obtained from the National Institute for Water and Atmospheric Research in NZ (www.niwa.cri.nz). Both

are very valuable, and the James & Hayden one looks specifically at the bottoms of ships. Unfortunately I have lent that to someone and forgot to stick the details into my database, but "James & Hayden 2000 on ship hull fouling" should be enough info for NIWA to know what you want. Ashley Coutts' thesis is VERY interesting; He looks at the hulls of merchant vessels and identifies high-risk areas on the hull, where exotic species are most likely to be. I would encourage you to send him an email (ashley@cawthron.org.nz) and ask him for an abstract via email, as his thesis is 330 pages long....
All the other references are very interesting, too, and can be obtained from libraries or, if that does not work, I can photocopy and post them to you if you like (except when they're 200-page reports...).

> and can you suggest any management
> options (assuming the state govt gets its way and the expansion goes ahead)
> to ameliorate impacts? Do you know what they've done overseas for eg? Is it
> possible to legislate that all vessels entering Australia must undergo a
> quarantine inspection?

My personal opinion is that "an ounce of prevention is worth a pound of cure". Clearly, not much might happen for years even when no hulls or ballast water are checked. But once a pest gets in, and it happens to be nasty one that displaces native biota or harms humans (toxicity, etc) then the costs will be MUCH larger than those it would have taken to prevent it. The zebra mussel costs the US government about $US600 million per year, since almost a decade !! Therefore, in theory (always different from practice, unfortunately), the best way to go would be (1) the undertaking of a thorough port survey for introduced organisms (pontoons, pilings, sediments, plankton, fish, ship hulls - everything is sampled over a week or so) to establish baseline data on what is there. (2) From then onward, a monitoring program should be started to see whether anything new gets in. This could consist of, e.g., the incubation of experimental test panels in the water to see what recruits to them (fouling organisms...new things can be found that way), regular plankton sampling, and new port surveys every few years. You raised the most important point yourself though - incoming vessel hulls could/should be sampled, as all the 100s of 1000s of $$ for port surveys and monitoring are at risk of being wasted if no prevention efforts are implemented. To get to your question - no, nothing is done overseas on this (myself and a few collegues are trying to get people's attention on this via a review publication (in prep.) and some conference talks), they're all ballast water heads !! In theory it is possible to have legislation that requires quarantine checks for every incoming vessel. But first we'd have to be able to present a way to deal with "high-risk" vessels, and that way would have to be cheap, otherwise it's unlikely that much is going to happen.
The identification of exotic species on a hull is not easy - there are usually only a few specialised taxonomists around, and samples can take months to be processed. It would be much better to have a silver-bullet method which gets rid of all fouling if a quarantine check finds a lot of it on a given vessel. In that case, a few divers would be required, some sort of underwater vehicle that can clean the hull (there are things like that around), and an on-land dumping facility where the removed biota can be disposed of. If it is simple dumped on the port bottom then it might still get established. This is all difficult to achieve, but for the sake of Australia's marine ecosystems I would suggest it is worth thinking about.

Sorry this turned into such a long email - I hope you are still awake. I am happy to provide feedback on these issues, as we're dealing with a problem that is entirely underestimated. If Port Botany introduces some sort of innovative screening protocol it would be a leading example for other coastal nations, isn't that something to strive for ??!

Well, thanks again for getting in touch, and I hope everything goes well. Get back to me anytime if you have further queries. Oh, and that reference list is at the bottom.

Cheers,
Oli

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Thresher R.E. (1999). Diversity, impacts and options for managing invasive marine species in Australian waters. J. Environ. Man. 6:137-48.

>
> Thanks for your time, Juanita

> --
> Juanita Higgs
> Regional Projects Manager
> Southern Sydney Regional Organisation of Councils
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> Ph: 02 9317 2811
> Fax: 02 9669 2112
> Email: jh@ssroc.nsw.gov.au
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(15)

File: PPTY 228-40(P2)

City of Botany Bay

8 January 2002

Mr Gordon Kirkby
Acting Assistant Director
Development and Infrastructure Assessment
Planning NSW
GPO Box 3927
SYDNEY NSW 2001

Dear Mr Kirkby

**PROPOSED EXPANSION OF PORT BOTANY**
**Your Ref: SO1.02520**

In response to your letter of December 2001, the following are submitted as requirements that the City of Botany Bay would request be included in the Director-General's Requirement for the EIS for the Proposed Expansion of Port Botany.

Council has reviewed the Background Paper (dated 18 December 2001) prepared by URS for Sydney Ports Corporation and supports the inclusion of all those environmental matters forming Table 1 of Section 8, of the "Paper" in the Director General's Requirements.

In addition to the matters addressed in the following paragraphs it is Council's view that the proposed port expansion is linked to the redevelopment of the Patrick Container Terminal and the matters identified for the "Patrick" EIS should be reconsidered in the overall Port expansion EIS.

Additional emphasis should be placed on the following:

1 Full and further examination of the various options for the location of the Port expansion within Port Botany (Page 3 – 1).

2 Further examination of the social impact of the loss of a major portion of Foreshore Beach on local residents.

3 Fully consider the effect on the road network of the increase in freight volumes on road transport to and from the port. The actual number of containers moved by road will significantly increase regardless of the proposed rail upgrade and increase in use.

4 Consideration of the effect on the flows from Springvale and Floodvale drains.

5 Consideration of the effect on the flows of other minor catchments such as Dent Street and Fremlin Street.

6 Consideration of the effect on surface and stormwater flows. Flooding of local areas occurred where previously there had been no flooding when Port Botany was originally constructed.

7 The effects on the groundwater contamination plumes at Orica and other relevant areas in Banksmeadow should be fully examined.

8 The effects of the proposal on groundwater levels and the level of water in the ponds in the adjacent Sir Joseph Banks Park.

9 Further to Point 3 above specific attention should be paid to:

- entry and exit from Botany Road;
- Foreshore Drive and General Holmes Drive connection to Eastern Distributor;
- Hale Street connection to Foreshore Drive to further develop area as Port related;
- restrictions on use of Botany Road;
- construction of area on Botany Road for RTA Inspectors;
- contribution towards construction of McPherson Street to Foreshore Drive road link.

10 Review of the current lack of provision of a Hazard Facility at the Port and construction of same included in the project.

11 Effect of wind borne sand drift from dredging operations. This was a problem with the original construction.

12 Review the Port Botany Hazard Study and the combined effect on the Botany/Randwick Industrial Area Land Use Safety Study.

13 Consideration of the effects of the combined noise created by the increased road and rail use on the residential population of the areas adjoining the rail and road networks.

14 The effect of truck queuing on the road network. Truck queuing on Penryhn Road as indicated in Patrick's proposal is not shown or identified in this overall proposal.

15 Consideration of vibration issues caused by the expanded rail line use.

16 No assessment or survey has been carried out on the availability of Port related land uses both now and in the future.

17 Further consideration should be given to the social impacts of the development as well as the impact of the view of the Port as seen from land and water.

18 The effects on the use and safety of pleasure craft resulting from the relocation of the boat ramp. The effect on the community of any loss or reduction in availability of the boat ramp.

19 Full consideration during the construction of the facility of noise from:

- traffic;
- pile driving; and
- dredging.

20 Full consideration on the effects of the proposal on the Acid Sulphate Soils of the area, both local and imported.

21 The effects on AV gas pipeline on Foreshore Drive.

22 The ability of the project to meet the requirements and recommendation of the SSROC "Turning the Tide" Botany Bay Report.

23 Effect of dredging and proposed works on the cleansing action of the existing drainage outlets and the Mill Pond channel.

24 Effects of dredging on the bay seagrass and sand movements.

25 Full review of the "public benefit" to be given to the Community from the developers at the Port facility.

26 Where will the Port expand, when the proposed expansion reaches capacity in 2020.

Whilst this list is not inclusive of all matters to be considered in the EIS for the development when read in conjunction with submissions from the agencies and community groups it emphasizes those specific areas of concern to the City of Botany Bay.

I look forward to receiving a copy of the final D.G.R.'s in due course.

Should you wish to discuss any matter further, I can be contacted on 9366-3659.

Yours sincerely

Paul S Shepherd

**Paul S Shepherd**
***DIRECTOR – TECHNICAL & REGULATORY SERVICES***

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(6)

RANDWICK CITY COUNCIL
a sense of community

INCORPORATED
AS A MUNICIPALITY
22 FEBRUARY 1859
PROCLAIMED AS
A CITY 1ST JULY 1990

ABN: 77 362 844 121

Our Ref: (98/S/3118)
Your Ref: S01/02520

17 January 2002

Mr Gordon Kirkby
A/Assistant Director
Development and Infrastructure Assessment
Planning NSW
Level 4, Henry Deane Building
20 Lee Street
Sydney NSW 2000

Dear Sir,

**RE: Proposed Expansion of Port Botany**

I refer to your letter to Council dated 20 December 2001 and the recent planning focus meeting in relation to the abovementioned matter.

Council would require that the following issues be addressed in the EIS for the proposed expansion of Port Botany:

**Issues specific to Randwick City**

- **Identify the economic benefits for industrial areas in Randwick City**

  The EIS should identify the economic impacts that the proposal would have specifically on adjoining industrial zoned lands. While the national and international economic significance of the proposal were highlighted at the recent planning focus meeting, the impact of the proposal for local industries in the adjoining industrial areas within Randwick City should also be addressed. Among other things, the EIS should indicate the nature of uses proposed in the expanded port and the expected linkages these uses would have to surrounding local industries, and the mechanisms necessary to facilitate economic benefits from the expanded port to adjoining industrial areas.

- **Impact of the expanded port on existing port facilities in Randwick**

  The EIS should identify the impact of the expanded port on existing port facilities within Randwick in terms of the expected linkages, spin offs and economies of scale. The relevance of this relationship between the expanded and existing port to the selection of Port Botany for expansion should be addressed.

- **Prevent port-related traffic in local residential streets**

  The expected reduction in TEUs carried on road was highlighted at the recent planning focus meeting. It is contended that this expected reduction in TEUs via road is a reduction that the relative rate of increase in road haulage arising from the proposed expanded port will reduce by. More critically, the EIS should address how traffic arising from the expanded port will be directed away from streets in residential areas. The EIS should also identify the measures that will be taken to maximise rail usage.

- **No increase in cumulative risk from the proposed development**

  The EIS should identify any potential cumulative risk impacts and indicate how the proposed port expansion will meet and demonstrate compliance with relevant risk criteria. In particular, the EIS should note that there should be no increase in cumulative risk, including both individual and societal risk, beyond that identified in the DUAP Port Botany Land Use Safety Study – Overview Report (1996) and any relevant . The potential for risk expanding towards the airport should be assessed.

- **Hazard Analysis**

  The EIS should assess the nature of goods to be handled at the proposed terminal to identify any potential hazards impacts. In particular, the provisions of SEPP 33 should be applied where applicable.

- **Address ecological issues arising from impacts on Botany Bay**

  The EIS should assess the potential ecological impacts, including, but not limited to, the following:

  Impacts on the hydrodynamics of Botany Bay
  Loss of biodiversity in the Botany Bay
  Disturbance of acid sulphate soil particularly related to dredging and use of dredged material for fill
  Impacts on water quality
  Impact on the groundwater levels and quality including the Botany Aquifer
  Impact on wetland areas

- **Identify potential noise, odour and pollution impacts**

  Expanded port activity potentially will generate an increase in port-related noise. The EIS should assess the changes in background noise levels as a result of noise generating activities of the expanded port, and if necessary identify noise mitigation measures for surrounding residential areas. In addition, the potential for odour and any other pollution from the future uses on the site should be addressed.

- **Ensure comprehensive community consultation**

There should be adequate and comprehensive consultation of the community and stakeholders in the Randwick City area throughout the EIS process. Council will be happy to assist with contact details of key local groups such as resident precinct committees.

**Issues relevant to the broader region**

- **Assess other alternative ports for expansion**

  The EIS should include a detailed assessment of the capacity and suitability for expansion in other alternative ports in the region (in full or in combination with Port Botany), and why and how the selection of Port Botany is justified in the light of this assessment.

- **Address visual impacts**

  The visual impact of the proposed development should be examined in the EIS including the treatment of key edges, and entries and exits. Consideration should be given to the fact that the port is an active and interesting land use that may have potential for vantage points for visitors including tourists.

- **Regional Open Space**

  The proposal will eliminate a significant portion of existing foreshore area that currently allows access to the water. The EIS should examine the possibility of regional open space being provided to offset the loss of foreshore area.

- **Phasing/Timing**

  The EIS should show and assess the nature of any phasing for the proposed development including the adequacy and timing of various phases in relation to the provision of infrastructure and services.

- **Construction Issues**

  The impact of construction on local and regional land-uses and local residents should be examined in the EIS. Safety measures at construction stage should be detailed.

Should you have any further enquiries on this matter, please contact David Ongkili 9399 0793.

Yours faithfully,

Gordon Messiter,
GENERAL MANAGER

Per: ..........................................
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ROCKDALE
CITY
COUNCIL
*On Historic Botany Bay*
*Australia*

4 January 2002

Our Ref: T17/0199
Contact: Richard Jarvis 9562 1645

Development & Infrastructure Assessment
Department of Urban Affairs & Planning
GPO Box 3927
Sydney NSW 2001

***Attention: Mr Gordon Kirkby***

Dear Mr Kirkby

***S01/02520, Proposed Expansion of Port Botany - EIS Requirements***

Thank you for this opportunity to confirm the matters raised at the Planning Focus Meeting. Deliberation on the matters of concern to Rockdale City Council will be undertaken by the Council at its next meeting on 30 January 2002. The report to that Council meeting will recommend that the following matters be considered in the planning and assessment processes. If the Council determines to modify or extend this list of issues, I will advise you of the changes after the Council meeting.

- The effect of further dredging of Botany Bay on the sand migration patterns of the Bay, and the impacts on the Lady Robinson's Beach shoreline. This includes changes to depths, wave patterns, bay floor vegetation, sand movements, and beach stability.
- The ongoing effects of maintenance dredging to maintain shipping channel depths.
- A sub-regional traffic study of land transport impacts, incorporating traffic from all sources including the Port:
  - integrated with the growth in air traffic - passengers and freight;
  - integrated with local development and intensifying land uses;
  - including sub-regional economy growth generated by the air and sea port growths;
  - detailing travel and haulage routes, origins and destinations, and traffic quantities;
  - including routes for dangerous goods;
  - including traffic and transport of persons employed on the site or servicing the site.
- A Plan for the encouragement of rail transport, and discouragement of road transport; aligned with:
- A Plan of Government initiatives to improve regional air quality and conserve energy (such as through economic measures or regulatory controls on land-side port access).
- A Plan to provide public commuter transport for site based, and other employees in the locality and discouraging the use of private cars for commuting. (7,770 direct jobs generated)

Yours faithfully

RICHARD JARVIS
MANAGER TRANSPORT & INFRASTRUCTURE SERVICES

G:\Service Planning\Transport & Infrastructure\RJcorresp2002\01Jan2002PortBotanyEISRequirements

Administration Offices: 2 Bryant Street, Rockdale
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(10)

Our Contact: Leta Webb
Direct Phone: 9330 9450
Our Reference:



7 February, 2002



Gordon Kirkby
A/ Assistant Director
Development and Infrastructure Assessment
Planning NSW
GPO Box 3927
Sydney NSW 2001

**KOGARAH COUNCIL**

Dear Sir,,

**Proposed Port Botany Expansion: Your Reference S01/0250**

Thank you for the opportunity to have input into the Director General's requirements for the proposed expansion for Port Botany.

**Introduction**

Kogarah Council has many areas which front the Georges River or are part of the catchment of that river which feeds into Botany Bay. While Kogarah Council does not actually front the Bay, Council regards the Bay as a major employment, recreational and environmental resource for the subregion and as is a resource which is used and valued by members of Kogarah's community. Kogarah Council has always taken an active role in encouraging effective management of the Bay and its catchment. For example, Kogarah Council has had a major role in the design and conduct of several symposia and workshops focusing on the Bay and its catchment.

The close proximity of the Bay to the Kogarah Council area means that any changes to the bay and to transport patterns around the Bay will impact on the residents of Kogarah.

Because of Council's interest in the Bay and its catchment, Kogarah Council sent two staff to the recent presentation on the proposed Port expansion.

**Issues for inclusion in the Director's requirement for the EIS**

Council staff attended the recent meeting on the Port expansion at which a number of issues were raised by various parties. Council had hoped that a copy of the issues that emerged from that meeting might have been available for consideration as the issues raised were all matters that Councils would like to see addressed.

Matters of particular concern are listed below:

**COUNCIL AND COMMITTEE MEETINGS**
Civic Centre,
2 Belgrave Street
Kogarah NSW 2217

**CUSTOMER SERVICE CENTRE**
84 Railway Parade,
Kogarah NSW 2217

**POSTAL ADDRESS**
Locked Bag 8,
PO Kogarah NSW 2217
DX 11118 Kogarah

**TEL** 02 9330 9400
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**WEB SITE**
www.kogarah.nsw.gov.au

1. *Demonstration of need for an additional facility in Sydney.*
The EIS should explore options of expansion and better utilisation of existing Ports at Botany, Wollongong and Newcastle.

2. *Traffic and transport*
An additional Port will have a huge impact on traffic. While Council is aware that improved freight rail facilities will be available to Botany Bay, much of this increased capacity will be utilised by the existing Port and its proposed expansion and modal shift. Council would like to see a realistic appraisal of the capacity of the enhanced freight line to cope with both the demands of the current Port and the proposed Port and the likelihood of modal shift. Such an appraisal should take account of the additional volumes of freight that will need to be handled, type of freight that is likely to be handled, its likely destinations, the capacity of the whole rail system to cope with increased volumes, not just that line.

The recent opening of the M5 east has seen a change in traffic patterns with an increase in vehicular traffic along certain routes that feed into the new freeway and which are also used by residents of Kogarah. Additional road transport will add further to that volume.

3. *Consistency of the proposal with other reports and plans.*
The Healthy Rivers Commission made a number of recommendations in relation to Botany Bay. The Minister for the Environment made a statement about a new planning framework on 14 November and it is understood that State Parliament will soon introduce legislation for PlanFirst. It is unclear how the proposal for a new Port fits with these initiatives. Perhaps planning for the Port should be deferred until other planning initiatives are implemented so that it is considered within a wider policy and planning framework.

4. *Exploration of alternatives*
This should include an equally thorough assessment of alternative sites around the Bay itself and alternatives in Wollongong and Newcastle.

The summary that has previously been provided to Council seems to dismiss consideration of alternatives and indicate that an additional Port in the Botany Bay at the proposed location within the Bay is the only option. The appears to be a premature conclusion in the absence of a thorough EIS assessment.

5. *Loss of habitat and foreshore.*
The area is currently used by many wading birds and it an area that is used for recreational fishing and is one of the few areas where people with dogs can take them to the beach and allow them to swim. The impact on bird species and the loss of recreational uses needs to be assessed.

6. Other environmental impacts.
- The issue of the increased contamination from fuel and the introduction of damaging marine pests from ballast water needs to be assessed together with the need for new legislation to deal with these matters.
- The impact of the dredging on ground water.
- Hydrological impacts.

KOGARAH COUNCIL

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- Risks to the environment at the operational stage and adequacy of emergency procedures for dealing with these.

6. Cumulative environmental impact on the whole Bay as well as its immediate environment.

If you wish to discuss this letter further please contact me on 9330 9450.

Leta Webb
**Manager Urban Planning and Design.**

G. Kirkby


KOGARAH COUNCIL

**COUNCIL AND COMMITTEE MEETINGS**
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BEW

# BOTANY ENVIRONMENT WATCH

7/2/2003

## PORT BOTANY EXPANSION

## ITEMS TO BE INCLUDED IN E.I.S. FOR PORT BOTANY EXPANSION

Plans and impacts on the following:

1. DRAINS - Includes large drains, street drains and individual house drains, Kensington area, Botany Wetlands and Botany Acquifer.

2. a) DREDGING, Plans and impacts
   b) BEACH LOSS
   c) BOAT RAMP
   d) WAVE PATTERN CHANGES, Turbulance, Erosion- Wharf development impact
   e) impact on ECOSYSTEMS OF BOTANY BAY
   f) LOSS OF BREEDING HABITAT
   g) LOSS OF SANCTUARY FOR MIGRATING BIRDS
   h) RECREATIONAL BOATING – Fishing and sailing area restrictions
   i) INCREASED SHIPPING – Effect on Bulk Liquids Berth and impacts of ballast water The use of Super Container Ships both by Patricks and the Proposal for expansion of Port Botany

3. HERITAGE – Indiginous and European

4. POLLUTION, AIR, NOISE, WATER, VISUAL – Seaport, rail and road
   Noise barriers, Code of Behaviour for workers manning cranes and containers being deposited on wharf (more careful handling – no dumping and dropping

5. TRANSPORT - Rail and Road Impacts - Type of road vehicles
   Numbers, types, lengths, weights of road tankers, semi tailers etc.
   Level crossing at Banksia Street
   Proposed traffic routes in all areas
   Designated truck routes for Dangerous Goods, Foreshore Road widening

6. CUMULATIVE NEW HAZARD / RISK ASSESSMENT – to contain airplane crash, Port expansion, transport, rail, terrorist attacks, submarine access to Botany Bay, Seaport and Airport.
   Port to have own Fire Fighting Service
   Adequate supply of foam and water; booms for oil and chemical spills.
   Health impacts
   Fugitive exotic insects, fumigation.
   Port Botany Security.
   Lights on Foreshore Road

7. SHIPS OF SHAME

8. INCREASE OF CRIME

9. ADEQUATE INSPECTION OF CONTAINERS – regular inspection depending on numbers and amount of manpower available. Container storage – empty and full. Locaion

10. PORT BOTANY MANAGED BY PERSON ASSIGNED TO THAT POSITION INDEPENDENT OF SYDNEY HARBOUR MANAGEMENT

11. PORT BOTANY ADMINISTRATION BUILDING IN BOTANY, a building that people can respect and with access from main road

12. EMPLOYMENT OPPORTUNITIES – real jobs taking into considertion modern technologies

13. AESTHETICS

14. CONSIDER COMMUNITY'S LOSS OF AMENITY AND QUALITY OF LIFE.

15. ALTERNATIVES. NEWCASTLE AND PORT KEMBLA to be thoroughly investigated and report of investigations to be fully documented in the E.I.S. A brief description of those alternatives is not to be accepted.

TOO MANY OF THE COUNTRY'S RESOURCES ARE IN THE ONE AREA - Port and Airport, which makes it an easy target for terrorists

EXPORT / IMPORT - Proof of future trade growth. Why encourage imports - buy Australian

NO MANUFACTURING INDUSTRY AT PORT

WE WANT TO KNOW THE SITUATION CONCERNING PATRICK STEVEDORES AND THIS NEW PROPOSAL

and any other matters which are of concern and must be considered.

Nancy Hillier

NANCY HILLIER
President

F I N A L   R E P O R T

# Review of Contamination Issues Associated with the Port Botany Expansion

*Prepared for*

**Sydney Ports Corporation**

Level 8, 207 Kent St
Sydney, NSW, 2000

21 May 2003

S:43027/012/FINAL REPORT



URS

| | | | |
|---|---|---|---|
| Prepared By | ........................................ Stuart Taylor Senior Environmental Scientist | URS Australia Pty Ltd Level 3, 116 Miller Street North Sydney, NSW 2060 Australia Tel: 61 2 8925 5500 Fax: 61 2 8925 5555 | |
| Reviewed By | ........................................ Martin Howell Senior Principal | | |
| Authorised By | ........................................ Martin Howell Senior Principal | Date: Reference: Status: | **21 May 2003** 43027/012 Final |

# Contents

# List of Figures, Tables and Appendices

## Figures



## Table



## Appendices

| | |
|---|---|
| AHD | Australian height datum |
| ANZECC | Australian and New Zealand Environmental Conservation Commission (ANZECC)/Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) |
| BOD | Biological oxygen demand |
| BTEX | Benzene, toluene, ethylbenzene and xylenes (monoaromatic hydrocarbons) |
| CN | Cyanide (total or free) |
| COPC | Chemicals of potential concern |
| CTC | Carbon tetrachloride |
| DO | Dissolved oxygen |
| EDC | 1, 2 dichoroethane |
| EPA | Environment Protection Authority (NSW) |
| HCB | Hexachlorobenzene |
| ha | Hectare |
| ISQG-L | Interim sediment quality guideline – low value |
| L and T | Lawson and Treloar Pty Ltd |
| LAT | Lowest Astronomical Tide |
| Mercury | Inorganic mercury unless noted otherwise |
| Metals | As: Arsenic, Cd: cadmium, Cr: chromium, Cu: copper, Fe: iron, Ni: nickel, Pb: lead, Zn: zinc, Hg: mercury |
| mg $kg^{-1}$ | Milligrams per kilogram |
| mg $L^{-1}$ | Milligrams per litre |
| µg $L^{-1}$ | Micrograms per litre |
| NEPM | National Environment Protection Measure |
| NHMRC | National Health and Medical Research Council |
| NOAEL | No observed adverse effect level |
| OCs | Organochlorine pesticides |
| Orica | Orica Australia Pty Ltd |
| PAHs | Polycyclic aromatic hydrocarbons |

| | |
|---|---|
| PCBs | Polychlorinated biphenyls |
| pH | A measure of acidity, hydrogen ion activity |
| PVC | Poly vinyl chloride |
| QA/QC | Quality Assurance/Quality Control |
| SACL | Sydney Airport Corporation Limited |
| SPC | Sydney Ports Corporation |
| SVOCs | Semi-volatile organic compounds |
| SWOOS | Southern and Western Suburbs Ocean Outfall Sewer (SWOOS) |
| TEL | The Ecology Lab Pty Ltd |
| TKN | Total Kjeldal nitrogen |
| TOC | Total organic carbon |
| TN | Total nitrogen |
| TP | Total phosphorous |
| TPH | Total petroleum hydrocarbons |
| VC | Vinyl chloride |
| VHC | Volatile halogenated compound |

## 1.1 Background

Sydney Ports Corporation (SPC) is proposing an expansion of shipping facilities in north-eastern Botany Bay. The new facility will comprise a major new terminal, the construction of which will involve dredging and reclamation works.

URS Australia Pty Ltd (URS) has undertaken a review of the ecotoxicological and human health issues that may arise due to potential changes in the hydrodynamics and contaminant concentrations in the project area, as a result of the proposed development. The assessment has focussed on changes in risks to the environment and human health that may arise as a result of the development, rather than an evaluation of risks associated with existing contamination issues in this part of Botany Bay.

The review has drawn on related studies undertaken for SPC namely:

- hydrodynamic studies by Lawson and Treloar Pty Ltd (L and T);
- groundwater studies by AccessUTS Ltd (AccessUTS);
- terrestrial ecology by URS; and
- aquatic ecology by The Ecology Lab Pty Ltd (TEL).

The study has been developed to assist in meeting the following Director-General's requirements:

- NSW Environment Protection Authority –
    - an assessment of the potential impacts on the bay from disturbance of potentially contaminated groundwater/soil/sediment during dredging and land reclamation;
    - actions to address existing soil and/or groundwater contamination;
    - describe the catchment including proximity of the development to any waterways and provide an assessment of their sensitivity/significance from a public health, ecological and economic perspective;
    - provide details of site history and contamination investigations with regard to sediment contamination;
    - describe existing surface water quality and an assessment of any water resource likely to be affected by the proposal under all conditions;
    - apply the Australian and New Zealand Environmental Conservation Commission (ANZECC)/Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) water quality guidelines to assess potential ecosystem impacts of contaminants in water;

- describe the effects and significance any pollutant loads may have on the receiving environment;
- describe water quality impacts and their significance resulting from changes to hydraulic flow regimes (such as nutrient enrichment, or turbidity resulting from changes in frequency, or magnitude of stream flow);
- identify impacts associated with the disturbance of acid sulphate soils and potential acid sulphate soils;
- identify any likely impacts resulting from the construction or operation of the proposal, including dredging and land reclamation – this should include the likelihood of disturbing any existing contaminated soil and/or sediment;

- NSW Fisheries –
  - describe contaminated sediment mobilisation and use/reuse of spoil;
  - impact on water quality, particularly turbidity;
  - impact on fish and invertebrate populations;
- Healthy Rivers Commission
  - the suitability of water quality for recreational activities;
- Department of Land and Water Conservation –
  - reduce or halt any decline in water quality in estuaries or rivers;
  - water entering natural wetlands will be of sufficient quality so as not to degrade the wetland;
- Rockdale City Council
  - examine the impacts on water quality; and
- Botany Environment Watch
  - assess the impacts of dredging
  - assess the impact of the development on water quality.

## 1.2 Objectives

The specific objectives of the review were to address the following questions:

- Will changes to the hydrodynamic regime in Penrhyn Estuary associated with the proposed development alter the risks to aquatic and terrestrial organisms?
- Will changes to the hydrodynamic regime in Penrhyn Estuary with the proposed development alter the risks to human health, either through the consumption of fish caught by recreational anglers, or the recreational use of Penrhyn Estuary (e.g. children swimming and wading)?
- Will changes to the hydrodynamic regime in north-eastern Botany Bay between the new terminal and the Parallel Runway alter the risks to aquatic organisms?
- Will changes to the hydrodynamic regime in north-eastern Botany Bay between the new terminal and the Parallel Runway alter the risks to human health either through the consumption of fish caught by recreational anglers or the recreational use of this area?
- Will disturbance of the marine sediments and subsequent reclamation drainage in the areas to be reclaimed, or dredged during the construction of the proposed development, alter the risks to aquatic organisms and human health through consumption of fish caught from these areas?
- Will disturbance of sediments/soil in Penrhyn Estuary associated with the construction of the rail line and habitat enhancement works alter the risks to aquatic organisms and human health through consumption of fish caught and the recreational use of the estuary?

In answering these questions the review has:

- briefly described catchments adjacent to the new terminal;
- briefly described land use focussing on the ecology of areas potentially affected by the development and human usage of these areas (e.g. fishing and swimming);
- summarised previous contamination investigations of water (ground and surface) and sediments in Penrhyn Estuary and north-eastern Botany Bay;
- documented existing surface water quality and applied ANZECC (2000) water quality guidelines to assess potential impacts of contaminants in water on the ecosystem;
- documented existing sediment water quality and applied ANZECC (2000) sediment quality guidelines to assess potential impacts of contaminants in sediment on the ecosystem;
- identified chemicals of potential concern (COPC) relevant to assessment of risks to human health and the environment;
- identified other potential environmental stressors including water quality issues (e.g. salinity, temperature and suspended solids);
- assessed water quality along Foreshore Beach for recreational activities;
- assessed possible disturbance of acid sulphate soils and potential acid sulphate soils;

- assessed potential contaminant release from sediment during dredging and land reclamation in Botany Bay;
- assessed impacts on water quality resulting from changes to flow regimes in Penrhyn Estuary and Botany Bay;
- assessed impacts on contaminant concentrations in sediment from changes to flow regimes in Penrhyn Estuary and Botany Bay;
- assessed potential for remobilisation of contaminated sediment in Penrhyn Estuary and Botany Bay; and
- assessed the sensitivity/significance of identified impacts from a public health and ecological perspective.

## 1.3 Assessment Criteria and Methodology

This review characterises changes to ecotoxicological and human health risks associated with the proposed development, variation in the concentration and distribution of chemicals of concern, as well as changes in environmental stressors, that may occur as a consequence of the port development.

Assessment of changes of risks to human health has been undertaken using the following approach:

- comparison of chemical concentrations (either measured or estimated) with environmental quality guidelines relevant to the protection of human health; and
- for the relevant contaminants a comparison with the risks identified in the Orica Stage 2 risk assessment study has been made.

This latter approach is considered the most appropriate basis for assessment of the proposed development for the following reasons:

- the Orica Stage 2 risk assessment study presents the full range of exposure scenarios relevant to the recreational use of Penrhyn Estuary after development; and
- the Orica Stage 2 risk assessment effectively presents a quantitative baseline assessment of risks for the principal contaminants of concern associated with groundwater discharges to Springvale Drain, Floodvale Drain and Penrhyn Estuary prior to the proposed port expansion.

Environmental risks have been assessed on a qualitative basis with reference to environmental quality indicators relevant to the protection of the environment. Where possible environmental quality indicators specific to ecological receptors have been utilised (e.g. sediment quality guidelines relevant to benthic organisms, water quality guidelines relevant to aquatic organisms, environmental benchmark values for birds etc.).

Key factors contributing to significant changes in risk to both human health and the environment have been identified.

## 2.1 Site Location

The proposed development at Port Botany is located in north-eastern Botany Bay, a shallow embayment 12 km south of the CBD of Sydney (Figure 1). The proposal incorporates reclamation and creation of a new terminal north-west of an existing container terminal (Brotherson Dock).

The study area in north-eastern Botany Bay, referred to in the text as the area between the Parallel Runway of Sydney Airport and Molineux Point, includes Penrhyn Estuary and Foreshore Beach. Penrhyn Estuary was formed by the construction of the Port Botany container terminal and is located east of the Parallel Runway. Foreshore Beach forms the shoreline between Penrhyn Estuary and the Parallel Runway. The proposed dredge area for reclamation of the new terminal lies between the existing container terminal and the Parallel Runway. The study area also includes the catchments of the Mill Stream and Floodvale and Springvale Drains (Figure 2). The proposed port development layout is shown in Figure 3.

## 2.2 Botany Bay

Botany Bay is a major estuary (approximately 7 km in diameter) south of Port Jackson. The bay shoals westward from the heads and previous dredging operations have provided deepwater access to berths at Port Botany. The tidal regime in Botany Bay is essentially the same as in Port Jackson. Generally two high tides and two low tides occur each day (semi-diurnal) and occur almost simultaneously throughout the bay. The tidal amplitude varies fortnightly, on a high and low range tidal cycle (spring and neap tides, respectively) and the maximum and minimum heights of each successive tide varies significantly (i.e. a pronounced diurnal inequity). The range of astronomical tides is 2.1 m, mean high to mean low water spring tides is 1.3 m and mean high to mean low water neaps is 0.9 m. Water circulation is tidally dominated in the upper layers. Wind-generated waves are locally important in controlling circulation and resuspension of bottom sediment. Diurnal north-easterly winds (~8 m $s^{-1}$) during summer produce waves with heights up to 0.3 m along the southern shoreline of Botany Bay. Botany Bay is stratified immediately after heavy rainfall (>50 mm $d^{-1}$) and turbid, buoyant, freshwater plumes exit the mouth of the bay (Kingsford, 1994). Water temperatures range from ~11$^{o}$ C in winter to ~25$^{o}$ C in mid summer.

The water quality in the bay is affected by a variety of factors, with contaminant inflows and outflows dominated by tidal water movement from the Georges River. Other sources of contaminant input to Botany Bay include:

- major tributaries including Mill Stream and Cooks River;
- minor tributaries (e.g. Floodvale and Springvale Drains);
- surface runoff from foreshore catchments;
- infrastructure in, or around the bay (e.g. Sydney Airport); and

- groundwater inflows.

