APPENDIX K

ODOUR REPORT (UNSW)

environmental odour laboratory

CENTRE FOR WATER AND WASTE TECHNOLOGY

UNSW

Odour Impact Assessment:

Proposed extension of shipping channels,

Port of Newcastle

March 2003

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1. Executive summary

The Newcastle Port Corporation (NPC) is currently in the process of preparing a development application for "Proposed extension of shipping channels, Port of Newcastle". GHD and Patterson Britton have been engaged to prepare an Environmental impact assessment (EIS) for the project. The Environmental Odour Laboratory (EOL) at the University of New South Wales was commissioned to undertake an odour impact assessment.

The assessment involved identification of the odour emission sources, and estimation of odour emission rate for each possible source. Odour sources were investigated for several simulation tests:

- A dredging simulation test was arranged on the dredging barge on 14 – 15 January 2003, and
- Onshore treatment and disposal simulation tests were carried out inside a large shed at Dyke Point, Newcastle from 20 January 2003 to 31 January 2003.

The potential odour impact of the proposed project was assessed using the Ausplume dispersion model with the Newcastle BHP site meteorological data for 1991-95 and test results as input.

The assessment results indicated that PAH compounds would cause the majority of odour arising from this project. It was found that there was little difference in odour emissions with either of the dredging methods proposed: mechanical excavator on a barge, hydraulic cutter suction dredge. However, the proposal to dewater the recovered material prior to stabilisation with the use of geotextile bags over a large area within a temporary treatment facility (TTF) was found to generate more odour than a confined disposal facility (CDF). It was also found that dredging and disposal activities may not necessarily need to be covered, if geotextile bag dewatering is not used.

It is concluded that the odour impact to the sensitive receptors around the site would be maintained at acceptable levels if the treatment and disposal options are implemented, in accordance with the recommendations of this study.

2. Introduction

2.1 Background

The University of New South Wales Environmental Odour Laboratory (EOL) was engaged by the GHD/Patterson Britton project team to prepare an odour impact assessment as part of the preparation of an EIS for the dredging of the South Arm of Hunter River, Newcastle.

2.2 Project summary

The project would involve the removal and disposal of an estimated 13 million m^3 of material. Some of this material (an estimated 250,000 m^3 of soft sediment), which is located immediately adjacent to the former BHP steelworks site, is contaminated and is unsuitable for unconfined sea disposal or reclamation purposes onshore. This material, which is comprised of silts and clays, will need to undergo a remediation process onshore prior to appropriate onshore/offshore disposal. Onshore treatment alternatives under consideration comprise confined disposal of fines (CDF) and a temporary treatment facility (TTF) utilising geotextile tubes.

The contaminants that have been identified in this material include naphthalene, petrol/hydrocarbons and hydrogen sulfide. However, where naphthalene is present, the smell of "moth balls" tends to dominate. Odour generation during the removal, transportation and treatment activities is anticipated to be a key issue and may ultimately influence the selection of the type of plant and equipment, and the construction methodology.

This outline describes the approach proposed by EOL in the determination of odour emissions and chemical composition of the off gas released during the remediation. It covers sample collection, testing and emission rate determination of odour, hydrogen sulphide, PAHs and VOCs. Also included are meteorological data analysis, dispersion modelling, odour impact assessment and recommendations for dredging and treatment methods.

2.3 Scope of study

In order to satisfy the requirements of NSW EPA, the scope of work for this study involved the completion of the following activities:

- Initial consultation with the EPA to confirm the scope of work and methodology for air quality and odour studies;
- Completion of air quality sampling and analysis to identify the compositions and concentrations of gases that are likely to be emitted:
    a) From the excavator which involved obtaining representative snap shot odour samples for bulk sediment sampling locations corresponding to medium and high contamination levels,
    b) From samples stored onshore which were mixed at moisture contents to replicate slurries likely to be produced by the two different dredging technologies under

consideration for sediment samples corresponding to medium and high contamination levels;

- Establishment of odour emission rates from the bulk samples stored onshore for sediment sampling locations corresponding to low, medium and high contamination levels for each dredging processes under consideration (mechanical and cutter suction) and for each onshore treatment options under consideration (CDF and TTF);
- Dispersion modelling of the odour emission under the prevailing local weather conditions utilising the Ausplume Dispersion Model (version 5.4);
- Interpretation of the results of the modelling for nuisance odour;
- If required, the recommendation of mitigation measures to reduce the risks associated with nuisance odour; and
- Preparation of a final odour assessment report summarising approach, methodology, results, findings and recommendations, which would be a stand-alone document and form an Appendix to the EIS document.

The above scope of works would be undertaken to satisfy the requirements of the EPA as outlined in their letter, dated 27the November 2002. A copy of this letter is included in Appendix 9.4.

3. Statutory requirements and other issues considered

The requirements of the NSW EPA were outlined in the EPA letter dated 27th November 2002 (refer to Appendix 9.4).

The EPA's preferred approach to the AQIA (Air Quality Impact Assessment) was set out in the document titled "Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales" (NSW EPA, 2001).

The AQIA must include a detailed odour impact assessment for all activities associated with the excavation, dredging, handling or remediation of contaminated soils and sediments with a potential to emit odours. The EPA's preferred approach to odour assessment is detailed in the document titled "Assessment and Management of Odour from Statutory Sources in NSW" (NSW EPA, 2001).

Given that the sediments are known to contain high concentrations of naphthalene and other odour generating substances, the methodology described for a "level 3 assessment" in the above-mentioned document should be followed. Odour source data used in the assessment should be derived in accordance with procedures described in the document titled "Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales" (NSW EPA) methods OM7 and OM8.

The EIS must describe in detail the measures proposed to mitigate the impacts and quantitatively describe the extent to which the mitigation measures are likely to be effective in achieving relevant assessment criteria.

The EIS should describe the methods and procedures that will be adopted to monitor the performance of the pollution control systems or site management practices to be implemented to control or mitigate the emissions to air for the duration of the development works.

4. Methodology

4.1 Sources of odours

Three potential emission sources were identified for the whole project process:

- Barge Mounted Excavator Process (BMEP) if this dredging technology were adopted
- Confined Disposal Facility (CDF)
- Temporary Treatment Facility (TTF)

The odour emissions were further sub-divided into five major odour sources:

1) Open area on the hopper barge, which would be used to store and transport material removed by the mechanical excavator type dredger. This, could be:
   - 40 meters long by 6 meters wide (if uncovered), or
   - 2 meters long by 2 meters wide (if covered)
2) The water surface located immediately adjacent to the dredging location. For the purpose of this study, this water surface area has been considered to be 10 m long by 10m wide which corresponds to the dimensions of the turbidity curtain.
3) Unloading/ transfer of material from barge at the temporary wharf, which could be:
   - 40 meters long by 6 meters wide, or
   - 2 meters long by 2 meters wide
4) Transporting of material by truck (with dimensions 5m by 2m) between the wharf and the temporary holding/ containment basin.
5) Cement stabilisation area and/or cement stabilisation area plus geotextile bag dewatering area which would have the following dimensions:
   - Cement stabilisation area: 50m by 50m
   - Geotextile bag dewatering area: 200m by 400m

Each of these sources was considered to be an area source, which generated odour emission rates determined from the field sampling undertaken between 14-31 January 2003.

4.2 Simulation tests

In order to assess the impact of the project, the following simulation tests were undertaken:

1) Dredging simulation

The UNSW undertook a review of the compilation of existing contaminant results measured during earlier sampling and testing programs. This review confirmed the types of contaminants that may produce odour in excess of their U.S. EPA odour thresholds. It was concluded following a completion of this review that PAHs and in particular, Napthalene is likely to be the major source of odour that may be detected due to a combination of its volatility, low detection threshold and presence in relatively high concentrations.

The simulation test of the dredging process was carried out between 14-15 January 2003. The material was excavated and loaded into several containers by barge mounted excavator fitted with a clamshell bucket. The dredging activity was restricted within a 4m by 8m turbidity curtain. Three locations (low, medium and high contamination levels) were selected to simulate the process.

2) Odour pens

Twelve pens were set up to simulate sedimentation, dewatering and treatment processes. These pens comprised 1.1m by 1.1m tanks into which a layer of contaminated material was placed for:

- Excavated material dredged from different contaminated locations (low, medium and high);
- Two different moisture contents to reflect the two different dredging technologies under consideration, in-situ (as excavated) and slurried (cutter-suction);
- The use of geotubes with all around drainage (TTF) versus undrained uncovered deposition with supernatant removal (CDF); and
- The effect of Dolocrete and Portland Cement additives on the "as excavated material, placed as 'undrained deposition' (CDF) into the pens.

4.3 Sampling and measurement

The sampling and measurement methods for odour impact assessment were following the NSW EPA ***Approved methods for the sampling and analysis of air pollutants in New South Wales*** except for the sampling and analysis method for hydrogen sulfide, which was presented and approved by the Newcastle EPA.

4.3.1 Odour sampling and analysis

Odour generation during the removal, transportation and treatment activities associated with the project monitored during the above simulation test processes for nine days from 20 January to 31 January 2003.

All the odour emission sources of this project can be considered as area sources. Specific odour emission rates were determined using flux hood and portable wind tunnel as documented in the NSW EPA ***Approved methods for the sampling and analysis of air pollutants in New South Wales***, OM-8 Measurement of gaseous emission rates from land surfaces using an emission isolation flux chamber (for sampling of odour from diffuse sources).

For the BMEP, odour samples were collected from the water surface after a dredging process utilising a portable wind tunnel sampling system as shown in **Figure 1**.
Odour samples from the other sources (such as the barrels used to store sediment samples and the odour pens used to replicate the CDF and TTF facilities) were collected to determine the odour emission rates by the use of an isolation chamber as shown in **Figure 2**.