## 2.3 Penrhyn Estuary

Penrhyn Estuary was formed by development of Port Botany in the late 1970s. It is bounded by Foreshore Road to the north, Penrhyn Road to the east and the existing container terminal to the south. The estuary (~30 ha) is characterised by intertidal sand/mud flats. A deeper pool (~1 m deep at LAT) has formed at the confluence of Springvale and Floodvale Drains north of the old boat ramp. At low tide, much of the bed is exposed and reveals incised channels ~1 m wide. The channel narrows upstream of the current boat ramp before widening out to Botany Bay (Figure 2).

Penrhyn Estuary receives stormwater from Floodvale and Springvale Drains, as well as groundwater discharge to intertidal areas. Water quality in the estuary is also dependent on circulation and processes operating in Botany Bay (L and T, 2003).

Sediment consists of medium grained, well-sorted quartzose sand and minor gravel composed of shell material at the estuary mouth. To the west of the constriction, Penrhyn Estuary is subject to little wave action and is a low energy environment in Botany Bay. The mean sediment grainsize decreases upstream of the present boat ramp and muddy sands and thin surficial mud layers predominate in the upper estuary.

Topography is low lying in the vicinity of Penrhyn Estuary, with sand dunes reaching 2.5 to 3 m in elevation. The upper reaches of the Springvale Drain inflow branch have been extensively colonised by mangroves. Observation made between 1996 and 2002 indicate spreading of mangroves to include areas adjacent to the outlet of Floodvale Drain. The fringe of the estuary comprises well-vegetated saltmarsh (samphire, sea blight etc.) and deeper areas of the estuary have been colonised by seagrass beds.

## 2.4 Foreshore Beach

Foreshore Beach (1.5 km long) forms the north-eastern shoreline of Botany Bay, west of Penrhyn Estuary, to the confluence of the Mill Stream. Foreshore Beach is exposed to waves generated over a long fetch by southerly winds. The south-eastern end of the beach is currently subject to moderate wave energies and is receding, as evidenced by undercutting of the fence constructed to assist dune stabilisation. The beach consists of well-sorted, clean quartzose sand. Behind the beach’s low lying topography lies Foreshore Road, Sir Joseph Banks Park and Recreation Area and Botany Golf Course.

## 2.5 Catchment Description

Four catchments (Mill Pond, Springvale, Floodvale and Foreshore Beach) totalling 24.7 $km^2$ affect water quality in Penrhyn Estuary and north-eastern Botany Bay in the vicinity of the proposed new terminal. Springvale and Floodvale Drains discharge stormwater to Botany Bay via Penrhyn Estuary (Figure 2).

Drainage infrastructure within each catchment is managed by local Councils (City of Botany Bay, Randwick, Waverley, Woollahra and South Sydney Councils) or Sydney Water Corporation, i. e. the Mill Pond drainage.

### 2.5.1 Mill Pond Catchment

The Mill Pond catchment (1,773 ha) comprises Centennial Park in the northern, upper reaches and the Botany Wetlands. Ponds in Centennial Park and the Botany Wetlands are connected by a stormwater drainage system that discharges to Botany Bay near Sydney Airport. The Botany Wetlands are the largest freshwater wetlands in the Sydney Region and contribute to stormwater attenuation and water quality treatment. The Mill Stream is tidal and is defined as the channel that flows parallel to the Parallel Runway from the weir at Foreshore Road to Botany Bay. The natural landform of the Mill Pond catchment comprises rounded sand dunes and expanses of gentle slopes. The maximum elevation is approximately 100 m AHD at the north-eastern corner of the catchment.

### 2.5.2 Floodvale and Springvale Drainage Systems

The total areas drained by the Floodvale and Springvale Drainage Systems are 118 and 241 ha, respectively. The total length of Floodvale Drain is 2.9 km, with about 2.1 km of closed conduit and 0.8 km of open channel. The total length of Springvale Drain is about 3.9 km, comprised of 2.5 km closed conduit and 1.4 km of open channel. A stormwater quality improvement device (trashrack) is located on Springvale Drain approximately 400 m upstream of Foreshore Road.

### 2.5.3 Foreshore Beach Catchment

The Foreshore Beach stormwater drainage system (339 ha) has five outlets to Botany Bay along Foreshore Beach. The total length of the five drains (closed conduits) is approximately 5.5 km.

## 2.6 Land Use

Land use in the northern part of the fluvial catchments which drain into Botany Bay is mainly residential with some large open space areas such as parks and a golf course. Other open areas are largely low-lying, swampy land that act as flood storage areas.

The southern part of the catchments is predominantly industrial and contains large- and small-scale developments including petroleum and chemical industries, food processing plants, transportation facilities and various light industries. There are some residential areas located to the north of Foreshore Beach, but the area to the north of Penrhyn Estuary is commercial/industrial (Figure 4).

### 2.6.1 Industrial

A number of premises within the catchments are licensed under the NSW EPA's load-based licensing regulations and discharge pollutant loads to the stormwater system and Botany Bay. Industrial activity in the catchment includes production of paint, paper, petrochemicals, detergent and plastics.

Sydney Airport Corporation Ltd (SACL) operates Sydney Airport west of the proposed new terminal. Runoff from the airport discharges via the Mill Stream and Cooks River to Botany Bay.

Sydney Ports Corporation (SPC) owns land at Port Botany including two container terminals and the Bulk Liquid Berth. Runoff from the terminals discharges via Brotherson Dock to Botany Bay.

### 2.6.2 Residential

The closest residential area, located to the north of Foreshore Road, Botany Golf Course and Sir Joseph Banks Park and Recreation Area, is approximately 300 m from Foreshore Beach and is characterised by the presence of single dwellings.

### 2.6.3 Recreational

The foreshore areas of north-eastern Botany Bay are used for a number of recreational pursuits, including. fishing, walking and dog exercise. Existing infrastructure for recreational boating in Penrhyn Estuary includes a boat ramp, jetty, carpark and fish cleaning table, which are highly utilised particularly on weekends. Signs erected by the City of Botany Bay advise the public not to swim in Penrhyn Estuary, or eat any form of marine life “due to possible danger to health”.

## 2.7 Ecology

The ecology of the study area has been described by Woodward-Clyde (1997) as well as the supporting studies undertaken for the EIS by URS and The Ecology Lab Pty Ltd (TEL). The following sections provide a summary of the ecology of Penrhyn Estuary and north-eastern Botany Bay. Detailed descriptions are provided in the other reports, in particular the TEL (2003) report.

### 2.7.1 Penrhyn Estuary

Penrhyn Estuary is a small (about 600 m long) estuarine ecosystem on the northern shore of Botany Bay north of the existing Port Botany container terminals. Aerial photographs from 1978 show Penrhyn Estuary as a barren, sandy area. In recent years, various wetland vegetation communities have colonised the estuary and surrounding sand dunes. Penrhyn Estuary presently contains several small, but significant habitat types for a diversity of species. Successional vegetation communities developing within the estuary include Saltmarsh and Herbland (with some small mangroves) forming a Closed Heathland and

Rushland in low-lying areas and Open to Closed Shrubland of mainly *Acacia* shrubs on the surrounding sand dunes.

Key ecological features within Penrhyn Estuary include generally supratidal saltmarsh, shallow waters fringing extensive intertidal mudflats and an open, deeper water area supporting fish and other aquatic organisms. Penrhyn Estuary can be described as consisting of three key areas:

- an upper section consisting of the lower portions of Springvale Drain and Floodvale Drain south of Botany Road;
- a middle intertidal area within the estuary (at the confluence of Floodvale and Springvale Drains) containing mudflats and open water; and
- deeper, open water areas at the mouth of the estuary fronting Botany Bay.

Floodvale and Springvale Drains incise narrow channels in the upper sections of Penrhyn Estuary. Birds roost in saltmarsh areas in the upper estuary where approach of predators can be detected.

An abundance of benthic organisms live in, or on the intertidal mudflats in Penrhyn Estuary. The supporting studies undertaken by TEL (2003) made the following conclusions in relation to Penrhyn Estuary:

- The benthos within Penrhyn Estuary were found to be relatively diverse and abundant.
- The presence of a diversity of feeding types and life styles in the subtidal benthic communities in Penrhyn Estuary indicate a functioning ecological unit, which TEL expect to interface with other components of the Botany Bay ecosystem.

Whilst differences at a number of levels were measured between the various reference sites and Penrhyn Estuary, there is no evidence to suggest that the biota at Penrhyn Estuary is being adversely affected by contamination.

The mudflats therefore provide suitable foraging habitat for a variety of shorebird species. The waters of the estuary support a range of fish species and other aquatic organisms. Waterbirds forage and rest on the open waters within the estuary.

The intertidal flats decrease in mud content downstream in the estuary. The mouth of the estuary consists of intertidal sandflats and sandy beaches. Shrub-lined sand dunes predominate in elevated areas, particularly on the northern section of the estuary (Figure 2). Sand dunes covered by Shrubland occur at most elevated areas around the estuary. The sandy beaches and sand spits are used for roosting by various seabird species. Intertidal sandflats line the foreshores of the estuary mouth. These are used for foraging by various shorebirds (waders), at low tide.

Seagrasses occur in discontinuous beds within open water areas of the estuary and provide habitat for a variety of organisms including juvenile fish.

### 2.7.2 North-eastern Botany Bay

The habitats represented in north-eastern Botany Bay include the open waters of Botany Bay, and the sandy beach and associated intertidal zone of Foreshore Beach. Foreshore Beach is a recently formed (1970s) beach comprised of estuarine sands dredged from Botany Bay during the construction of Port Botany and Sydney Airport. Coastal dune heath has colonised the sand dunes located behind the beach. Foreshore Beach is commonly used by dog walkers and for general recreation purposes. The beach also provides habitat, albeit disturbed, for wading birds. A deeper water area immediately west of the existing port facilities was previously dredged during the construction of the Parallel Runway.

## 2.8 Geology and Climate

### 2.8.1 Geology

Regional geology is characterised by recent sand deposits overlying thick Quaternary sedimentary units. Sediment has infilled drowned river valleys incised into bedrock of Triassic Hawkesbury Sandstone during periods of lower sea level.

The Geological Series Sheet No 9130 (NSW Department of Mineral Resources, 1983), describes the soil type in the Mill Pond catchment (Botany Sands) as “medium to fine grained marine sand with podsols”. The Botany Sands provide an extensive, shallow groundwater aquifer.

In the vicinity of the proposed new terminal, three units of estuarine sediment have been identified (Coffey, 1999). Subunits of these sediments are highly variable in distribution, thickness and origin. Clays, silts and clayey sand (Unit1) probably represent recent deposition, disturbed by dredging activities and overlie a dense, fine to medium grained sand (Unit 2). Organic rich clays and peat/lignite layers were penetrated at depth and represents Unit 3.

### 2.8.2 Climate

Sydney has a temperate coastal climate, summers are humid and winters rarely produce frosts. Rainfall has average 1,223 mm annually over 141 years, but is highly variable (700-1600 mm $y^{-1}$) (Commonwealth Bureau of Meteorology, Summary Statistics, [1999]). Mean monthly rainfall is higher in the first six months of the year (~120 mm) and is generally <80 mm from July to December. Daily rainfall is substantially higher during the first half of the year, predominantly due to intense summer storms.

The summer wind pattern in Sydney is dominated by diurnal sea and land-sea breezes punctuated by strong southerly gales associated with frontal systems. Offshore (westerly) winds that prevail during winter are caused by high pressure systems at low latitudes. Winds during winter (April to September) are generally west to north-westerly during the morning, but variable in the afternoons. Wind velocities exceeding 7 m $s^{-1}$ are more frequent during winter, i. e. July to October, but storms and cloudy conditions are most prevalent from November to April.

## 3.1 Introduction

Numerous investigations have been undertaken in the study area to address site-specific contamination issues including:

- Stage 2 Groundwater Study, undertaken by Woodward-Clyde (now URS) on behalf of Orica, which includes a human health risk assessment and a biota sampling program; and
- studies related to the Penrhyn Road Boat Ramp (Johnstone Environmental Technology, 1993).

In addition, construction proposals and scientific research have investigated possible contamination of water and sediment using a more regional approach including:

- EIS for the Parallel Runway for Sydney Airport (Kinhill, 1990, 1991);
- Healthy Rivers Commission Inquiry into Georges River and Botany Bay System (Final Report, 2001); and
- research and other investigations (e.g. Birch, 1996 and van Senden et al., 1993).

In addition, environmental monitoring is carried out within the study area by:

- Sydney Water Corporation;
- City of Botany Bay Council (2001); and
- NSW EPA.

The following sections present a summary of the previous investigations undertaken in the study area.

## 3.2 Previous Water Quality Investigations

### 3.2.1 Surface Water Investigations

**ICI (Orica) Botany Environmental Survey Stage 1 AG Environmental Engineers & Woodward-Clyde, (1990)**

Four samples were collected in Penrhyn Estuary and analysed for volatile and semi-volatile halogenated compounds, mercury, chromium and sulphide.

**Proposed Third Runway Sydney (Kingsford Smith) Airport Draft EIS (1990) and supplement to the Draft EIS, Kinhill (1991)**

Surface and bottom water samples were collected at six sites adjacent to Foreshore Beach, between Floodvale Drain and the Mill Stream. Freshwater samples (five) were also collected from the Mill Stream drainage. Samples were analysed for nutrients, hydrocarbons, phytoplankton, chlorophyll-a, suspended solids, organochlorine pesticide residues (OCs) and heavy metals.

**Additional Baseline Water Quality Data in Botany Bay, Aquatec (1992).**

Four sites near Foreshore Beach and in Botany Bay were sampled on two dry weather occasions and during a rain event.

Suspended solids, dissolved oxygen, temperature, pH, salinity were determined and samples were analysed for chlorophyll-a, faecal coliform bacteria, nutrients, hydrocarbons, polychlorinated biphenyls (PCBs) and a suite of heavy metals.

**The City of Botany Bay (CBB)**

Water quality data has been collected at numerous sites under dry weather conditions (three monthly to annual sampling intervals) since 1996:

- Springvale Interceptor Drain (Council Site 21) (no estuarine influence);
- McPherson Street West (Floodvale Drain) (Council Site 22);
- Penrhyn Estuary (Council Site 23) (estuarine influence);
- Botany Golf Club (Council Site 24) (no estuarine influence);
- Sir Joseph Banks Park (Council Site 25) (no estuarine influence);
- Springvale Drain (upper reaches) (Council Site 26) (no estuarine influence);
- Wool Stores (Mill Stream) (Council Site 30) (estuarine influence); and
- Mill Pond (upstream of SWSOOS) (Council Site 31) (estuarine influence).

Samples were analysed for the following parameters: total suspended solids, pH, conductivity, ammonia, dissolved oxygen, Biological oxygen demand (BOD), faecal coliform, faecal streptococci, nitrate, oxidised nitrogen, Total Kjeldahl nitrogen (TKN), total nitrogen (TN), phosphorus, reactive total phosphorus, total petroleum hydrocarbons (TPH), total oil and grease, phenols, arsenic, cadmium, chromium, copper, lead, mercury and zinc.

**Harbourwatch Annual Reports, NSW EPA (2000-2001)**

The NSW EPA's Harbourwatch program samples a site at Foreshore Beach (EPA Site 93) every 6 days. The water sample is analysed for enterococci and faecal coliforms. Compliance with the guideline values is highly variable. However, during periods of heavy rainfall resulting non-compliance with guideline values is common. Maximum recorded values followed a prolonged rainfall period in April 1998.

**ICI (Orica) Botany Groundwater Stage 2 Survey, Woodward-Clyde (1996)**

Monitoring was conducted to assess the impact of groundwater contamination associated with the historic operations of the ICI petrochemical facility. Samples were collected at low and high tide heights in fluvial and estuarine sections in Penrhyn Estuary and along Foreshore Beach. The samples were analysed for a range of volatile and semi-volatile halogenated compounds and several inorganic compounds and physico-chemical parameters (conductivity, temperature, pH, redox, and dissolved oxygen).

**Orica Botany Stage 3 Investigations, Woodward-Clyde (1996 to 2001)**

Since completion of the Stage 2 program, surface sampling has been typically conducted quarterly between May 1999 and July 2001, with additional samples from 21 July 1999 to 9 September 1999 at low and high tide conditions.

Samples were collected at the following sites within the study area:-

- Springvale Drain outlet (SW031);
- Floodvale Drain outlet (SW029);
- Penrhyn Estuary near the old boat ramp (SW028);
- Penrhyn Estuary near the existing boat ramp (SW048);
- Within the Orica facilities (stormwater pipe to Springvale Drain) (SW006); and
- Within the Orica facilities (Springvale Drain) (SW046), McPherson Street (Springvale Drain) (SW0005), McPherson Street (Floodvale Drain) (SW0053).

**Sydney Airport Corporation Limited**

As part of ongoing monitoring programs, Sydney Airport Corporation Limited (SACL) has determined surface water quality at sites within the airport. Analytes include cadmium, chromium, copper, iron, lead, manganese, zinc, TN, total phosphorus (TP), hydrocarbons, ammonia and suspended solids.

**Third Runway EIS, Kinhill (1993)**

Surface and groundwater was sampled between 1989 and 1993 for the environmental impact statement of the Parallel Runway at Sydney Airport. Surface water (7 sites) from the Mill Pond catchment (November 1989) and groundwater (6 sites) from the Botany Aquifer (November 1989) were sampled. Analytes included calcium, magnesium, sodium, potassium and zinc cations, carbonate, chlorine, sulphate, nitrate and phosphate anions, total iron, molybdenum, zinc, lead, cadmium, arsenic, silicon, total coliform bacteria, pH, water temperature and conductivity. Surface water samples (11 sites) from Botany Bay (February to May 1990) were analysed for faecal coliform bacteria, suspended solids, total nitrogen, total phosphorus, chlorophyll a, total hydrocarbons, PCBs, aluminium, cadmium, total chromium, manganese, mercury and zinc.

**Other**

Other relevant data collection programs are not specific to the investigation area affected by the proposed port development and include, random or one-off sampling programs and other miscellaneous data. These sources include:-

- van Senden et al. (1993) (turbidity, Secchi depths and suspended solids sampling over period April - July 1992); and
- OzGreen (2001) environmental network unpublished data, reported faecal coliform counts from 24 sites.

### 3.2.2 Groundwater Investigations

**ICI (Orica) Botany Environmental Survey Stage 1 (1990) AG Environ. Engineers & Woodward-Clyde**

Samples from 39 boreholes at the ICI Botany site and adjacent industrial land were analysed for a suite of volatile and semi-volatile halogenated compounds as well as mercury, chromium and sulphide.

**ICI (Orica) Botany Groundwater Stage 2 Survey (1996) Woodward-Clyde**

Samples from 56 boreholes at 26 locations in and around the ICI Botany site were analysed for a range of volatile and semi-volatile halogenated compounds and several inorganic compounds.

**Orica Botany Stage 3 Study 1996 to present**

The Stage 2 monitoring bores have been sampled and monitored on an approximate quarterly basis. Additional bores have been installed as part of on-going investigation and remediation programs.

## 3.3 Previous Sediment Quality Investigations

**ICI Botany Environmental Survey Stage 1 (1990) AG Environ. Engineers & Woodward-Clyde**

Sediment samples were collected from Floodvale and Springvale Drains and Penrhyn Estuary. Seven depositional sites were sampled in Penrhyn Estuary using a clean PVC sampling tube and analysed for volatile and semi-volatile halogenated compounds, and hexachlorobenzene (HCB), mercury and chromium.

**Proposed Third Runway Sydney (Kingsford Smith) Airport Draft EIS (1990) Kinhill**

Kinhill (1990) collected six surface sediment samples in the proposed dredge and reclamation areas. Samples were analysed for heavy metals, OCs, TPH, TP, organic nitrogen and total organic carbon (TOC).

**Proposed Third Runway Sydney (Kingford Smith) Airport. Supplement to the Draft EIS (1991) Kinhill**

Two surface sediment samples in the proposed dredge and reclamation area were analysed for heavy metals and OC pesticides.

**Penrhyn Road Boat Launching Ramp Woodward-Clyde (1992)**

Eleven surface sediment samples in Penrhyn Estuary were analysed for HCB, chromium and mercury.

**Johnstone Environmental Technology (1993)**

JET (1993) collected 25 sediment samples (October 1993) from sites in Penrhyn Estuary to assess contamination issues regarding relocation of the Penrhyn Road boat ramp. These sites included five push cores, five surface sediment samples and four hand auger samples. In addition to grain size analysis, analytes included mercury, chromium, chromium V1 and HCB in core and grab samples.

**Third Runway EIS (Kinhill, 1993)**

Kinhill (1993) collected sediment quality data for the Parallel Runway EIS (23 sites, 2 grab samples, 3 core samples). Sample analytes included: arsenic, cadmium, chromium, cobalt, copper, lead, mercury, tin, zinc, HCB, alpha-BHC, TPH, phosphorous, TOC and organic nitrogen.

**ICI Botany Groundwater Stage 2 Survey (1996) Woodward-Clyde**

Seven surface sediment samples and samples from three cores in Penrhyn Estuary were analysed for a range of volatile and semi-volatile halogenated compounds as well as mercury and chromium.

**Teutsch (1992) (University of Sydney, Honours Thesis) summarised in Birch (1996)**

Teutsch (1992) and Birch (1996) reported heavy metal concentrations in surficial sediment throughout Botany Bay. Six samples (out of a total of 196 samples) are relevant to the study area and were collected from four sites between the Parallel Runway and Penrhyn Estuary.

**Sydney Ports Corporation Additional Port Facilities, Port Botany Vol. 1, Factual Data – Part A Coffey Partners International, (1999).**

Coffey Partners (1999) assessed subsurface stratigraphy and design considerations for the container berths and hardstand areas of the new terminal. Contaminant concentrations in dredged material were assessed for possible disposal at sea. A total of 27 boreholes were completed and 8 boreholes (CP 20-27) were located within the proposed dredge area.

Thirteen push cores (S1-13) of surficial sediment and samples from 17 boreholes (CP6 to 12, CP17, 18 and CP 20 to 27) were collected at surface, 1.0 and 3.0 m depths. Twenty-three sediment samples were analysed for contaminants in the proposed dredge material (heavy metals, PCBs, OCs, TPH, polynuclear aromatic hydrocarbons (PAHs), organotin compounds and radionuclides).

An additional, seven borehole samples (to 1 m depth) and two composite samples (3 m depth) were collected in the proposed dredge and reclamation area and analysed for heavy metals and organotin compounds.

## 4.1 Introduction

Chemicals of potential concern (COPC) are defined as chemicals present at concentrations sufficiently high to warrant further assessment in relation to the potential to cause unacceptable risks to human health, or the environment. Identification of COPC relies on the use of environmental quality guidelines. COPC are identified as contaminants present at concentrations above the environmental quality guideline values, while contaminants having concentrations less than the guideline values do not warrant further assessment. This screening process is aimed at eliminating contaminants that are unlikely to present an unacceptable risk to human health, or the environment. Further assessments are required to determine whether a COPC may present an unacceptable risk to human health or the environment.

In addition to the use of environmental quality guidelines, the identification of COPC has drawn on the human health risk assessment studies undertaken by Orica (Woodward-Clyde 1996) as these investigations have specifically evaluated risks to human health associated with recreational use of Penrhyn Estuary and include the consumption of fish.

## 4.2 Environmental Quality Guidelines

The environmental quality guidelines relevant to the assessment of Penrhyn Estuary and north-eastern Botany Bay are contained in:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environmental Conservation Commission (ANZECC)/Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), October 2000 (ANZECC, 2000).

The ANZECC (2000) guidelines provide trigger values relevant to the assessment of surface water quality and sediment quality.

The trigger values for marine water are appropriate environmental quality guidelines for the protection of marine aquatic species. ANZECC (2000) also provides water quality guidelines for recreational use relevant to primary contact (swimming) and are considered appropriate to this assessment.

Due to a paucity of local ecotoxicity data, ANZECC has compiled interim sediment quality guidelines (ISQG), based on the North American effects range approach. The ISQGs are relevant to the protection of benthic (bottom dwelling) organisms and provide screening levels for sediment assessment in a tiered decision making approach. Sediment contaminant concentrations are compared to guideline values and those samples above the lower limit (ISQG-L), or trigger value are further examined for bioavailability, e.g. subjected to acute and chronic toxicity testing.

The trigger values for marine waters, and sediment quality guidelines are not relevant to the assessment of risks to wildlife (e.g. birds) that may be exposed to contaminants via consumption of food or incidental ingestion of water and sediments during feeding. To assist in the evaluation of surface water quality in relation to wildlife the following document has been referenced:

Toxicological Benchmarks for Wildlife: 1996 Revision. Prepared by the Risk Assessment Program Health Sciences Research Division Oak Ridge for the US Department of Energy Office of Environmental Management. (Sample et al., 1996) (extract of this report in Appendix A).

This document provides several benchmark values for birds including food, drinking water and water concentrations relevant to piscivorous species that incorporates consumption of water and fish. There are a number of uncertainties in the derivation of the benchmark values and as such should only be used for broad screening purposes.

Appendix A provides a summary of the relevant ANZECC (2000) guideline values and the toxicological benchmarks.

The following sections present a summary and discussion of COPC identified for the study area. These have been separated into COPC relevant to human health and COPC relevant to the protection of the environment.

## 4.3 Human Health

The identification of COPC for human health is based on recreational use of Penrhyn Estuary and north-eastern Botany Bay (i.e. Foreshore Beach). These areas are considered separately in the following section, however the majority of available data pertains to previously identified higher contaminant concentrations in Penrhyn Estuary.

The potential effects of sediment-bound contaminants have been assessed as part of the previous Orica risk assessment (Woodward-Clyde 1996). The findings of this risk assessment show that sediment-bound contaminants within the project area do not pose a significant risk to human health. Therefore the following discussion of COPC relevant to human health is based on contaminant concentrations in water.

### 4.3.1 Penrhyn Estuary

The following COPC (and maximum measured concentrations) have been identified based on the ANZECC (2000) water quality guidelines for recreational purposes and the Orica risk assessment studies (Woodward-Clyde 1996):

- Volatile halogenated compounds:
  - 1, 2 dichloroethane (EDC), (ANZECC [2,000] recreation guideline value, 10 $\mu g\ L^{-1}$) in Floodvale and Springvale Drains (max. 2000 $\mu g\ L^{-1}$) and Penrhyn Estuary (max. 100 $\mu g\ L^{-1}$);
  - 1, 1 dichloroethene, (ANZECC [2000] recreation guideline value, 0.3 $\mu g\ L^{-1}$) in Floodvale Drain (max. 10 $\mu g\ L^{-1}$) and Springvale Drain (max. 100 $\mu g\ L^{-1}$);

- vinyl chloride (VC) or chloroethene was determined to be a COPC in the Orica risk assessments (max. 3,800 $\mu g\ L^{-1}$, total chloroethene);
- carbon tetrachloride (CTC) (ANZECC [2000] recreation guideline value, 3.0 $\mu g\ L^{-1}$) in Penrhyn Estuary (max. 10 $\mu g\ L^{-1}$) and Floodvale and Springvale Drains (max. 1,000 $\mu g\ L^{-1}$).;
- trichloroethene (ANZECC [2000] recreation guideline value, 30 $\mu g\ L^{-1}$) in Floodvale (max. 300 $\mu g\ L^{-1}$) and Springvale Drains (max. 2000 $\mu g\ L^{-1}$); and
- tetrachloroethene (ANZECC [2000] recreation guideline value, 10 $\mu g\ L^{-1}$) in Floodvale (max. 80 $\mu g\ L^{-1}$) and Springvale Drains (max. 200 $\mu g\ L^{-1}$).

• Semi volatile organic compounds:

- benzene (ANZECC [2000] recreation guideline value, 10 $\mu g\ L^{-1}$) in Floodvale and Springvale Drains (max. 20 $\mu g\ L^{-1}$).

• Inorganics:

- mercury (ANZECC [2000] recreation guideline value, 1.0 $\mu g\ L^{-1}$) in Springvale Drain (max. 2 $\mu g\ L^{-1}$); and
- sulphide (ANZECC [2000] recreation guideline value, 50 $\mu g\ L^{-1}$) in Penrhyn Estuary and Floodvale and Springvale Drains (max. 700 $\mu g\ L^{-1}$).

Concentrations of VHCs in Penrhyn Estuary are influenced by tide height and are notably higher at low tide (Woodward-Clyde, 1996). Mixing with Botany Bay waters and the volatility of many of the halogenated compound, restricts high concentrations of these contaminants to an area upstream of the present constriction in Penrhyn Estuary. As a consequence, the monitoring data shows concentrations of the VHCs to be less than the laboratory reporting limits within a short distance of the current constriction of Penrhyn Estuary.

### 4.3.2 North-eastern Botany Bay (Foreshore Beach)

The main focus of surface water quality monitoring outside Penrhyn Estuary to-date has been the occurrence of faecal contamination indicators, determined as part of the Harbourwatch program. Water quality monitoring undertaken by Orica indicates that VHCs present at elevated concentrations within Penrhyn Estuary decrease to below laboratory detection limits in the open waters of north-eastern Botany Bay.

Organic compounds in waters collected off Foreshore Beach have not exceeded ANZECC (2000) guideline values for recreational purposes. Data on concentrations of organic compounds are not available for waters from other parts of Botany Bay and the Mill Stream. Chromium and mercury concentrations have been reported to exceed guideline values in north-eastern Botany Bay (Kinhill, 1990), but these metal concentrations analysed in water are higher than and inconsistent with, other sampling programs.

Based on available data, no COPC have been identified in north-eastern Botany Bay. Therefore, the prime issue of concern relating to risk to human health outside Penrhyn Estuary is related to faecal contamination discharged to Botany Bay predominantly via the Mill Stream (Section 6.4.1).

## 4.4 Environment

### 4.4.1 Water Quality

Volatile halogenated compounds (VHC) are a group of chemicals with a wide range of densities, solubilities and chemical properties. These compounds have a low affinity for particulate materials including soil and sediment, are generally stable in groundwater, but volatilise rapidly (half-lives from less than one hour to several days) in surface waters. Halogenated compounds do not readily hydrolyse in water or soils, but are subject to biodegradation, particularly in anaerobic conditions. Once released to the atmosphere, the halogenated compounds may be subject to photo-oxidation. These chemicals generally have a low potential to accumulate in organisms indicated by low octanol/water partition coefficients.

Water sampling in Penrhyn Estuary and along Foreshore Beach indicates that a steep gradient of VHC concentrations currently exists seaward of the constriction in Penrhyn Estuary (URS, 2002). The ANZECC (2000) aquatic ecosystem guideline values for marine waters available for concentrations of 1,1,2-trichloroethane, 1,2,4-trichlorobenzene and benzene were not exceeded in Penrhyn Estuary or off Foreshore Beach. Guideline values are not specified by ANZECC (2000) for other chemicals occurring in high concentrations in Penrhyn Estuary.

Wildlife benchmark values for birds are available for 1, 2 dichloroethane (EDC) but not for other VHCs identified in Penrhyn Estuary. Drinking water NOAEL[1] based benchmarks fall in the range of 70 mg $L^{-1}$ to 525 mg $L^{-1}$ EDC dependent on the size of the bird. In contrast, water benchmarks protective of piscivorous birds range from 4 mg $L^{-1}$ to 12 mg $L^{-1}$. Existing concentrations of EDC in Penrhyn Estuary water vary with the state of the tide and have been recorded at up to 41.3 mg $L^{-1}$ (Site SW028, May 1999). The latter benchmarks assume consumption of food (following uptake) and water. These benchmarks are not relevant to Penrhyn Estuary as it would not provide a drinking water supply. The benchmarks are useful for broad screening purposes and suggest that high concentrations of EDC would be required before adverse effects in wading birds would be expected.

The concentration of mercury (max. 2 µg $L^{-1}$) in Penrhyn Estuary has exceeded the ANZECC (2000) guideline value (0.4 µg $L^{-1}$) on several occasions (Appendix B). Copper concentrations have exceeded

[1] No Observed Adverse Effect Level

the ANZECC (2000) guideline value (1.3 μg $L^{-1}$) in the Mill Stream, along Foreshore Beach and in Botany Bay (max. 11, 8 and 8 μg $L^{-1}$, respectively).

Kinhill (1990) reported concentrations of cadmium, mercury and zinc in water exceeding ANZECC (2000) guideline values. However, the concentrations of metals appear anomalously high and are not representative of typical concentrations from other investigations in north-eastern Botany Bay.

### 4.4.2 Sediment Quality

Mercury, chromium and HCB present in Penrhyn Estuary originated from historical sources in the catchment. These contaminants are generally affiliated with sediment and bound to fine grained material.

Mercury may be present as different species in the environment including elemental (metallic) and stable mineral forms, soluble inorganic salts (e.g. mercuric chloride), and amalgams with other elements (e.g. silver and gold). Organic complexes, especially methylated forms of mercury are highly toxic. The solubility, environmental fate and toxicity of mercury are dependent on the speciation. Hence, total mercury concentrations determined in sediment (and water) samples from Penrhyn Estuary are only indicative of toxicity. Unlike the majority of heavy metals, mercury has potential to bioaccumulate in organisms, hence increasing in concentration in species higher in the food chain. Mercury is present in sediment in Penrhyn Estuary at concentrations up to 183 mg $kg^{-1}$, considerably in excess of the ANZECC (2000) ISQG-L value (0.15 mg $kg^{-1}$)(Appendix B). The average concentration of mercury in available sediment data from Penrhyn Estuary is 11.5 mg $kg^{-1}$, but excluding two exceptionally high samples, the average concentration is 3.7 mg $kg^{-1}$.

The maximum chromium concentration (130 mg $kg^{-1}$) in sediment exceeds the ANZECC (2000) ISQG-L value (80 mg $kg^{-1}$) in Penrhyn Estuary. However, chromium is unlikely to constitute a COPC, as the mean concentration of chromium in estuarine sediment is low (17.3 mg $kg^{-1}$).

Hexachlorobenzene (HCB) has a strong affinity to particulate material and is persistent in estuarine sediment. HCB has low solubility in water, is non-volatile, but can bioaccumulate in fish and other aquatic animals. Limited data indicates that HCB is present in sediment of Penrhyn Estuary at concentrations up to 2.2 mg $kg^{-1}$ (ICI Botany, 1990)(Appendix B). ANZECC (2000) does not include a guideline value for HCB in sediment. By way of comparison, a study of estuarine sediment in Port Jackson (140 samples) determined that the maximum and mean concentrations of HCB in sediment were 0.14 and 0.06 mg $kg^{-1}$, respectively (Taylor, 2000).