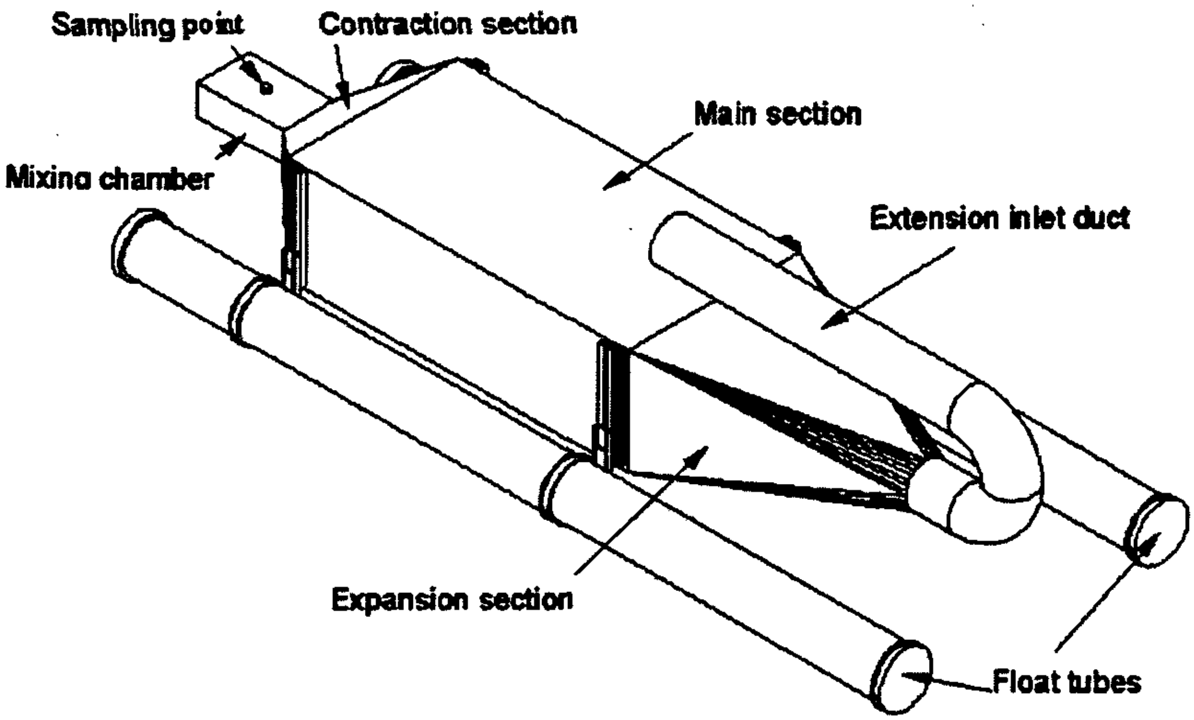

Figure 1 Wind tunnel sampling system

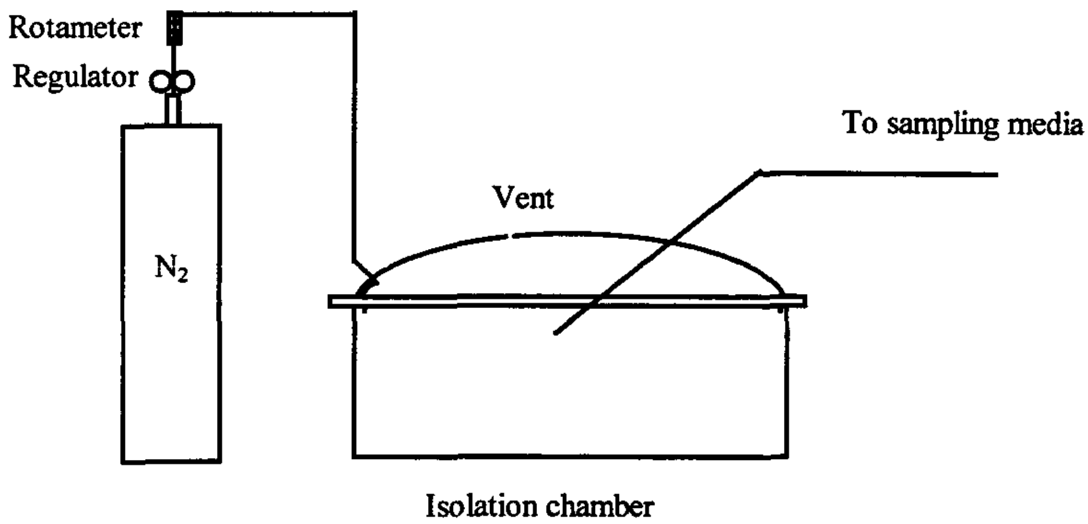

Figure 2 Isolation chamber sampling system

For the isolation chamber sampling system, the sampling rate for odour samples was strictly controlled by the use of a rotameter at the outlet of each sampling drum. Because the purging flow rate was 5 L/m as recommended by US EPA, the sampling rate was controlled to be around 2 L/m in case the outside air was sucked into the flux hood. It normally took about ten minutes to fill a sampling bag with a capacity of 15 – 20 litres.

Based on experience with the odour generation of organic slurry, specific odour emission rates were determined for seven individual days over an eleven-day period for the twelve simulation odour pens. Odour samples were taken on the first day, second day, third day, fourth day, ninth day, tenth day and eleventh day.

A total of 78 odour samples were collected, among which eight samples were collected by wind tunnel from the dredging water surface, four samples were collected from the barrels on board the barge and 66 samples were collected from the twelve pens.

All sampling bags were made at the Environmental Odour Laboratory with 2 μm Tedlar sheets and flushed three times with odour-free air before use. Odour samples collected in Tedlar bags were transported to Australian Water Technology (AWT) and odour concentrations analyses were carried out on the ACSCENT Olfactometer within 24 hours of sampling, according to the Australian and New Zealand standard: Air Quality – Determination of odour concentration by dynamic olfactometry (AS/NZS 4323.3: 2001).

4.3.2 Sampling and analysis of estimated major gases

In order to identify the compositions and concentrations of gases that are likely to be emitted from the dredging barge and onshore CDF and TTF sources, the most probable odorous gases: hydrogen sulfide, volatile organic compounds (VOCs) and polynuclear aromatic hydrocarbons (PAHs) were sampled and measured. For the collection of all these samples, an isolation chamber flux hood was used. For each sample, nitrogen gas was used to purge for at least 24 minutes at the flow rate of 5 litres per minute. The sampling rate for H_2S, VOCs and PAHs were set to be 1 litre/minute, 0.1 litre/minute and 2 litres/minute separately. All sampling rates of the pumps were calibrated with the soap bubble meter.

Sampling arrangement for VOCs, PAHs and H_2S is shown in **Table 1**.

Table 1 Sampling arrangement for VOCs, PAHs and H_2S

Source	XAD2 (for PAH's)	Charcoal (for VOCs)	H_2S
Drums on barge (BMEP)	3 + 2 Blanks	3 + 2 Blanks	3 + 3 Blanks
Excavated with and without geotextile bag (CDF)	6	6	6 + 1 Blank
Excavated Slurry with and without geotextile bag (TTF)	4 + 1 Blank	4 + 1 Blank	4 + 2 Blank
	16	16	19

4.3.2.1 Sampling and analysis method for hydrogen sulfide

Hydrogen sulphide was sampled with absorbing solution and impingers and determined by using the standard HACH method. The methods used in this study were different from that specified in NSW EPA "***Approved methods for the sampling and analysis of air pollutants in New South Wales***".

H_2S is an inorganic compound and it is recommended that a different sampling and analysis method be used rather than the US EPA Method 15 (1997), which uses gas chromatographic (GC) separation and flame photometric detection (FPD). The ambient hydrogen sulphide was sampled into the absorbing solution (Ambient Air Method 701) and then determined by standard HACH Method (adopted from Standards for the Examination of Water and Wastewater and US EPA approved). The other advantage of this method is that it can be analysed on-site after sampling, which eliminates sample losses and transformation. This method had been used by EOL in several research projects and consulting work for Sydney Water and Australian Pork Limited (APL). The methods were sent to NSW EPA in January 2003 and were approved.

The measuring results of hydrogen sulfide are contained in **Table 13.**

4.3.3.2 Sampling and analysis method for volatile organic compounds (VOCs)

Samples of volatile organic compounds were collected with charcoal adsorbent tubes for subsequent GC Gas Chromatography analysing of volatile organic compounds (VOCs). The samples were collected using the above mentioned isolation chamber. The Charcoal sample tubes were taken to the lab and desorbed with CS_2. An aliquot of this CS_2 was introduced into a GC fitted with Flame Ionised Detector (FID) for analysis. The system was calibrated for quantitation of aromatic hydrocarbons. However, a GC-MS system was also used for the identification of other peaks. The sampling and analysis methods followed the US EPA Method 18 for volatile organic compounds as recommended by NSW EPA. The VOCs measuring results are listed in

Table 14.

4.3.3.3 Sampling and analysis method for polynuclear aromatic hydrocarbons (PAHs)

Samples were collected with XAD2 tubes for Gas Chromatography (GC) analysis of polynuclear aromatic hydrocarbons (PAHs). GC analysis for PAHs was carried out by the NSW Workcover Laboratory Services Unit. It is a specialised occupational health analytical service focusing on the presence of hazardous substances in the workplace and is accredited by the National Association of Testing Authorities, Australia (NATA). The analysis method (WorkCover Method No: WCA.178) is a modified NIOSH (National Institute of Occupational Safety & Health, United States) NIOSH Method 5515, California EPA method 429. Polynuclear aromatic hydrocarbons in the air can be absorbed on the XAD-2 sorbent tube with PTFE filter and then extracted with cyclohexane and analysed by GC/MS. The detection limit of this method is 0.1 µg. A sampling rate of 2 litres per minute was used to get a minimum of 100 litres sampled. The sampling time was set at 120 minutes. The PAHs concentrations of the samples collected are contained in **Table 15.**

4.4 Calculation of odour emission rate

The total odour emission rate has been calculated from the total surface area and operational conditions. The specific odour emission rate was calculated by the equation:

$$SOER = \frac{Q \cdot C}{A} \qquad \text{(1)}$$

where

$SOER$: specific odour emission rate, OU/s/m^2
Q: air flow rate, m^3/s
C: odour concentration, OU/m^3
A: surface area covered by the sampling hood or wind tunnel, m^2

4.5 Development of correlation between odorous pollutants and odour concentration

The major odorous pollutants were selected based on the GC measurement results. With the known concentrations of the individual odorous pollutants, several odour samples were prepared and tested with the dynamic dilution olfactometer by trained panellists. Then the correlation can be simply determined matching the mass concentration corresponding to 1 Ou/m^3 odour concentration. *(this has been delayed because the PAHs measurement results had not been received at time of writing this report.)*

4.6 Odour assessment methods

Based on the odour emissions from all odour sources of the project and the meteorological data, odour dispersion modelling was then conducted using the Ausplume atmospheric dispersion model to predict ground level concentration of odour from the proposed project.

The Ausplume Model originally extended from USEPA ISC (Industrial Source Complex), is a Gaussian plume dispersion model. For this study, the current Ausplume Atmospheric Dispersion Model, Version 5.4, was used.

In order to reflect meteorological fluctuations in the development of the model, the peak-to-mean factor calculation was used. The near-field-peak-mean ratios used for Pasquill-Guilford stability classes were 2.5 for A, B, C, D and 2.3 for E and F.

The results of the modelling are presented in the form of contours for a 1-hour average concentration of 2 OU/m^3 as a 99th percentile. The contours represented the area where the maximum hourly average ground level concentration will be greater than 2 OU/m^3 for more than 1% of the hours in the year.

5. Existing environment

5.1 Land uses and current environmental odour

The site is located at Dyke Point, Newcastle Harbour and is occupied by Newcastle Port Corporation (NPC). It is located approximately five kilometers northwest of the Newcastle CBD. Kooragang Island is located to the north of the South Arm of the Hunter River. The land near the shore along the north bank of the South Arm of the Hunter River is industrial area and undeveloped land. The OneSteel site and the former BHP Steelworks site (also known as the BHP Closure Area site) adjoin the South Arm to the south. Residential areas in the suburb of Mayfield are located further to the south. The South Arm itself currently experiences the following uses:

- Prawn trawling (6am – 6pm October to May)
- Recreational fishing on the north bank of the south arm
- Shipping movements containing bulk cargo
- Ships docking at berths

The former BHP Steelworks site is the proposed location for the temporary storage, remediation and disposal of contaminated sediments.

A variety of industrial and port related land uses are located to the east. Further to the east, the Hunter River discharges to the sea, to the south of the suburb of Stockton.

The area affected by activities that form part of the proposal, are located just to the west of the existing Port of Newcastle.

The major Port and industrial activities are located in the vicinity of the South Arm, and the river mouth to the east (down stream). Port activities are concentrated to the east of the dredging site.

There is a wide range of industrial land uses in the vicinity of the Suth Aarm, focused on uses requiring access to port facilities. These include:

- Coal loading
- Steel processing
- Scrap metal processing
- Cement production
- Terminal for LPG storage and distribution
- Liquid waste management facilities
- Oilseed processing plant
- Carbon dioxide plant
- Grain terminal
- Rail stabling area

A number of significant industrial and infrastructure developments have been proposed in the vicinity of the area of the proposed remediation.

There would be some background odour around the site because of the nature of these existing industries. This was evident during the on-site field work.

The nearest residential community is the suburb of Mayfield, located approximately 1-2 km to the south of the river (adjacent the former BHP Steelworks site). The suburb of Stockton is located approximately 4-5 km to the east and Fern Bay is located approximately 4 km to the northeast. As proposed, public access to the banks would be restricted during excavation of the banks. Public access along the south arm is also likely to be restricted at times during of the dredging and excavation process.

5.2 Complaint history

No information is available at this stage.

5.3 Potential odour receptors

The typical odour receptors are residential areas, schools and hospitals. Eight possible sensitive receptor points were considered as discrete receptors in this assessment. Their coordinates are as shown on **Figure 4** to **Figure 11** and described in **Table 2**.

Table 2 Location of closest receptors around the site

	Direction from the site	X (m)	Y (m)
1	Southwest	3000	4667
2	Southwest	3722	4222
3	Southwest	4222	3722
4	Southwest	4333	3278
5	Southwest	4778	2833
6	South	5722	2500
7	East	6444	3444
8	East	6500	3944

6. Potential impacts

6.1 Odour impact assessment

6.1.1 Odour emission rate

Based on the odour testing results (**Table 12**), the specific odour emission rate for each source was calculated according to the Equation (1) as follows:

- Open area on the excavation barge: 3.357 OU/s/m^2
- Excavator dredging water surface: 3.357 OU/s/m^2
- Loading/unloading barge at the temporary wharf: 3.357 OU/s/m^2
- Transporting truck: 3.357 OU/s/m^2
- Cement stabilisation area: 0.7166 OU/s/m^2
- Geotextile bag dewatering area: 0.504 OU/s/m^2

To input the emission rate to Ausplume, it is necessary to consider the peak-to-mean ratio. Emission data characteristics of the eight modelling programs are summarised in **Table 3** to **Table 12.**

Four modelling programs (Modelling program 1 – 4) had been considered without the TTF dewatering geotextile bag (200m × 400m):

Modelling program 1: Dredging site I, open barge without geotextile bag
The source input data for the modelling for this modelling program is listed in **Table 3.**

Table 3 Input data for modelling program 1

Source ID		OB1	DS	OB2	OT	BT
Source		Open barge	Dredging surface	Open barge	Open truck	Buffer tank
Location of the source		Barge on river	On river	Wharf for unloading	Unloading loading	Buffer tank on shore
Dimensions		40m × 6m	10m × 10m	40m × 6m	5m × 2m	50m × 50m
Coordinate (m)	x	5056	5068	6056	6077	5278
	y	4667	4653	4278	4264	3833
Odour concentration (OU/m^3)		5060		5060	5060	1080
Sampling method		Flux hood		Flux hood	Flux hood	Flux hood
Peak to mean factor	Stability A, B, C, D	2.5	2.5	2.5	2.5	2.5
	Stability E, F	2.3	2.3	2.3	2.3	2.3
Odour emission (OU/s/m^2)	Stability A, B, C, D	8.3925	8.3925	8.3925	8.3925	1.7925
	Stability E, F	7.7211	7.7211	7.7211	7.7211	1.6491

Modelling program 2: Dredging site I, covered barge without geotextile bag
The source input data for the modelling for this modelling program is listed in **Table 4.**

Table 4 Input data for modelling program 2

Source ID		CB1	DS	CB2	OT	BT
Source		Covered barge	Dredging surface	Covered barge	Open truck	Buffer tank
Location of the source		Barge on river	On river	Wharf for unloading	Unloading loading	Buffer tank on shore
Dimensions		2m×2m	10m×10m	2m×2m	5m×2m	50m×50m
Coordinate (m)	x	5056	5068	6056	6077	5278
	y	4667	4653	4278	4264	3833
Odour concentration (OU/m^3)		5060		5060	5060	1080
Sampling method		Flux hood		Flux hood	Flux hood	Flux hood
Peak to mean factor	Stability A, B, C, D	2.5	2.5	2.5	2.5	2.5
	Stability E, F	2.3	2.3	2.3	2.3	2.3
Odour emission (OU/s/m^2)	Stability A, B, C, D	8.3925	8.3925	8.3925	8.3925	1.7925
	Stability E, F	7.7211	7.7211	7.7211	7.7211	1.6491

Modelling program 3: Dredging site II, open barge without geotextile bag
The source input data for the modelling for this modelling program is listed in **Table 5.**

Table 5 Input data for modelling program 3

Source ID		OB1	DS	OB2	OT	BT
Source		Open barge	Dredging surface	Open barge	Open truck	Buffer tank
Location of the source		Barge on river	On river	Wharf for unloading	Unloading loading	Buffer tank on shore
Dimensions		40m × 6m	10m × 10m	40m × 6m	5m × 2m	50m × 50m
Coordinate (m)	x	3778	3790	6056	6077	5278
	y	5500	5486	4278	4264	3833
Odour concentration (OU/m^3)		5060		5060	5060	1080
Sampling method		Flux hood		Flux hood	Flux hood	Flux hood
Peak to mean factor	Stability A, B, C, D	2.5	2.5	2.5	2.5	2.5
	Stability E, F	2.3	2.3	2.3	2.3	2.3
Odour emission (OU/s/m^2)	Stability A, B, C, D	8.3925	8.3925	8.3925	8.3925	1.7925
	Stability E, F	7.7211	7.7211	7.7211	7.7211	1.6491

Modelling program 4: Dredging site II, covered barge without geotextile bag
The source input data for the modelling for this modelling program is listed in **Table 5.**

Table 6 Input data for modelling program 4

Source ID		CB1	DS	CB2	OT	BT
Source		Covered barge	Dredging surface	Covered barge	Open truck	Buffer tank
Location of the source		Barge on river	On river	Wharf for unloading	Unloading loading	Buffer tank on shore
Dimensions		2m × 2m	10m × 10m	2m × 2m	5m × 2m	50m × 50m
Coordinate (m)	x	3778	3790	6056	6077	5278
	y	5500	5486	4278	4264	3833
Odour concentration (OU/m^3)		5060		5060	5060	1080
Sampling method		Flux hood		Flux hood	Flux hood	Flux hood
Peak to mean factor	Stability A, B, C, D	2.5	2.5	2.5	2.5	2.5
	Stability E, F	2.3	2.3	2.3	2.3	2.3
Odour emission ($OU/s/m^2$)	Stability A, B, C, D	8.3925	8.3925	8.3925	8.3925	1.7925
	Stability E, F	7.7211	7.7211	7.7211	7.7211	1.6491

Another four modelling programs (Modelling program 5 – 8) had been considered with dewatering geotextile bag (200m × 400m):
Modelling program 5: Dredging site I, open barge with geotextile bag
The source input data for the modelling for this modelling program is listed in **Table 7.**

Table 7 Input data for modelling program 5

Source ID		OB1	DS	OB2	OT	BT	DWG
Source		Open barge	Dredging surface	Open barge	Open truck	Buffer tank	Dewatering Geotextile bag
Location of the source		Barge on river	On river	Wharf for unloading	Unloadin g loading	Disposal on shore	Treatment on shore
Dimensions		40m×6m	10m×10m	40m×6m	5m×2m	50m×50m	200m×200m
Coordinat e (m)	x	5056	5068	6077	5278	6056	4889
	y	4667	4653	4264	3833	4278	4111
Odour concentration (OU/m^3)		5060		5060	5060	1080	760
Sampling method		Flux hood		Flux hood	Flux hood	Flux hood	Flux hood
Peak to mean factor	Stability A, B, C, D	2.5	2.5	2.5	2.5	2.5	2.5
	Stability E, F	2.3	2.3	2.3	2.3	2.3	2.3
Odour emission ($OU/s/m^2$)	Stability A,B,C, D	8.3925	8.3925	8.3925	8.3925	1.7925	1.26
	Stability E, F	7.7211	7.7211	7.7211	7.7211	1.6491	1.1592