Kinhill (1990) reported concentrations of DDT, DDE and dieldrin in sediment exceeding ANZECC (2000) guideline values from sample locations in the proposed dredged area (Appendix B). These concentrations appear anomalously high relative to data from other studies and are therefore not representative of typical concentrations in north-eastern Botany Bay.

Organotin compounds (and mercury) detected in surficial sediment in the proposed dredge area (Coffey, 1999) are discussed in Section 7.1.1.

## 5.1 Introduction

This section presents a summary of the contamination issues based on the studies undertaken by L and T, AccessUTS, TEL and URS, as well as previous investigations (refer to Section 3). Contamination of sediment and water identified by previous studies in Penrhyn Estuary is not related to past or current operations of the Port Botany container terminal.

## 5.2 Groundwater

Groundwater to the north of Penrhyn Estuary and Foreshore Beach has been subject to extensive investigations over an extended time. Most of the available studies and data relate to investigations of groundwater issues associated with the Orica petrochemical facility. These studies indicate the following:

- both shallow and deep groundwater has been contaminated as a result of historic operations at the Orica petrochemical facility;
- the prime contamination issues relate to the presence of VHCs;
- VHC is present in both shallow and deep groundwater and has the potential to affect surface water quality in Floodvale Drain, Springvale Drain and Penrhyn Estuary;
- the source of VHCs in surface waters of Penrhyn Estuary is a result of the discharge of both shallow and deep groundwater; and
- the groundwater contamination is the subject of ongoing investigation and remediation programs by Orica under voluntary agreements with the NSW EPA.

The available groundwater data has been utilised by AccessUTS (2002) in their groundwater assessment report prepared for SPC.

## 5.3 Surface Water

### 5.3.1 Penrhyn Estuary

The prime contamination issue in the surface waters of Penrhyn Estuary is the presence of VHCs associated with groundwater contamination. Concentrations of several VHCs (listed in Section 4.3.1) currently exceed ANZECC (2000) water guideline values in Penrhyn Estuary, notably at low tide. Water quality in Penrhyn Estuary is currently affected by discharge of groundwater to Springvale and Floodvale Drains as well as Penrhyn Estuary. These processes are described in the AccessUTS (2002) report. The monitoring data collected by Orica indicates that surface water concentrations of 1, 2 dichoroethane (also known as EDC) and to a lesser extent vinyl chloride (VC) and carbon tetrachloride (CTC) have increased since sampling commenced in the early 1990s. These contaminants have been identified as COPC in risk assessment studies (Woodward-Clyde 1996). Penrhyn Estuary, situated within an urban and industrial catchment is also subject to a range of gross contaminants and nutrients as described by L and T (2003). The volatility of VHC contaminants is responsible for the rapid seaward decline in concentrations and the reported low concentrations of VHCs in north-eastern Botany Bay outside Penrhyn Estuary.

AccessUTS (2002) describe three deep groundwater plumes that are characterised by high concentrations of EDC. These plumes are predicted to ultimately discharge to surface waters via the intertidal zones of Penrhyn Estuary and along Foreshore Beach. The discharge of the so called “central plume” has the potential to result in higher concentrations of VHCs in surface waters of Penrhyn Estuary, because the area of discharge is predicted to occur in the intertidal zone between Floodvale and Springvale Drains. The final discharge concentrations of VHCs will be dependent on the amount of attenuation (by dilution and volatilisation) occurring during transport and at the point of discharge, as well as the implementation of remedial measures by Orica.

### 5.3.2 North-eastern Botany Bay

Water quality issues within north-eastern Botany Bay are dominated by the Mill Stream outflow and are influenced by overflows from the SWSOOS. The Harbourwatch monitoring program indicates that Foreshore Beach has, on a relative scale, poorer water quality with respect to indicators of sewage contamination than most other beaches monitored by Harbourwatch.

The available data indicates that VHCs in north-eastern Botany Bay are below the laboratory detection limits within a short distance from the current constriction in Penrhyn Estuary. Under current conditions, VHCs would not be expected to be detected off Foreshore Beach. Furthermore, under the current configuration the discharge of VHCs in deep groundwater would not be expected to have a significant effect on the water quality outside of Penrhyn Estuary (i. e. Foreshore Beach) due to rapid dispersion and volatilisation.

## 5.4 Sediment

Concentrations of HCB and mercury in sediment exceed ANZECC (2000) guideline values in Penrhyn Estuary. These contaminants were derived from historical sources in the Floodvale and Springvale Drain catchments. Sources of HCB and mercury in the catchment have been mitigated and no longer provide a significant flux to Penrhyn Estuary, therefore surficial sediment concentrations of these COPC are expected to decrease over time. However, Penrhyn Estuary is the receiving water for an industrialised and urbanised catchment and a flux of contaminants, typical of developed catchments will continue to accumulate in the estuary. Sediment-bound contaminants are generally associated with fine grained material and contaminant concentrations of total sediment are “diluted” by higher sand content. Therefore, the steep seaward gradient of concentrations from Penrhyn Estuary to north-eastern Botany Bay with increasing distance from source is also accentuated by an increase in grainsize.

Heavy metal concentrations in north-eastern Botany Bay, in particular the proposed dredge area are enriched above background values for the Sydney Region (Birch, 1996; Taylor, 2000), but are generally below ANZECC (2000) guideline values.

## 5.5 Biota

There has been limited sampling and analysis of biota within Penrhyn Estuary and north-eastern Botany Bay. Sampling has been undertaken as part of the environmental investigations for the Orica petrochemical facility to address risks to human health associated with the consumption of fish. These studies have focussed primarily on the concentration of potential contaminants associated with the Orica petrochemical facility that have the potential to bioaccumulate namely, mercury, chromium and semi-volatile halogenated compounds. The biological monitoring has focused on potentially edible species of fish, but has also included a number of invertebrate species. The studies indicate accumulation of HCB in some species at concentrations greater than that found at reference sites elsewhere in Botany Bay (Woodward-Clyde 1996). In contrast, mercury and chromium concentrations in biota have been generally found to be not significantly different from those found at reference sites.

## 6.1 Introduction

The proposed development at Port Botany involves the dredging of sediment from Botany Bay and reclamation of the new terminal west of Penrhyn Estuary and the existing Brotherson Dock. Under present conditions, the exchange of water is largely unrestricted between Botany Bay and the outer section of Penrhyn Estuary. Post-development water exchange between Botany Bay and Penrhyn Estuary would be via a 130 m channel approximately 700 m long, north of the new terminal and adjacent to Foreshore Beach (Figure 3).

COPC to human health, identified in Section 4, are predominantly dissolved phase contaminants including VHCs. This section considers likely changes to concentrations of dissolved contaminants as a result of the proposed development. Mercury and HCB, also identified as COPC in Penrhyn Estuary, are associated with particulate material and likely changes in hydrodynamic conditions that affect the concentration and distribution of these contaminants are also discussed.

Nutrients, including total nitrogen and phosphorous, are not considered to pose a direct risk to human health. Ecological risks from possible changes to nutrient concentrations in Penrhyn Estuary are related to the propensity of nutrients to accentuate phytoplankton growth, i.e. algal blooms and are discussed by TEL (2003).

## 6.2 Dissolved Contaminants in Penrhyn Estuary

### 6.2.1 Changes to Dissolved Contaminant Concentrations

Changes to the distribution and concentrations of VHCs in Penrhyn Estuary, as a result of the proposed development, have been estimated from predicted changes to the concentrations of TN and TP modelled by L and T (2003). Due to the complex relationship between volatilisation of volatile COPC (i.e. VHCs) and water exchange with Botany Bay, likely changes to concentrations of halogenated compounds in Penrhyn Estuary cannot be determined with a high degree of certainty. Locations A to G refer to output locations of modelling conducted by L and T (2003) (Figure 3).

The concentration of nutrients at Locations B and D in Penrhyn Estuary are predicted to increase by factors up to 3.0 and 2.8 times for TN and TP, respectively as a result of the proposed new terminal (Table 1). However, the concentration of nutrients at these locations is predicted to remain lower than concentrations at Location C, upstream of the constriction in the estuary. Modelling results indicate that concentrations of nutrients are highest at location C, but are predicted to increase by a factor of 1.7 and 1.6 for TN and TP, respectively. The model predicts marginally lower nutrient concentrations at Locations E and G than at present, at the seaward extent of the proposed channel and along western Foreshore Beach, respectively. At Location A, i.e. the south-east corner of the existing terminal, concentrations of TN and TP are unaffected by the proposed development.

Table 1 Predicted changes to low flow nutrient concentrations in north-eastern Botany Bay

| Location | A | B | C | D | E | G |
|---|---|---|---|---|---|---|
| **Increase factor for dry weather TN concentrations** | 1.0 | 2.6 | 1.7 | 3 | 0.9 | 0.9 |
| **Increase factor for dry weather TP concentrations** | 1.0 | 2.5 | 1.6 | 2.8 | 0.9 | 0.9 |

Source (L and T, 2003; Vol. 2, Tables 7.4 and 7.5)

The output of nutrient modelling may represent a reasonable estimate of changes in concentrations for conservative (non-volatile) halogenated compounds in Penrhyn Estuary, however the model input incorporates nutrient influx from the Mill Stream and Foreshore Beach drains, which is not appropriate for modelling halogenated compounds in north-eastern Botany Bay. The modelling of nutrients does not incorporate all of the complexities of nutrient dynamics (denitification, sediment uptake etc.) which would not be relevant to other contaminant concentrations. However, the model parameters include a (small) exponential decay rate (0.05 $days^{-1}$) for nutrients that would be considerably lower than the volatilisation rate of VHCs. For these reasons the modelled approach represents a worse case scenario for halogenated compound concentrations in north-eastern Botany Bay.

The modelling was aimed at estimating existing concentrations of nutrients and other parameters in north-eastern Botany Bay and changes in concentrations as a result of the new terminal construction. Interpretation of data available for a suite of volatile and non-volatile halogenated compounds in Springvale and Floodvale Drains, and Penrhyn Estuary demonstrates that the environmental fate of volatile compounds is markedly different to that predicted for nutrients. Modelled output concentrations of TN and TP in Penrhyn Estuary and north-eastern Botany Bay are substantially higher than concentrations in estimated fluvial input. For example, TN and TP concentrations at Location C in Penrhyn Estuary are more than 60 times higher than estimated catchment load concentrations from Springvale and Floodvale Drains. The opposite is true of concentrations of VHC, where concentrations measured in estuarine waters were always significantly lower than measured in the drains, presumably due to the rapid volatilisation and loss to the atmosphere. Hence, modelling of nutrient concentrations cannot be used to predict concentrations of halogenated compounds in estuarine waters, but some data on present concentrations of VHCs in Penrhyn Estuary are available (Section 4.4.1). However, changes in nutrient concentrations in Penrhyn Estuary attributed to the development can be used to predict the likely magnitude of change in VHC concentrations in the estuary.

Analogies from modelling conducted by L and T on conservative elements (nutrients) suggests that due to restricted exchange of water:

- the concentration of VHCs will increase upstream of the constriction in Penrhyn Estuary, i. e. at Location C; and

- the total areal extent where VHCs occur at concentrations above the laboratory level of reporting is likely to increase after construction of the new terminal.

The increase in both the extent and maximum concentration of halogenated compounds is highly dependent on the environmental fate of each chemical and is expected to be greatest for non-volatile, persistent chemicals. Halogenated compounds with short half-lives in surface waters are expected to occur at detectable concentrations over a smaller area in Penrhyn Estuary than those with longer half-lives.

Volatilisation and degradation of a VHC from a body of water is dependent on factors including temperature, water turbulence and microbiological activity. Half-lives for VHCs have been estimated from theoretical data and modelled in rivers, lakes and ponds. Using a reported Henry's Law constant of 0.0560 atm/cu m-mole, a half-life of 0.805 h was estimated for volatilisation of vinyl chloride from a river 1 m deep with current and wind velocities of 3 m $s^{-1}$ (US EPA, 2003). Similar calculations estimate the half-life of EDC from several hours to 10 days. These calculations are based on dynamic riverine conditions, which may approximate conditions in Floodvale and Springvale Drains. Half-lives for highly volatile halogenated compounds in a less dynamic environment, such as Penrhyn Estuary, are probably in the order of hours to many days.

Results of water sampling have shown that existing concentrations of VHCs in Penrhyn Estuary are substantially higher at low tide, relative to high tide concentrations. The existing rapid decline in contaminant concentrations in Penrhyn Estuary is therefore due to mixing with water in Botany Bay, as well as volatilisation. At present, the concentration of volatile COPC are close to, or below detection limits seaward of the existing boat ramp. A decrease in flushing of Penrhyn Estuary, post construction of the new terminal, would probably result in higher concentrations of VHCs throughout the majority of Penrhyn Estuary, including Locations B and D. A rapid decline of concentrations is likely to occur along the proposed channel, i. e. from Location D to Location E due to mixing with Botany Bay waters.

The current source of VHCs in Penrhyn Estuary is predominantly from the discharge of shallow groundwater into Springvale and Floodvale Drains and subsequent flow to the estuary. As reported by AccessUTS (2002), monitoring by Orica shows that a deep groundwater plume discharges into Penrhyn Estuary. A substantial additional flux of halogenated compounds from two other deep groundwater plumes is expected to discharge to the intertidal zone in Penrhyn Estuary within seven years. Hence, irrespective of whether the development proceeds, the concentrations of VHCs are expected to increase within the confined area of Penrhyn Estuary, as a result of historical contamination of groundwater.

### 6.2.2 Dissolved Contaminant Concentrations During High Rainfall Events

Catchment storage of TN and TP and periodic flushing by heavy rainfall, is predicted to substantially increase concentrations (>7 times at Location D) of these nutrients in Penrhyn Estuary during storm events (L and T, 2003; Vol. 2; Tables 7.1 & 7.2 and Figure 7.3 & 7.4). Modelling results show that the highest nutrient concentrations are predicted to occur upstream of the existing boat ramp (Location C) during high rainfall events. Nutrient concentrations are likely to decrease at Locations A and E. However, the modelling indicates that nutrients reach higher peak concentrations over a greater areal extent of

Penrhyn Estuary (at locations B, D and G) and that elevated concentrations persist for longer periods (L and T, 2003; Vol. 2; Figures 7.3 and 7.4), as a result of the new terminal construction.

In contrast to results based on nutrients, the distribution, maximum concentration and persistence of VHCs in Penrhyn Estuary during high flow events is unlikely to be accurately represented by modelling for the following reasons:

- the source of VHCs is groundwater;
- the distribution of VHCs is not catchment wide; and
- VHCs are assumed not to accumulate in the catchment during prolonged dry periods.

The concentrations of VHCs in Penrhyn Estuary are likely to decrease substantially during high flow events, due to dilution by stormwater and flushing of the estuary. The effect of stormwater dilution on VHC concentrations has been observed in regular monitoring of water quality in Penrhyn Estuary. For example, a marked decrease in concentrations of VHCs in Springvale and Floodvale Drains, and Penrhyn Estuary in February 2001 was attributed to heavy rainfall prior to sampling (URS, 2002; p 2-3).

Over longer time intervals, groundwater levels and prolonged periods of heavy rainfall may vary the flux of halogenated compounds to Penrhyn Estuary. However, there is insufficient data available to determine the long term temporal variability of the contaminant flux to Penrhyn Estuary.

## 6.3 Fate of Sediment-bound Contaminants in Penrhyn Estuary

### 6.3.1 Wave Energy and Sediment Transport

Lawson and Treloar (2003; Vol. 3) addressed the bay wide impacts of the proposed new terminal and focussed on possible changes to swell wave conditions along the wall of the Parallel Runway. No change is expected to the swell/wave climate in Botany Bay (outside Port Botany) due to the new terminal. Changes to swell wave climate would be limited to an area between the Parallel Runway and Molineux Point. A marginal decrease in wave height is predicted at some locations along the eastern side of the Parallel Runway due to the new terminal. Long waves are not expected to affect sediment transport on Foreshore Beach, as current velocities generated by these waves are estimated to be $<0.02$ m $s^{-1}$.

Eastern Foreshore Beach is currently undergoing recession, with transportation of sediment towards the Parallel Runway occurring by longshore drift. The proposed new terminal would significantly reduce wave energies (particularly local sea waves) and sediment transport at the existing mouth of Penrhyn Estuary. The resultant lower ambient wave energies would allow fine grained sediment that is currently remobilised to accumulate in the larger confined area of Penrhyn Estuary. Comparison with photographs taken in 1996 shows that sand has accreted in intertidal zones of outer Penrhyn Estuary over the last 5-6 years. This well-sorted (clean) sand in intertidal areas near the existing boat ramp would probably increase in mud content.

Sediment in Penrhyn Estuary is enriched in mercury and HCB from historical sources. New sediment particles arriving in Penrhyn Estuary will be of lower concentration due to a reduction of catchment contaminant sources. These contaminants are commonly preferentially bound to fine-grained fraction of sediment due to the high cation exchange capacity of clay material. Fine sediment at the estuary mouth is presently mobilised and redistributed by wave action. A seaward gradient of sediment contaminant concentrations from Penrhyn Estuary to Botany Bay is therefore partly due to a seaward increase in mean grainsize in the estuary. Effective dispersion of fine grained material from the mouth of Penrhyn Estuary has probably restricted accumulation of sediment-bound contaminants to within the estuary. Decreases in mean sediment grainsize resulting from lower energy regimes in Penrhyn Estuary due to the new terminal, would potentially increase contaminant concentrations in total sediment in the larger confined area of the estuary. However, changes in particulate-bound contaminant concentrations as a result of a decrease in sediment grainsize are likely to be offset by a lower contemporary contaminant influx.

Depressions in the seabed of Botany Bay are known to be preferential sites for accumulation of fine grained sediment and contaminants (Birch, 1996). Heavy metals are substantially enriched in north-west Botany Bay in a location previously dredged for the original runway at Sydney Airport. The concentration of contaminants in surficial sediment of the proposed dredge area in north-eastern Botany Bay have been investigated (Coffey, 1999), however, interpretation of the most recent contaminant depositional history (i.e. in a thin surface layer) is confounded by sampling over wide intervals.

### 6.3.2 Siltation of Penrhyn Estuary

Siltation from sediment deposited during high flow events is currently low in Penrhyn Estuary and the highest siltation rates (2.6 cm $y^{-1}$) occur in the upstream reaches of the estuary (L and T, 2003; Vol. 2; Fig. 7.9 and 7.10). Fine particulate material is not expected to accumulate along the shorelines, but disperse to lower energy environments. Due to decreased wave energies in Penrhyn Estuary, fine sediment and contemporary contaminants are expected to accumulate in the estuary over a larger area, seaward of the current distribution.

Under low flow conditions, fine particulate material arriving in Penrhyn Estuary via Springvale and Floodvale Drains is expected to flocculate when mixed with water of increased salinity (1-2 mg $L^{-1}$). Suspended sediment represents an insignificant risk during low flow meteorological conditions in Penrhyn Estuary. High flow conditions are discussed below.

### 6.3.3 Remobilisation of Historical Contaminants During High Rainfall Events

Resuspension velocity thresholds are highly dependent on physical parameters including grainsize, cohesivity and temperature, and vary seasonally due to biological influences. Lawson and Treloar (2003) predict peak current velocities of 0.26 m $s^{-1}$ in Penrhyn Estuary post construction of the new terminal (5 year average recurrence interval [ARI]). Velocities in excess of 0.25 m $s^{-1}$ are probably sufficient to resuspend unconsolidated fine grained sediment, therefore only freshwater flow events with a frequency lower than 5 years ARI are likely to resuspend sediment. Fine sediment deposited upstream of Location C may be resuspended and transported further seaward.

Post development, peak flow velocities for 1 year ARI events in Penrhyn Estuary are predicted to marginally decrease and flows <0.11 m $s^{-1}$ are predicted throughout the estuary. At Locations B and C, a marginal reduction in flow velocity is expected. In contrast, at Location D, the flow velocities increase from 0.05 to 0.10 m $s^{-1}$, but remain low. The area of Penrhyn Estuary likely to experience peak flow velocities at 5 year ARI flows would be increased (0.6 to 0.12 m $s^{-1}$ at Location D) by the proposed development, however the maximum flow velocities in the outer Penrhyn Estuary are predicted to be low (0.12 m $s^{-1}$).

In many areas the formed waterway created by the proposed habitat enhancement works would provide only a very small channel in the overall water column, especially in the proposed seagrass area. During a fresh water flood that coincides with high tides, it would be likely the flow would at least be partially outside the formed waterway and may create additional channel(s). Historical sediment-bound contaminants including mercury and HCB in Penrhyn Estuary may be dispersed into Botany Bay if deep scouring occurs. Creation of sea grass habitats within Penrhyn Estuary and the proposed channel adjacent to eastern Foreshore Beach may assist in stabilising existing sediment-bound contaminants in areas with sufficient water depth to allow long term establishment.

Habitat enhancement for wading birds proposed in Penrhyn Estuary would redistribute sand in dunes to the north of the estuary to create larger areas of intertidal flats suitable for wading birds. The proposal may include importation of additional clean material. An additional benefit of the habitat enhancement would be to cover existing contaminated sediment with a layer of clean material. Fine grained organic rich material may also be imported to promote the colonisation of estuarine sediment for benthic invertebrates which would form part of the food supply for the birds. The long term stability of the newly created intertidal flats would be dependent on flow regimes in the estuary under various hydrodynamic conditions.

## 6.4 Other Water Quality Issues in North-Eastern Botany Bay

### 6.4.1 Sewer Overflows

The Sydney Water Sewer Overflow Licensing Project (SOLP) and an Environmental Impact Statement (SWC/SKM, 1998) indicate significant sewer input from the Southern and Western Suburbs Ocean Outfall Sewer (SWSOOS), to Botany Bay. The reports detail typical raw sewage microbiological characteristics, which includes concentrations of faecal coliforms, viruses, Giardia and Cryptosporidium. High volumes of trade waste from the heavily industrialised area immediately north of Botany Bay also degrade water quality in the Mill Stream. Water quality issues concerning the source of faecal contaminants and sewer overflows are not related to current or future port activities. Sydney Water Corporation (SWC) is undertaking a program of activities to improve the management and capacity of the sewerage system (SWC, 2002). The proposed devices are expected to reduce the catchment load of pollutants to the Botany Bay.

Primary and secondary contact recreation on Foreshore Beach poses considerable human health risks due to faecal contamination from the Mill Stream at present. Relocation of the existing boat ramp from Penrhyn Estuary to Foreshore Beach and creation of public recreation areas at the north-western end of Foreshore Beach may increase exposure of humans to poor water quality particularly after heavy rains. However, remedial action being undertaken by SWC is designed to significantly reduce this risk by the time the proposed new terminal is due to be constructed. Modelling of faecal coliform concentrations indicates that the concentrations may decrease slightly near the Mill Stream outlet during high rainfall events. However, the same modelling indicates that concentrations of faecal coliform are likely to increase during high rainfall events in Penrhyn Estuary as a result of reduced flushing caused by the new terminal (L and T 2003).

### 6.4.2 Changes in Other Water Parameters

Salinity in Penrhyn Estuary is not expected to vary significantly from existing conditions with the construction of the new terminal (D. Treloar, Penrhyn Estuary Workshop 13/11/02).

Only minor changes ($<0.3^{o}$ C increase) in water temperature are predicted within Penrhyn Estuary (L and T, 2003; Vol. 2). Slightly lower temperatures are predicted to occur where water depths are increased. The overall change in temperature is negligible compared to natural variation.

Nutrient concentrations during low rainfall periods are predicted to increase (by a factor between 1.7 and 3.0) within the confined area of Penrhyn Estuary as a result of the new terminal. The peak concentrations of nutrients during high rainfall events are also predicted to increase, due to decreased flushing of the estuary and extend throughout the larger confined area of the estuary. Elevated nutrient concentrations in estuarine waters would persist longer.

The range of DO concentrations is expected to be less in Penrhyn Estuary post development, however a small reduction in average dissolved oxygen concentrations is predicted in the estuary. Overall, the proposed port expansion would not negatively impact DO concentrations in Penrhyn Estuary.

## 7.1 Introduction

As part of the ongoing groundwater investigation and remediation program, Orica has undertaken assessments of risks to human health associated with contamination arising from historical operations of the Orica petrochemical facility. The Orica studies provide a basis for assessment of the changes to risk associated with the proposed port development, as they have focussed on a range of potential receptors and exposure pathways, including recreational activities at Penrhyn Estuary and the consumption of fish. These assessments have been made on a quantitative basis. In contrast to human health, there have been only limited studies on risks to the environment associated with contamination of water and sediment at Penrhyn Estuary.

The following sections provide a summary of potential changes in risks to both human health and the environment during the construction and operation of the proposed Port Botany Expansion.

## 7.2 Human Health

### 7.2.1 Exposure Pathways and Existing Risk

The receptor group relevant to the proposed port development is recreational users of Penrhyn Estuary and Foreshore Beach. The AccessUTS (2002) study indicated no significant changes to groundwater levels north of Penrhyn Estuary and Foreshore Beach, and to the fate of the plume, as a consequence of the development. Hence, there is no need to consider risk associated with VHCs in groundwater to residential and industrial receptors in the catchment, as the existing risks will not be altered by the development .

Recreational users of Penrhyn Estuary and Foreshore Beach may be exposed to contaminants by the following mechanisms, or exposure pathways:

- contact with surface water while swimming. Water may be swallowed during swimming and chemicals present in the water may be absorbed through skin in contact with water;
- contact with sediment, which may be accidentally swallowed. Chemicals present in sediment may be absorbed through skin;
- inhalation of VHCs that volatilise from surface water and enter the breathing zone of swimmers; and
- consumption of fish caught from Penrhyn Estuary.

In general, young children are the most sensitive group due to their greater tendency to wade and swim, their potential greater sensitivity to chemicals and lower body weight.

The studies undertaken by Orica indicated that:

- the most significant exposure pathways for recreational users of Penrhyn Estuary are incidental ingestion of surface water and dermal contact with water during swimming. These pathways account for >95% of the total risk;
- the VHCs that contribute most to health risk are EDC, VC and CTC; (Woodward-Clyde 1996);
- the most sensitive group is young children (5 to 12 years); and
- consumption of fish caught from Penrhyn Estuary represented a negligible risk for both adults and children.

The concentrations of VHCs within the existing constricted area of Penrhyn Estuary have approached values that exceed commonly accepted risk goals for recreational use of this area, should the estuary be visited on a regular basis. Recreational use near the existing boat ramp, which lies outside of the constriction, did not present an unacceptable risk to human health. Due to the generally muddy and unattractive nature of the upper reaches of Penrhyn Estuary, current recreational use occurs predominantly on the sandier and more open area near the existing boat ramp. The concentrations of VHCs in this area are substantially lower than those measured within the confined area of Penrhyn Estuary and have been identified as being acceptable with respect to risk to human health.

Risks to human health may increase as a consequence of the discharge of deep groundwater plumes into Penrhyn Estuary. It is not possible to predict with certainty the magnitude of increase in risk, as the concentration of VHCs at the point of discharge will be dependent on the extent of dilution during migration and discharge of groundwater, and the outcomes of remediation strategies. However, no change in contaminate influx is expected as a result of the construction or operation of the new terminal.

Due to the dispersion of VHCs in the atmosphere, the risk posed by the volatilisation of VHCs from surface water is low. The quantitative assessments of risk to human health through industrial (i.e. non-recreational) activities in the Springvale Drain catchment where the primary exposure pathway was the inhalation of VHC vapours was determined by the Orica Stage 2 risk assessment to be negligible (Woodward-Clyde 1996).

### 7.2.2 Changes in Risk – Post Development

The proposed port development has the potential to result in increased risks to human health due to:

- the confinement of a larger area of Penrhyn Estuary and resultant reduction in flushing may increase the area in which VHCs and other catchment contaminants are present at elevated concentrations; and
- the concentrations of VHCs within the current confined area of Penrhyn Estuary are likely to increase. The highest VHC concentrations would also occur in this area. The amount by which the concentrations increase is likely to be less than that predicted for the conservative nutrients (TN and TP), due to the volatilisation of VHCs.

The proposed development would alter the current recreational use of Penrhyn Estuary and Foreshore Beach in the following ways:

- access to the current boat ramp and the upstream sections of Penrhyn Estuary would be restricted as the current road access to the eastern side of Penrhyn Estuary will be closed to the general public. Access to Penrhyn Estuary would be by foot from Foreshore Beach on controlled access paths. It is conceivable that recreational use of south-eastern Foreshore Beach would be limited to passive activities (i. e. unlikely to involve swimming). This would reduce the potential for exposure to VHCs in the areas having the highest contaminant concentrations, i.e. upper Penrhyn Estuary and could result in a reduction of risks to human health; and

- the relocation of the boat ramp to north-west Foreshore Beach may increase active recreational use of this area, which could conceivably including wading or swimming. The concentration of VHCs may increase along the section of Foreshore Beach that forms the constructed channel. However, no significant changes in water quality are predicted for Foreshore Beach west of the constructed channel which, given the open nature of the beach, is the area most likely to be used for swimming.

It is not possible to predict contaminant concentrations with accuracy for the following reasons:

- due to their volatility the concentrations of VHCs will not be as high as predicted on the basis of modelling for the conservative nutrients

- the concentration of VHCs discharged into Penrhyn Estuary from deep groundwater source(s) cannot be predicted with accuracy, but will not be affected by the proposed port development ; and

- the deep groundwater plumes are expected to discharge to the intertidal zones of Penrhyn Estuary, but the extent of mixing of the groundwater and seawater at the point of discharge is uncertain.

As a consequence of the above, it is not possible to predict the magnitude of changes in risk with certainty. It is possible that the overall risk to human health following the port development may be reduced. Whilst the area potentially affected by elevated concentrations of VHCs may be increased due to the development, the changes in recreational use of the area and low concentrations occurring along Foreshore Beach, due to volatilisation of the VHCs during transport from the point of discharge, may result in a net reduction in exposure to VHCs.

The Harbourwatch monitoring program has indicated that Foreshore Beach has generally poorer water quality relative to other monitored beaches. The health risks associated with microbial contamination at Foreshore Beach would be largely unaltered, except through remedial action by Sydney Water Corporation.

Whilst the development may result in the migration of fine sediments along Foreshore Beach into areas currently containing coarse sediments with low contaminant concentrations, the risk assessment undertaken by Orica indicates exposure to sediments to be an insignificant exposure pathway. Similarly, the larger confined area of Penrhyn Estuary would not be expected to result in increased accumulation of contaminants in edible biota. This exposure pathway was identified in the Orica risk assessment and calculated to be insignificant. No change to this conclusion is expected as a result of the proposed development.

## 8.1 Introduction

The assessment of ecological risks relies heavily on consideration of the quality of sediment and water in relation to environmental quality guidelines. At best this allows only a screening level assessment of risks to be made with a broad qualitative characterisation of the risks. This type of assessment is not able to identify whether actual harm, or impact has occurred, or is likely to occur. Assumptions as to potential changes in the risks relies primarily on an assessment of expected changes in concentrations of COPC and or changes in the area affected by elevated concentrations of COPC. Because of the complexity of factors that influence risks to ecological receptors it is not possible to make a definitive characterisation of the risks to the environment following development.

## 8.2 Current Risks

Several studies have assessed the diversity and abundance of organisms in the study area (e.g. TEL 2003). However, URS are not aware of any studies that have assessed existing risks to aquatic and terrestrial organisms within and in the vicinity of Penrhyn Estuary. The available studies and observations show that Penrhyn Estuary provides habitat for both aquatic and terrestrial organisms. The available environmental quality benchmarks and sediment quality guidelines indicate that some contaminants are present at concentrations which would warrant further assessment to determine whether they cause adverse biological effects. However, it is currently not possible to state whether the contaminants are causing an adverse effect(s) or not.

The available studies indicate an abundance of both benthic and aquatic organisms within Penrhyn Estuary. Similarly, Penrhyn Estuary provides both feeding and roosting grounds for birds including waders feeding on the mudflats and larger piscivorous species, such as pelicans. The baseline benthic studies by TEL (2003), assessed the existing abundance and assemblage of benthic organisms in Penrhyn Estuary relative to other sites in Botany Bay . As indicated previously the TEL (2003) studies indicate that Penrhyn Estuary is a functioning ecological unit that is expected to interface with Botany Bay. None of the data collected indicates that the presence of existing contamination has resulted in a reduction of diversity and abundance when compared to elsewhere in Botany Bay. Whilst it is not possible to state that the contamination has not influenced the assemblage of biota present in Penrhyn Estuary, it is apparent that the benthos is diverse and abundant.

Meaningful assessment of risks to bird species, in particular waders, is not possible for the following reasons:

- there are many factors that influence the population of wading birds in Botany Bay. The assessment of terrestrial ecology (URS 2003) describes an overall decrease in wading bird numbers throughout Botany Bay. Factors causing this overall decline presently also influence the abundance of wading birds at Penrhyn Estuary;
- as the wading birds do not breed at Penrhyn Estuary, it is not possible to determine whether exposure to contaminants is adversely affecting the reproductive ability of the birds; and

- assessment of the health of wild bird populations is very difficult, particularly for small and transient populations such as those visiting Penrhyn Estuary.

In summary, it is not possible to identify whether the current contaminant status of Penrhyn Estuary is having an adverse effect on aquatic and terrestrial organisms present at Penrhyn Estuary, or whether the ecological functioning of the estuary has been adversely affected. However, the following observations can be made:

- benthic organisms and algae are likely to accumulate sediment-bound contaminants such as mercury and HCB. Higher order species such as fish and birds may be exposed to these contaminants through feeding on the benthic species, algae and associated detritus. Studies of fish and invertebrates (a small number of species) suggests only limited accumulation potential in higher order aquatic species, however no assessment of potential accumulation in birds has been undertaken;

- aquatic organisms and birds may be directly exposed to VHCs in surface water. Available environmental quality guidelines and benchmarks indicate that current concentrations within the confined upstream area of Penrhyn Estuary warrant further assessment to determine whether potential adverse effects are occurring; and

- similar to risks to human health, the discharge of VHCs in groundwater plumes may result in increased concentrations of VHCs in Penrhyn Estuary and therefore increase risks to environmental receptors, irrespective of the development of the new terminal.

## 8.3 Assessment of Ecological Risk – During Construction

### 8.3.1 Dredging Operations in North-eastern Botany Bay

Dredging operations to reclaim land for the new terminal in Port Botany has potential to create risks to aquatic organisms from high turbidity, release of contaminants from disturbed sediment, and oxidation of sulphides. These issues are discussed in the following sections.

### 8.3.2 Mobilisation of Sediment-bound Contaminants

Available data on contaminant concentrations of sediment in the proposed dredged area (Coffey, 1999) were assessed to determine risks related to disturbance and possible dispersion of contaminants in Botany Bay during dredging and reclamation of the proposed new terminal. In some samples, mercury and organotin compounds exceeded ANZECC (1996) guideline values for sea disposal of dredged and excavated material, and ANZECC (2000) guideline values.

Nine sediment samples contained mercury concentrations exceeding the ANZECC (2000) ISQG –low value (0.15 mg $kg^{-1}$). The highest mercury concentration recorded was 0.5 mg $kg^{-1}$ (borehole CP5). The mean concentration of mercury is well below the guideline value.

Organotin compounds exceeding ANZECC (1996) guideline values were reported for eight samples. The highest tributyltin (TBT) concentrations were present in surface sample S12 and borehole C5 (0.0077 and 0.013 mg $kg^{-1}$, respectively). However, due to analysis of several tributyl tin (TBT) compounds the organotin results are not directly comparable to guideline concentrations which are based on analysis of TBT oxides.

Organotin compounds are highly toxic to marine organisms and have been effectively used to reduce/prevent fouling of vessels by marine organisms. However, organotin concentrations in sediments adjacent to terminal facilities in Botany Bay are unlikely to cause significant risk to aquatic organism as:

- current concentrations are generally low;
- organotin compounds degrade in sediment; and
- the predominant contemporary source of these contaminants, antifouling paint on commercial shipping, is being phased out and is scheduled to be completed by 2008.

The distribution of mercury and organotin is irregular and does not indicate widespread enrichment in surficial sediment. Concentrations of mercury and TBT are generally low and close to detection limits and exceed sediment quality guideline values only in a limited number of sites. Therefore, mobilisation of these contaminants during dredging of sediment in Botany Bay is likely to pose a temporary and insignificant risk to aquatic organisms.

Data is currently unavailable for the concentrations of nutrients in sediment, however, mobilisation of nutrients during dredging is also likely to pose a temporary and insignificant risk.

### 8.3.3 Turbidity in North-eastern Botany Bay During Dredging Operations

The concentration of total suspended solids in estuarine waters varies seasonally and is generally higher in summer, due to higher resuspension rates and phytoplankton growth (Taylor, 2000). Typical concentrations of suspended solids in estuarine waters are 10 to 20 mg $L^{-1}$. The dredging in north-eastern Botany Bay is predicted by L and T to result in a sediment plume between the Parallel Runway and existing Brotherson Dock during dredging operations (L and T, 2003). The maximum predicted concentrations of suspended solids in surface waters at the dredge site exceed 200 mg $L^{-1}$. Concentrations of suspended solids near the seabed are likely to be substantially higher, however the small volume of sediment expected to settle from the plume would pose an insignificant risk.

### 8.3.4 Sulphide Rich Sediment

Disturbance and oxidation of acid generating material is possible during dredging of estuarine sediment. Dredged sediment deposited above sea level may oxidise and produce acid sulphate conditions that lowers the pH resulting in oxidative release of contaminants. Large areas of Botany Bay, including the proposed dredge area, have been classified as areas at high risk of containing acid generating sulphides (DLWC, 1995). As part of investigations into proposed dredging areas, Coffey (1999) identified sediments in the dredged area as sand, or silty sands overlying fissured clays. Cores CP 24 to 27, in the proposed dredge area, intersected several sedimentary units described as peaty or sandy peat, which may contain high sulphide contents. Clayey sand and dark grey, high plasticity clays, intersected in deeper stratigraphy also have potential to generate acid sulphate conditions but are situated generally below the designed dredge depth. Sediment from the boreholes was not assessed for sulphide content.

### 8.3.5 Potential Acid Sulphate Soils

The Botany Bay Acid Sulphate Soil Risk Map identifies the dune area in Penrhyn Estuary and behind Foreshore Beach as “disturbed land” (DLWC, 1995). Oxidised, iron-stained dune sands can be observed 100 m east of the derelict jetty structure at the eastern end of Foreshore Beach. Sulphides deposited in dunes during the creation of Penrhyn Estuary and Foreshore Beach are likely to have been fully oxidised and probably pose no further risk of acid generation, if disturbed. In contrast, earthworks involving modification of sand dunes and soils below the existing water table in Penrhyn Estuary may encounter potential acid sulphate soils. At an intertidal saltmarsh location in Penrhyn Estuary, approximately 200 m west of Floodvale Drain, sulphitic, iron cemented sediment can be observed. Potential acid sulphate soils have not been tested in the study area. Environmental risks associated with changes to pH and solubilisation of heavy metals from oxidation of sulphitic sediments may be mitigated by monitoring and other measures proposed in Section 10.1.

## 8.4 Changes in Ecological Risk – Post Development

As with human health, the prime factor to consider in relation to risks to the environment is the increased area of Penrhyn Estuary potentially affected by:

- elevated concentrations of VHCs in surface water; and
- increased area of deposition of fine and potentially contaminated sediments.

In relation to the above, the following points are relevant:

- the input of contaminants to Penrhyn Estuary that have potential to bioaccumulate (i. e. mercury and HCB) is primarily related to historic inputs to Springvale Drain and the redistribution of fine sediments post development would not be expected to significantly increase the accumulation of these contaminants in higher order species. This is largely because the concentration in the surface fine sediments are expected to reduce with time due to deposition of “cleaner” sediments;
- although the concentration of VHCs is likely to increase throughout Penrhyn Estuary as a consequence of the development, the concentrations are likely to be in the same order of magnitude as prior to development, in the absence of additional sources of VHCs. On this basis, the level of effects on organisms is not expected to be altered dramatically by the proposed development. VHCs have limited potential to bioaccumulate, therefore the prime issue of concern is related to adverse effects associated with direct exposure. It is not possible on the basis of the current studies to

determine whether concentrations of VHCs will be sufficiently high to cause adverse effects on either aquatic, or terrestrial species. This is due to the lack of data on the toxicity of VHCs to environmental receptors as well as the complexity of the factors influencing risk to the range of species; and

- the expected discharge of VHCs in deep groundwater plumes is likely to increase VHC concentrations in Penrhyn Estuary. However, it is not possible to accurately predict whether an increase in concentrations, as a result of the groundwater plumes entering the estuary, would adversely effect aquatic and terrestrial species .

Whilst uncertainty exists in the assessment of change in risks to aquatic and terrestrial species, it is expected that the overall post development conditions, with respect to contamination issues within Penrhyn Estuary, are unlikely to be substantially different to those occurring now. The available studies and observations indicate that Penrhyn Estuary provides habitat for both aquatic and terrestrial species. It is not possible to determine with certainty whether the value of this habitat has been degraded by the contamination (surface water and sediment), however the level of degradation would not be expected to be significantly altered by the development.

Risks to aquatic organisms in north-eastern Botany Bay including, Foreshore Beach, are considered to be low.

No other issues have been identified.

## 9.1 Introduction

Risks during construction of the new terminal are predominantly related to environmental issues including the oxidation of potential acid sulphate soils/sediment and sediment dispersion during dredging of estuarine sediment.

Post development risks to human health and ecological systems are related to the concentrations of contaminants, notably volatile halogenated compounds in Penrhyn Estuary.

## 9.2 Risk Mitigation – During Construction

Dredging in Botany Bay for reclamation of the proposed new terminal may encounter estuarine sediment with high sulphide content that, if oxidised, could produce acid runoff and liberate heavy metals. Sediment with a high oxidisable sulphide content is typically fine grained, organic rich and is commonly dark grey to black, or green. Potential acid sulphate dredged material used in the reclamation of the new terminal should be deposited below water level, where oxidising conditions are unlikely.

Changes to the groundwater levels due to the proposed development are expected to be insignificant compared to natural variation (AccessUTS, 2000) and is unlikely to oxidise sulphitic soil/sediment. However, potential acid sulphate soils may be disturbed during modifications to low-lying soils in Penrhyn Estuary. Similar to disturbance of sediment, material involved with dune removal and nourishment should be monitored for high oxidisable sulphide concentrations and potential acid sulphate soils. .

Predicted suspended solids concentrations in the plume created by dredging operations should be verified using the capacity (discharge rate, solids/water ratio etc.) of the proposed dredging apparatus. Mitigation measures such as silt curtains to contain the suspended sediment plume and control of discharge locations to minimise surface runoff would reduce ecological risks associated with dredging. Monitoring of turbidity levels in north-eastern Botany Bay should also be undertaken.

## 9.3 Risk Mitigation – Post Construction

The proposed Port Botany development would result in changes to the hydrodynamics of Penrhyn Estuary and therefore change contaminant concentrations in the estuary (Section 6.2). Mitigation measures that would reduce the human health and ecological risks in Penrhyn Estuary and along Foreshore Beach include:

- restrictions to public access and recreational activities in the upper reaches of Penrhyn Estuary, barriers, signage etc.;
- monitoring the shorebird habitat and aquatic organisms in Penrhyn Estuary; and

- devices to capture sediment from Springvale and Floodvale Drains to reduce influx of contaminants and nutrients to receiving waters.

These recommended mitigation measures are discussed below.

### 9.3.1 Public Access

Public access to the upper reaches of Penrhyn Estuary is currently not restricted. Post development concentrations of dissolved COPC in Penrhyn Estuary are likely to increase in the upper estuary, but decline markedly in the outer sections of the confined Penrhyn Estuary, i.e. along south-eastern Foreshore Beach. Due to the steep gradient in VHC concentrations, a reduction in risks to human health would be achieved by limiting access to the upper reaches of Penrhyn Estuary. Access to upper estuary areas would be restricted to a bird viewing platform to observe wading shorebirds during daylight hours. Odours in Penrhyn Estuary and possibly along south-eastern Foreshore Beach from groundwater discharge may decrease the recreational amenity of these areas.

### 9.3.2 Habitat Monitoring

Intertidal areas in Penrhyn Estuary represent a valuable habitat for some species of migratory shorebird in northern Botany Bay. Assessment of changes to risk related to shorebirds that continue to use Penrhyn Estuary is not definitive due to uncertainty in both the concentrations of contaminants that may eventuate, the concentrations at which shorebirds are likely to suffer adverse effects, and the range of activities undertaken by different bird species. Due to the volatile nature of many of the COPC present in Penrhyn Estuary substantial bioaccumulation of contaminants in the food source of birds is unlikely. However, the long term viability of Penrhyn Estuary as a habitat suitable for shorebirds cannot be established with certainty. Therefore, monitoring of species diversity and abundances of birds is required to determine effects of potentially increasing concentrations of COPC. However, many of the species of birds are migratory and results of such monitoring would be confounded by survival and breeding success in areas remote to Penrhyn Estuary. In addition, the population of birds and utilisation of the habitat may be affected by issues other than contamination, e.g. disruption of flight path, noise, lights etc.

### 9.3.3 Stormwater Treatment

Sediment traps on Floodvale and Springvale Drains would have the effect of reducing the influx of particulate-bound contaminants to Penrhyn Estuary. These measures may improve water quality by decreasing nutrient and contaminant concentrations in Penrhyn Estuary and Botany Bay, however they would not reduce the concentrations of VHCs discharging to the estuary via deep groundwater.

Increased retention time in the upper (non-tidal) sections of Floodvale and Springvale Drains may decrease the flux of halogenated compounds entering Penrhyn Estuary from the shallow groundwater plumes discharged into the drains, due to increased retention times and therefore greater volatilisation.

The conclusions from the review of contamination issues and changes in risk associated with the construction and operation of the proposed Port Botany Expansion are summarised in the following sections:

## 10.1 Chemicals of Potential Concern in North-eastern Botany Bay

The confinement of a larger area of Penrhyn Estuary by the proposed development would have the following key outcomes:

- the area of reduced flushing would be increased and higher contaminant concentrations in surface waters would occur in the upper reaches of Penrhyn Estuary and in areas that are currently subject to flushing;
- fine sediment may accumulate in areas where currently coarse sediments predominate, thereby increasing whole sediment concentrations; and
- no changes in contaminant concentrations are expected outside the confined area of Penrhyn Estuary.

## 10.2 Human Health Risk

Risks to human health may increase due to the increased concentrations of VHCs in the upper reaches of Penrhyn Estuary. However, recreational use of this area is likely to be restricted and risks may be reduced as a consequence.

Risks to human health associated with swimming at eastern Foreshore Beach along the constructed channel outlet may be increased due to the reduced flushing and potential for higher concentrations of VHCs in this area. It is not possible to predict the magnitude of the risk with accuracy due to uncertainties in the estimation of VHC concentrations following the proposed port development and the discharge of the VHC groundwater plumes to Penrhyn Estuary.

No changes in risk due to potential increases in VHC concentrations are expected for the following exposure pathways:

- recreational use of Foreshore Beach west of the constructed channel outlet; and
- consumption of edible fish species caught by recreational anglers.

The risk to human health from sediment-bound contaminants is considered to be low due to limited exposure. The low risk of adverse effects to human health is based on restriction of public access to the upper reaches of Penrhyn Estuary.

## 10.3 Ecological Risk

Changes in risks to aquatic and terrestrial organisms are difficult to predict due to uncertainties in estimating both current and future risks. The enlargement of Penrhyn Estuary would increase the area available for species such as wading shorebirds and estuarine aquatic species to be exposed to contaminants in Penrhyn Estuary such as VHCs. It is apparent that Penrhyn Estuary currently provides a functioning habitat for these species, however it is not possible to determine whether the functioning of the habitat is significantly affected by the existing contaminants. Following the proposed development, the overall contamination conditions are not expected to change markedly from the present conditions and on this basis, the habitat could be expected to continue to function at the current level.

The development is not expected to affect the fate, or ultimate discharge of the deep VHC groundwater plumes associated with Orica petrochemical facility. The discharge of these plumes is expected to result in an increase in the concentration of VHCs in Penrhyn Estuary. However, it is not possible to estimate the likely concentration of VHCs due to uncertainties in the concentration at the point of discharge and the effectiveness of remediation strategies being implemented by Orica.

## 10.4 Specific Issues Related To Risk Assessment

Based on the above findings, the following conclusions have been framed around the questions raised in Section 1.

- *Will changes to the hydrodynamic regime in Penrhyn Estuary associated with the proposed development alter the risks to aquatic and terrestrial organisms?*

The development is not expected to significantly alter the risks. It should be noted, however that the concentration of VHCs may increase with discharge of contaminated groundwater into Penrhyn Estuary, however, the development would alter neither the rate, nor the location of the discharge. The development may, however, increase the area of water affected by elevated concentrations of VHCs.

- *Will changes to the hydrodynamic regime in Penrhyn Estuary with the proposed development alter the risks to human health, either through the consumption of fish caught by recreational anglers, or the recreational use of Penrhyn Estuary (e.g. children swimming and wading)?*

The risks to human health are not expected to be significantly altered by the development. The concentrations of VHCs are expected to increase over time with discharge of contaminated groundwater. The physical layout of the development will limit public access to the area of Penrhyn Estuary most affected by VHCs i.e. the current confined upper section of the estuary. Reduced access to this area would be expected to result in reduced risks to human health. No change in the concentrations of COPC that might bioaccumulate in edible fish species is expected, thus the development is not expected to alter risks associated with the consumption of fish caught by recreational anglers.

- *Will changes to the hydrodynamic regime of north-eastern Botany Bay between the new terminal and the Parallel Runway alter the risks to aquatic organisms?*

None of the available information indicates a change in the risks to aquatic organisms in this area as a consequence of development.

- *Will changes to the hydrodynamic regime in north-eastern Botany Bay between the new terminal and the Parallel Runway alter the risks to human health, either through the consumption of fish caught by recreational anglers, or the recreational use of this area?*

None of the available information indicates a change in the risks to human health in this area as a consequence of development. The quantity of fish caught in Penrhyn Estuary and proposed channel would be reduced due to a restriction of public access.

- *Will disturbance of the marine sediments and subsequent reclamation drainage in the areas to be reclaimed or dredged during the construction of the proposed development alter the risks to aquatic organisms and human health through consumption of fish caught from these areas?*

None of the studies has indicated changes in conditions that would significantly alter the risks to human health or aquatic organisms with respect to contamination issues. The presence of elevated concentrations of COPC having potential to bioaccumulate is restricted to Penrhyn Estuary, which will be subject to minimal disturbance during construction. The habitat enhancement for wading birds would include burial of some areas of contaminated sediment below clean sand currently contained in sand dunes immediately north of the estuary.

- *Will disturbance of sediments/soil in Penrhyn Estuary associated with the construction of the rail line or alter the risks to aquatic organisms and human health through consumption of fish caught and the recreational use of Penrhyn estuary?*

The construction of the rail line should be able to be undertaken with minimal disturbance to sediments in Penrhyn Estuary. The mechanism by which construction works could alter risks to aquatic organisms and human health (through consumption of fish) would be by dispersion of sediments and exposure of sediments containing elevated concentrations of COPC that have the potential to bioaccumulate. The implementation of appropriate environmental controls during construction would minimise this potential.

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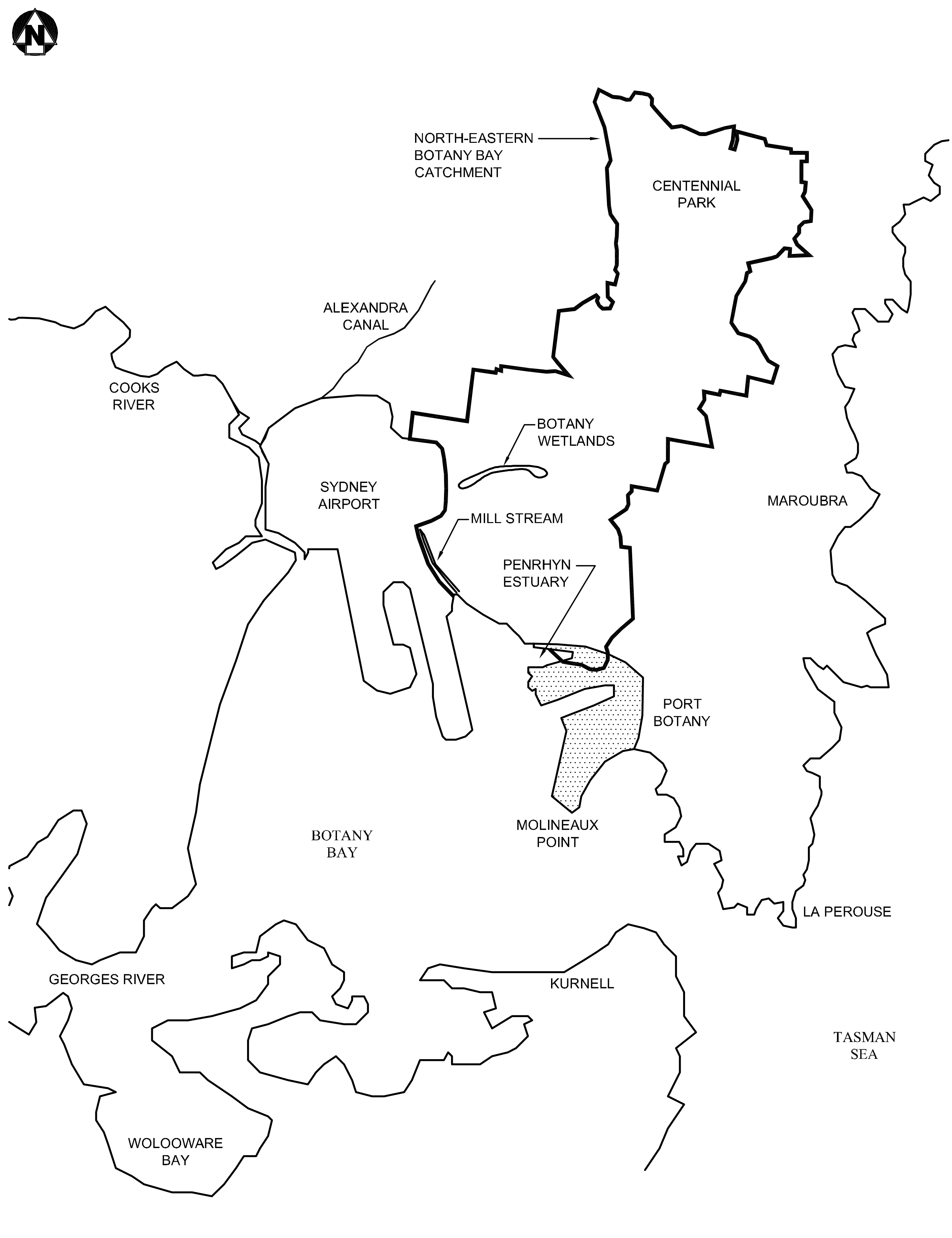


CLIENT
**SYDNEY PORTS CORPORATION**

PROJECT
**PORT BOTANY EXPANSION -**
**REVIEW OF CONTAMINATION ISSUES**

TITLE
**REGIONAL LOCATION MAP**

A4

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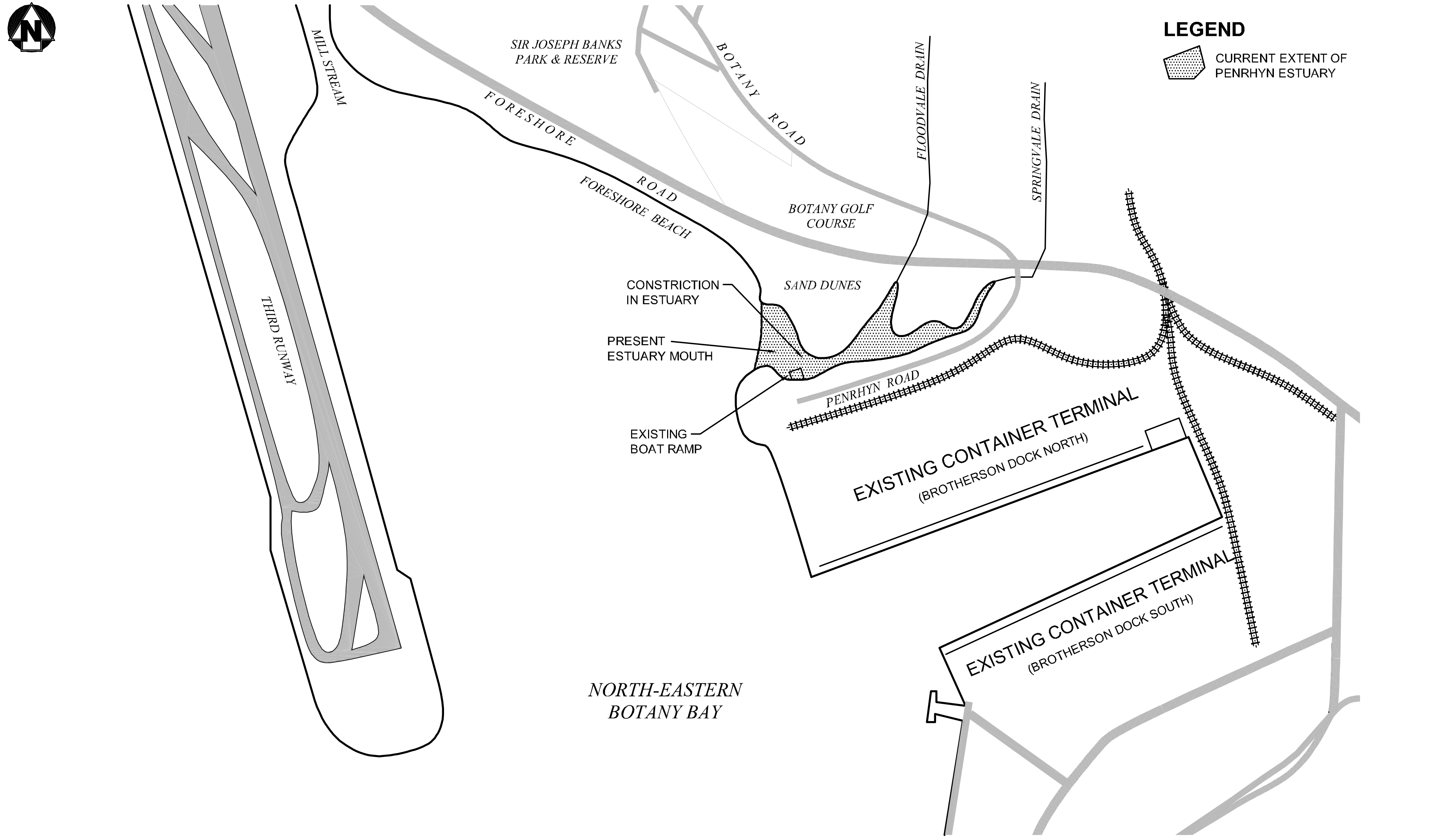


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|---|---|
| PROJECT<br>**PORT BOTANY EXPANSION - REVIEW OF CONTAMINATION ISSUES** | A4 |

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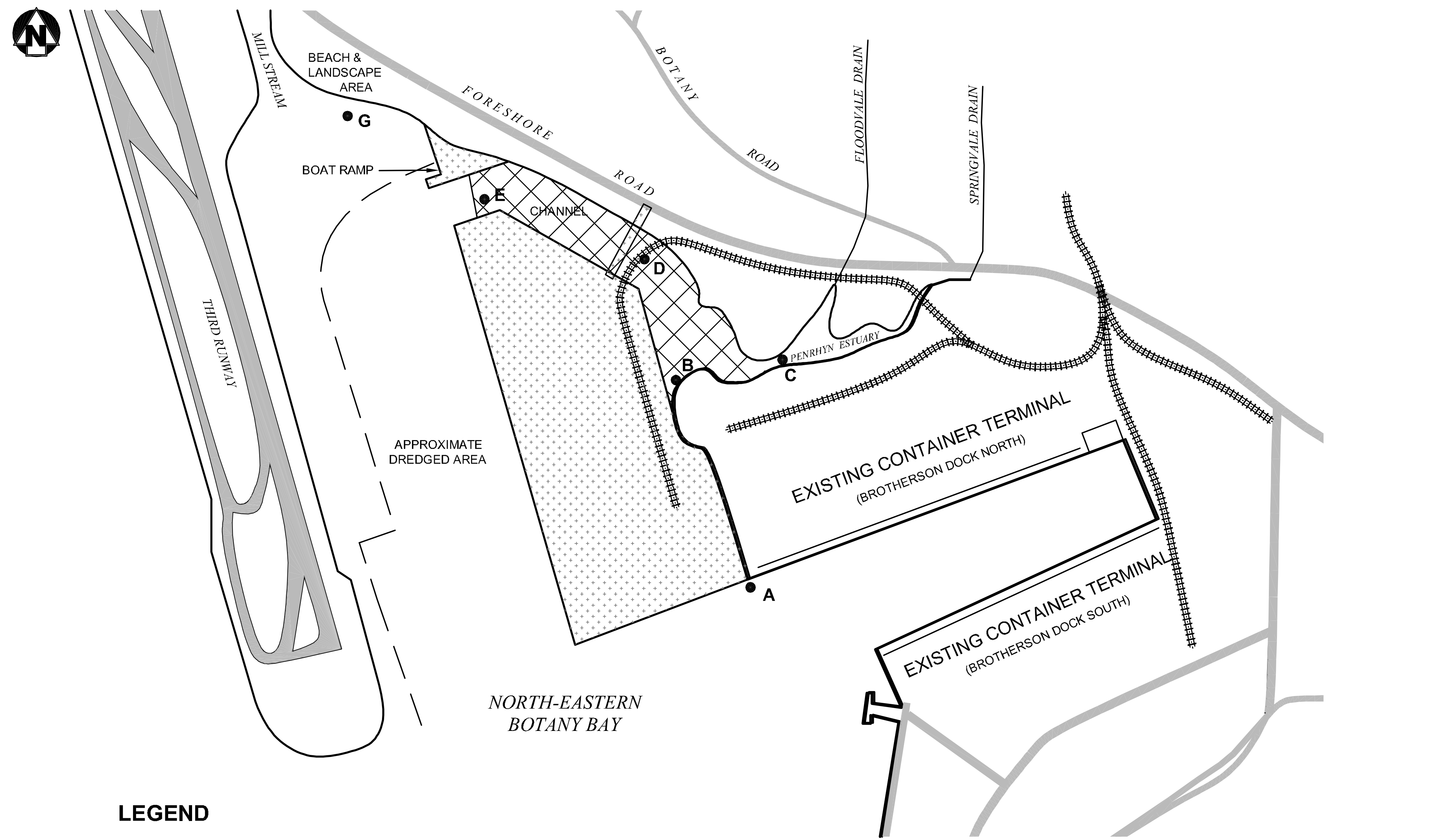


## LEGEND

- B● PRELIMINARY MODEL OUPUT LOCATIONS
- EXISTING PORT FACILITIES
- PROPOSED DEVELOPMENT
- INCREASED CONFINED AREA OF PENRHYN ESTUARY

| | | |
|---|---|---|
| CLIENT<br>**SYDNEY PORTS CORPORATION**<br>PROJECT<br>**PORT BOTANY EXPANSION - REVIEW OF CONTAMINATION ISSUES** | | TITLE<br>**PORT BOTANY EXPANSION PROPOSED LAYOUT**<br>A4 |
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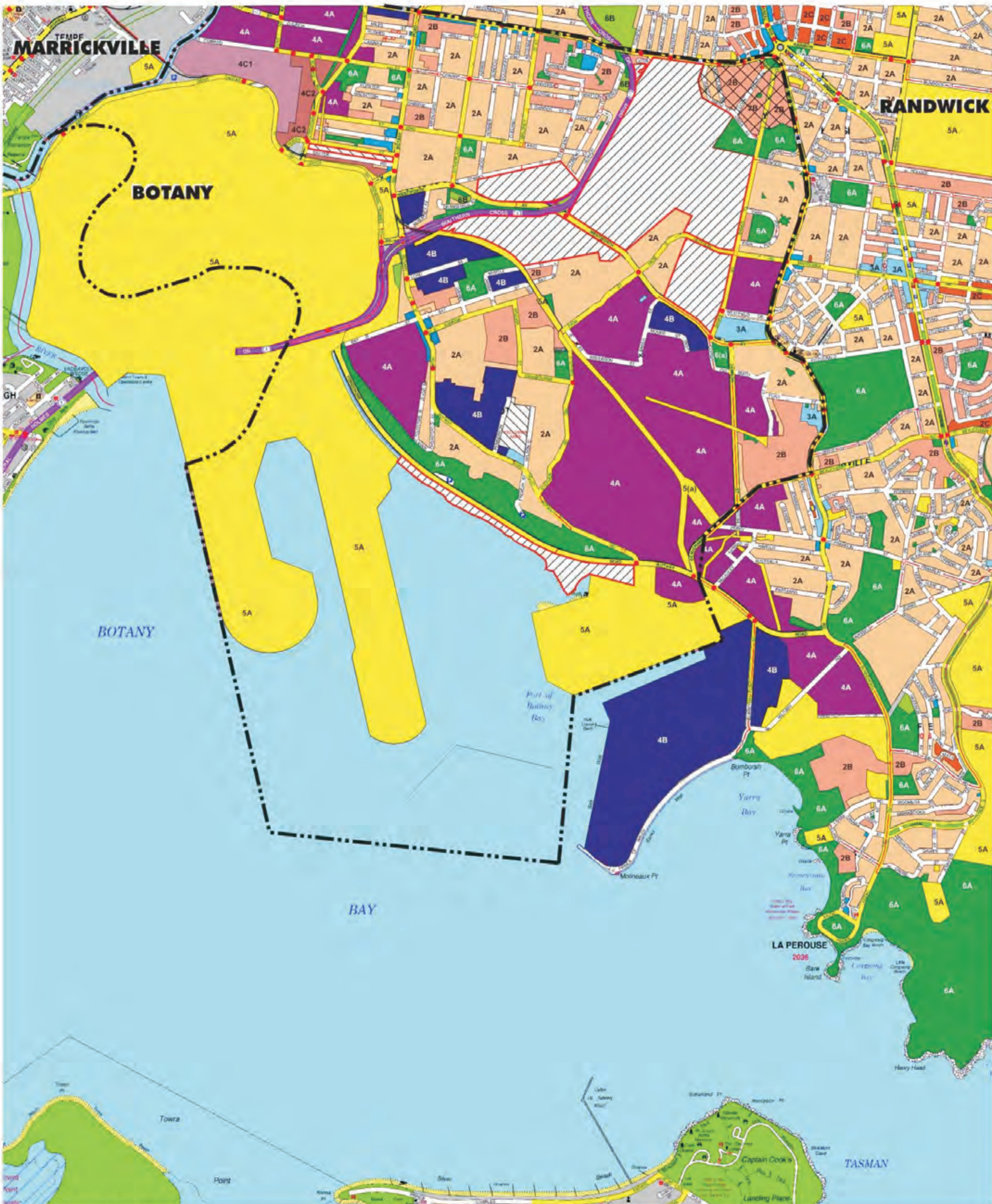


**Botany Council Zoning**

| | |
|---|---|
| 2A | Residential "A" |
| 2B | Residential "B" |
| 3A | General Business |
| 4A | Industrial General "A" |
| 4B | Mixed Industrial "B" |
| 4C1 | Industrial Special Airport Related "C1" |
| 4C2 | Industrial Special Airport Related Restricted "C2" |
| 5A | Special Uses/Road Widening |
| 6A | Recreation Existing "A" |
| 6B | Recreation Private "B" |
| | Excluded Area |
| | Heritage Conservation |
| | Deferred Area |

**Randwick Council Zoning**

| | |
|---|---|
| 2A | Residential A |
| 2B | Residential B |
| 2C | Residential C |
| 3A | General Business |
| 3B | Local Business |
| 4A | Industrial |
| 4B | Port Botany |
| 5A | Special Uses |
| 6A | Open Space |
| 6B | Private Open Space |
| 8 | National Park |
| | Council Boundary |

0 250 500 750 1000
metres

| | |
|---|---|
| DESIGNED | JC |
| DRAWN | HC |
| CAD FILE No | 43027-014-006.Cdr |
| CHECKED | |
| APPROVED | |
| DATE | 28/11/02 |
| STATUS | FINAL |