Modelling program 6: Dredging site I, covered barge with geotextile bag
The source input data for the modelling for this modelling program is listed in **Table 8.**

Table 8 Input data for modelling program 6

Source ID		CB1	DS	CB2	OT	BT	DWG
Source		Covered barge	Dredging surface	Covered barge	Open truck	Buffer tank	Dewatering Geotextile bag
Location of the source		Barge on river	On river	Wharf for unloading	Unloading loading	Disposal on shore	Treatment on shore
Dimensions		2m×2m	10m×10m	2m×2m	5m×2m	50m×50m	200m×200m
Coordinate (m)	x	5056	5068	6077	5278	6056	4889
	y	4667	4653	4264	3833	4278	4111
Odour concentration (OU/m^3)		5060		5060	5060	1080	760
Sampling method		Flux hood		Flux hood	Flux hood	Flux hood	Flux hood
Peak to mean factor	Stability A, B, C, D	2.5	2.5	2.5	2.5	2.5	2.5
	Stability E, F	2.3	2.3	2.3	2.3	2.3	2.3
Odour emission (OU/s/m^2)	Stability A, B, C, D	8.3925	8.3925	8.3925	8.3925	1.7925	1.26
	Stability E, F	7.7211	7.7211	7.7211	7.7211	1.6491	1.1592

Modelling program 7: Dredging site II, open barge with geotextile bag
The source input data for the modelling for this modelling program is listed in **Table 9.**

Table 9 Input data for modelling program 7

Source ID		OB1	DS	OB2	OT	BT	DWG
Source		Open barge	Dredging surface	Open barge	Open truck	Buffer tank	Dewatering Geotextile bag
Location of the source		Barge on river	On river	Wharf for unloading	Unloading loading	Disposal on shore	Treatment on shore
Dimensions		40m×6m	10m×10m	40m×6m	5m×2m	50m×50m	200m×200m
Coordinate (m)	x	3778	3790	6077	5278	6056	4889
	y	5500	5486	4264	3833	4278	4111
Odour concentration (OU/m^3)		5060		5060	5060	1080	760
Sampling method		Flux hood		Flux hood	Flux hood	Flux hood	Flux hood
Peak to mean factor	Stability A, B, C, D	2.5	2.5	2.5	2.5	2.5	2.5
	Stability E, F	2.3	2.3	2.3	2.3	2.3	2.3
Odour emission (OU/s/m^2)	Stability A, B, C, D	8.3925	8.3925	8.3925	8.3925	1.7925	1.26
	Stability E, F	7.7211	7.7211	7.7211	7.7211	1.6491	1.1592

Modelling program 8: Dredging site II, covered barge with geotextile bag
The source input data for the modelling for this modelling program is listed in **Table 10**.

Table 10 Input data for modelling program 8

Source ID		CB1	DS	CB2	OT	BT	DWG
Source		Covered barge	Dredging surface	Covered barge	Open truck	Buffer tank	Dewatering Geotextile bag
Location of the source		Barge on river	On river	Wharf for unloading	Unloadi ng loading	Disposal on shore	Treatment on shore
Dimensions		2m×2m	10m×10m	2m×2m	5m×2m	50m×50m	200m×200m
Coordinate (m)	x	3778	3790	6077	5278	6056	4889
	y	5500	5486	4264	3833	4278	4111
Odour concentration (OU/m^3)		5060		5060	5060	1080	760
Sampling method		Flux hood		Flux hood	Flux hood	Flux hood	Flux hood
Peak to mean factor	Stability A, B, C, D	2.5	2.5	2.5	2.5	2.5	2.5
	Stability E, F	2.3	2.3	2.3	2.3	2.3	2.3
Odour emission ($OU/s/m^2$)	Stability A, B, C, D	8.3925	8.3925	8.3925	8.3925	1.7925	1.26
	Stability E, F	7.7211	7.7211	7.7211	7.7211	1.6491	1.1592

6.1.2 Impact criteria

The results of the modelling are presented in the form of contour (or isopleths – lines connecting points with equal frequency of occurrence) for a 1-hour average limit concentration limit concentration of 2 OU/m^3 as a 99% percentile.

6.1.3 Some basic assumptions

For the Ausplume dispersion modelling, some basic assumptions were made before the model was run. They were:

- Odour emission from each source will be adjusted by the peak-to-mean factor
- Two typical dredging sites were being evaluated, site I (x = 5056m, y = 4667m) and site II (x = 3778m, y = 5500m). Most of dredging and transport activities on the river will be in between these two sites
- The locations of odour sources provided by the project team were input to run the model
- Area source alignment was parallel to the major shore line of the South Arm of the Hunter River – 57 degree West of North

6.1.4 Meteorological data

Two sets of weather station data were provided by Patterson Britton, one is in Williamtown about 12 kilometres away from Newcastle port and another is near the lighthouse of Nobby Head. Although the Nobby Head weather station is closer to the site than the Williamtown one, the data coverage for Nobby Head weather station was incomplete. In addition the meteorological data collected from Williamtown weather station covered 92% of data for the year of 2001 and was considered unsuitable for utilisation in the odour dispersion modelling in this investigation.

To ensure that the NSW EPA requirements were met, the Ausplume dispersion model was run with a meteorological data file (met file) provided by an independent third party. The data in this file covered weather station data collected at the BHP Closure area during 1991 to 1995. The data used from the met file covered two complete years (16,536 hours during 1994 and 1995). All four seasons (Summer, Autumn, Winter and Spring) were well represented.

Wind Speed and Direction

Wind speed and direction information are required for dispersion modelling, as they determine the direction and rate at which an emission will disperse into the atmosphere. Records of wind speed and direction have been sourced from a wind speed and direction indicator previously installed on the BHP Newcastle Steelworks site. The approximate height of the indicator is 28 m above ground level. This is of sufficient height to provide reliable data on wind speed and direction.

Wind speed and direction information were collected over a period of five years (1991-1995), and the 1994 and 1995 data was chosen as the year most appropriate for modelling purposes. The predominant winds in the area are from the north, with north-east winds prevailing in the warmer months of the year, while north-west winds prevail in the cooler months (see wind rose, **Figure 3**).

Mixed Layer Height

Mixed layer height is the height above ground level through which emissions will be dispersed, once a plume has mixed with the surrounding atmosphere. In general the mixed layer height will increase during the day as convection causes the turbulent layer of the atmosphere to deepen. For the purposes of this project mixed layer height has been determined in two different ways. During the day mixed layer height has been determined in accordance with a procedure developed by Powell 1976, while at night a procedure developed by Venkatram 1980 has been used.

Atmospheric Stability Class

Atmospheric stability class is a system, which categorises the rate at which a plume will disperse. For dispersion modelling using AUSPLUME, Pasquill-Gifford stability class is used, and there are six classes, A through to F. Class A relates to unstable conditions which usually prevail on sunny days with light winds. Class F relates to stable conditions, which generally occur when the sky is clear, winds are light and a temperature inversion is present. Plume dispersion is usually slowest under F class stability.

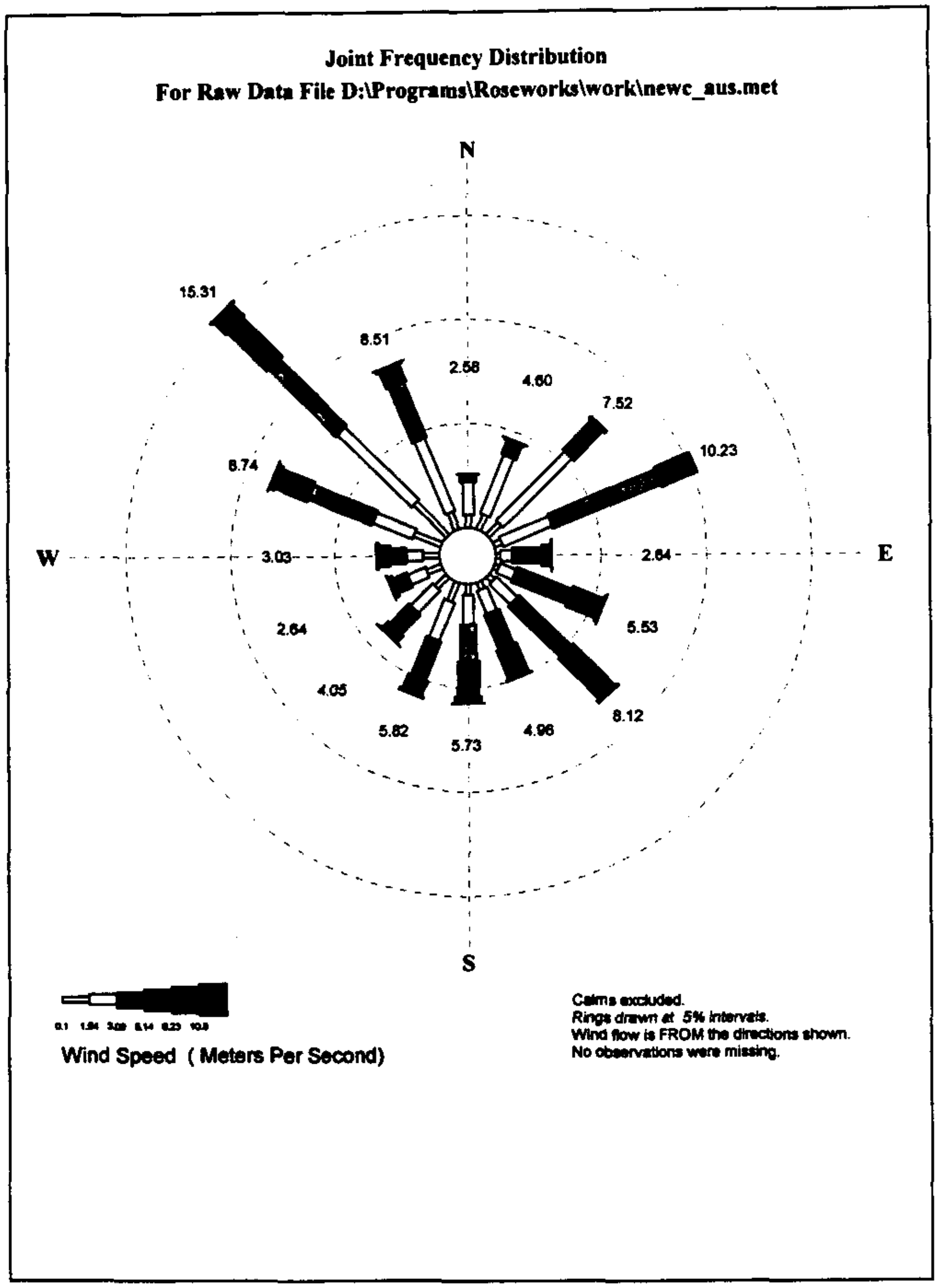

Figure 3 Wind rose d frequency distribution

6.1.5 Modelling results

The modelling results are shown in **Figure 4** to**Figure 11**. With respect to the potential receptors, it can be seen by comparing these figures that:

- There is significant difference between "with" and "without" geotextile bag. From the results obtained, it would be nearly impossible to meet the impact criteria if the dewatering geotextile bags are used (**Figure 8** to **Figure 11**).
- There is very limited difference of impact between the dredging site I and the dredging site II. This means that the nearest residents to the site appear to be unlikely to be affected by the dredging process along the South Arm of Hunter River as long as the onshore treatment and disposal are reasonably arranged.
- The odour impact can be reduced to some extent when the barge is covered, by comparing the impact results of open barge (**Figure 4, Figure 6, Figure 8** and **Figure 10**) and those of covered barge (**Figure 5, Figure 7, Figure 9** and **Figure 11**) for four different scenarios.
- As long as the dewatering geotextile bags are not used, both open barge and covered barge operations will meet the impact criteria.

Figure 4 Modelling result for dredging site 1, open barge without geotextile bag

Figure 5 Modelling result for dredging site 1, covered barge without geotextile bag

Figure 6 Modelling result for dredging site II, open barge without geotextile bag

Figure 7 Modelling results for dredging site 2, covered barge without geotextile bag

Figure 8 Modelling result for dredging site 1, open barge with geotextile bag

Figure 9 Modelling result for dredging site 1, covered barge with geotextile bag

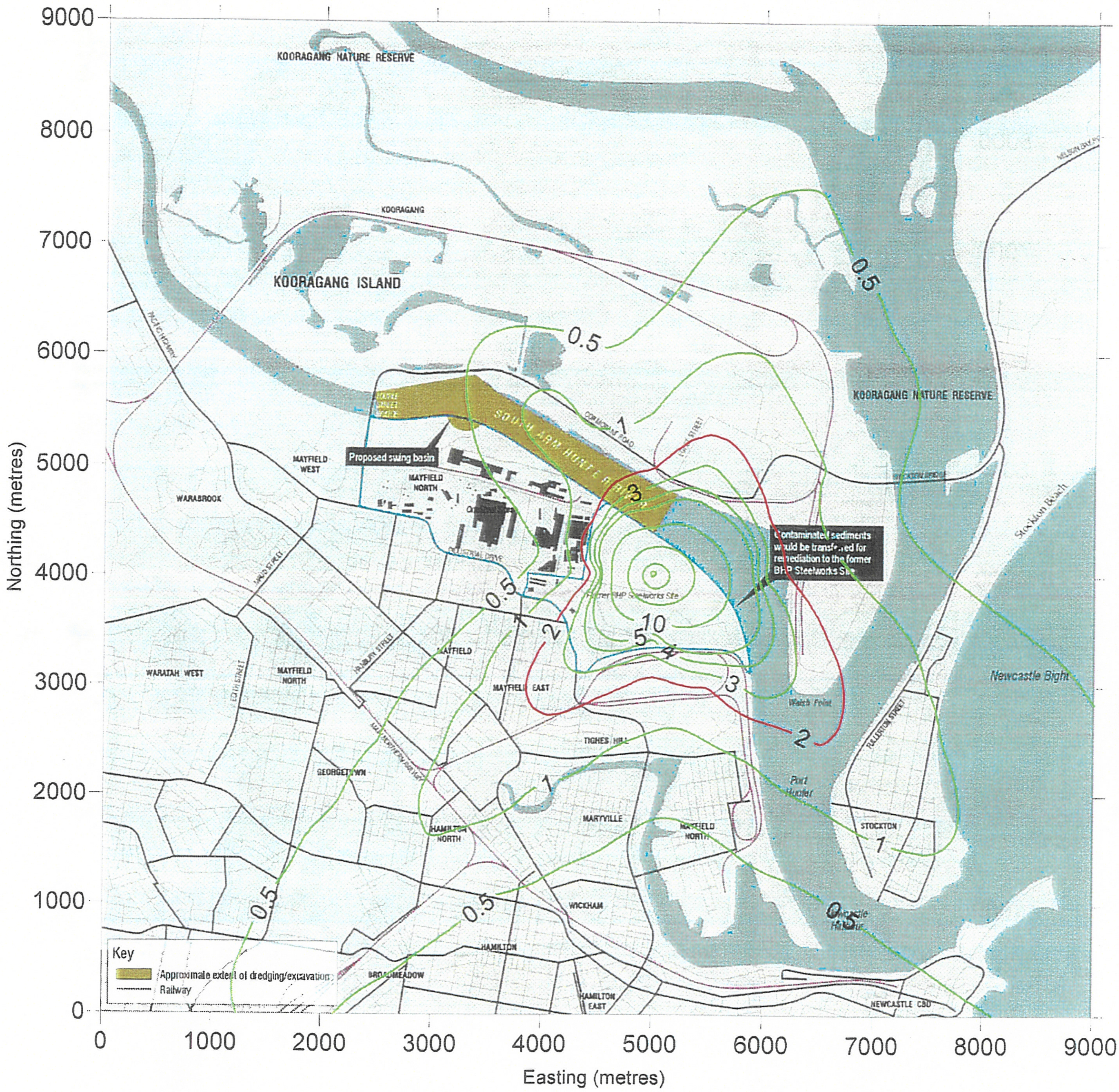

Figure 10 Modelling result for dredging site 2, open barge with geotextile bag

Figure 11 Modelling result for dredging site 2, covered barge with geotextile bag

6.2 Hydrogen sulfide

Table 13 shows the hydrogen sulfide concentration for the sampling hood. It can be seen that all the results except the sample taken for the fresh dredged high-contaminated material are similar to the blank. That means the hydrogen sulfide is not the key compound for generating odours during the dredging and disposal of the dredging material.

6.3 Volatile organic compounds

For all charcoal tube samples, the VOCs concentrations as summarised in **Table 14** were below detection limit except for one sample collected from the dredging material on the barge. The analytical detection limits reported in Table 13 translates approximately to 0.03 ppm for benzene, 0.03 ppm for Toluene and 0.08 ppm for xylenes. Method 18 recommends that the detection limits be al least 1 ppm for all species. The repeat analysis on GC-MS system showed that there were hardly any VOCs but Naphthalene was detected in some of the samples. This was expected since the primary contaminant was Naphthalene. However it should be noted that method 18 is not recommended for the quantification of Naphthalene. The results confirm that VOCs would not have any impact on the potential odour emitted during excavation and subsequent treatment of the sediment.

6.4 Polynuclear Aromatic Hydrocarbons (PAHs)

The volatile PAH compounds were sampled and analysed to verify if the concentrations correlate to the corresponding odour sample collected on the same day. These PAH samples were collected by means of the flux hood in the same manner the odour flux samples were collected. The air stream from the flux hood was passed through a trap containing XAD resin by sucking the air with the help of a small battery operated pump. The flow rate was 2000 ml/min and each sample was collected for 120 minutes. The samples were analysed on a GC-MS system. The entire analytical procedure was adopted from NIOSH method 5515 and EPA method 429. The analytical work for this was done by the NATA accredited Laboratory Service Unit of WorkCover, New South Wales.

Figure 12 and **Figure 13** shows the correlation between odour concentrations and corresponding PAH concentration found in various simulation pens. This exercise confirms that odour flux is directly proportional to the total PAH concentration in the sediment. The experiment also reveals that the geotextile bags do not have any appreciable effect on the odour emission fluxes.

Sixteen PAH compounds were analysed but only the first six members were detected in the samples. This was expected as the heavier members in the group are less volatile and are not usually found in the vapour phase. The individual concentrations of each species in the samples have been presented in **Table 15.** Note that by far the most predominant species is Naphthalene.

In order to determine the correlation between the odorous pollutants and odour concentration, three PAH compounds were selected for analysis and testing: acenaphthene, nanphthalene and phenanthrene.

Table 11 The correlation between the concentration of PAHs and the odours

PAH compound	Chemical volumetric concentration (mg/m^3)	Odour concentration (OU/m^3)	Concentration equivalent to 1 OU/m^3 (mg/m^3)
Acenaphthene	4633	620	7.5
Nanphthalene	4773	540	8.8
Phenanthrene	680	240	2.8

A sample of each compound: 69.5 mg acenaphthene (99.8% pure), 71.6 mg naphthalene (99.9% pure) and 10.2 mg phenanthrene (99.9% pure), were weighed and put inside three separate Tedlar bags. Each bag was then filled with 15 litres of nitrogen gas (odour free), and the bag left for 16 hours to allow the nitrogen to mix with the vapour emitted by each odorous compound. The created odour samples were then presented to an odour panel for olfactometry testing to determine their odour concentrations. The relationship between the volumetric concentration of each compound in the 15 litre bag and the odour concentration of each compound is described in Table 11.

It has been shown by this test that 7.5 mg/m^3 of acenaphthen corresponds to 1 OU/m^3 of odour, 8.8 mg/m^3 of nanphthalene corresponds to 1 OU/m^3 of odour and 2.8 mg/m^3 of phenanthrene corresponds to 1 OU/m^3 of odour.