**SOURCE:** Botany Local Environment Plan 1995, Council File ST/4/33, Dept File R91/01472

**Title**
Land Use

**Project**
Proposed Port Botany Expansion EIS

**Client**
Sydney Ports Corporation

URS SYDNEY PORTS

**FIGURE 4**

# APPENDIX A
# ANZECC/ARMACANZ (2000) GUIDELINE VALUES AND SELECTED TOXICOLOGICAL BENCHMARK VALUES FOR WILDLIFE

**Appendix A**

**Recommended Sediment Quality Guidelines [a]**

| Contaminant | ISQG-Low | ISQG-High |
|---|---|---|
| | (Trigger value) | |
| | | |
| METALS (mg/kg dry wt) | | |
| Antimony | 2 | 25 |
| Cadmium | 1.5 | 10 |
| Chromium | 80 | 370 |
| Copper | 65 | 270 |
| Lead | 50 | 220 |
| Mercury | 0.15 | 1 |
| Nickel | 21 | 52 |
| Silver | 1 | 3.7 |
| Zinc | 200 | 410 |
| METALLOIDS (mg/kg dry wt) | | |
| Arsenic | 20 | 70 |
| ORGANOMETALLICS | | |
| Tributyltin (µg Sn/kg dry wt.) | 5 | 70 |
| ORGANICS (µg/kg dry Wt) b | | |
| Acenaphthene | 16 | 500 |
| Acenaphthalene | 44 | 640 |
| Anthracene | 85 | 1100 |
| Fluorene | 19 | 540 |
| Naphthalene | 160 | 2100 |
| Phenanthrene | 240 | 1500 |
| Low Molecular Weight PAHs c | 552 | 3160 |
| Benzo(a)anthracene | 261 | 1600 |
| Berizo(a)pyrene | 430 | 1600 |
| Dibenzo(a,h)anthracene | 63 | 260 |
| Chrysene | 384 | 2800 |
| Fluoranthene | 600 | 5100 |
| Pyrene | 665 | 2600 |
| High Molecular Weight PAHs c | 1700 | 9600 |
| Total PAHs | 4000 | 45000 |
| Total DDT | 1.6 | 46 |
| p.p'-DDE | 2.2 | 27 |
| o,p'- + p,p'-DDD | 2 | 20 |
| Chlordane | 0.5 | 6 |
| Dieldrin | 0.02 | 8 |
| Endrin | 0.02 | 8 |
| Lindane | 0.32 | 1 |
| Total PCBs | 23 | - |

a. Primarily adapted from Long at al. (1995);

b. Normalised to 1% organic carbon;

c. Low molecular weight PAHs are the sum of concentrations of acenaphthene, acenaphthalene, anthracene, fluorene, 2-methylnaphthalene, naphthalene and phenanthrene; high molecular weight PAHs are the sum of concentrations of benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene and pyrene

**Appendix A**

**Summary of Water Quality Guidelines for Recreational Purposes: General Chemicals**

| Parameter | Guideline values (µg/L, unless otherwise stated) |
|---|---|
| Inorganic: | |
| Arsenic | 50 |
| Asbestos | NR |
| Barium | 1000 |
| Boron | 1000 |
| Cadmium | 5 |
| Chromium | 50 |
| Cyanide | 100 |
| Lead | 50 |
| Mercury | 1 |
| Nickel | 100 |
| Nitrate-N | 10000 |
| Nitrite-N | 1000 |
| Selenium | 10 |
| Silver | 50 |
| | |
| Benzene | 10 |
| Benzo(a)pyrene | 0.01 |
| Carbon tetrachloride | 3 |
| 1,1-Dichloroethene | 0.3 |
| 1,2-Dichloroethane | 10 |
| Pentachlorophenol | 10 |
| Polychlorinated biphenyls | 0.1 |
| Tetrachloroethene | 10 |
| 2,3,4,6-Tetrachlorophenol | 1 |
| Trichloroethene | 30 |
| 2,4,5-Trichlorophenol | 1 |
| 2,4,6-Trichlorophenol | 10 |
| | |
| Gross alpha activity | 0.1 Bq/L |
| Gross beta activity (excluding activity of $^{40}K$) | 0.1 Bq/L |
| | |
| Aluminium | 200 |
| Ammonia (as N) | 10 |
| Chloride | 400000 |
| Copper | 1000 |
| Oxygen | >6.5 (>80% saturation) |
| Hardness (as $CaC0_3$) | 500000 |
| Iron | 300 |
| Manganese | 100 |
| Organics (CCE & CAE) | 200 |
| pH | 6.5-8.5 |
| Phenolics | 2 |
| Sodium | 300000 |
| Sulfate | 400000 |
| Sulfide | 50 |
| Surfactant (MBAS) | 200 |
| Total dissolved solids | 1000000 |
| Zinc | 5000 |

NR = No guideline recommended

**Appendix A**
**Summary of Water Quality Guidelines for Recreational Purposes: Pesticides**

| Compound | Maximum concentration (μg/L) | Compound | Maximum concentration (μg/L) |
|---|---|---|---|
| Acephate | 20 | Fenvalerate | 40 |
| Alachlor | 3 | Flamprop-rnethyl | 6 |
| Aldrin | 1 | Fluometuron | 100 |
| Amitrol | 1 | Formothion | 100 |
| Asulam | 100 | Fosamine (ammonium salt) | 3000 |
| Azinphos-methyl | 10 | Glyphosate | 200 |
| Barban | 300 | Heptachlor | 3 |
| Benomyl | 200 | Hexaflurate | 60 |
| Bentazone | 400 | Hexazinone | 600 |
| Bioresmethrin | 60 | Lindane | 10 |
| Bromazil | 600 | Maldison | 100 |
| Bromophos-ethyl | 20 | Methidathion | 60 |
| Bromoxynil | 30 | Methomyl | 60 |
| Carbaryl | 60 | Metolachlor | 800 |
| Carbendazim | 200 | Metribuzin | 5 |
| Carbofuran | 30 | Mevinphos | 6 |
| Carbophenothion | 1 | Molinate | 1 |
| Chlordane | 6 | Monocrotophos | 2 |
| Chlordimeform | 20 | Nabam | 30 |
| Chlorfenvinphos | 10 | Nitralin | 1000 |
| Chloroxuron | 30 | Omethoate | 0.4 |
| Chlorpyrifos | 2 | Oryzalin | 60 |
| Clopzralid | 1000 | Paraquat | 40 |
| Cyhexatin | 200 | Parathion | 30 |
| 2,4-D | 100 | Parathion-methyl | 6 |
| DDT | 3 | Pendimethalin | 600 |
| Demeton | 30 | Perfluidone | 20 |
| Diazinon | 10 | Permethrin | 300 |
| Dicamba | 300 | Picloram | 30 |
| Dichlobenil | 20 | Piperonyl butoxide | 200 |
| 3,6-Dichloropicolinic acid | 1000 | Pirimicarb | 100 |
| Dichlorvos | 20 | Pirimiphos-ethyl | 1 |
| Diclofop-rnethyl | 3 | Pirimiphos-methyl | 60 |
| Dicofol | 100 | Profenofos | 0.6 |
| Dieldrin | 1 | Promecarb | 60 |
| Difenzoquat | 200 | Propanil | 1000 |
| Dimethoate | 100 | Propargite | 1000 |
| Diquat | 10 | Propoxur | 1000 |
| Disulfoton | 6 | Pyrazophos | 1000 |
| Diuron | 40 | Quintozene | 6 |
| DPA | 500 | Sulprofos | 20 |
| Endosulfan | 40 | 2,4,5-T | 2 |
| Endothal | 600 | Temephos | 30 |
| Endrin | 1 | Thiobencarb | 40 |
| EPTC | 60 | Thiometon | 20 |
| Ethion | 6 | Thiophanate | 100 |
| Ethoprophos | 1 | Thiram | 30 |
| Fenchlorphos | 60 | Trichlorofon | 10 |
| Fenitrothion | 20 | Triclopyr | 20 |
| Fenoprop | 20 | Trifluralin | 500 |
| Fensulfothion | 20 | | |

Sources: NHMRC&AWRC(1987),NHMRC(1989)

ES/ER/TM-86/R3

# Toxicological Benchmarks for Wildlife: 1996 Revision


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Date Issued—June 1996

Prepared by the
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Prepared for the
U.S. Department of Energy
Office of Environmental Management
under budget and reporting code EW 20

LOCKHEED MARTIN ENERGY SYSTEMS, INC.
managing the
Environmental Management Activities at the
Oak Ridge K-25 Site Paducah Gaseous Diffusion Plant
Oak Ridge Y-12 Plant Portsmouth Gaseous Diffusion Plant
Oak Ridge National Laboratory
under contract DE-AC05-84OR21400
for the
U.S. DEPARTMENT OF ENERGY

The following pages are taken from Table 12 of the Toxicological Benchmark for Wildlife.

The Table should be read in conjunction with the main report which provides explanation as to the derivation and use of the various benchmarks.