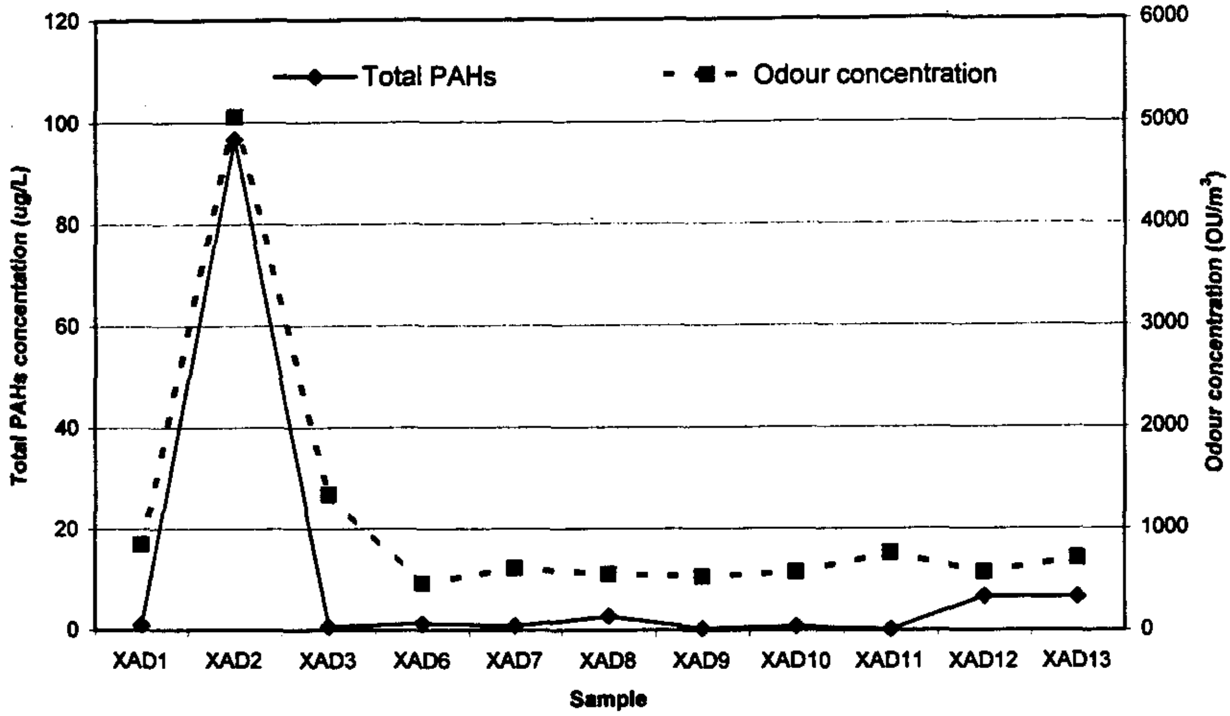

Figure 12 Total PAHs and corresponding odour concentration of all odour simulation pens

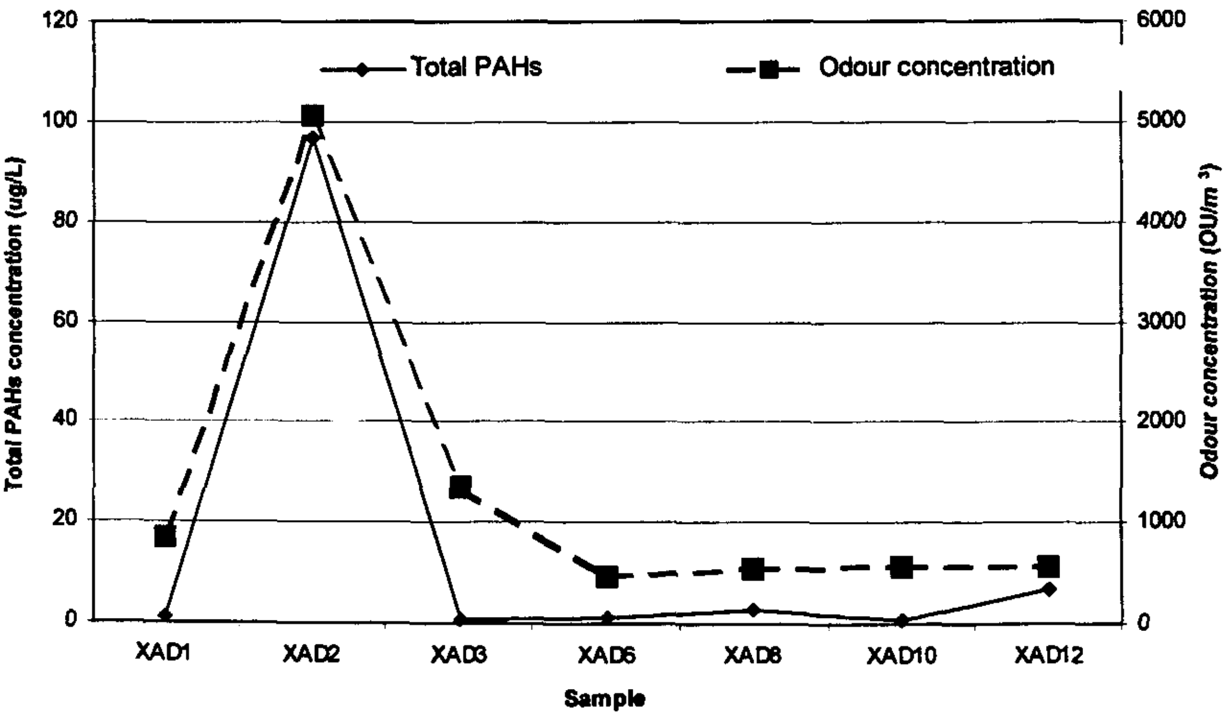

Figure 13 Total PAHs and corresponding odour concentration of odour simulation pens without geotextile bag

7. Recommended mitigation measures

Controlling odours is an important consideration for protecting the environment and the community amenity. Because of the temporary features of the project, the economic and practical mitigation measures for this project would include

- Selection of the proper dredging method
- Selection of remediation options
- Covering of the main odour sources

7.1 The dredging methodologies and the odour impact

The following dredging methodologies have been considered for use in the project:

- Removal by (open) barge-mounted excavator fitted with a clamshell bucket, which seals when closed. The excavated material would be placed into a trailing barge and pumped by positive displacement pump to shore for remediation.
- Removal by cutter-suction dredging on a covered barge and pumping via pipeline to shore for remediation.

From the modelling results there is little difference between the two dredging methodologies. However, using the first method but with the barge covered would reduce odour emission.

7.2 Remediation Options

From discussions with the project team it is understood that the remediation options under consideration comprise:

- Dewatering of the sediment with a low level of contamination;
- Dewatering and stabilisation using cement based additives of sediment with a low to medium contamination level. Pre-treatment by dewatering to be conducted as necessary; and
- Dewatering and thermal desorption of sediment with a high contamination level, for which dewatering is expected to be necessary as a pre-treatment process.

It is also understood that the dewatering options under consideration include:

- The use of large geotextile bags (geotubes) placed in a Temporary Treatment Facility (TTF).);
- Placement into a 'tailings' type facility Confined Disposal Facility (CDF).); and
- A combination of the above.

Dispersion modelling results showed that the dewatering process using geotextile bags would generate greater odour because of the large surface area normally required by this process. The greater the area of contaminated material exposed to the atmosphere the larger the odour emission.

If this method were used incrementally over smaller areas there would be less odour emission at any individual time during the process.

It was also found from the modelling results that the use of CDF over large areas was also a problem but as a treatment process using smaller areas of material covering 50m by 50m at a time the EPA's requirements would be met.

The use of combined dewatering and CDF would still be a problem unless the area of dewatering is restricted.

Other mitigation measures that can be implemented to reduce odour generation include the addition of lime on the barges (also required to manage acid sulfate soils) and the addition of cement upon transfer from the barge to the TTF for subsequent treatment. Covering the surface of the sediment onshore with some suitable material would also reduce odour.

8. Summary and Recommendations

8.1 Sampling and Analysis Program

The results of the sampling and analysis program have found that

- The generation of odours from this project will be largely caused by PAHs (in particular, Napthalene) rather than hydrogen sulfide and VOCs. In terms of odour the activities associated with the removal, transportation and disposal of the dredging material sediment should be focused on the control and removal of PAHs compounds.
- Odour was measured at the water surface during sampling and was found to increase from low to high for each of the low, medium and high level, contamination areas sampled. Odour units varied between 600 and 1400 OU/m^3.
- Similarly, odour was measured in the barrels after sampling and was found to increase from low to high for each of the low, medium and high level contamination areas sampled. Odour units varied between 900 and 5000 OU/m^3.
- Geotextile bags were found to provide only marginal benefit to odour generation
- The odour generated was found to diminish with time except for a spike recorded on 28th January 2003, which occurred in all samples. This spike may have been due to high evaporation rates that were experienced during such a hot day.
- The odour generation was found to correspond with the low, medium and high level contamination areas.
- 5% dolocrete mix was found to perform marginally better at suppressing odour than 20% portland cement mix, however, the benefits of these treatments were found to be well below expectations.

8.2 Ausplume Dispersion Modelling

The results of the Ausplume dispersion modelling have found that:

- Odour generated by each of the dredging technologies proposed would be acceptable and that the barges used for the transfer of material would not need to be covered to meet the EPA requirements. However, if the barges are covered, the odour impact will be reduced.
- Odour emission would be greater and could cause a problem if the 200m by 400m geotextile bag de-watering system is used alone. This large area source was the major odour contributor. If there were no mitigation measure used (addition of lime, cement and coverage of sediment), the project would not meet the NSW EPA's requirements.
- It is recommended that the two remediation options that can be used: stabilisation using cement based additives, and the combination of dewatering and stabilisation, but with the restriction of the area of geotextile bag to be less than one quarter of proposed (200m by 400m), for the highly contaminated dredging material.
- Without geotextile bag dewatering, the proposed 50m by 50m on-shore cement stabilisation area does not necessarily need to be covered.

- The dredging process and the movement of the dredging barge, along the South Arm of the Hunter River will have a minimal effect on the surrounding residents if the above steps are followed.

In summary, it is considered that odour, which will be generated with the removal, transportation and onshore treatment of material, can be managed by the implementation of mitigation measures that include the limiting the size of the on-shore remediation area, covering of exposed areas of deposited dredged material on-shore and the addition of lime and cement to the dredged material during dredging and transportation.

However, it is recommended that an odour-monitoring program should be considered for implementation to ensure that the odour generated does not exceed acceptable levels at any stage.

This program should comprise:

a) Monitoring odour concentration level of each odour source at different process periods.

b) Confirming that the size of each area source is no larger than the recommended area.

c) Confirming that the mitigation measures recommended in this study will have been executed in the project.

d) Design of a community odour impact survey if required.

9 Appendices

9.1 References

Environmental Odour Laboratory/UNSW http://www.odour.unsw.edu.au

HACH company 1990 DR/2000 spectrophotometer instruction manual

James P. Lodge, JR., 1989 Methods of air sampling and analysis (3rd edition) Lewis Publishers, INC.

NSW EPA Approved methods for the sampling and analysis of air pollutants in New South Wales

NSW EPA, 2001 Approved methods and guidance for the modelling and assessment of air pollutants in New South Wales August 2001

NSW EPA, 2001 Draft policy: assessment and management of odour from stationary sources in NSW (Technical notes) January 2001

Powell, 1976 details to be provided

State of California Air Resources Board Method 15 Determination of hydrogen sulfide, carbonyl sulfide, and carbon disulfide emission from stationary sources (adopted on June 2, 1983 and amended on July 1, 1999)

Venkatram, 1980 details to be provided

Victoria EPA 1999 Ausplume Gaussian Plume Dispersion Model Technical User Manual

9.2 Tabulated results

Table 12 Odour sample concentrations

Sample ID	Sampling source	Sampling date	Sampling method	Odour concentration (OU/m3)
98792	Low dredging water surface	14/01/2003	Wind tunnel	885
98793	Low dredging water surface			760
98794	L1 barrel on barge		Flux hood	940
98795	L1 barrel on barge			760
98796	Low dredging water surface		Wind tunnel	400
98797	Low dredging water surface			580
98798	High dredging water surface	15/01/2003		1250
98799	High dredging water surface			1550
98800	High barrel on barge		Flux hood	5060
98801	Medium dredging water surface		Wind tunnel	1250
98802	Medium dredging water surface			1340
98803	Medium barrel on barge		Flux hood	1340
98804	Medium mix without geotextile bag	20/01/2003	Flux hood	260
98805	*Medium mix with geotextile bag*			310
98806	Low mix without geotextile bag			340
98807	Low mix with geotextile bag			1770
98808	High mix without geotextile bag			3100
98809	High mix with geotextile bag			460
98810	Low mix with geotextile bag	21/01/2003		530
98811	Low mix without geotextile bag			550
98812	Medium mix with geotextile bag			610
98813	Medium mix without geotextile bag			460
98814	Medium slurry without geotextile bag			570
98815	Medium slurry with geotextile bag			760
98816	Medium slurry with geotextile bag	22/01/2003		510
98817	Medium slurry without geotextile bag			340
98818	High slurry without geotextile bag			570
98819	High mix with geotextile bag			610
98820	High mix without geotextile bag			470
98821	High excavated cement treatment			760
98822	*High excavated dolocrete treatment*			660
98823	High slurry with geotextile bag			710
98824	High slurry with geotextile bag	23/01/2003		870
98825	High slurry without geotextile bag			1090
98826	High mix with geotextile bag			875
98827	High mix without geotextile bag			940
98828	High excavated cement treatment			720
98829	High excavated dolocrete treatment			890
98830	Medium mix with geotextile bag			880

98831	Medium mix without geotextile bag			470
98832	Medium slurry with geotextile bag			470
98833	Medium slurry without geotextile bag			570
98834	High mix with geotextile bag	28/01/2003		910
98835	High mix without geotextile bag			1550
98836	High slurry with geotextile bag			910
98837	High slurry without geotextile bag			760
98838	High excavated with dolocrete treatment			760
98839	High excavated with cement treatment			1080
98840	Medium mix with geotextile bag			820
98841	Medium mix without geotextile bag			1260
98842	Medium slurry with geotextile bag			915
98843	Low mix without geotextile bag			840
98844	Low mix with geotextile bag			1360
98845	Medium slurry without geotextile bag			1880
98846	High mix with geotextile bag	29/01/2003		580
98847	High mix without geotextile bag			440
98848	High slurry with geotextile bag			440
98849	High slurry without geotextile bag			490
98850	High excavated with dolocrete treatment			490
98851	High excavated with cement treatment			915
98852	Medium mix without geotextile bag			360
98853	Medium mix with geotextile bag			660
98854	Medium slurry without geotextile bag			390
98855	Medium slurry with geotextile bag			425
98856	Low mix without geotextile bag			410
98857	Low mix with geotextile bag			200
98858	Low mix with geotextile bag	30/01/2003		430
98859	Low mix without geotextile bag			540
98860	Medium mix with geotextile bag			660
98861	Medium mix without geotextile bag			610
98862	Medium slurry with geotextile bag			250
98863	Medium slurry without geotextile bag			400
98864	High mix with geotextile bag			540
98865	High mix without geotextile bag			390
98866	High slurry with geotextile bag			420
98867	High slurry without geotextile bag			765
98868	High excavated with dolocrete treatment			820
98869	High excavated with cement treatment			430

Table 13 H_2S concentration inside sampling hood

Date	Source	Sampling time	H_2S in Air (mg/L)
1/14/2003	L1 barrel on barge	19:00	4.66511E-05
	Blank		5.33156E-05
1/15/2003	H1 barrel on barge	14:50	0.000844718
	Blank		3.16561E-05
	M1 barrel on barge	17:58	5.83139E-05
	Blank		4.99833E-05
1/20/2003	Medium mix without geotextile bag	13:00	5.16495E-05
	Medium mix with geotextile bag	14:30	4.83172E-05
	Low mix without geotextile bag	17:05	5.83139E-05
	Low mix with geotextile bag	18:36	5.66478E-05
	High mix without geotextile bag	20:10	6.16461E-05
	High mix with geotextile bag	19:40	5.998E-05
	Blank		5.49817E-05
1/21/2003	Medium slurry without geotextile bag	18:32	7.33089E-05
	Medium slurry without geotextile bag	19:05	6.16461E-05
	Medium slurry with geotextile bag	Blank	5.49817E-05
1/21/2003	High slurry without geotextile bag	12:40	7.33089E-05
	High slurry with geotextile bag	16:50	6.83106E-05
	Blank		6.16461E-05

Table 14 Concentration of VOCs (µg/L)

Sample ID	Sampling date	Source	Benzene	Toluene	Xylenes
Blank 1	14/1/03	On barge	<0.1	<0.1	<0.2
Blank 2	21/1/03	Shed	<0.1	<0.1	<0.2
Blank 3	22/1/03	Shed	<0.1	<0.1	<0.2
VOC1	14/1/03	Low dredging	<0.1	<0.1	<0.2
VOC2	15/1/03	High dredging	<0.1	<0.1	0.6
VOC3		Medium dredging	<0.1	<0.1	<0.2
VOC4	21/1/03	High mix pen	<0.1	<0.1	<0.2
VOC5		High mix pen with geotextile bag	<0.1	<0.1	<0.2
VOC6		Medium mix pen	<0.1	<0.1	<0.2
VOC7		Medium mix pen with geotextile bag	<0.1	<0.1	<0.2
VOC8		Low mix pen	<0.1	<0.1	<0.2
VOC9		Low mix pen with geotextile bag	<0.1	<0.1	<0.2
VOC10		Medium slurry	<0.1	<0.1	<0.2
VOC11		Medium slurry with geotextile bag	<0.1	<0.1	<0.2
VOC12	22/1/03	High slurry	<0.1	<0.1	<0.2
VOC13		High slurry with geotextile bag	<0.1	<0.1	<0.2

Table 15 Concentrations of PAHs (µg/L)

	XAD1	XAD2	XAD3	XAD4	XAD5	XAD6	XAD7	XAD8	XAD9	XAD10	XAD11	XAD12	XAD13
Source	L1 barrel on barge	H1 barrel on barge	M1 barrel on barge	High mix without geotextile bag	High mix with geotextile bag	Medium mix without geotextile bag	Medium mix with geotextile bag	Low mix without geotextile bag	Low mix with geotextile bag	Medium slurry without geotextile bag	Medium slurry with geotextile bag	High slurry without geotextile bag	High slurry with geotextile bag
Naphthalene	0.973	86.425	0.637	6.327	2.306	1.370	0.764	2.643	0.265	0.701	0.092	6.313	6.373
Acenaphthylene	0.006	0.146	0.002	0.055	0.008	0.002	0.003	0.009	0.002	0.002	ND	0.031	0.019
Acenaphthene	0.020	9.065	0.034	0.307	0.046	0.017	0.023	0.036	0.015	0.019	0.007	0.249	0.115
Fluorene	0.009	0.856	0.012	0.121	0.008	0.005	0.005	0.021	0.004	0.005	0.002	0.058	0.025
Phenanthrene	0.003	0.192	0.008	0.050	0.001	0.007	0.002	0.011	ND	0.003	ND	0.020	0.006
Anthracene	ND	ND	ND	0.011	ND	0.001	ND	0.002	ND	ND	ND	0.003	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benz[a]anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo[b]fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo[k]fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo[a]pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno[1.2.3-cd]pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz[a,h]antracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo[ghi]perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