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cadmium | cadmium chloride | mallard duck | 1.45 | 20 | Great Blue Heron | 1.45 | 8.25 | 32.76 | 0.001 | 20.00 | 113.81 | 451.80 | 0.009 |
| Cadmium | cadmium chloride | mallard duck | 1.45 | 20 | Wild Turkey | 1.45 | 48.33 | 44.26 | | 20.00 | 666.67 | 610.53 | |
| Carbon Tetrachloride | n/a | rat | 16 | | Little Brown Bat | 41.8 | 125.5 | 261.4 | | | | | |
| Carbon Tetrachloride | n/a | rat | 16 | | Short-tailed Shrew | 35.2 | 58.6 | 159.8 | | | | | |
| Carbon Tetrachloride | n/a | rat | 16 | | White-footed Mouse | 32.0 | 206.8 | 106.5 | | | | | |
| Carbon Tetrachloride | n/a | rat | 16 | | Meadow Vole | 26.9 | 236.5 | 197.0 | | | | | |
| Carbon Tetrachloride | n/a | rat | 16 | | Mink | 12.3 | 89.8 | 124.3 | 1.259 | | | | |
| Carbon Tetrachloride | n/a | rat | 16 | | Cottontail Rabbit | 11.8 | 59.5 | 121.6 | | | | | |
| Carbon Tetrachloride | n/a | rat | 16 | | Red Fox | 8.4 | 84.5 | 100.1 | | | | | |
| Carbon Tetrachloride | n/a | rat | 16 | | River Otter | 7.3 | 65.0 | 91.5 | 0.913 | | | | |
| Carbon Tetrachloride | n/a | rat | 16 | | Whitetail Deer | 4.5 | 145.8 | 68.5 | | | | | |
| Chlordane | n/a | mouse | 4.6 | 9.2 | Little Brown Bat | 6.5 | 19.5 | 40.7 | | 13.0 | 39.0 | 81.3 | |
| Chlordane | n/a | mouse | 4.6 | 9.2 | Short-tailed Shrew | 5.5 | 9.1 | 24.9 | | 10.9 | 18.2 | 49.7 | |
| Chlordane | n/a | mouse | 4.6 | 9.2 | White-footed Mouse | 5.0 | 32.2 | 16.6 | | 9.9 | 64.3 | 33.1 | |
| Chlordane | n/a | mouse | 4.6 | 9.2 | Meadow Vole | 4.2 | 36.8 | 30.7 | | 8.4 | 73.6 | 61.3 | |
| Chlordane | n/a | mouse | 4.6 | 9.2 | Mink | 1.9 | 14.0 | 19.3 | 2.942e-05 | 3.8 | 27.9 | 38.7 | 5.884e-05 |
| Chlordane | n/a | mouse | 4.6 | 9.2 | Cottontail Rabbit | 1.8 | 9.3 | 18.9 | | 3.7 | 18.5 | 37.8 | |
| Chlordane | n/a | mouse | 4.6 | 9.2 | Red Fox | 1.3 | 13.1 | 15.6 | | 2.6 | 26.3 | 31.1 | |
| Chlordane | n/a | mouse | 4.6 | 9.2 | River Otter | 1.1 | 10.1 | 14.2 | 1.866e-05 | 2.3 | 20.2 | 28.5 | 3.732e-05 |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks: Food[d] (mg/kg) | NOAEL-Based Benchmarks: Water[e] (mg/L) | NOAEL-Based Benchmarks: Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks: Food[d] (mg/kg) | LOAEL-Based Benchmarks: Water[e] (mg/L) | LOAEL-Based Benchmarks: Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chlordecone (kepone) | n/a | rat | 0.08 | 0.4 | Mink | 0.062 | 0.449 | 0.622 | 1.489e-05 | 0.308 | 2.246 | 3.108 | 7.445e-05 |
| Chlordecone (kepone) | n/a | rat | 0.08 | 0.4 | Cottontail Rabbit | 0.059 | 0.298 | 0.608 | | 0.294 | 1.488 | 3.041 | |
| Chlordecone (kepone) | n/a | rat | 0.08 | 0.4 | Red Fox | 0.042 | 0.422 | 0.500 | | 0.211 | 2.112 | 2.502 | |
| Chlordecone (kepone) | n/a | rat | 0.08 | 0.4 | River Otter | 0.037 | 0.325 | 0.457 | 1.081e-05 | 0.183 | 1.626 | 2.287 | 5.404e-05 |
| Chlordecone (kepone) | n/a | rat | 0.08 | 0.4 | Whitetail Deer | 0.022 | 0.729 | 0.343 | | 0.112 | 3.644 | 1.714 | |
| Chloroform | n/a | rat | 15 | 41 | Little Brown Bat | 39.2 | 118 | 245 | | 107 | 321 | 670 | |
| Chloroform | n/a | rat | 15 | 41 | Short-tailed Shrew | 33.0 | 55 | 150 | | 90 | 150 | 410 | |
| Chloroform | n/a | rat | 15 | 41 | White-footed Mouse | 30.0 | 194 | 100 | | 82 | 530 | 273 | |
| Chloroform | n/a | rat | 15 | 41 | Meadow Vole | 25.2 | 222 | 185 | | 69 | 606 | 505 | |
| Chloroform | n/a | rat | 15 | 41 | Mink | 11.5 | 84 | 117 | 4.741 | 32 | 230 | 319 | 12.959 |
| Chloroform | n/a | rat | 15 | 41 | Cottontail Rabbit | 11.0 | 56 | 114 | | 30 | 153 | 312 | |
| Chloroform | n/a | rat | 15 | 41 | Red Fox | 7.9 | 79 | 94 | | 22 | 217 | 256 | |
| Chloroform | n/a | rat | 15 | 41 | River Otter | 6.9 | 61 | 86 | 3.439 | 19 | 167 | 234 | 9.399 |
| Chloroform | n/a | rat | 15 | 41 | Whitetail Deer | 4.2 | 137 | 64 | | 12 | 373 | 176 | |
| Chromium | $Cr^{+3}$ as $Cr_2O_3$ | rat | 2737 | | Little Brown Bat | 7154 | 21461 | 44710 | | | | | |
| Chromium | $Cr^{+3}$ as $Cr_2O_3$ | rat | 2737 | | Short-tailed Shrew | 6015 | 10026 | 27343 | | | | | |
| Chromium | $Cr^{+3}$ as $Cr_2O_3$ | rat | 2737 | | White-footed Mouse | 5466 | 35370 | 18221 | | | | | |
| Chromium | $Cr^{+3}$ as $Cr_2O_3$ | rat | 2737 | | Meadow Vole | 4597 | 40449 | 33708 | | | | | |
| Chromium | $Cr^{+3}$ as $Cr_2O_3$ | rat | 2737 | | Mink | 2105 | 15366 | 21265 | | | | | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chromium | $Cr^{+3}$ as $Cr_2O_3$ | rat | 2737 | | Cottontail Rabbit | 2011 | 10184 | 20807 | | | | | |
| Chromium | $Cr^{+3}$ as $Cr_2O_3$ | rat | 2737 | | Red Fox | 1445 | 14454 | 17117 | | | | | |
| Chromium | $Cr^{+3}$ as $Cr_2O_3$ | rat | 2737 | | River Otter | 1252 | 11127 | 15647 | | | | | |
| Chromium | $Cr^{+3}$ as $Cr_2O_3$ | rat | 2737 | | Whitetail Deer | 768 | 24933 | 11725 | | | | | |
| Chromium | $Cr^{+3}$ as $CrK(SO_4)_2$ | black duck | 1 | 5 | Rough-winged Swallow | 1.00 | 1.33 | 4.30 | | 5.00 | 6.63 | 21.49 | |
| Chromium | $Cr^{+3}$ as $CrK(SO_4)_2$ | black duck | 1 | 5 | American Robin | 1.00 | 0.83 | 7.26 | | 5.00 | 4.14 | 36.32 | |
| Chromium | $Cr^{+3}$ as $CrK(SO_4)_2$ | black duck | 1 | 5 | Belted Kingfisher | 1.00 | 1.97 | 9.25 | | 5.00 | 9.87 | 46.25 | |
| Chromium | $Cr^{+3}$ as $CrK(SO_4)_2$ | black duck | 1 | 5 | American Woodcock | 1.00 | 1.32 | 9.90 | | 5.00 | 6.60 | 49.50 | |
| Chromium | $Cr^{+3}$ as $CrK(SO_4)_2$ | black duck | 1 | 5 | Cooper's Hawk | 1.00 | 5.78 | 12.91 | | 5.00 | 28.88 | 64.56 | |
| Chromium | $Cr^{+3}$ as $CrK(SO_4)_2$ | black duck | 1 | 5 | Barn Owl | 1.00 | 3.73 | 13.31 | | 5.00 | 18.64 | 66.57 | |
| Chromium | $Cr^{+3}$ as $CrK(SO_4)_2$ | black duck | 1 | 5 | Barred Owl | 1.00 | 8.54 | 15.26 | | 5.00 | 42.68 | 76.28 | |
| Chromium | $Cr^{+3}$ as $CrK(SO_4)_2$ | black duck | 1 | 5 | Red-tailed Hawk | 1.00 | 10.33 | 17.59 | | 5.00 | 51.65 | 87.97 | |
| Chromium | $Cr^{+3}$ as $CrK(SO_4)_2$ | black duck | 1 | 5 | Osprey | 1.00 | 5.00 | 19.48 | | 5.00 | 25.00 | 97.40 | |
| Chromium | $Cr^{+3}$ as $CrK(SO_4)_2$ | black duck | 1 | 5 | Great Blue Heron | 1.00 | 5.69 | 22.59 | | 5.00 | 28.45 | 112.95 | |
| Chromium | $Cr^{+3}$ as $CrK(SO_4)_2$ | black duck | 1 | 5 | Wild Turkey | 1.00 | 33.33 | 30.53 | | 5.00 | 166.67 | 152.63 | |
| Chromium | $Cr^{+6}$ | rat | 3.28 | 13.14 | Little Brown Bat | 8.57 | 25.72 | 53.58 | | 34.34 | 103.03 | 214.65 | |
| Chromium | $Cr^{+6}$ | rat | 3.28 | 13.14 | Short-tailed Shrew | 7.21 | 12.01 | 32.77 | | 28.88 | 48.13 | 131.27 | |
| Chromium | $Cr^{+6}$ | rat | 3.28 | 13.14 | White-footed Mouse | 6.55 | 42.39 | 21.84 | | 26.24 | 169.80 | 87.48 | |
| Chromium | $Cr^{+6}$ | rat | 3.28 | 13.14 | Meadow Vole | 5.51 | 48.47 | 40.40 | | 22.07 | 194.19 | 161.83 | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chromium | $Cr^{+6}$ | rat | 3.28 | 13.14 | Mink | 2.52 | 18.41 | 25.48 | 4.947 | 10.11 | 73.77 | 102.09 | 19.817 |
| Chromium | $Cr^{+6}$ | rat | 3.28 | 13.14 | Cottontail Rabbit | 2.41 | 12.20 | 24.94 | | 9.66 | 48.89 | 99.89 | |
| Chromium | $Cr^{+6}$ | rat | 3.28 | 13.14 | Red Fox | 1.73 | 17.32 | 20.51 | | 6.94 | 69.39 | 82.17 | |
| Chromium | $Cr^{+6}$ | rat | 3.28 | 13.14 | River Otter | 1.50 | 13.33 | 18.75 | 3.593 | 6.01 | 53.42 | 75.12 | 14.394 |
| Chromium | $Cr^{+6}$ | rat | 3.28 | 13.14 | Whitetail Deer | 0.92 | 29.88 | 14.05 | | 3.69 | 119.70 | 56.29 | |
| Copper | copper sulfate | mink | 11.7 | 15.4 | Little Brown Bat | 39.8 | 119.3 | 248.5 | | 52.3 | 157.0 | 327.1 | |
| Copper | copper sulfate | mink | 11.7 | 15.4 | Short-tailed Shrew | 33.4 | 55.7 | 152.0 | | 44.0 | 73.3 | 200.0 | |
| Copper | copper sulfate | mink | 11.7 | 15.4 | White-footed Mouse | 30.4 | 196.6 | 101.3 | | 40.0 | 258.7 | 133.3 | |
| Copper | copper sulfate | mink | 11.7 | 15.4 | Meadow Vole | 25.5 | 224.8 | 187.3 | | 33.6 | 295.9 | 246.6 | |
| Copper | copper sulfate | mink | 11.7 | 15.4 | Mink | 11.7 | 85.4 | 118.2 | 0.294 | 15.4 | 112.4 | 155.6 | 0.387 |
| Copper | copper sulfate | mink | 11.7 | 15.4 | Cottontail Rabbit | 11.2 | 56.6 | 115.6 | | 14.7 | 74.5 | 152.2 | |
| Copper | copper sulfate | mink | 11.7 | 15.4 | Red Fox | 8.0 | 80.3 | 95.1 | | 10.6 | 105.7 | 125.2 | |
| Copper | copper sulfate | mink | 11.7 | 15.4 | River Otter | 7.0 | 61.8 | 87.0 | 0.213 | 9.2 | 81.4 | 114.5 | 0.280 |
| Copper | copper sulfate | mink | 11.7 | 15.4 | Whitetail Deer | 4.3 | 138.6 | 65.2 | | 5.6 | 182.4 | 85.8 | |
| Copper | copper oxide | 1 day old chicks | 47 | 61.7 | Rough-winged Swallow | 47.0 | 62.3 | 202.0 | | 61.7 | 81.8 | 265.1 | |
| Copper | copper oxide | 1 day old chicks | 47 | 61.7 | American Robin | 47.0 | 38.9 | 341.4 | | 61.7 | 51.1 | 448.2 | |
| Copper | copper oxide | 1 day old chicks | 47 | 61.7 | Belted Kingfisher | 47.0 | 92.7 | 434.8 | 0.320 | 61.7 | 121.8 | 570.7 | 0.420 |
| Copper | copper oxide | 1 day old chicks | 47 | 61.7 | American Woodcock | 47.0 | 62.0 | 465.3 | | 61.7 | 81.4 | 610.8 | |
| Copper | copper oxide | 1 day old chicks | 47 | 61.7 | Cooper's Hawk | 47.0 | 271.5 | 606.9 | | 61.7 | 356.4 | 796.7 | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | NOAEL-Based Benchmarks Water[e] (mg/L) | NOAEL-Based Benchmarks Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | LOAEL-Based Benchmarks Water[e] (mg/L) | LOAEL-Based Benchmarks Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DDT and metabolites | n/a | brown pelican | 0.0028 | 0.028 | American Woodcock | 0.003 | 0.004 | 0.028 | | 0.028 | 0.037 | 0.277 | |
| DDT and metabolites | n/a | brown pelican | 0.0028 | 0.028 | Cooper's Hawk | 0.003 | 0.016 | 0.036 | | 0.028 | 0.162 | 0.362 | |
| DDT and metabolites | n/a | brown pelican | 0.0028 | 0.028 | Barn Owl | 0.003 | 0.010 | 0.037 | | 0.028 | 0.104 | 0.373 | |
| DDT and metabolites | n/a | brown pelican | 0.0028 | 0.028 | Barred Owl | 0.003 | 0.024 | 0.043 | | 0.028 | 0.239 | 0.427 | |
| DDT and metabolites | n/a | brown pelican | 0.0028 | 0.028 | Red-tailed Hawk | 0.003 | 0.029 | 0.049 | | 0.028 | 0.289 | 0.493 | |
| DDT and metabolites | n/a | brown pelican | 0.0028 | 0.028 | Osprey | 0.003 | 0.014 | 0.055 | 1.048e-08 | 0.028 | 0.140 | 0.545 | 1.048e-07 |
| DDT and metabolites | n/a | brown pelican | 0.0028 | 0.028 | Great Blue Heron | 0.003 | 0.016 | 0.063 | 1.193e-08 | 0.028 | 0.159 | 0.633 | 1.193e-07 |
| DDT and metabolites | n/a | brown pelican | 0.0028 | 0.028 | Wild Turkey | 0.003 | 0.093 | 0.085 | | 0.028 | 0.933 | 0.855 | |
| 1,2-Dichloroethane | n/a | mouse | 50 | | Little Brown Bat | 73.5 | 220.5 | 459.3 | | | | | |
| 1,2-Dichloroethane | n/a | mouse | 50 | | Short-tailed Shrew | 61.8 | 103.0 | 280.9 | | | | | |
| 1,2-Dichloroethane | n/a | mouse | 50 | | White-footed Mouse | 56.2 | 363.3 | 187.2 | | | | | |
| 1,2-Dichloroethane | n/a | mouse | 50 | | Meadow Vole | 47.2 | 415.5 | 346.3 | | | | | |
| 1,2-Dichloroethane | n/a | mouse | 50 | | Mink | 21.6 | 157.9 | 218.4 | 18.720 | | | | |
| 1,2-Dichloroethane | n/a | mouse | 50 | | Cottontail Rabbit | 20.7 | 104.6 | 213.8 | | | | | |
| 1,2-Dichloroethane | n/a | mouse | 50 | | Red Fox | 14.8 | 148.5 | 175.8 | | | | | |
| 1,2-Dichloroethane | n/a | mouse | 50 | | River Otter | 12.9 | 114.3 | 160.7 | 13.574 | | | | |
| 1,2-Dichloroethane | n/a | mouse | 50 | | Whitetail Deer | 7.9 | 256.1 | 120.5 | | | | | |
| 1,2-Dichloroethane | n/a | chicken | 17.2 | 34.4 | Rough-winged Swallow | 17.2 | 22.8 | 73.9 | | 34.4 | 45.6 | 147.8 | |
| 1,2-Dichloroethane | n/a | chicken | 17.2 | 34.4 | American Robin | 17.2 | 14.2 | 124.9 | | 34.4 | 28.5 | 249.9 | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks: Food[d] (mg/kg) | NOAEL-Based Benchmarks: Water[e] (mg/L) | NOAEL-Based Benchmarks: Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks: Food[d] (mg/kg) | LOAEL-Based Benchmarks: Water[e] (mg/L) | LOAEL-Based Benchmarks: Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,2-Dichloroethane | n/a | chicken | 17.2 | 34.4 | Belted Kingfisher | 17.2 | 33.9 | 159.1 | 4.284 | 34.4 | 67.9 | 318.2 | 8.567 |
| 1,2-Dichloroethane | n/a | chicken | 17.2 | 34.4 | American Woodcock | 17.2 | 22.7 | 170.3 | | 34.4 | 45.4 | 340.6 | |
| 1,2-Dichloroethane | n/a | chicken | 17.2 | 34.4 | Cooper's Hawk | 17.2 | 99.4 | 222.1 | | 34.4 | 198.7 | 444.2 | |
| 1,2-Dichloroethane | n/a | chicken | 17.2 | 34.4 | Barn Owl | 17.2 | 64.1 | 229.0 | | 34.4 | 128.2 | 458.0 | |
| 1,2-Dichloroethane | n/a | chicken | 17.2 | 34.4 | Barred Owl | 17.2 | 146.8 | 262.4 | | 34.4 | 293.6 | 524.8 | |
| 1,2-Dichloroethane | n/a | chicken | 17.2 | 34.4 | Red-tailed Hawk | 17.2 | 177.7 | 302.6 | | 34.4 | 355.4 | 605.2 | |
| 1,2-Dichloroethane | n/a | chicken | 17.2 | 34.4 | Osprey | 17.2 | 86.0 | 335.1 | 10.795 | 34.4 | 172.0 | 670.1 | 21.590 |
| 1,2-Dichloroethane | n/a | chicken | 17.2 | 34.4 | Great Blue Heron | 17.2 | 97.9 | 388.5 | 12.293 | 34.4 | 195.8 | 777.1 | 24.586 |
| 1,2-Dichloroethane | n/a | chicken | 17.2 | 34.4 | Wild Turkey | 17.2 | 573.3 | 525.1 | | 34.4 | 1146.7 | 1050.1 | |
| 1,1-Dichloroethylene | n/a | rat | 30 | | Little Brown Bat | 78.4 | 235.2 | 490.1 | | | | | |
| 1,1-Dichloroethylene | n/a | rat | 30 | | Short-tailed Shrew | 65.9 | 109.9 | 299.7 | | | | | |
| 1,1-Dichloroethylene | n/a | rat | 30 | | White-footed Mouse | 59.9 | 387.7 | 199.7 | | | | | |
| 1,1-Dichloroethylene | n/a | rat | 30 | | Meadow Vole | 50.4 | 443.4 | 369.5 | | | | | |
| 1,1-Dichloroethylene | n/a | beagle dog | 2.5 | | Mink | 4.4 | 32.5 | 44.9 | 1.281 | | | | |
| 1,1-Dichloroethylene | n/a | rat | 30 | | Cottontail Rabbit | 22.0 | 111.6 | 228.1 | | | | | |
| 1,1-Dichloroethylene | n/a | beagle dog | 2.5 | | Red Fox | 3.1 | 30.5 | 36.1 | | | | | |
| 1,1-Dichloroethylene | n/a | beagle dog | 2.5 | | River Otter | 2.6 | 23.5 | 33.0 | 0.929 | | | | |
| 1,1-Dichloroethylene | n/a | rat | 30 | | Whitetail Deer | 8.4 | 273.3 | 128.5 | | | | | |
| 1,2-Dichloroethylene | n/a | mouse | 45.2 | | Little Brown Bat | 63.9 | 191.8 | 399.5 | | | | | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | NOAEL-Based Benchmarks Water[e] (mg/L) | NOAEL-Based Benchmarks Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | LOAEL-Based Benchmarks Water[e] (mg/L) | LOAEL-Based Benchmarks Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,2-Dichloroethylene | n/a | mouse | 45.2 | | Short-tailed Shrew | 53.8 | 89.6 | 244.3 | | | | | |
| 1,2-Dichloroethylene | n/a | mouse | 45.2 | | White-footed Mouse | 48.8 | 316.1 | 162.8 | | | | | |
| 1,2-Dichloroethylene | n/a | mouse | 45.2 | | Meadow Vole | 41.1 | 361.4 | 301.2 | | | | | |
| 1,2-Dichloroethylene | n/a | mouse | 45.2 | | Mink | 18.8 | 137.3 | 190.0 | 8.543 | | | | |
| 1,2-Dichloroethylene | n/a | mouse | 45.2 | | Cottontail Rabbit | 18.0 | 91.0 | 185.9 | | | | | |
| 1,2-Dichloroethylene | n/a | mouse | 45.2 | | Red Fox | 12.9 | 129.2 | 152.9 | | | | | |
| 1,2-Dichloroethylene | n/a | mouse | 45.2 | | River Otter | 11.2 | 99.4 | 139.8 | 6.197 | | | | |
| 1,2-Dichloroethylene | n/a | mouse | 45.2 | | Whitetail Deer | 6.9 | 222.8 | 104.8 | | | | | |
| Dieldrin | n/a | rat | 0.02 | 0.2 | Little Brown Bat | 0.052 | 0.157 | 0.327 | | 0.523 | 1.568 | 3.267 | |
| Dieldrin | n/a | rat | 0.02 | 0.2 | Short-tailed Shrew | 0.044 | 0.073 | 0.200 | | 0.440 | 0.733 | 1.998 | |
| Dieldrin | n/a | rat | 0.02 | 0.2 | White-footed Mouse | 0.040 | 0.258 | 0.133 | | 0.399 | 2.585 | 1.331 | |
| Dieldrin | n/a | rat | 0.02 | 0.2 | Meadow Vole | 0.034 | 0.296 | 0.246 | | 0.336 | 2.956 | 2.463 | |
| Dieldrin | n/a | rat | 0.02 | 0.2 | Mink | 0.015 | 0.112 | 0.155 | 1.987e-06 | 0.154 | 1.123 | 1.554 | 1.987e-05 |
| Dieldrin | n/a | rat | 0.02 | 0.2 | Cottontail Rabbit | 0.015 | 0.074 | 0.152 | | 0.147 | 0.744 | 1.520 | |
| Dieldrin | n/a | rat | 0.02 | 0.2 | Red Fox | 0.011 | 0.106 | 0.125 | | 0.106 | 1.056 | 1.251 | |
| Dieldrin | n/a | rat | 0.02 | 0.2 | River Otter | 0.009 | 0.081 | 0.114 | 1.362e-06 | 0.091 | 0.813 | 1.143 | 1.362e-05 |
| Dieldrin | n/a | rat | 0.02 | 0.2 | Whitetail Deer | 0.006 | 0.182 | 0.086 | | 0.056 | 1.822 | 0.857 | |
| Dieldrin | n/a | barn owl | 0.077 | | Rough-winged Swallow | 0.077 | 0.102 | 0.331 | | | | | |
| Dieldrin | n/a | barn owl | 0.077 | | American Robin | 0.077 | 0.064 | 0.559 | | | | | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | NOAEL-Based Benchmarks Water[e] (mg/L) | NOAEL-Based Benchmarks Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | LOAEL-Based Benchmarks Water[e] (mg/L) | LOAEL-Based Benchmarks Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manganese | $Mn_3O_4$ | rat | 88 | 284 | White-footed Mouse | 176 | 1137 | 586 | | 567 | 3670 | 1891 | |
| Manganese | $Mn_3O_4$ | rat | 88 | 284 | Meadow Vole | 148 | 1301 | 1084 | | 477 | 4197 | 3498 | |
| Manganese | $Mn_3O_4$ | rat | 88 | 284 | Mink | 68 | 494 | 684 | | 218 | 1594 | 2206 | |
| Manganese | $Mn_3O_4$ | rat | 88 | 284 | Cottontail Rabbit | 65 | 327 | 669 | | 209 | 1057 | 2159 | |
| Manganese | $Mn_3O_4$ | rat | 88 | 284 | Red Fox | 46 | 465 | 550 | | 150 | 1500 | 1776 | |
| Manganese | $Mn_3O_4$ | rat | 88 | 284 | River Otter | 40 | 358 | 503 | | 130 | 1155 | 1624 | |
| Manganese | $Mn_3O_4$ | rat | 88 | 284 | Whitetail Deer | 25 | 802 | 377 | | 80 | 2587 | 1217 | |
| Manganese | $Mn_3O_4$ | Japanese quail | 997 | | Rough-winged Swallow | 997 | 1321 | 4284 | | | | | |
| Manganese | $Mn_3O_4$ | Japanese quail | 997 | | American Robin | 997 | 825 | 7242 | | | | | |
| Manganese | $Mn_3O_4$ | Japanese quail | 997 | | Belted Kingfisher | 997 | 1967 | 9222 | | | | | |
| Manganese | $Mn_3O_4$ | Japanese quail | 997 | | American Woodcock | 997 | 1316 | 9870 | | | | | |
| Manganese | $Mn_3O_4$ | Japanese quail | 997 | | Cooper's Hawk | 997 | 5759 | 12873 | | | | | |
| Manganese | $Mn_3O_4$ | Japanese quail | 997 | | Barn Owl | 997 | 3717 | 13274 | | | | | |
| Manganese | $Mn_3O_4$ | Japanese quail | 997 | | Barred Owl | 997 | 8510 | 15210 | | | | | |
| Manganese | $Mn_3O_4$ | Japanese quail | 997 | | Red-tailed Hawk | 997 | 10299 | 17541 | | | | | |
| Manganese | $Mn_3O_4$ | Japanese quail | 997 | | Osprey | 997 | 4985 | 19422 | | | | | |
| Manganese | $Mn_3O_4$ | Japanese quail | 997 | | Great Blue Heron | 997 | 5673 | 22522 | | | | | |
| Manganese | $Mn_3O_4$ | Japanese quail | 997 | | Wild Turkey | 997 | 33233 | 30435 | | | | | |
| Mercury | mercuric chloride | mink | 1 | | Little Brown Bat | 3.40 | 10.19 | 21.24 | | | | | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mercury | mercuric chloride | mink | 1 | | Short-tailed Shrew | 2.86 | 4.76 | 12.99 | | | | | |
| Mercury | mercuric chloride | mink | 1 | | White-footed Mouse | 2.60 | 16.80 | 8.66 | | | | | |
| Mercury | mercuric chloride | mink | 1 | | Meadow Vole | 2.18 | 19.21 | 16.01 | | | | | |
| Mercury | mercuric chloride | mink | 1 | | Mink | 1.00 | 7.30 | 10.10 | | | | | |
| Mercury | mercuric chloride | mink | 1 | | Cottontail Rabbit | 0.96 | 4.84 | 9.88 | | | | | |
| Mercury | mercuric chloride | mink | 1 | | Red Fox | 0.69 | 6.87 | 8.13 | | | | | |
| Mercury | mercuric chloride | mink | 1 | | River Otter | 0.59 | 5.29 | 7.43 | | | | | |
| Mercury | mercuric chloride | mink | 1 | | Whitetail Deer | 0.36 | 11.84 | 5.57 | | | | | |
| Mercury | mercuric chloride | Japanese Quail | 0.45 | 0.9 | Rough-winged Swallow | 0.45 | 0.60 | 1.93 | | 0.90 | 1.19 | 3.87 | |
| Mercury | mercuric chloride | Japanese Quail | 0.45 | 0.9 | American Robin | 0.45 | 0.37 | 3.27 | | 0.90 | 0.75 | 6.54 | |
| Mercury | mercuric chloride | Japanese Quail | 0.45 | 0.9 | Belted Kingfisher | 0.45 | 0.89 | 4.16 | | 0.90 | 1.78 | 8.33 | |
| Mercury | mercuric chloride | Japanese Quail | 0.45 | 0.9 | American Woodcock | 0.45 | 0.59 | 4.46 | | 0.90 | 1.19 | 8.91 | |
| Mercury | mercuric chloride | Japanese Quail | 0.45 | 0.9 | Cooper's Hawk | 0.45 | 2.60 | 5.81 | | 0.90 | 5.20 | 11.62 | |
| Mercury | mercuric chloride | Japanese Quail | 0.45 | 0.9 | Barn Owl | 0.45 | 1.68 | 5.99 | | 0.90 | 3.36 | 11.98 | |
| Mercury | mercuric chloride | Japanese Quail | 0.45 | 0.9 | Barred Owl | 0.45 | 3.84 | 6.86 | | 0.90 | 7.68 | 13.73 | |
| Mercury | mercuric chloride | Japanese Quail | 0.45 | 0.9 | Red-tailed Hawk | 0.45 | 4.65 | 7.92 | | 0.90 | 9.30 | 15.83 | |
| Mercury | mercuric chloride | Japanese Quail | 0.45 | 0.9 | Osprey | 0.45 | 2.25 | 8.77 | | 0.90 | 4.50 | 17.53 | |
| Mercury | mercuric chloride | Japanese Quail | 0.45 | 0.9 | Great Blue Heron | 0.45 | 2.56 | 10.17 | | 0.90 | 5.12 | 20.33 | |
| Mercury | mercuric chloride | Japanese Quail | 0.45 | 0.9 | Wild Turkey | 0.45 | 15.00 | 13.74 | | 0.90 | 30.00 | 27.47 | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mercury | mercuric sulfide | mouse | 13.2 | | Little Brown Bat | 18.67 | 56.00 | 116.67 | | | | | |
| Mercury | mercuric sulfide | mouse | 13.2 | | Short-tailed Shrew | 15.70 | 26.16 | 71.35 | | | | | |
| Mercury | mercuric sulfide | mouse | 13.2 | | White-footed Mouse | 14.26 | 92.30 | 47.55 | | | | | |
| Mercury | mercuric sulfide | mouse | 13.2 | | Meadow Vole | 11.99 | 105.55 | 87.96 | | | | | |
| Mercury | mercuric sulfide | mouse | 13.2 | | Mink | 5.49 | 40.10 | 55.49 | | | | | |
| Mercury | mercuric sulfide | mouse | 13.2 | | Cottontail Rabbit | 5.25 | 26.58 | 54.30 | | | | | |
| Mercury | mercuric sulfide | mouse | 13.2 | | Red Fox | 3.77 | 37.72 | 44.67 | | | | | |
| Mercury | mercuric sulfide | mouse | 13.2 | | River Otter | 3.27 | 29.04 | 40.83 | | | | | |
| Mercury | mercuric sulfide | mouse | 13.2 | | Whitetail Deer | 2.00 | 65.06 | 30.60 | | | | | |
| Mercury | Methyl Mercury Chloride | rat | 0.032 | 0.16 | Little Brown Bat | 0.084 | 0.251 | 0.523 | | 0.418 | 1.255 | 2.614 | |
| Mercury | Methyl Mercury Chloride | rat | 0.032 | 0.16 | Short-tailed Shrew | 0.070 | 0.117 | 0.320 | | 0.352 | 0.586 | 1.598 | |
| Mercury | Methyl Mercury Chloride | rat | 0.032 | 0.16 | White-footed Mouse | 0.064 | 0.414 | 0.213 | | 0.320 | 2.068 | 1.065 | |
| Mercury | Methyl Mercury Chloride | rat | 0.032 | 0.16 | Meadow Vole | 0.054 | 0.473 | 0.394 | | 0.269 | 2.365 | 1.970 | |
| Mercury | Methyl Mercury Chloride | mink | 0.015 | 0.025 | Mink | 0.015 | 0.109 | 0.152 | 3.924e-06 | 0.025 | 0.182 | 0.253 | 6.540e-06 |
| Mercury | Methyl Mercury Chloride | rat | 0.032 | 0.16 | Cottontail Rabbit | 0.024 | 0.119 | 0.243 | | 0.118 | 0.595 | 1.216 | |
| Mercury | Methyl Mercury Chloride | mink | 0.015 | 0.025 | Red Fox | 0.010 | 0.103 | 0.122 | | 0.017 | 0.172 | 0.203 | |
| Mercury | Methyl Mercury Chloride | mink | 0.015 | 0.025 | River Otter | 0.009 | 0.079 | 0.111 | 1.576e-06 | 0.015 | 0.132 | 0.186 | 2.626e-06 |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | NOAEL-Based Benchmarks Water[e] (mg/L) | NOAEL-Based Benchmarks Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | LOAEL-Based Benchmarks Water[e] (mg/L) | LOAEL-Based Benchmarks Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mercury | Methyl Mercury Chloride | rat | 0.032 | 0.16 | Whitetail Deer | 0.009 | 0.292 | 0.137 | | 0.045 | 1.458 | 0.685 | |
| Mercury | Methyl Mercury Dicyandiamide | mallard duck | 0.0064 | 0.064 | Rough-winged Swallow | 0.006 | 0.008 | 0.028 | | 0.064 | 0.085 | 0.275 | |
| Mercury | Methyl Mercury Dicyandiamide | mallard duck | 0.0064 | 0.064 | American Robin | 0.006 | 0.005 | 0.046 | | 0.064 | 0.053 | 0.465 | |
| Mercury | Methyl Mercury Dicyandiamide | mallard duck | 0.0064 | 0.064 | Belted Kingfisher | 0.006 | 0.013 | 0.059 | 4.527e-07 | 0.064 | 0.126 | 0.592 | 4.527e-06 |
| Mercury | Methyl Mercury Dicyandiamide | mallard duck | 0.0064 | 0.064 | American Woodcock | 0.006 | 0.008 | 0.063 | | 0.064 | 0.084 | 0.634 | |
| Mercury | Methyl Mercury Dicyandiamide | mallard duck | 0.0064 | 0.064 | Cooper's Hawk | 0.006 | 0.037 | 0.083 | | 0.064 | 0.370 | 0.826 | |
| Mercury | Methyl Mercury Dicyandiamide | mallard duck | 0.0064 | 0.064 | Barn Owl | 0.006 | 0.024 | 0.085 | | 0.064 | 0.239 | 0.852 | |
| Mercury | Methyl Mercury Dicyandiamide | mallard duck | 0.0064 | 0.064 | Barred Owl | 0.006 | 0.055 | 0.098 | | 0.064 | 0.546 | 0.976 | |
| Mercury | Methyl Mercury Dicyandiamide | mallard duck | 0.0064 | 0.064 | Red-tailed Hawk | 0.006 | 0.066 | 0.113 | | 0.064 | 0.661 | 1.126 | |
| Mercury | Methyl Mercury Dicyandiamide | mallard duck | 0.0064 | 0.064 | Osprey | 0.006 | 0.032 | 0.125 | 1.147e-06 | 0.064 | 0.320 | 1.247 | 1.147e-05 |
| Mercury | Methyl Mercury Dicyandiamide | mallard duck | 0.0064 | 0.064 | Great Blue Heron | 0.006 | 0.036 | 0.145 | 1.305e-06 | 0.064 | 0.364 | 1.446 | 1.305e-05 |
| Mercury | Methyl Mercury Dicyandiamide | mallard duck | 0.0064 | 0.064 | Wild Turkey | 0.006 | 0.213 | 0.195 | | 0.064 | 2.133 | 1.954 | |
| Methanol | n/a | rat | 50 | 250 | Little Brown Bat | 130.7 | 392.1 | 816.8 | | 653.4 | 1960.3 | 4083.9 | |
| Methanol | n/a | rat | 50 | 250 | Short-tailed Shrew | 109.9 | 183.2 | 499.5 | | 549.5 | 915.8 | 2497.5 | |
| Methanol | n/a | rat | 50 | 250 | White-footed Mouse | 99.9 | 646.1 | 332.9 | | 499.3 | 3230.7 | 1664.3 | |
| Methanol | n/a | rat | 50 | 250 | Meadow Vole | 84.0 | 738.9 | 615.8 | | 419.8 | 3694.7 | 3078.9 | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Methanol | n/a | rat | 50 | 250 | Mink | 38.5 | 280.7 | 388.5 | 314.482 | 192.3 | 1403.6 | 1942.3 | 1572.411 |
| Methanol | n/a | rat | 50 | 250 | Cottontail Rabbit | 36.7 | 186.0 | 380.1 | | 183.7 | 930.2 | 1900.6 | |
| Methanol | n/a | rat | 50 | 250 | Red Fox | 26.4 | 264.0 | 312.7 | | 132.0 | 1320.2 | 1563.4 | |
| Methanol | n/a | rat | 50 | 250 | River Otter | 22.9 | 203.3 | 285.8 | 230.691 | 114.3 | 1016.3 | 1429.2 | 1153.457 |
| Methanol | n/a | rat | 50 | 250 | Whitetail Deer | 14.0 | 455.5 | 214.2 | | 70.1 | 2277.4 | 1071.0 | |
| Methoxychlor | n/a | rat | 4 | 8 | Little Brown Bat | 10.5 | 31.4 | 65.3 | | 20.9 | 62.7 | 130.7 | |
| Methoxychlor | n/a | rat | 4 | 8 | Short-tailed Shrew | 8.8 | 14.7 | 40.0 | | 17.6 | 29.3 | 79.9 | |
| Methoxychlor | n/a | rat | 4 | 8 | White-footed Mouse | 8.0 | 51.7 | 26.6 | | 16.0 | 103.4 | 53.3 | |
| Methoxychlor | n/a | rat | 4 | 8 | Meadow Vole | 6.7 | 59.1 | 49.3 | | 13.4 | 118.2 | 98.5 | |
| Methoxychlor | n/a | rat | 4 | 8 | Mink | 3.1 | 22.5 | 31.1 | 0.001 | 6.2 | 44.9 | 62.2 | 0.003 |
| Methoxychlor | n/a | rat | 4 | 8 | Cottontail Rabbit | 2.9 | 14.9 | 30.4 | | 5.9 | 29.8 | 60.8 | |
| Methoxychlor | n/a | rat | 4 | 8 | Red Fox | 2.1 | 21.1 | 25.0 | | 4.2 | 42.2 | 50.0 | |
| Methoxychlor | n/a | rat | 4 | 8 | River Otter | 1.8 | 16.3 | 22.9 | 0.001 | 3.7 | 32.5 | 45.7 | 0.002 |
| Methoxychlor | n/a | rat | 4 | 8 | Whitetail Deer | 1.1 | 36.4 | 17.1 | | 2.2 | 72.9 | 34.3 | |
| Methylene Chloride | n/a | rat | 5.85 | 50 | Little Brown Bat | 15.3 | 45.9 | 95.6 | | 130.7 | 392.1 | 816.8 | |
| Methylene Chloride | n/a | rat | 5.85 | 50 | Short-tailed Shrew | 12.9 | 21.4 | 58.4 | | 109.9 | 183.2 | 499.5 | |
| Methylene Chloride | n/a | rat | 5.85 | 50 | White-footed Mouse | 11.7 | 75.6 | 38.9 | | 99.9 | 646.1 | 332.9 | |
| Methylene Chloride | n/a | rat | 5.85 | 50 | Meadow Vole | 9.8 | 86.5 | 72.0 | | 84.0 | 738.9 | 615.8 | |
| Methylene Chloride | n/a | rat | 5.85 | 50 | Mink | 4.5 | 32.8 | 45.5 | 5.499 | 38.5 | 280.7 | 388.5 | 47.000 |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | Water[e] (mg/L) | Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Methylene Chloride | n/a | rat | 5.85 | 50 | Cottontail Rabbit | 4.3 | 21.8 | 44.5 | | 36.7 | 186.0 | 380.1 | |
| Methylene Chloride | n/a | rat | 5.85 | 50 | Red Fox | 3.1 | 30.9 | 36.6 | | 26.4 | 264.0 | 312.7 | |
| Methylene Chloride | n/a | rat | 5.85 | 50 | River Otter | 2.7 | 23.8 | 33.4 | 3.990 | 22.9 | 203.3 | 285.8 | 34.098 |
| Methylene Chloride | n/a | rat | 5.85 | 50 | Whitetail Deer | 1.6 | 53.3 | 25.1 | | 14.0 | 455.5 | 214.2 | |
| Methyl Ethyl Ketone | n/a | rat | 1771 | 4571 | Little Brown Bat | 4629 | 13886 | 28930 | | 11947 | 35841 | 74669 | |
| Methyl Ethyl Ketone | n/a | rat | 1771 | 4571 | Short-tailed Shrew | 3892 | 6487 | 17693 | | 10046 | 16744 | 45665 | |
| Methyl Ethyl Ketone | n/a | rat | 1771 | 4571 | White-footed Mouse | 3537 | 22886 | 11790 | | 9129 | 59070 | 30430 | |
| Methyl Ethyl Ketone | n/a | rat | 1771 | 4571 | Meadow Vole | 2974 | 26173 | 21811 | | 7677 | 67553 | 56295 | |
| Methyl Ethyl Ketone | n/a | rat | 1771 | 4571 | Mink | 1362 | 9943 | 13759 | 5909.176 | 3516 | 25663 | 35513 | 15251.748 |
| Methyl Ethyl Ketone | n/a | rat | 1771 | 4571 | Cottontail Rabbit | 1301 | 6590 | 13464 | | 3359 | 17008 | 34750 | |
| Methyl Ethyl Ketone | n/a | rat | 1771 | 4571 | Red Fox | 935 | 9353 | 11075 | | 2414 | 24139 | 28586 | |
| Methyl Ethyl Ketone | n/a | rat | 1771 | 4571 | River Otter | 810 | 7200 | 10124 | 4308.293 | 2091 | 18582 | 26132 | 11119.823 |
| Methyl Ethyl Ketone | n/a | rat | 1771 | 4571 | Whitetail Deer | 497 | 16133 | 7587 | | 1282 | 41640 | 19582 | |
| 4-Methyl 2-Pentanone | methyl isobutyl ketone | rat | 25 | | Little Brown Bat | 65.3 | 196.0 | 408.4 | | | | | |
| 4-Methyl 2-Pentanone | methyl isobutyl ketone | rat | 25 | | Short-tailed Shrew | 54.9 | 91.6 | 249.8 | | | | | |
| 4-Methyl 2-Pentanone | methyl isobutyl ketone | rat | 25 | | White-footed Mouse | 49.9 | 323.1 | 166.4 | | | | | |
| 4-Methyl 2-Pentanone | methyl isobutyl ketone | rat | 25 | | Meadow Vole | 42.0 | 369.5 | 307.9 | | | | | |
| 4-Methyl 2-Pentanone | methyl isobutyl ketone | rat | 25 | | Mink | 19.2 | 140.4 | 194.2 | 25.789 | | | | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | NOAEL-Based Benchmarks Water[e] (mg/L) | NOAEL-Based Benchmarks Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | LOAEL-Based Benchmarks Water[e] (mg/L) | LOAEL-Based Benchmarks Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2,3,7,8-Tetrachloro-dibenzofuran | n/a | 1 day old chick | 0.000001 | 0.00001 | Rough-winged Swallow | 0.0000010 | 0.0000013 | 0.0000043 | | 0.0000100 | 0.0000133 | 0.0000430 | |
| 2,3,7,8-Tetrachloro-dibenzofuran | n/a | 1 day old chick | 0.000001 | 0.00001 | American Robin | 0.0000010 | 0.0000008 | 0.0000073 | | 0.0000100 | 0.0000083 | 0.0000726 | |
| 2,3,7,8-Tetrachloro-dibenzofuran | n/a | 1 day old chick | 0.000001 | 0.00001 | Belted Kingfisher | 0.0000010 | 0.0000020 | 0.0000093 | | 0.0000100 | 0.0000197 | 0.0000925 | |
| 2,3,7,8-Tetrachloro-dibenzofuran | n/a | 1 day old chick | 0.000001 | 0.00001 | American Woodcock | 0.0000010 | 0.0000013 | 0.0000099 | | 0.0000100 | 0.0000132 | 0.0000990 | |
| 2,3,7,8-Tetrachloro-dibenzofuran | n/a | 1 day old chick | 0.000001 | 0.00001 | Cooper's Hawk | 0.0000010 | 0.0000058 | 0.0000129 | | 0.0000100 | 0.0000578 | 0.0001291 | |
| 2,3,7,8-Tetrachloro-dibenzofuran | n/a | 1 day old chick | 0.000001 | 0.00001 | Barn Owl | 0.0000010 | 0.0000037 | 0.0000133 | | 0.0000100 | 0.0000373 | 0.0001331 | |
| 2,3,7,8-Tetrachloro-dibenzofuran | n/a | 1 day old chick | 0.000001 | 0.00001 | Barred Owl | 0.0000010 | 0.0000085 | 0.0000153 | | 0.0000100 | 0.0000854 | 0.0001526 | |
| 2,3,7,8-Tetrachloro-dibenzofuran | n/a | 1 day old chick | 0.000001 | 0.00001 | Red-tailed Hawk | 0.0000010 | 0.0000103 | 0.0000176 | | 0.0000100 | 0.0001033 | 0.0001759 | |
| 2,3,7,8-Tetrachloro-dibenzofuran | n/a | 1 day old chick | 0.000001 | 0.00001 | Osprey | 0.0000010 | 0.0000050 | 0.0000195 | | 0.0000100 | 0.0000500 | 0.0001948 | |
| 2,3,7,8-Tetrachloro-dibenzofuran | n/a | 1 day old chick | 0.000001 | 0.00001 | Great Blue Heron | 0.0000010 | 0.0000057 | 0.0000226 | | 0.0000100 | 0.0000569 | 0.0002259 | |
| 2,3,7,8-Tetrachloro-dibenzofuran | n/a | 1 day old chick | 0.000001 | 0.00001 | Wild Turkey | 0.0000010 | 0.0000333 | 0.0000305 | | 0.0000100 | 0.0003333 | 0.0003053 | |
| 1,1,2,2-Tetrachloro-ethylene | n/a | mouse | 1.4 | 7 | Little Brown Bat | 1.98 | 5.94 | 12.37 | | 9.90 | 29.70 | 61.87 | |
| 1,1,2,2-Tetrachloro-ethylene | n/a | mouse | 1.4 | 7 | Short-tailed Shrew | 1.66 | 2.77 | 7.57 | | 8.32 | 13.87 | 37.84 | |
| 1,1,2,2-Tetrachloro-ethylene | n/a | mouse | 1.4 | 7 | White-footed Mouse | 1.51 | 9.79 | 5.04 | | 7.56 | 48.95 | 25.21 | |
| 1,1,2,2-Tetrachloro-ethylene | n/a | mouse | 1.4 | 7 | Meadow Vole | 1.27 | 11.20 | 9.33 | | 6.36 | 55.98 | 46.65 | |
| 1,1,2,2-Tetrachloro-ethylene | n/a | mouse | 1.4 | 7 | Mink | 0.58 | 4.25 | 5.89 | 0.066 | 2.91 | 21.26 | 29.43 | 0.331 |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | NOAEL-Based Benchmarks Water[e] (mg/L) | NOAEL-Based Benchmarks Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | LOAEL-Based Benchmarks Water[e] (mg/L) | LOAEL-Based Benchmarks Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloro-ethylene | n/a | mouse | 1.4 | 7 | Cottontail Rabbit | 0.56 | 2.82 | 5.76 | | 2.78 | 14.09 | 28.79 | |
| 1,1,2,2-Tetrachloro-ethylene | n/a | mouse | 1.4 | 7 | Red Fox | 0.40 | 4.00 | 4.74 | | 2.00 | 20.00 | 23.69 | |
| 1,1,2,2-Tetrachloro-ethylene | n/a | mouse | 1.4 | 7 | River Otter | 0.35 | 3.08 | 4.33 | 0.048 | 1.73 | 15.40 | 21.65 | 0.240 |
| 1,1,2,2-Tetrachloro-ethylene | n/a | mouse | 1.4 | 7 | Whitetail Deer | 0.21 | 6.90 | 3.25 | | 1.06 | 34.50 | 16.23 | |
| Thallium | thallium sulfate | rat | 0.0074 | 0.074 | Little Brown Bat | 0.020 | 0.059 | 0.122 | | 0.195 | 0.586 | 1.222 | |
| Thallium | thallium sulfate | rat | 0.0074 | 0.074 | Short-tailed Shrew | 0.016 | 0.027 | 0.075 | | 0.164 | 0.274 | 0.747 | |
| Thallium | thallium sulfate | rat | 0.0074 | 0.074 | White-footed Mouse | 0.015 | 0.097 | 0.050 | | 0.149 | 0.966 | 0.498 | |
| Thallium | thallium sulfate | rat | 0.0074 | 0.074 | Meadow Vole | 0.013 | 0.111 | 0.092 | | 0.126 | 1.105 | 0.921 | |
| Thallium | thallium sulfate | rat | 0.0074 | 0.074 | Mink | 0.006 | 0.042 | 0.058 | 0.001 | 0.058 | 0.420 | 0.581 | 0.012 |
| Thallium | thallium sulfate | rat | 0.0074 | 0.074 | Cottontail Rabbit | 0.005 | 0.028 | 0.057 | | 0.055 | 0.278 | 0.569 | |
| Thallium | thallium sulfate | rat | 0.0074 | 0.074 | Red Fox | 0.004 | 0.039 | 0.047 | | 0.039 | 0.395 | 0.468 | |
| Thallium | thallium sulfate | rat | 0.0074 | 0.074 | River Otter | 0.003 | 0.030 | 0.043 | 0.001 | 0.034 | 0.304 | 0.428 | 0.009 |
| Thallium | thallium sulfate | rat | 0.0074 | 0.074 | Whitetail Deer | 0.002 | 0.068 | 0.032 | | 0.021 | 0.681 | 0.320 | |
| Tin | bis(tributyltin)-oxide (TBTO) | mouse | 23.4 | 35 | Little Brown Bat | 33.1 | 99.3 | 206.8 | | 49.5 | 148.5 | 309.4 | |
| Tin | bis(tributyltin)-oxide (TBTO) | mouse | 23.4 | 35 | Short-tailed Shrew | 27.8 | 46.4 | 126.5 | | 41.6 | 69.4 | 189.2 | |
| Tin | bis(tributyltin)-oxide (TBTO) | mouse | 23.4 | 35 | White-footed Mouse | 25.3 | 163.6 | 84.3 | | 37.8 | 244.7 | 126.1 | |
| Tin | bis(tributyltin)-oxide (TBTO) | mouse | 23.4 | 35 | Meadow Vole | 21.3 | 187.1 | 155.9 | | 31.8 | 279.9 | 233.2 | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks: Food[d] (mg/kg) | NOAEL-Based Benchmarks: Water[e] (mg/L) | NOAEL-Based Benchmarks: Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks: Food[d] (mg/kg) | LOAEL-Based Benchmarks: Water[e] (mg/L) | LOAEL-Based Benchmarks: Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Toluene | n/a | mouse | 26 | 260 | Little Brown Bat | 36.8 | 110.3 | 229.8 | | 367.7 | 1103.1 | 2298.1 | |
| Toluene | n/a | mouse | 26 | 260 | Short-tailed Shrew | 30.9 | 51.5 | 140.5 | | 309.2 | 515.3 | 1405.4 | |
| Toluene | n/a | mouse | 26 | 260 | White-footed Mouse | 28.1 | 181.8 | 93.7 | | 281.0 | 1818.0 | 936.5 | |
| Toluene | n/a | mouse | 26 | 260 | Meadow Vole | 23.6 | 207.9 | 173.3 | | 236.3 | 2079.1 | 1732.6 | |
| Toluene | n/a | mouse | 26 | 260 | Mink | 10.8 | 79.0 | 109.3 | 1.050 | 108.2 | 789.8 | 1093.0 | 10.504 |
| Toluene | n/a | mouse | 26 | 260 | Cottontail Rabbit | 10.3 | 52.3 | 107.0 | | 103.4 | 523.5 | 1069.5 | |
| Toluene | n/a | mouse | 26 | 260 | Red Fox | 7.4 | 74.3 | 88.0 | | 74.3 | 742.9 | 879.8 | |
| Toluene | n/a | mouse | 26 | 260 | River Otter | 6.4 | 57.2 | 80.4 | 0.764 | 64.3 | 571.9 | 804.3 | 7.638 |
| Toluene | n/a | mouse | 26 | 260 | Whitetail Deer | 3.9 | 128.2 | 60.3 | | 39.5 | 1281.6 | 602.7 | |
| Toxaphene | n/a | rat | 8 | | Little Brown Bat | 20.9 | 62.7 | 130.7 | | | | | |
| Toxaphene | n/a | rat | 8 | | Short-tailed Shrew | 17.6 | 29.3 | 79.9 | | | | | |
| Toxaphene | n/a | rat | 8 | | White-footed Mouse | 16.0 | 103.4 | 53.3 | | | | | |
| Toxaphene | n/a | rat | 8 | | Meadow Vole | 13.4 | 118.2 | 98.5 | | | | | |
| Toxaphene | n/a | rat | 8 | | Mink | 6.2 | 44.9 | 62.2 | 0.001 | | | | |
| Toxaphene | n/a | rat | 8 | | Cottontail Rabbit | 5.9 | 29.8 | 60.8 | | | | | |
| Toxaphene | n/a | rat | 8 | | Red Fox | 4.2 | 42.2 | 50.0 | | | | | |
| Toxaphene | n/a | rat | 8 | | River Otter | 3.7 | 32.5 | 45.7 | 0.001 | | | | |
| Toxaphene | n/a | rat | 8 | | Whitetail Deer | 2.2 | 72.9 | 34.3 | | | | | |
| 1,1,1-Trichloroeth-ane | n/a | mouse | 1000 | | Little Brown Bat | 1470 | 4409 | 9186 | | | | | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | NOAEL-Based Benchmarks Water[e] (mg/L) | NOAEL-Based Benchmarks Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | LOAEL-Based Benchmarks Water[e] (mg/L) | LOAEL-Based Benchmarks Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,1,1-Trichloroeth-ane | n/a | mouse | 1000 | | Short-tailed Shrew | 1236 | 2060 | 5618 | | | | | |
| 1,1,1-Trichloroeth-ane | n/a | mouse | 1000 | | White-footed Mouse | 1123 | 7267 | 3744 | | | | | |
| 1,1,1-Trichloroeth-ane | n/a | mouse | 1000 | | Meadow Vole | 944 | 8311 | 6926 | | | | | |
| 1,1,1-Trichloroeth-ane | n/a | mouse | 1000 | | Mink | 433 | 3157 | 4369 | 68.126 | | | | |
| 1,1,1-Trichloroeth-ane | n/a | mouse | 1000 | | Cottontail Rabbit | 413 | 2092 | 4275 | | | | | |
| 1,1,1-Trichloroeth-ane | n/a | mouse | 1000 | | Red Fox | 297 | 2970 | 3517 | | | | | |
| 1,1,1-Trichloroeth-ane | n/a | mouse | 1000 | | River Otter | 257 | 2286 | 3215 | 49.419 | | | | |
| 1,1,1-Trichloroeth-ane | n/a | mouse | 1000 | | Whitetail Deer | 158 | 5123 | 2409 | | | | | |
| Trichloroethylene | n/a | mouse | 0.7 | 7 | Little Brown Bat | 0.990 | 2.970 | 6.187 | | 9.899 | 29.698 | 61.872 | |
| Trichloroethylene | n/a | mouse | 0.7 | 7 | Short-tailed Shrew | 0.832 | 1.387 | 3.784 | | 8.324 | 13.874 | 37.838 | |
| Trichloroethylene | n/a | mouse | 0.7 | 7 | White-footed Mouse | 0.756 | 4.895 | 2.521 | | 7.564 | 48.946 | 25.215 | |
| Trichloroethylene | n/a | mouse | 0.7 | 7 | Meadow Vole | 0.636 | 5.598 | 4.665 | | 6.361 | 55.975 | 46.646 | |
| Trichloroethylene | n/a | mouse | 0.7 | 7 | Mink | 0.291 | 2.126 | 2.943 | 0.031 | 2.913 | 21.265 | 29.427 | 0.308 |
| Trichloroethylene | n/a | mouse | 0.7 | 7 | Cottontail Rabbit | 0.278 | 1.409 | 2.879 | | 2.783 | 14.093 | 28.794 | |
| Trichloroethylene | n/a | mouse | 0.7 | 7 | Red Fox | 0.200 | 2.000 | 2.369 | | 2.000 | 20.002 | 23.687 | |
| Trichloroethylene | n/a | mouse | 0.7 | 7 | River Otter | 0.173 | 1.540 | 2.165 | 0.022 | 1.732 | 15.398 | 21.653 | 0.224 |
| Trichloroethylene | n/a | mouse | 0.7 | 7 | Whitetail Deer | 0.106 | 3.450 | 1.623 | | 1.063 | 34.504 | 16.226 | |
| Uranium | Uranyl acetate | mouse | 3.07 | 6.13 | Little Brown Bat | 4.267 | 12.802 | 26.671 | | 8.521 | 25.563 | 53.256 | |
| Uranium | Uranyl acetate | mouse | 3.07 | 6.13 | Short-tailed Shrew | 3.588 | 5.981 | 16.311 | | 7.165 | 11.942 | 32.569 | |

Table 12. (continued)

| Analyte | Form | Test Species | Test Species NOAEL[a] (mg/kg/d) | Test Species LOAEL[a] (mg/kg/d) | Endpoint Species[b] | Estimated Wildlife NOAEL[c] (mg/kg/d) | NOAEL-Based Benchmarks Food[d] (mg/kg) | NOAEL-Based Benchmarks Water[e] (mg/L) | NOAEL-Based Benchmarks Piscivore[f] (mg/L) | Estimated Wildlife LOAEL[c] (mg/kg/d) | LOAEL-Based Benchmarks Food[d] (mg/kg) | LOAEL-Based Benchmarks Water[e] (mg/L) | LOAEL-Based Benchmarks Piscivore[f] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vanadium | vanadyl sulfate | mallard duck | 11.4 | | Belted Kingfisher | 11.400 | 22.496 | 105.450 | | | | | |
| Vanadium | vanadyl sulfate | mallard duck | 11.4 | | American Woodcock | 11.400 | 15.048 | 112.860 | | | | | |
| Vanadium | vanadyl sulfate | mallard duck | 11.4 | | Cooper's Hawk | 11.400 | 65.850 | 147.194 | | | | | |
| Vanadium | vanadyl sulfate | mallard duck | 11.4 | | Barn Owl | 11.400 | 42.499 | 151.783 | | | | | |
| Vanadium | vanadyl sulfate | mallard duck | 11.4 | | Barred Owl | 11.400 | 97.307 | 173.911 | | | | | |
| Vanadium | vanadyl sulfate | mallard duck | 11.4 | | Red-tailed Hawk | 11.400 | 117.765 | 200.569 | | | | | |
| Vanadium | vanadyl sulfate | mallard duck | 11.4 | | Osprey | 11.400 | 57.000 | 222.078 | | | | | |
| Vanadium | vanadyl sulfate | mallard duck | 11.4 | | Great Blue Heron | 11.400 | 64.871 | 257.524 | | | | | |
| Vanadium | vanadyl sulfate | mallard duck | 11.4 | | Wild Turkey | 11.400 | 380.000 | 348.000 | | | | | |
| Vinyl Chloride | n/a | rat | 0.17 | 1.7 | Little Brown Bat | 0.444 | 1.333 | 2.777 | | 4.443 | 13.330 | 27.770 | |
| Vinyl Chloride | n/a | rat | 0.17 | 1.7 | Short-tailed Shrew | 0.374 | 0.623 | 1.698 | | 3.736 | 6.227 | 16.983 | |
| Vinyl Chloride | n/a | rat | 0.17 | 1.7 | White-footed Mouse | 0.340 | 2.197 | 1.132 | | 3.395 | 21.969 | 11.317 | |
| Vinyl Chloride | n/a | rat | 0.17 | 1.7 | Meadow Vole | 0.285 | 2.512 | 2.094 | | 2.855 | 25.124 | 20.937 | |
| Vinyl Chloride | n/a | rat | 0.17 | 1.7 | Mink | 0.131 | 0.954 | 1.321 | 0.108 | 1.308 | 9.544 | 13.208 | 1.078 |
| Vinyl Chloride | n/a | rat | 0.17 | 1.7 | Cottontail Rabbit | 0.125 | 0.633 | 1.292 | | 1.249 | 6.326 | 12.924 | |
| Vinyl Chloride | n/a | rat | 0.17 | 1.7 | Red Fox | 0.090 | 0.898 | 1.063 | | 0.898 | 8.978 | 10.631 | |
| Vinyl Chloride | n/a | rat | 0.17 | 1.7 | River Otter | 0.078 | 0.691 | 0.972 | 0.078 | 0.777 | 6.911 | 9.719 | 0.782 |
| Vinyl Chloride | n/a | rat | 0.17 | 1.7 | Whitetail Deer | 0.048 | 1.549 | 0.728 | | 0.477 | 15.486 | 7.283 | |
| Xylene | mixed isomers | mouse | 2.1 | 2.6 | Little Brown Bat | 2.970 | 8.910 | 18.562 | | 3.677 | 11.031 | 22.981 | |

**Appendix A**

| Chemicals | | Trigger values for freshwater (µgL$^{-1}$) Level of protection (% species) | | | | Trigger values for freshwater (µgL$^{-1}$) Level of protection (% species) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 99% | 95% | 90% | 80% | 99% | 95% | 90% | 80% |
| **METALS & METALLOIDS** | | | | | | | | | |
| Aluminium | pH >6.5 | 27 | 55 | 80 | 150 | ID | ID | ID | ID |
| Aluminium | pH <6.5 | ID | ID | ID | ID | ID | ID | ID | ID |
| Antimony | | ID | ID | ID | ID | ID | ID | ID | ID |
| Arsenic (AsIII) | | 1 | 24 | 94[C] | 360[C] | ID | ID | ID | ID |
| Arsenic (AsV) | | 0.8 | 13 | 42 | 140[C] | ID | ID | ID | ID |
| Beryllium | | ID | ID | ID | ID | ID | ID | ID | ID |
| Bismuth | | ID | ID | ID | ID | ID | ID | ID | ID |
| Boron | | 90 | 370[C] | 680[C] | 1300[C] | ID | ID | ID | ID |
| Cadmium | H | 0.06 | 0.2 | 0.4 | 0.8[C] | 0.7[B] | 5.5[B, C] | 14[B, C] | 36[B, A] |
| Chromium (Cr III) | H | ID | ID | ID | ID | 7.7 | 27.4 | 48.6 | 90.6 |
| Chromium (CrVI) | | 0.01 | 1.0[C] | 6[A] | 40[A] | 0.14 | 4.4 | 20[C] | 85[C] |
| Cobalt | | ID | ID | ID | ID | 0.005 | 1 | 14 | 150[C] |
| Copper | H | 1.0 | 1.4 | 1.8[C] | 2.5[C] | 0.3 | 1.3 | 3[C] | 8[A] |
| Gallium | | ID | ID | ID | ID | ID | ID | ID | ID |
| Iron | | ID | ID | ID | ID | ID | ID | ID | ID |
| Lanthanum | | ID | ID | ID | ID | ID | ID | ID | ID |
| Lead | H | 1.0 | 3.4 | 5.6 | 9.4[C] | 2.2 | 4.4 | 6.6 | 12[C] |
| Manganese | | 1200 | 1900[C] | 2500[C] | 3600[C] | ID | ID | ID | ID |
| Mercury (inorganic) | B | 0.06 | 0.6 | 1.9[C] | 5.4[A] | 0.1 | 0.4[C] | 0.7[C] | 1.4[C] |
| Mercury (methyl) | | ID | ID | ID | ID | ID | ID | ID | ID |
| Molybdenum | | ID | ID | ID | ID | ID | ID | ID | ID |
| Nickel | H | 8 | 11 | 13 | 17[C] | 7 | 70[C] | 200[C] | 560[A] |
| Selenium (Total) | B | 5 | 11 | 18 | 34 | ID | ID | ID | ID |
| Selenium (SeIV) | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Silver | | 0.02 | 0.05 | 0.1 | 0.2[C] | 0.8 | 1.4 | 1.8 | 2.6[C] |
| Thallium | | ID | ID | ID | ID | ID | ID | ID | ID |
| Tin (inorganic, SnIV) | | ID | ID | ID | ID | ID | ID | ID | ID |
| Tributyltin (as µg/L Sn) | | ID | ID | ID | ID | 0.0004 | 0.006[C] | 0.02[C] | 0.05[C] |
| Uranium | | ID | ID | ID | ]D | ID | ID | ID | ID |
| Vanadium | | ID | ID | ID | ID | 50 | 100 | 160 | 280 |
| Zinc | H | 2.4 | 0.8 | 15[C] | 31[C] | 7 | 15[C] | 23[C] | 43[C] |
| **NON-METALLIC INORGANICS** | | | | | | | | | |
| Ammonia | D | 320 | 900[C] | 1430[C] | 2300[C] | 500 | 910 | 1200 | 1700 |
| Chlorine | E | 0.4 | 3 | 6[A] | 13[A] | ID | ID | ID | ID |
| Cyanide | F | 4 | 7 | 11 | 18 | 2 | 4 | 7 | 14 |
| Nitrate | J | 17 | 700 | 3400[C] | 17000[A] | ID | ID | ID | ID |
| Hydrogen sulfide | G | 0.5 | 1.0 | 1.5 | 2.6 | ID | 10 | ID | ID |
| **ORGANIC ALCOHOLS** | | | | | | | | | |
| Ethanol | | 400 | 1400 | 2400[C] | 4000[C] | ID | ID | ID | ID |
| Ethylene glycol | | ID | ID | ID | ID | ID | ID | ID | ID |
| Isopropyl alcohol | | ID | D | ID | ID | ID | ID | ID | ID |
| **CHLORINATED ALKANES** | | | | | | | | | |
| **Chloromethanes** | | | | | | | | | |
| Dichloromethane | | ID | ID | ID | ID | ID | ID | ID | ID |
| Chloroform | | ID | ID | ID | ID | ID | ID | ID | ID |
| Carbon tetrachloride | | ID | ID | ID | ID | ID | ID | ID | ID |
| **Chloroethanes** | | | | | | | | | |
| 1,2-dichloroethane | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,1,1-trichloroethane | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,1,2-trichloroethane | | 5400 | 6500 | 7300 | 8400 | 140 | 1900 | 5800[C] | 18000[C] |
| 1,1,2,2-tetrachloroethane | | ID | ID | ID | ID | ID | ID | ID | ID |
| Pentachloroethane | | ID | ID | ID | ID | ID | ID | ID | ID |
| Hexachloroethane | B | 290 | 360 | 420 | 500 | ID | ID | ID | ID |
| **Chloropropanes** | | | | | | | | | |
| 1,1-dichloropropane | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,2-dichloropropane | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,3-dichloropropane | | ID | ID | ID | ID | ID | ID | ID | ID |
| **CHLORINATED ALKENES** | | | | | | | | | |
| Chloroethylene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,1-dichloroethylene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1, 1,2-trichloroethylene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1, 1,2,2-tetrachloroethylene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 3-chloropropene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,3-dichloropropene | | ID | ID | ID | ID | ID | ID | ID | ID |
| **ANILINES** | | | | | | | | | |
| Aniline | | 8 | 250[A] | 1100[A] | 4800[A] | ID | ID | ID | ID |

**Appendix A**

| Chemicals | | Trigger values for freshwater | | | | Trigger values for freshwater | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ($\mu gL^{-1}$) | | | | ($\mu gL^{-1}$) | | | |
| | | Level of protection (% species) | | | | Level of protection (% species) | | | |
| | | **99%** | **95%** | **90%** | **80%** | **99%** | **95%** | **90%** | **80%** |
| 2,*4-dichloroaniline | | 0.6 | 7 | 20 | 60[C] | ID | ID | ID | ID |
| 2,5-dichloroaniline | | ID | ID | ID | ID | ID | ID | ID | ID |
| 3,4-dichloroaniline | | 1.3 | 3 | 6[C] | 13[C] | 85 | 150 | 190 | 260 |
| 3,5-dichloroaniline | | ID | ID | ID | ID | ID | ID | ID | ID |
| Benzidine | | ID | ID | ID | ID | ID | ID | ID | ID |
| Dichlorobenzidine | | ID | ID | ID | ID | ID | ID | ID | ID |
| **AROMATIC HYDROCARBONS** | | | | | | | | | |
| Benzene | | 600 | 950 | 1300 | 2000 | 500[C] | 700[C] | 900[C] | 1300[C] |
| Toluene | | ID | ID | ID | ID | ID | ID | ID | ID |
| Ethylbenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| o-xylene | | 200 | 350 | 470 | 640 | ID | ID | ID | ID |
| rn-xylene | | ID | ID | ID | ID | ID | ID | ID | ID |
| p-xylene | | 140 | 200 | 250 | 340 | ID | ID | ID | ID |
| m+p-xylene | | ID | ID | ID | ID | ID | ID | ID | ID |
| Cumene | | ID | ID | ID | ID | ID | ID | ID | ID |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | |
| Naphthalene | | 2.5 | 16 | 37 | 85 | 50[C] | 70[C] | 90[C] | 120[C] |
| Anthracene | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Phenanthrene | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Fluoranthene | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Benzo(a)pyrene | B | ID | ID | ID | ID | ID | ID | ID | ID |
| **Nitrobenzenes** | | | | | | | | | |
| Nitrobenzene | | 230 | 550 | 820 | 1300 | ID | ID | ID | ID |
| 1,2-dinitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,3-dinitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,4-dinitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,3,5-trinitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1-methoxy-2-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1-methoxy-4-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1-chloro-2-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1-chloro-3-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1-chloro-4-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1-chloro-2,4-dinitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,2-dichforo-3-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,3-dichloro-5-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,4-dichloro-2-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,4-dichforo-2-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,2,4,5-tetrachloro-3-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,5-dichloro-2,4-dinitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,3,5-trichloro-2,4-dinitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1-fluoro-4-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| **Nitrotoluenes** | | | | | | | | | |
| 2-nitrotoluene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 3-nitrotoluene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 4-nitrotoluene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,3-dinitrotoluene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,4-dinitrotoluene | | 16 | 65[C] | 130[C] | 250[C] | ID | ID | ID | ID |
| 2,4,6-trinitrotoluene | | 100 | 140 | 160 | 210 | ID | ID | ID | ID |
| 1,2-dimethyl-3-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,2-dimethyi-4-nitrobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 4-chloro-3-nitrotoluene | | ID | ID | ID | ID | ID | ID | ID | ID |
| **Chlorobenzenes and Chloronaphthalenes** | | | | | | | | | |
| Monochforobenzene | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,2-dichlorobenzene | | 120 | 160 | 200 | 270 | ID | ID | ID | ID |
| 1,3-dichlorobenzene | | 160 | 260 | 350 | 520[C] | ID | ID | ID | ID |
| 1,4-dichlorobenzene | | 40 | 60 | 75 | 100 | ID | ID | ID | ID |
| 1,2,3-thchlorobenzene | B | 3 | 10 | 16 | 30[C] | ID | ID | ID | ID |
| 1,2,4-thchlorobenzene | B | 85 | 170[C] | 220[C] | 300[C] | 20 | 80 | 140 | 240 |
| 1,3,5-thchlorobenzene | B | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,2,3,4-tetrachlorobenzene | B | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,2,3,5-tetrachiorobenzene | B | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,2,4,5-tetrachlorobenzene | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Pentachlorobenzene | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Hexachlorobenzene | B | ID | ID | ID | ID | ID | ID | ID | ID |
| 1-chloronaphthalene | | ID | ID | ID | ID | ID | ID | ID | ID |
| **Polychlorinated Biphenyis (PCBs) & Dioxins** | | | | | | | | | |
| Capacitor 21 | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Aroclor 1016 | B | ID | ID | ID | ID | ID | ID | ID | ID |

**Appendix A**

| Chemicals | | Trigger values for freshwater ($\mu gL^{-1}$) | | | | Trigger values for freshwater ($\mu gL^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Level of protection (% species) | | | | Level of protection (% species) | | | |
| | | **99%** | **95%** | **90%** | **80%** | **99%** | **95%** | **90%** | **80%** |
| Aroclor 1221 | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Aroclor 1232 | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Aroclor 1242 | B | 0.3 | 0.6 | 1 | 1.7 | ID | ID | ID | ID |
| Aroclor 1248 | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Aroclor 1254 | B | 0.01 | 0.03 | 0.07 | 0.2 | ID | ID | ID | ID |
| Aroclor 1260 | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Aroclor 1262 | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Aroclor 1268 | B | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,3,4'-trichlorobiphenyl | B | ID | ID | ID | ID | ID | ID | ID | ID |
| 4,4'-dichlorobiphenyl | B | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,2',4,5,5'-pentachloro- 1, 1'-biphenyl | B | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,4,6,2',4',6'-hexachlorobiphenyl | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Total PCBs | B | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,3,7,8-TCDD | B | ID | ID | ID | ID | ID | ID | ID | ID |
| **PHENOLS and XYLENOLS** | | | | | | | | | |
| Phenol | | 85 | 320 | 600 | 1200[C] | 270 | 400 | 520 | 720 |
| 2,4 dimethyl phenol | | ID | ID | ID | ID | ID | ID | ID | ID |
| Nonylphenol | | ID | ID | ID | ID | ID | ID | ID | ID |
| 2-chlorophenol | T | 340[C] | 490[C] | 630[C] | 870[C] | ID | ID | ID | ID |
| 3-chlorophenol | T | ID | ID | ID | ID | ID | ID | ID | ID |
| 4-chlorophenol | T | 160 | 220 | 280[C] | 360[C] | ID | ID | ID | ID |
| 2,3-dichlorophenol | T | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,4-dichlorophenol | T | 120 | 160[C] | 200[C] | 270[C] | ID | ID | ID | ID |
| 2,5-dichlorophenol | T | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,6-dichlorophenol | T | ID | ID | ID | ID | ID | ID | ID | ID |
| 3,4-dichiorophenol | T | ID | ID | ID | ID | ID | ID | ID | ID |
| 3,5-dichlorophenol | T | ID | ID | ID | ID | ID | [D | 0 | ID |
| 2,3,4-trichlorophenol | T | ID | ID | ]D | 10 | ID | ID | ID | ID |
| 2,3,5-trichlorophenol | T | ID | ID | ID | ID | 10 | ID | ID | ID |
| 2,3,6-trichlorophenoi | T | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,4,5-trichlorophenol | T,B | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,4,6-trichlorophenol | T,B | 3 | 20 | 40 | 95 | ID | ID | ID | ID |
| 2,3,4,5-tetrachlorophenol | T,B | ID | ID | ID | ID | 0 | ID | ID | 10 |
| 2,3,4,6- tetrachlorophenol | T,B | 10 | 20 | 25 | 30 | ID | ID | ID | ID |
| 2,3,5,6- tetrachlorophenol | T,B | ID | 0 | ID | ID | ID | ID | ID | ID |
| Pentachlorophenol | T,B | 3.6 | 10 | 17 | 27[A] | 11 | 22 | 33 | 55[A] |
| **Nitraphenols** | | | | | | | | | |
| 2-nitrophenol | | ID | ID | ID | ID | ID | ID | ID | ID |
| 3-nitrophenol | | ID | ID | ID | ID | ID | ID | ID | ID |
| 4-nitrophenol | | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,4-dinitrophenol | | 13 | 45 | 80 | 140 | ID | ID | ID | ID |
| 2,4,6-trinitrophenol | | ID | ID | ID | ID | ID | ID | ID | ID |
| **ORGANIC SULFUR COMPOUNDS** | | | | | | | | | |
| Carbon disulfide | | ID | ID | ID | ID | ID | ID | ID | ID |
| Isopropyl disulfide | | ID | ID | ID | ID | ID | ID | ID | ID |
| n-propyl sulfide | | ID | ID | ID | ID | ID | ID | ID | ID |
| Propyl disulfide | | ID | ID | ID | ID | ID | ID | ID | ID |
| Tert-butyl sulfide | | ID | ID | ID | ID | ID | ID | ID | ID |
| Phenyl disulfide | | ID | ID | ID | ID | ID | ID | ID | ID |
| Bis(dimethylthiocarbamyl)sulfide | | ID | ID | ID | ID | ID | ID | ID | ID |
| Bis(dimethylthiocarbamyl)disulfide | | ID | ID | ID | ID | ID | ID | ID | ID |
| 2-methoxy-4H-1,3,2- | | 0 | ID | ID | ID | ID | ID | ID | ID |
| benzodioxaphosphorium-2-sulfide | | | | | | | | | |
| **Xanthates** | | | | | | | | | |
| Potassium amyl xanthate | | ID | ID | ID | ID | ID | ID | ID | ID |
| Potassium ethyl xanthate | | ID | ID | ID | ID | ID | ID | ID | ID |
| Potassium hexyl xanthate | | ID | ID | ID | ID | ID | ID | ID | ID |
| Potassium isopropyl xanthate | | ID | ID | ID | ID | ID | ID | ID | ID |
| Sodium ethyl xanthate | | ID | ID | ID | ID | ID | ID | ID | ID |
| Sodium isobutyl xanthate | | ID | ID | ID | ID | ID | ID | ID | ID |
| Sodium isopropyl xanthate | | ID | ID | ID | ID | ID | ID | ID | ID |
| Sodium sec-butyl xanthate | | ID | ID | ID | ID | ID | ID | ID | ID |
| **PHTHALATES** | | | | | | | | | |
| Dimethylphthalate | | 3000 | 3700 | 4300 | 5100 | ID | ID | ID | ID |
| Diethylphthalate | | 900 | 1000 | 1100 | 1300 | ID | ID | ID | ID |
| Dibutylphthalate | B | 9.9 | 26 | 40.2 | 64.6 | ID | ID | ID | ID |
| Di(2-ethylhexyl)phthalate | B | ID | ID | ID | ID | ID | ID | ID | ID |
| **MISCELLANEOUS INDUSTRIAL CHEMICALS** | | | | | | | | | |
| Acetonitrile | | ID | ID | ID | ID | ID | ID | ID | ID |

**Appendix A**

| Chemicals | | Trigger values for freshwater ($\mu gL^{-1}$) Level of protection (% species) | | | | Trigger values for freshwater ($\mu gL^{-1}$) Level of protection (% species) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 99% | 95% | 90% | 80% | 99% | 95% | 90% | 80% |
| Acrylonitrile | | ID | ID | ID | ID | ID | ID | ID | ID |
| Poly(acrylonithle-co-butadiene-co-styrene) | | 200 | 530 | 800[C] | 1200[C] | 200 | 250 | 280 | 340 |
| Dimethyformamide | | ID | ID | ID | ID | ID | ID | ID | ID |
| 1,2-di phenylhydrazine | | ID | ID | ID | ID | ID | ID | ID | ID |
| Diphenylnitrosamine | | ID | ID | ID | ID | ID | ID | ID | ID |
| Hexachlorobutadiene | | ID | ID | ID | ID | ID | ID | ID | ID |
| Hexachlorocyclopentadiene | | ID | ID | ID | ID | ID | ID | ID | ID |
| Isophorone | | ID | ID | ID | ID | ID | ID | ID | ID |
| **ORGANOCHLORINE PESTICIDES** | | | | | | | | | |
| Aildn | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Chlordane | B | 0.03 | 0.08 | 0.14 | 0.27[C] | ID | ID | 0 | ID |
| DDE | B | ID | ID | ID | ID | ID | ID | ID | ID |
| DDT | B | 0.006 | 0.01 | 0.02 | 0.04 | ID | ID | ID | ID |
| Dicofol | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Dieldrin | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Endosulfan | B | 0.03 | 0.2[A] | 0.6[A] | 1.8[A] | 0.005 | 0.01 | 0.02 | 0.05[A] |
| Endosulfan alpha | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Endosulfan beta | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Endrin | B | 0.01 | 0.02 | 0.04[C] | 0.06[A] | 0.004 | 0.008 | 0.01 | 0.02 |
| Heptachlor | B | 0.01 | 0.09 | 0.25 | 0.7[A] | ID | ID | ID | ID |
| Undane | | 0.07 | 0.2 | 0.4 | 1.0[A] | ID | ID | ID | ID |
| Methoxychlor | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Mirex | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Toxaphene | B | 0.1 | 0.2 | 0.3 | 0.5 | ID | ID | ID | ID |
| **ORGANOPHOSPHORUS PESTICIDES** | | | | | | | | | |
| Azinphos methyl | | 0.01 | 0.02 | 0.05 | 0.11[A] | ID | ID | ID | ID |
| Chlorpyhfos | B | 0.00004 | 0.01 | 0.11[A] | 1.2[A] | 0.0005 | 0.009 | 0.04[A] | 0.3[A] |
| Demeton | | ID | ID | ID | ID | ID | ID | ID | ID |
| Demeton-S-methyl | | ID | ID | ID | ID | ID | ID | ID | ID |
| Diazinon | | 0.00003 | 0.01 | 0.2[A] | 2[A] | ID | ID | ID | ID |
| Dimethoate | | 0.1 | 0.15 | 0.2 | 0.3 | ID | ID | ID | ID |
| Fenitrothion | | 0.1 | 0.2 | 0.3 | 0.4 | ID | ID | ID | ID |
| Malathion | | 0.002 | 0.05 | 0.2 | 1.1[A] | ID | ID | ID | ID |
| Parathion | | 0.0007 | 0.004[C] | 0.01[C] | 0.04[A] | ID | ID | ID | ID |
| Profenofos | B | ID | ID | ID | ID | ID | ID | ID | ID |
| Temephos | B | ID | ID | ID | ID | 0.0004 | 0.05 | 0.4 | 3.6[A] |
| **CARBAMATE & OTHER PESTICIDES** | | | | | | | | | |
| Carbofuran | | 0.06 | 1.2[A] | 4[A] | 15[A] | ID | ID | ID | ID |
| Methomyl | | 0.5 | 3.5 | 9.5 | 23 | ID | ID | ID | ID |
| S-methoprene | | ID | ID | ID | ID | ID | ID | ID | ID |
| **PYRETHROIDS** | | | | | | | | | |
| Deltamethrin | | ID | ID | ID | ID | ID | ID | ID | ID |
| Esfenvalerate | | ID | 0.001* | ID | ID | ID | ID | ID | ID |
| **HERBICIDES & FUNGICIDES** | | | | | | | | | |
| **Bypyridilium herbicides** | | | | | | | | | |
| Diquat | | 0.01 | 1.4 | 10 | 80[A] | ID | ID | ID | ID |
| Paraquat | | ID | ID | ID | ID | ID | ID | ID | ID |
| **Phenoxyacetic acid herbicides** | | | | | | | | | |
| MCPA | | ID | ID | ID | ID | ID | ID | ID | ID |
| 2,4-D | | 140 | 280 | 450 | 830 | ID | ID | ID | ID |
| 2,4,5-T | | 3 | 36 | 100 | 290[A] | ID | ID | ID | ID |
| **Sulfonylurea herbicides** | | | | | | | | | |
| Bensulfuron | | ID | ID | ID | ID | ID | ID | ID | ID |
| Metsulfuron | | ID | ID | ID | ID | ID | ID | ID | ID |
| **Thiocarbamate herbicides** | | | | | | | | | |
| Molinate | | 0.1 | 3.4 | 14 | 57 | ID | ID | ID | ID |
| Thiobencarb | | 1 | 2.8 | 4.6 | 8[C] | ID | ID | ID | ID |
| Thiram | | 0.01 | 0.2 | 0.8C | 3[A] | ID | ID | ID | ID |
| **Triazine herbicides** | | | | | | | | | |
| Amitrole | | ID | ID | ID | ID | ID | ID | ID | ID |
| Atrazine | | 0.7 | 13 | 45[C] | 150[C] | ID | ID | ID | ID |
| Hexazinone | | ID | ID | ID | ID | ID | ID | ID | ID |
| Simazine | | 0.2 | 3.2 | 11 | 35 | ID | ID | ID | ID |
| **Urea herbicides** | | | | | | | | | |
| Diuron | | ID | ID | ID | 0 | ID | ID | ID | ID |
| Tebuthiuron | | 0.02 | 2.2 | 20 | 160[C] | ID | ID | ID | ID |
| **Miscellaneous herbicides** | | | | | | | | | |

## Appendix A

| Chemicals | | Trigger values for freshwater ($\mu gL^{-1}$) Level of protection (% species) | | | | Trigger values for freshwater ($\mu gL^{-1}$) Level of protection (% species) | | |
|---|---|---|---|---|---|---|---|---|
| | 99% | 95% | 90% | 80% | 99% | 95% | 90% | 80% |
| Acrolein | ID | ID | ID | ID | ID | ID | ID | ID |
| Bromacil | ID | ID | ID | ID | ID | ID | ID | ID |
| Glyphosate | 370 | 1200 | 2000 | 3600[A] | ID | ID | ID | ID |
| Irnazethapyr | ID | 10 | ID | ID | ID | ID | ID | ID |
| loxynil | ID | ID | ID | ]D | ID | ID | ID | ID |
| Metolachlor | ID | ID | ID | [D | ID | ID | ID | ID |
| Sethoxydim | ID | ID | ID | ]D | ID | ID | ID | ID |
| Trifluralin B | 2.6 | 4.4 | 6 | 9[A] | ID | ID | ID | ID |
| **GENERIC GROUPS OF CHEMICALS** | | | | | | | | |
| **Surfactants** | | | | | | | | |
| Linear alkylbenzene suifonates (LAS) | 65 | 280 | 520[C] | 1000[C] | ID | ID | ID | ID |
| Alcohol ethoxyolated sulfate (AES) | 340 | 650 | 850[C] | 1100[C] | ID | ID | ID | ID |
| Alcohol ethoxylated surfactants (AE) | 50 | 140 | 220 | 360[C] | ID | ID | ID | ID |
| **Oils & Petroleum Hydrocarbons** | ID | ID | ID | ID | ID | ID | ID | ID |
| **Oil Spill Dispersants** | | | | | | | | |
| BP 1100X | ID | ID | ID | ID | ID | ID | ID | ID |
| Corexit 7664 | ID | ID | ID | ID | ID | ID | ID | ID |
| Corexit 8667 | ID | ID | ID | ID | ID | ID | ID | ID |
| Corexit 9527 | ID | ID | ID | ID | 230 | 1100 | 2200 | 4400[A] |
| Corexit 9550 | ID | ID | ID | ID | ID | ID | ID | ID |

Notes: Where the final water quality guideline to be applied to a site is below current analytical practical quantitation limits, see Section 3.4.3.3 for guidance.

Most trigger values listed here for metals and metalloids are *High reliability* figures, derived from field or chronic NOEC data (see 3.4.2.3 for reference to Volume 2). The exceptions are *Moderate reliability* for freshwater aluminium (pH >6.5), manganese and marine chromium (111).

Most trigger values listed here for non-metallic inorganics and organic chemicals are *Moderate reliability* figures, derived from acute LC.. data (see 3.4.2.3 for reference to Volume 2). The exceptions are *High reliability* for freshwater ammonia, 3,4-DCA, endosulfan, chlorpyrifos, esfenvalerate, tebuthiuron, three surfactants and marine for 1,1,2-TCE and chlorpyhfos.

*High reliability figure for esfenvalerate derived from mesocosm NOEC data (no alternative protection levels available).

A = Figure may not protect key test spades from acute toxicity (and chronic) - check Section 8.3.7 for spread of data and its significance. 'A' indicates that trigger value > acute toxicity figure; note that trigger value should be <1/3 of acute figure (Section 8.3.4.4).

B = Chemicals for which possible bioaccumulation and secondary poisoning effects should be considered (see Sections 8.3.3.4 and 8.3.5.7).

C = Figure may not protect key test species from chronic toxicity (this refers to experimental chronic figures or geometric mean for species) - check Section 8.3.7 for spread of data and its significance. Where grey shading and 'C'coincide, refer to text in Section 8.3.7.

D = Ammonia as TOTAL ammonia as [$NH_3$-N] at pH 8. For changes in trigger value with pH refer to Section 8.3.7.2.

E = Chlorine as total chlorine, as [Cl]; see Section 8.3.7.2.

F = Cyanide as un-ionised I-ICN, measured as [CN]; see Section 8.3.7.2.

G = Suifide as un-lonised $H_2S$, measured as [S]; see Section 8.3.7.2.

H = Chemicals for which algorithms have been provided in table 3.4.3 to account for the effects of hardness. The values have been calculated using a hardness of 30 mg/L CaC03. These should be adjusted to the site-specific hardness (see Section 3.4.3).

J = Figures protect against toxicity and do not relate to eutrophication issues. Refer to Section 3.3 if eutrophication is the issue of concern.

D = Insufficient data to derive a reliable trigger value. Users advised to check if a low reliability value or an ECL is given in Section 8.3.7.

T = Tainting or flavour impairment of fish flesh may possibly occur at concentrations below the trigger value. See Sections 4.4.5.313 and 8.3.7.