9.2 Photos

Photo 1 Dredging simulation process

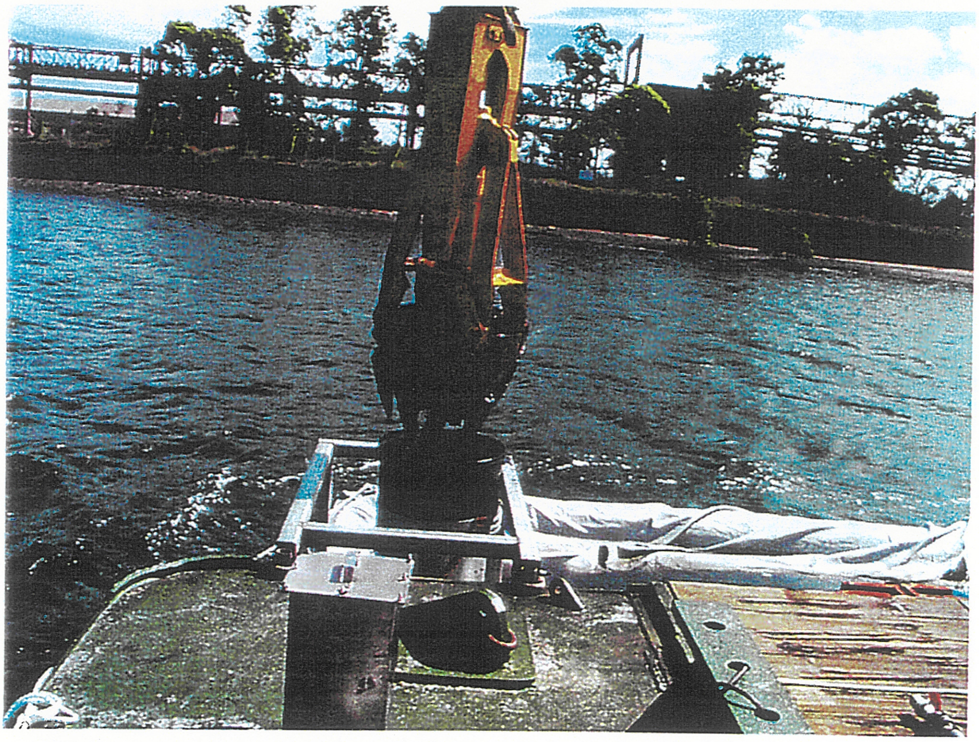

Photo 2 Dredging material filling to the container

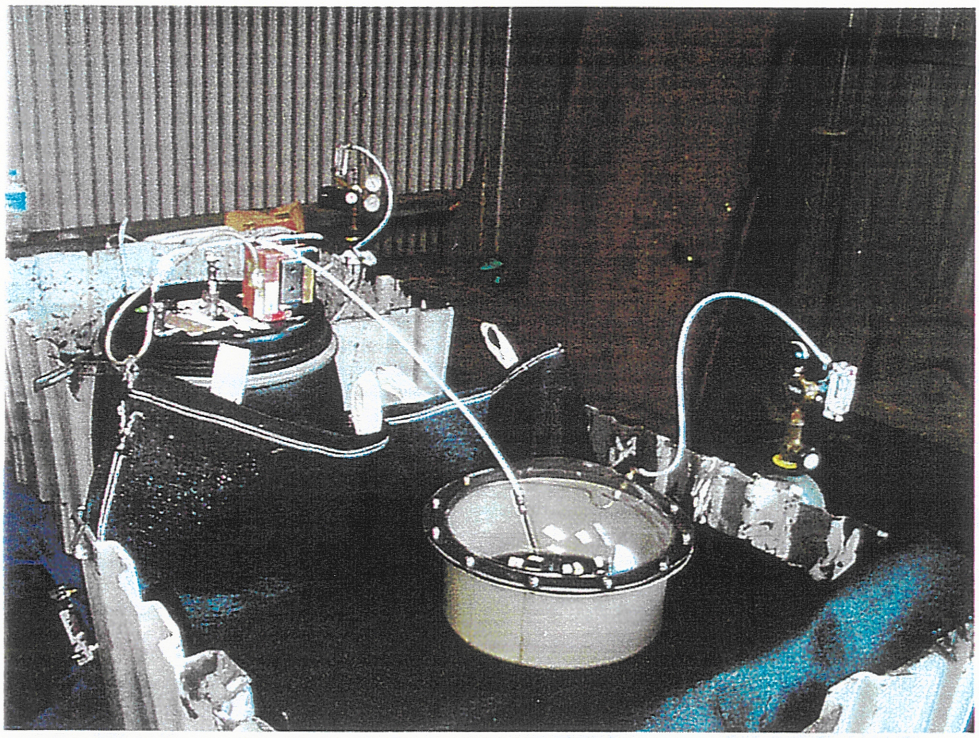

Photo 3 VOCs and PAHs Sampling from the odour pen with geotextile bag

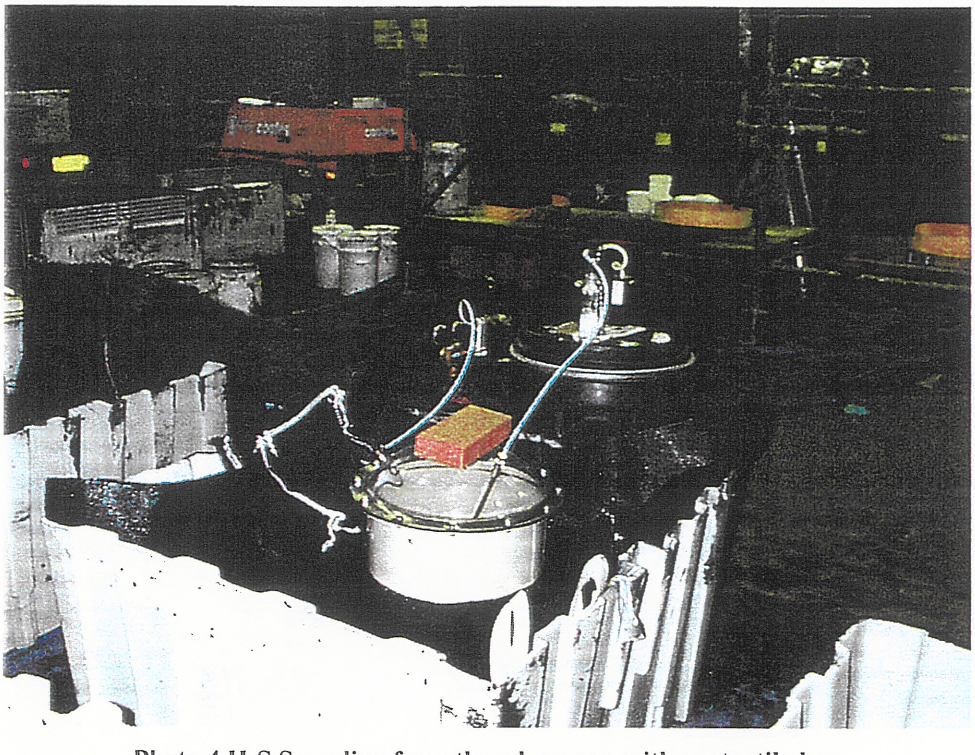

Photo 4 H_2S Sampling from the odour pen with geotextile bag

Photo 5 Odour sampling from the barrel on the dredging barge

9.3 Input details for Ausplume dispersion modelling and modelling results

Two of the text files of Ausplume dispersion modelling were attached: one is dredging site 1 open barge without geotextile bag, another is site 2 open barge with geotextile bag.

9.3.1 Site 1 open barge without geotextile bag

Site 1 open barge without geotextile bag

Concentration or deposition Concentration
Emission rate units OUV/second
Concentration units Odour_Units
Units conversion factor 1.00E+00
Constant background concentration 0.00E+00
Terrain effects None
Smooth stability class changes? No
Other stability class adjustments ("urban modes") None
Ignore building wake effects? No
Decay coefficient (unless overridden by met. file) 0.000
Anemometer height 10 m
Roughness height at the wind vane site 0.500 m
Averaging time for sigma-theta values 60 min.

DISPERSION CURVES
Horizontal dispersion curves for sources <100m high Sigma-theta
Vertical dispersion curves for sources <100m high Pasquill-Gifford
Horizontal dispersion curves for sources >100m high Briggs Rural
Vertical dispersion curves for sources >100m high Briggs Rural
Enhance horizontal plume spreads for buoyancy? Yes
Enhance vertical plume spreads for buoyancy? Yes
Adjust horizontal P-G formulae for roughness height? Yes
Adjust vertical P-G formulae for roughness height? Yes
Roughness height 0.500m
Adjustment for wind directional shear None

PLUME RISE OPTIONS
Gradual plume rise? Yes
Stack-tip downwash included? No
Building downwash algorithm: PRIME method.
Entrainment coeff. for neutral & stable lapse rates 0.60,0.60
Partial penetration of elevated inversions? No
Disregard temp. gradients in the hourly met. file? No

and in the absence of boundary-layer potential temperature gradients given by the hourly met. file, a value from the following table (in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

Site 1 open barge without geotextile bag

SOURCE CHARACTERISTICS

INTEGRATED AREA SOURCE: OB1

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
5056	4667	0m	40m	6m	33deg	0m	0m

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_3.1	3.1_5.1	5.1_8.2	8.2_10.8	>10.8
Stability A:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability B:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability C:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability D:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00

Stability E:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00
Stability F:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00

No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: DS

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
5068	4653	0m	10m	10m	33deg	0m	0m

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability B:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability C:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability D:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability E:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00
Stability F:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00

No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: OB2

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
6056	4278	0m	40m	6m	33deg	0m	0m

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability B:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability C:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability D:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability E:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00
Stability F:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00

No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: OT

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
6077	4264	0m	5m	2m	33deg	0m	1m

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability B:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability C:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability D:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability E:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00
Stability F:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00

No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: BT

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
5278	3833	0m	50m	50m	33deg	0m	0m

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00
Stability B:	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00
Stability C:	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00
Stability D:	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00
Stability E:	1.65E+00	1.65E+00	1.65E+00	1.65E+00	1.65E+00	1.65E+00
Stability F:	1.65E+00	1.65E+00	1.65E+00	1.65E+00	1.65E+00	1.65E+00

No gravitational settling or scavenging.

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Site 1 open barge without geotextile bag

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):

0.m 500.m 1000.m 1500.m 2000.m 2500.m 3000.m
3500.m 4000.m 4500.m 5000.m 5500.m 6000.m 6500.m
7000.m 7500.m 8000.m 8500.m 9000.m 9500.m

and these y-values (or northings):

0.m	500.m	1000.m	1500.m	2000.m	2500.m	3000.m
3500.m	4000.m	4500.m	5000.m	5500.m	6000.m	6500.m
7000.m	7500.m	8000.m	8500.m	9000.m	9500.m	

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	3000	4667	0.0