# APPENDIX B
# SUMMARY OF CONTAMINANT DATA IN PENRHYN ESTUARY, FORESHORE BEACH AND BOTANY BAY

**APPENDIX B**

**SEDIMENT CONTAMINATION IN PROPOSED DREDGE AND RECLAIM AREAS**

| | Guidelines | | | Surface Sediment Samples | | | | | | | | | | | | | Core Sediment Samples | | | | | | | | | | | | | Composite Samples | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ANZECC (2000) | | Source | Coffey (1999) | | | | | | | | | | | | | Kinhill (1990) | | | | Kinhill (1991) | | Coffey (1999) | | | | | | | Coffey (1999) | |
| | ISQG-Low | ISQG-High | Sample ID | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 | S10 | S11 | S12 | S13 | CP5 | S10 | S11 | S13 | S15 | 6 | 7 | CP20 | CP21 | CP22 | CP24 | CP25 | CP26 | CP27 | C1 | C2 |
| | | | Depth (m) | 0 - 0.25 | 0 - 0.3 | 0 - 0.25 | 0 - 0.4 | 0 - 0.3 | 0 - 0.45 | 0 - 0.4 | 0 - 0.35 | 0 - 0.2 | 0 - 0.35 | 0 - 0.2 | 0 - 0.35 | 0 - 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 - 1.2 | 1 - 1.2 | 1 - 1.2 | 1 - 1.2 | 1 - 1.2 | 1 - 1.2 | 1 - 1.2 | 3 | 3 |
| **INORGANICS** | | | Units | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Silver | 1 | 3.7 | mg/kg | <0.1 | <0.1 | <0.1 | 0.1 | <0.1 | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | <1 | | | | | | | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Arsenic | 20 | 70 | mg/kg | <1 | 1 | <1 | 2 | 2 | 7 | 5 | 2 | 11 | 2 | 6 | 2 | 5 | 3.3 | 5.5 | 0.5 | 2.9 | | | 1 | 1 | 1 | 1 | <1 | 2 | 1 | 1 | 2 |
| Cadmium | 1.5 | 10 | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | 0.3 | <0.2 | 1 | <0.2 | | | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Chromium | 80 | 370 | mg/kg | 1.2 | 3.8 | 1.4 | 8.7 | 4.4 | 18.7 | 19.1 | 11.8 | 27.8 | 8.7 | 15.9 | 8.1 | 23 | 9.4 | 14.1 | 2.9 | 5.8 | | | 1 | 1 | 6 | 1 | 1 | 2 | 3 | 4 | 2 |
| Copper | 65 | 270 | mg/kg | 0.9 | 2.2 | 1 | 4.2 | 2.5 | 6.7 | 7 | 5 | 12.3 | 5.4 | 8 | 4.6 | 16 | 6.1 | 10.8 | 1.4 | 3.8 | | | <1 | <1 | <1 | 2 | <1 | <1 | 4 | 4 | 9 |
| Mercury | 0.15 | 1 | mg/kg | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.3 | 0.3 | 0.2 | 0.3 | 0.2 | 0.2 | 0.1 | 0.5 | <0.2 | <0.2 | <0.3 | <0.2 | | | 0.1 | <0.1 | 0.1 | <0.1 | 0.1 | <0.1 | 0.1 | <0.1 | <0.1 |
| Nickel | 21 | 52 | mg/kg | <0.1 | 1.1 | 0.6 | 1.5 | 1 | 2.9 | 2.5 | 1.9 | 4.9 | 1.9 | 3.3 | 1.9 | 6 | | | | | | | <1 | <1 | <1 | 1 | <1 | 1 | <1 | <1 | 1 |
| Lead | 50 | 220 | mg/kg | 2.9 | 6.8 | 3.3 | 11 | 7.4 | 16.7 | 17.2 | 14.1 | 23.7 | 13.6 | 16.6 | 11.9 | 31 | 12.9 | 27.6 | 3.6 | 8.2 | | | <1 | <1 | <1 | 1 | 2 | 2 | 3 | 6 | 1 |
| Zinc | 200 | 410 | mg/kg | 4.3 | 10.1 | 4.3 | 9.6 | 6.8 | 37.1 | 36.6 | 26.2 | 59.6 | 25 | 39.8 | 21.7 | 75 | 30.5 | 47.1 | 9.5 | 19.3 | | | 1 | 2 | 9 | 4 | 1 | 6 | 7 | 9 | 4 |
| Cobalt | | | mg/kg | | | | | | | | | | | | | | 0.6 | 1 | 0.2 | 0.6 | | | | | | | | | | | |
| Tin | | | mg/kg | | | | | | | | | | | | | | 0.2 | 0.4 | 0.4 | 0.5 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **PCBS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total PCBs | 0.023 | - | mg/kg | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Organic Carbon | | | mg/kg | | | | | | | | | | | | | | 2800 | 5000 | 1200 | 2800 | | | | | | | | | | | |
| Organic Nitrogen | | | mg/kg | | | | | | | | | | | | | | <100 | <100 | <100 | <100 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **ORGANOCHLORINE PESTICIDES** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hexachlorobenzene | | | mg/kg | <0.02 | ` | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | | | | | | | | | | | | | | |
| DDT | | | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | | | | 0.77 | 0.06 | | | | | | | | | |
| DDE | 0.0022 | 0.027 | mg/kg | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | | | | 0.31 | | | | | | | | | | |
| Total DDT | 0.0016 | 0.046 | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | | | | 1.27 | 0.06 | | | | | | | | | |
| Dieldrin | 0.00002 | 0.008 | mg/kg | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | | | | 0.13 | | | | | | | | | | |
| Chlordane | 0.0005 | 0.006 | mg/kg | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | | | | | | | | | | | | | | |
| Heptachlor | | | mg/kg | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | | | | | | | | | | | | | | |
| Aldrin | | | mg/kg | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | | | | | 0.1 | | | | | | | | | |
| Endrin | 0.00002 | 0.008 | mg/kg | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | | | | | | | | | | | | | | |
| Chlorane | | | mg/kg | | | | | | | | | | | | | | | | | | 0.64 | 0.11 | | | | | | | | | |
| DDD | 0.002 | 0.02 | mg/kg | | | | | | | | | | | | | | | | | | 0.19 | | | | | | | | | | |
| Lindane | 0.00032 | 0.001 | mg/kg | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BHC | | | mg/kg | | | | | | | | | | | | | | <0.008 | <0.008 | <0.008 | <0.008 | | | | | | | | | | | |
| Heptachlor Epoxide | | | mg/kg | | | | | | | | | | | | | | | | | | 0.04 | | | | | | | | | | |
| Hexachlor biphenyl | | | mg/kg | | | | | | | | | | | | | | 0.02 | 0.02 | 0.008 | 0.1 | | | | | | | | | | | |
| Phosphorous | | | mg/kg | | | | | | | | | | | | | | 205 | 235 | 175 | 280 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **TOTAL PETROLEUM HYDROCARBONS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C6 - C9 Fraction | | | mg/kg | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | | | | | | | | | | | | | | | |
| C10 - C14 Fraction | | | mg/kg | <15 | <15 | <15 | <15 | <15 | <15 | <15 | <15 | <15 | <15 | <15 | <15 | <15 | | | | | | | | | | | | | | | |
| C15- C28 Fraction | | | mg/kg | <20 | <20 | <20 | 24 | <20 | 43 | 56 | 42 | 56 | 32 | 39 | 24 | 67 | | | | | | | | | | | | | | | |
| C19 - C36 Fraction | | | mg/kg | <20 | <20 | <20 | 28 | <20 | 45 | 61 | 44 | 67 | 34 | 46 | 25 | 65 | | | | | | | | | | | | | | | |
| Total C10 - C36 | | | mg/kg | <55 | <55 | <55 | 60 | <55 | 96 | 125 | 94 | 131 | 74 | 93 | 57 | 149 | 232 | 748 | <41 | <39 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **POLYNUCLEAR AROMATICS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| SURFACE WATER IN PENRYHN ESTUARY | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Guidelines** | | Location | **Penrhyn Estuary** | | | **Springvale Drain** | | | | | | | | | **Floodvale Drain** | | | |
| | **ANZECC (2000)** | | Source | **ICI Stage 1 (1990)** | **ICI Stage 2 (1996)** | | **ICI Stage 1 (1990)** | | | **ICI Stage 2 (1996)** | | | | | | **ICI Stage 1 (1990)** | **ICI Stage 2 (1996)** | | **Kinhill (1990)** |
| | **Fresh-water** | **Marine Waters/ Estuaries** | Sample ID | WS.1 | SW028-L | SW028-H | WS.3 | WS.30 | WS.4 | SW030-L | SW030-H | SW031-L | SW031-H | SW032-L | SW032-H | WS.2 | SW029-L | SW029-H | W11 |
| **Volatiles** | | | Units | | | | | | | | | | | | | | | | |
| 1,1-Dichlorethylene | - | - | ug/L | - | | | - | - | - | | | | | | | - | | | |
| Chloroform | - | - | ug/L | - | 10 | <1 | 48 | 54 | 290 | 300 | 20 | 1000 | 30 | 1000 | 100 | 69 | 100 | 100 | |
| 1,1,1-Trichloroethane | - | - | ug/L | - | <1 | <1 | - | - | - | 1 | <1 | 2 | <1 | 3 | <1 | - | <1 | <1 | |
| Carbon Tetrachloride | - | - | ug/L | 4 | 10 | <1 | 16 | 17 | 75 | 300 | 20 | 1000 | 20 | 1000 | 100 | 20 | 40 | 100 | |
| Trichloroethyene | - | - | ug/L | 27 | | | 67 | 67 | 670 | | | | | | | 27 | | | |
| 1,1,2-Trichloroethane | 6500 | 1900 | ug/L | 21 | 4 | 1 | 45 | 49 | 250 | 100 | 10 | 200 | 10 | 200 | 50 | 49 | 40 | 50 | |
| Perchloroethylene | | | ug/L | 5 | | | 13 | 12 | 66 | | | | | | | 4 | | | |
| Benzene | 950 | 700 | ug/L | | <1 | <1 | | | | 3 | <1 | 10 | <1 | 10 | <1 | | 20 | <1 | |
| Toluene | - | - | ug/L | | <1 | <1 | | | | 1 | 9 | 2 | <1 | 2 | <1 | | 2 | <1 | |
| Ethyl benzene | - | - | ug/L | | <1 | <1 | | | | <1 | <1 | <1 | <1 | <1 | <1 | | 1 | <1 | |
| p,m-Xylenes | - | - | ug/L | | <1 | <1 | | | | <1 | <1 | <1 | <1 | <1 | <1 | | 1 | <1 | |
| o-Xylene | 350 | - | ug/L | | <1 | <1 | | | | <1 | <1 | <1 | <1 | <1 | <1 | | 1 | <1 | |
| Dichloromethane | - | - | ug/L | | <10 | <1 | | | | 10 | <5 | 20 | <5 | 20 | <5 | | 10 | <5 | |
| Chloromethane | | | ug/L | | <1 | <1 | | | | <1 | <1 | <1 | <1 | <1 | <1 | | <1 | <1 | |
| Total Chloromethanes | | | ug/L | | 20 | 0 | | | | 610 | 40 | 2020 | 50 | 2020 | 200 | | 150 | 200 | |
| 1,2-Dichloroethane | - | - | ug/L | | 100 | 100 | | | | 1000 | 50 | 500 | 100 | 500 | 200 | | 2000 | 200 | |
| Chloroethane | | | ug/L | | <1 | <1 | | | | <1 | <1 | <1 | <1 | <1 | <1 | | <1 | <1 | |
| Total Chloroethanes | | | ug/L | | 14 | 40 | | | | 1100 | 60 | 702 | 110 | 703 | 250 | | 2040 | 250 | |
| Tetrachloroethene | - | - | ug/L | | 5 | <1 | | | | 200 | 80 | 200 | 20 | 100 | 80 | | 10 | 80 | |
| Trichloroethene | | | ug/L | | 20 | 2 | | | | 2000 | 50 | 2000 | 200 | 2000 | 300 | | 100 | 300 | |
| cis-1,2-Dichloroethene | | | ug/L | | 10 | <1 | | | | 1000 | 30 | 1000 | 100 | 1000 | 200 | | 30 | 200 | |
| trans-1,2-Dichloroethene | | | ug/L | | 2 | <1 | | | | 200 | 4 | 200 | 30 | 100 | 40 | | 10 | 40 | |
| 1,1-Dichloroethene | | | ug/L | | <1 | <1 | | | | 100 | | 100 | 4 | 100 | 10 | | 10 | 10 | |
| Chloroethene | | | ug/L | | 4 | <1 | | | | 200 | 10 | 300 | 40 | 300 | 100 | | 10 | 100 | |
| Total Chloroethenes | | | ug/L | | 41 | 2 | | | | 3700 | 175 | 3800 | 394 | 3600 | 730 | | 170 | 730 | |
| Ethene | | | ug/L | | <10 | <10 | | | | <10 | <10 | <10 | <10 | <10 | <10 | | <10 | <10 | |
| Cyclopentane | | | ug/L | | <10 | <10 | | | | <10 | <10 | <10 | <10 | <10 | <10 | | <10 | <10 | |
| Cylcohexane | | | ug/L | | <10 | <10 | | | | <10 | <10 | <10 | <10 | <10 | <10 | | <10 | <10 | |
| Carbon Bisulphide | | | ug/L | | 4 | <1 | | | | <1 | <1 | <1 | <1 | <1 | <1 | | <1 | <1 | |
| | | | | | | | | | | | | | | | | | | | |
| **Semivolatiles** | | | | | | | | | | | | | | | | | | | |
| Hexachloroethane | - | - | ug/L | - | <0.1 | <0.1 | - | - | - | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | - | <0.1 | <0.1 | |
| Hexachlorobutadiene | | | ug/L | - | <0.1 | <0.1 | - | - | - | 0.1 | <0.1 | 0.1 | <0.1 | <0.1 | <0.1 | - | <0.1 | <0.1 | |
| Hexachlorobenzene | 0.1 | - | ug/L | - | <0.1 | <0.1 | - | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | - | <0.1 | <0.1 | |
| 1,3-Dichlorobenzene | 260 | - | ug/L | | <0.1 | <0.1 | | | | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 | <0.1 | |
| 1,4-Dichlorobenzene | 60 | - | ug/L | | <0.1 | <0.1 | | | | 1 | 0.2 | 0.2 | 1 | <0.1 | <0.1 | | 0.3 | <0.1 | |
| 1,2-Dichlorobenzene | 160 | - | ug/L | | <0.1 | <0.1 | | | | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | 0.2 | <0.1 | |
| 1,3,5-Trichlorobenzene | 13 | - | ug/L | | <0.1 | <0.1 | | | | <0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 | <0.1 | |

| SURFACE WATER IN PENRYHN ESTUARY | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Guidelines** | | Location | **Penrhyn Estuary** | | | **Springvale Drain** | | | | | | | | | **Floodvale Drain** | | | |
| | **ANZECC (2000)** | | Source | **ICI Stage 1 (1990)** | **ICI Stage 2 (1996)** | | **ICI Stage 1 (1990)** | | | **ICI Stage 2 (1996)** | | | | | | **ICI Stage 1 (1990)** | **ICI Stage 2 (1996)** | | **Kinhill (1990)** |
| | **Fresh-water** | **Marine Waters/ Estuaries** | Sample ID | WS.1 | SW028-L | SW028-H | WS.3 | WS.30 | WS.4 | SW030-L | SW030-H | SW031-L | SW031-H | SW032-L | SW032-H | WS.2 | SW029-L | SW029-H | W11 |
| 1,2,4-Trichlorobenzene | 170 | - | ug/L | | <0.1 | <0.1 | | | | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 | <0.1 | |
| Tetrachlorobenzene | | | ug/L | | <0.1 | <0.1 | | | | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 | <0.1 | |
| Pentachlorobenzene | 2 | - | ug/L | | <0.1 | <0.1 | | | | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 | <0.1 | |
| | | | | | | | | | | | | | | | | | | | |
| **Inorganics** | | | | | | | | | | | | | | | | | | | |
| Mercury | 0.6 | 0.4 | ug/L | 0.4 | | | 2 | 0.7 | 1 | | | | | | | 0.9 | | | <1 |
| Chromium | - | 27.4 | ug/L | - | | | - | - | - | | | | | | | - | | | <100 |
| Aluminium | 55 | - | ug/L | | | | | | | | | | | | | | | | 300 |
| Cadmium | 0.2 | 5.5 | ug/L | | | | | | | | | | | | | | | | <100 |
| Manganese | 1900 | - | ug/L | | | | | | | | | | | | | | | | 300 |
| Zinc | 8 | 15 | ug/L | | | | | | | | | | | | | | | | 200 |
| Sulphide | | | ug/L | 130 | | | 300 | - | 700 | | | | | | | 130 | | | |
| | | | | | | | | | | | | | | | | | | | |
| THC | | | | | | | | | | | | | | | | | | | 2.5 |
| PCB | | | ug/L | | | | | | | | | | | | | | | | <0.5 |
| | | | | | | | | | | | | | | | | | | | |
| **Nutrients** | | | | | | | | | | | | | | | | | | | |
| Total N | 350 | 300 | ug/L | | | | | | | | | | | | | | | | 5580 |
| Total P | 10 | 30 | ug/L | | | | | | | | | | | | | | | | 120 |
| Chlorophyll-a | 5 | 4 | ug/L | | | | | | | | | | | | | | | | 20.5 |
| | | | | | | | | | | | | | | | | | | | |
| **Bacteria** | | | | | | | | | | | | | | | | | | | |
| Faecal Coliform | | | cfu/100mL | | | | | | | | | | | | | | | | 11800 |
| | | | | | | | | | | | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | | | | | | | |
| Conductivity | | | uS/cm | 36800 | | | #### | 14600 | 4650 | | | | | | | 30700 | | | |
| pH | 6.5-8.0 | 7.0-8.5 | | 7.74 | | | 7.44 | 7.44 | 7.52 | | | | | | | 7.34 | | | |
| TSS | | | mg/L | | | | | | | | | | | | | | | | 95.2 |
| * EPA guidelines (based on ANZECC 2000) | | | | | | | | | | | | | | | | | | | |
| L = Low tide | | | | | | | | | | | | | | | | | | | |
| H = High tide | | | | | | | | | | | | | | | | | | | |

| SURFACE WATER IN THE MILL STREAM | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Guidelines** | | | Location | **Mill Stream** | | | | | | | | | | | |
| | **ANZECC (2000)** | | **NHMRC/ ARMCANZ (1996)** | Source | **Kinhill (1990)** | | | | | | **Aquatec April 1992** | | **Aquatec July 1992** | | **Aquatec May 1992** | |
| | **Fresh-water** | **Marine water** | **Drinking Water** | Sample ID | W10 | E P SW | EP2 | EP3 | EP4 | EP5 | A20-S | A20-B | A20-S | A20-B | A20-S | A20-B |
| **Inorganics** | | | | Units | | | | | | | | | | | | |
| Mercury | 0.6 | 0.4 | 1 | ug/L | <1 | | | | | | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Chromium | - | 27.4 | (IV) 50 | ug/L | <100 | | | | | | <2 | 2 | <2 | <2 | <2 | <2 |
| Aluminium | 55 | - | - | ug/L | 400 | | | | | | <10 | 20 | 30 | 70 | 20 | 90 |
| Cadmium | 0.2 | 5.5 | 2 | ug/L | <100 | <10 | <10 | <10 | <10 | <10 | <1 | <1 | <1 | <1 | <1 | <1 |
| Manganese | 1900 | - | 500 | ug/L | <100 | | | | | | | | | | | |
| Zinc | 8 | 15 | - | ug/L | 200 | 70 | 440 | 200 | 50 | 60 | <50 | <50 | <50 | <50 | <50 | <50 |
| Lead | 3.4 | 4.4 | 10 | ug/L | | <100 | <100 | <100 | <100 | <100 | <5 | <5 | <5 | <5 | <5 | <5 |
| Arsenic | | | 7 | ug/L | | <1 | <1 | <1 | <1 | <1 | 0.8 | 1 | 1.1 | 1.5 | 1.4 | 1.4 |
| Molybdenum | | | | ug/L | | <100 | <100 | <100 | <100 | <100 | | | | | | |
| Nickel | 11 | 70 | 20 | | | | | | | | 2.5 | 2.5 | 6 | 9 | 5 | 8 |
| Iron | | | | | | <10 | 90 | 100 | 60 | 470 | | | | | | |
| Copper | 1.4 | 1.3 | 2 | | | | | | | | <5 | <5 | <5 | <5 | <5 | 11 |
| Total Cyanide | | | 80 | ug/L | | | | | | | <10 | <10 | <10 | <10 | <10 | <10 |
| | | | | | | | | | | | | | | | | |
| Oil and Grease | | | | ug/L | | | | | | | <1 | <1 | <1 | <1 | <1 | <1 |
| Total OC | | | | ug/L | | | | | | | <1 | <1 | <1 | <1 | <1 | <1 |
| TBT | | | | ug/L | | | | | | | <10 | <10 | <10 | <10 | <10 | <10 |
| PAH | | | | ug/L | | | | | | | <10 | <10 | <10 | <10 | <10 | <10 |
| TPH | - | - | | mg/L | | | | | | | <1 | <1 | <1 | <1 | <1 | <1 |
| TOC | | | | mg/L | | | | | | | 0.5 | <0.1 | 2.3 | 1.7 | 2 | 2.2 |
| THC | | | | | 3.3 | | | | | | | | | | | |
| PCB | | | | | <0.5 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| **Nutrients** | | | | | | | | | | | | | | | | |
| Total N | 0.35 | 0.12 | | mg/L | 5650 | | | | | | 0.4 | 0.3 | 0.6 | 0.24 | 0.3 | <0.2 |
| Total P | 0.01 | 0.025 | | mg/L | 1805 | | | | | | 0.05 | 0.07 | 0.09 | 0.065 | 0.035 | 0.075 |
| Chlorophyll-a | 5 | 1 | | ug/L | 3.6 | | | | | | 1 | 1 | <1 | | 2 | 2 |
| | | | | | | | | | | | | | | | | |
| **Bacteria** | | | | | | | | | | | | | | | | |
| Faecal Coliform | | | 150* | cfu/100mL | 1.5 mil | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | | | | |
| pH | | | - | | | 7.56 | 7.81 | 7.83 | 6.59 | 6.58 | | | | | | |
| Temperature | | | - | oC | | 22 | 22 | 22 | 20 | 21 | | | | | | |
| TSS | | | | mg/L | 33.7 | | | | | | 2 | 3 | <1 | <1 | <1 | <1 |
| Turbidity | | | 5-10* | NTU | | | | | | | 2 | 2 | 1.4 | 1.3 | 0.4 | 0.5 |
| BOD | | | | mg/L | | | | | | | 3.3 | 1.5 | 2.6 | 2.6 | <1 | <1 |

| SURFACE WATER IN THE MILL STREAM | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Guidelines** | | | Location | **Mill Stream** | | | | | | | | | | | |
| | **ANZECC (2000)** | | **NHMRC/ ARMCANZ (1996)** | Source | **Kinhill (1990)** | | | | | | **Aquatec April 1992** | | **Aquatec July 1992** | | **Aquatec May 1992** | |
| | **Fresh-water** | **Marine water** | **Drinking Water** | Sample ID | W10 | E P SW | EP2 | EP3 | EP4 | EP5 | A20-S | A20-B | A20-S | A20-B | A20-S | A20-B |
| * EPA guidelines (based on ANZECC 2000) | | | | | | | | | | | | | | | | |
| S = Surface sample | | | | | | | | | | | | | | | | |
| B = Bottom sample | | | | | | | | | | | | | | | | |

| SURFACE WATER NEAR FORESHORE BEACH | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Guidelines | | | Location | Foreshores Beach | | | | | | | | | | | | | | | | | | | | | | | | | |
| | ANZECC (2000) | | NHMRC/ ARMCANZ (1996) | Source | ICI Stage 2 (1996) | | | | | | Kinhill (1990) | | Aquatec April 1992 | | Aquatec July 1992 | | Aquatec May 1992 | | Harbourwatch (2001) | | | | | | | | | | | |
| | Fresh-water | Marine Waters | Drinking Water | Sample ID | SW 025-L | SW 025-H | SW 026-L | SW 026-H | SW 027-L | SW 027-H | W4 | W3 | A2-S | A2-B | A2-S | A2-B | A2-S | A2-B | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
| | | | | Units | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Volatiles** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,1-Dichlorethylene | - | - | | ug/L | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chloroform | - | - | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | - | - | - | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| Carbon Tetrachloride | - | - | 3 | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| Trichloroethyene | - | - | | ug/L | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,1,2-Trichloroethane | 6500 | 1900 | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| Perchloroethylene | | | | ug/L | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Benzene | 950 | 700 | 1 | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| Toluene | - | - | 800 | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| Ethyl benzene | - | - | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| p,m-Xylenes | - | - | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| o-Xylene | 350 | - | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| Dichloromethane | - | - | 4 | ug/L | <10 | <5 | <10 | <5 | <10 | <5 | | | | | | | | | | | | | | | | | | | | |
| Chloromethane | | | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| Total Chloromethanes | | | | ug/L | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | |
| 1,2-Dichloroethane | - | - | 3 | ug/L | <1 | <1 | <1 | <1 | <1 | 1 | | | | | | | | | | | | | | | | | | | | |
| Chloroethane | | | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| Total Chloroethanes | | | | ug/L | 0 | 0 | 0 | 0 | 0 | 1 | | | | | | | | | | | | | | | | | | | | |
| Tetrachloroethene | - | - | 50 | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| Trichloroethene | | | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| cis-1,2-Dichloroethene | | | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| trans-1,2-Dichloroethene | | | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| 1,1-Dichloroethene | | | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| Chloroethene | | | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| Total Chloroethenes | | | | ug/L | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | |
| Ethene | | | | ug/L | <10 | <10 | <10 | <10 | <10 | <1 | | | | | | | | | | | | | | | | | | | | |
| Cyclopentane | | | | ug/L | <10 | <10 | <10 | <10 | <10 | <1 | | | | | | | | | | | | | | | | | | | | |
| Cylcohexane | | | | ug/L | <10 | <10 | <10 | <10 | <10 | <1 | | | | | | | | | | | | | | | | | | | | |
| Carbon Bisulphide | | | | ug/L | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Semivolatiles** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hexachloroethane | - | - | | ug/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | | | | | | | | | | | | | | | | | | | |
| Hexachlorobutadiene | | | 0.7 | ug/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | | | | | | | | | | | | | | | | | | | |
| Hexachlorobenzene | 0.1 | - | | ug/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | | | | | | | | | | | | | | | | | | | |
| 1,3-Dichlorobenzene | 260 | - | - | ug/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | | | | | | | | | | | | | | | | | | | |
| 1,4-Dichlorobenzene | 60 | - | 40 | ug/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | | | | | | | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene | 160 | - | 1500 | ug/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | | | | | | | | | | | | | | | | | | | |
| 1,3,5-Trichlorobenzene | 13 | - | | ug/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | | | | | | | | | | | | | | | | | | | |
| 1,2,4-Trichlorobenzene | 170 | - | | ug/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | | | | | | | | | | | | | | | | | | | |
| Tetrachlorobenzene | | | | ug/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | | | | | | | | | | | | | | | | | | | |
| Pentachlorobenzene | 2 | - | | ug/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Inorganics** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mercury | 0.6 | 0.4 | 1 | ug/L | | | | | | | 2 | 1 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | | | | | | | | | | | | |
| Chromium | - | 27.4 | (IV) 50 | ug/L | | | | | | | 100 | 100 | <2 | <2 | 2 | <2 | <2 | <2 | | | | | | | | | | | | |
| Aluminium | 55 | - | - | ug/L | | | | | | | 200 | 100 | 10 | 10 | 10 | 40 | 30 | 80 | | | | | | | | | | | | |
| Cadmium | 0.2 | 5.5 | 2 | ug/L | | | | | | | 200 | 200 | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | |
| Manganese | 1900 | - | 500 | ug/L | | | | | | | 100 | <100 | | | | | | | | | | | | | | | | | | |

| SURFACE WATER NEAR FORESHORE BEACH | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Guidelines | | | Location | Foreshores Beach | | | | | | | | | | | | | | | | | | | | | | | | | |
| | ANZECC (2000) | | NHMRC/ ARMCANZ (1996) | Source | ICI Stage 2 (1996) | | | | | | Kinhill (1990) | | Aquatec April 1992 | | Aquatec July 1992 | | Aquatec May 1992 | | Harbourwatch (2001) | | | | | | | | | | | |
| | Fresh-water | Marine Waters | Drinking Water | Sample ID | SW 025-L | SW 025-H | SW 026-L | SW 026-H | SW 027-L | SW 027-H | W4 | W3 | A2-S | A2-B | A2-S | A2-B | A2-S | A2-B | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
| Zinc | 8 | 15 | - | ug/L | | | | | | | <100 | <100 | <50 | <50 | <50 | <50 | <50 | <50 | | | | | | | | | | | | |
| Lead | 3.4 | 4.4 | 10 | ug/L | | | | | | | | | <5 | <5 | <5 | <5 | <5 | <5 | | | | | | | | | | | | |
| Arsenic | | | 7 | ug/L | | | | | | | | | 1 | 1 | 1.7 | 1.2 | 1.3 | 1.3 | | | | | | | | | | | | |
| Nickel | 11 | 70 | 20 | ug/L | | | | | | | | | 2.5 | 2.5 | 6 | 6 | 7 | 7 | | | | | | | | | | | | |
| Copper | 1.4 | 1.3 | 2 | ug/L | | | | | | | | | <5 | <5 | 8 | 7 | 7 | 8 | | | | | | | | | | | | |
| Total Cyanide | | | 80 | ug/L | | | | | | | | | <10 | <10 | <10 | <10 | <10 | <10 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Oil and Grease | | | | ug/L | | | | | | | | | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | |
| Total OC | | | | ug/L | | | | | | | | | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | |
| TBT | | | | ug/L | | | | | | | | | <10 | <10 | <10 | <10 | <10 | <10 | | | | | | | | | | | | |
| PAH | | | | ug/L | | | | | | | | | <10 | <10 | <10 | <10 | <10 | <10 | | | | | | | | | | | | |
| TPH | - | - | | ug/L | | | | | | | | | <1 | <1 | <1 | <1 | <1 | <1 | | | | | | | | | | | | |
| TOC | | | | mg/L | | | | | | | | | 1.5 | 1.6 | 1.4 | 1.4 | 1.8 | 1.7 | | | | | | | | | | | | |
| THC | | | | ug/L | | | | | | | 3.5 | 2 | | | | | | | | | | | | | | | | | | |
| PCB | | | | ug/L | | | | | | | <0.5 | <0.5 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Nutrients** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total N | 0.35 | 0.12 | | mg/L | | | | | | | 2.1 | 0.27 | <0.2 | <0.2 | <0.2 | <0.2 | 0.5 | <0.2 | | | | | | | | | | | | |
| Total P | 0.01 | 0.025 | | mg/L | | | | | | | 0.048 | 0.05 | 0.1 | 0 | 0.1 | 0 | 0 | 0.1 | | | | | | | | | | | | |
| Chlorophyll-a | 5 | 1 | | ug/L | | | | | | | 15.5 | 12.3 | 1 | 1 | <1 | <1 | <1 | 1 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Bacteria** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Faecal Coliform | | | 150* | cfu/100mL | | | | | | | 3000 | 2100 | | | | | | | <150 | >150 | >150 | >150 | >150 | <150 | <150 | <150 | <150 | <150 | <150 | <150 |
| Enterococci | | | 35* | cfu/100mL | | | | | | | | | | | | | | | <35 | >35 | >35 | >35 | >35 | <35 | >35 | <35 | <35 | >35 | >35 | <35 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Conductivity | | | | uS/cm | | | | | | | | | | | | | | | | | | | | | | | | | | |
| pH | | | - | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dissolved O2 | | | - | % sat | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Temperature | | | - | oC | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TSS | | | | mg/L | | | | | | | 4.3 | 3.8 | 1 | <1 | 1 | 2 | 1 | <1 | | | | | | | | | | | | |
| Turbidity | | | 5-10* | NTU | | | | | | | | | 1.1 | 1 | 0.5 | 0.6 | 0.9 | 0.9 | | | | | | | | | | | | |
| BOD | | | | mg/L | | | | | | | | | 3 | 1.9 | 2.4 | 2.1 | <1 | <1 | | | | | | | | | | | | |

* EPA guidelines (based on ANZECC 2000) for rolling median (5 per month)
L = Low tide
H = High tide
S = Surface sample
B = Bottom sample

| SURFACE WATER IN BOTANY BAY | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Guidelines** | | | Location | **Botany Bay** | | | | | | | | | | | | |
| | **ANZECC (2000)** | | **NHMRC/ ARMCANZ (1996)** | Source | **Kinhill (1990)** | **Aquatec April 1992** | | | | **Aquatec July 1992** | | | | **Aquatec May 1992** | | | |
| | **Fresh-water** | **Marine Waters** | **Drinking Water** | Sample ID | W2 | A3-S | A3-B | A4-S | A4-B | A3-S | A3-B | A4-S | A4-B | A3-S | A3-B | A4-S | A4-B |
| **Inorganics** | | | | Units | | | | | | | | | | | | | |
| Mercury | 0.6 | 0.4 | 1 | ug/L | 3 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Chromium | - | 27.4 | (IV) 50 | ug/L | 100 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | 3 | <2 | <2 | <2 | <2 |
| Aluminium | 55 | - | - | ug/L | <100 | <10 | 20 | <10 | <10 | 20 | 40 | 20 | 50 | 40 | 80 | 20 | 20 |
| Cadmium | 0.2 | 5.5 | 2 | ug/L | 200 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Zinc | 8 | 15 | - | ug/L | <100 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 |
| Lead | 3.4 | 4.4 | 10 | ug/L | | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Arsenic | | | 7 | ug/L | | 1.1 | 1.1 | 1.1 | 1.1 | 1.4 | 1.3 | 1.4 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 |
| Nickel | 11 | 70 | 20 | | | 2.5 | 2.5 | 2.5 | 5 | 5 | 7 | 6 | 7 | 7 | 7 | 5 | 6 |
| Copper | 1.4 | 1.3 | 2 | | | <5 | 8 | <5 | 5 | <5 | 6 | <5 | <5 | 7 | 8 | 6 | <5 |
| Total Cyanide | | | 80 | ug/L | | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| | | | | | | | | | | | | | | | | | |
| Oil and Grease | | | | ug/L | | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Total OC | | | | ug/L | | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| TBT | | | | ug/L | | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| PAH | | | | ug/L | | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | |
| TPH | - | - | | ug/L | | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| TOC | | | | mg/L | | 1.3 | 1.4 | 1.7 | 2 | 1.2 | 1.4 | 1.4 | 0.9 | 1.7 | 1.7 | 1.7 | 23.4 |
| THC | | | | ug/L | 1.8 | | | | | | | | | | | | |
| PCB | | | | ug/L | <0.5 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| **Nutrients** | | | | | | | | | | | | | | | | | |
| Total N | 0.35 | 0.12 | | mg/L | 0.36 | <0.2 | <0.2 | 0.3 | 0.3 | <0.2 | 0.22 | 0.4 | 0.23 | <0.2 | <0.2 | 0.4 | <0.2 |
| Total P | 0.01 | 0.025 | | mg/L | 0.068 | 0.03 | 0.05 | 0.04 | 0.045 | 0.06 | 0.065 | 0.05 | 0.07 | 0.055 | 0.08 | 0.045 | 0.075 |
| Chlorophyll-a | 5 | 1 | | ug/L | 7.3 | <1 | 1 | <1 | <1 | 2 | <1 | 1 | 1 | 1 | 1 | 3 | <1 |
| | | | | | | | | | | | | | | | | | |
| **Bacteria** | | | | | | | | | | | | | | | | | |
| Faecal Coliform | | | 150* | cfu/100mL | 530 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | | | | | |
| TSS | | | | mg/L | 4.3 | 1 | 2 | <1 | 8 | 2 | 3 | 2 | 2 | <1 | 1 | <1 | 2 |
| Turbidity | | | 5-10* | NTU | | 1.1 | 1.3 | 1.1 | 4 | 0.6 | 0.6 | 0.7 | 0.8 | 0.6 | 0.9 | 0.8 | 0.5 |
| BOD | | | | mg/L | | 2.4 | 1.8 | 2.5 | 1.5 | 2.1 | 2 | 2.1 | 2 | <1 | <1 | <1 | 2.1 |
| * EPA guidelines (based on ANZECC 2000) | | | | | | | | | | | | | | | | | |
| S = Surface sample | | | | | | | | | | | | | | | | | |
| B = Bottom sample | | | | | | | | | | | | | | | | | |

**SEDIMENT CONTAMINATION IN PROPOSED DREDGE AND RECLAIM AREAS**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acenaphthene | 0.016 | 0.5 | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | | | | | | | | | | | | | | | |
| Anthracene | 0.085 | 1.1 | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | | | | | | | | | | | | | | | |
| Fluorene | 0.019 | 0.5 | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | | | | | | | | | | | | | | | |
| Napthlaene | 0.16 | 2.1 | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | | | | | | | | | | | | | | | |
| Phenanthrene | 0.24 | 1.5 | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.05 | 0.05 | <0.05 | 0.07 | <0.05 | <0.05 | <0.05 | 0.05 | | | | | | | | | | | | | | | |
| *Low Molecular Weight PAHs* | *0.508* | *2.52* | *mg/kg* | *0* | *0* | *0* | *0* | *0* | *0.05* | *0.05* | *0* | *0.07* | *0* | *0* | *0* | *0.05* | | | | | | | | | | | | | | | |
| Benz(a)anthracene | 0.261 | 1.6 | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.07 | 0.06 | 0.05 | 0.08 | <0.05 | <0.05 | <0.05 | 0.09 | | | | | | | | | | | | | | | |
| Benzo(a)pyrene | 0.43 | 1.6 | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.08 | 0.09 | 0.05 | 0.1 | <0.05 | <0.05 | <0.05 | 0.1 | | | | | | | | | | | | | | | |
| Dibenz(a.h) anthracene | 0.063 | 0.26 | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | | | | | | | | | | | | | | | |
| Chrysene | 0.384 | 2.8 | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.07 | 0.08 | 0.05 | 0.08 | <0.05 | <0.05 | <0.05 | 0.1 | | | | | | | | | | | | | | | |
| Fluoranthene | 0.6 | 5.1 | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.13 | 0.13 | 0.09 | 0.16 | <0.05 | 0.08 | <0.05 | 0.15 | | | | | | | | | | | | | | | |
| Pyrene | 0.665 | 2.6 | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.13 | 0.14 | 0.1 | 0.16 | <0.05 | 0.08 | <0.05 | 0.15 | | | | | | | | | | | | | | | |
| *High Molecular Weight PAHs* | *1.7* | *9.6* | *mg/kg* | *0* | *0* | *0* | *0* | *0* | *0.48* | *0.5* | *0.34* | *0.58* | *0* | *0.16* | *0* | *0.59* | | | | | | | | | | | | | | | |
| 2-Methylnapthalene | | | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | | | | | | | | | | | | | | | |
| Total PAH | 4 | 45 | mg/kg | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | 0.7 | 0.7 | 0.5 | 0.8 | <0.3 | 0.4 | <0.3 | 0.74 | | | | | | | | | | | | | | | |
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| **ORGANOTIN COMPOUNDS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Monobutyltin | | | mg/kg | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.0005 | <0.0005 | <0.0005 | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | | |
| Dibutyltin | | | mg/kg | 0.0005 | <0.0005 | <0.0005 | 0.0005 | <0.0005 | <0.0005 | 0.0005 | 0.0006 | <0.0005 | 0.0006 | 0.0002 | 0.0009 | 0.0028 | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | | |
| Tributyltin | 0.005 | 0.07 | mg/kg | 0.0005 | 0.0005 | 0.0006 | 0.0009 | 0.0006 | 0.0008 | 0.0009 | 0.0016 | 0.0028 | 0.0015 | 0.0077 | 0.0018 | 0.013 | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | | |
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| **RADIONUCLIDES** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Potassium-40 | | | Bq/kg | | | | | | 120 | | | | | | | | | | | | | | | | | | | | | | |
| Uranium-238 | | | Bq/kg | | | | | | 12 | | | | | | | | | | | | | | | | | | | | | | |
| Radium-226 | | | Bq/kg | | | | | | 18 | | | | | | | | | | | | | | | | | | | | | | |
| Lead-210 | | | Bq/kg | | | | | | 15 | | | | | | | | | | | | | | | | | | | | | | |
| Radium-228 | | | Bq/kg | | | | | | 12 | | | | | | | | | | | | | | | | | | | | | | |
| Thorium-228 | | | Bq/kg | | | | | | 12 | | | | | | | | | | | | | | | | | | | | | | |
| Caesium-137 | | | Bq/kg | | | | | | 0.7 | | | | | | | | | | | | | | | | | | | | | | |
| Beryllium-7 | | | Bq/kg | | | | | | <3 | | | | | | | | | | | | | | | | | | | | | | |
| C1 = Composite of samples CP20, CP21, CP23 and CP24 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C2 = Composite of samples CP25, C26 and CP27 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |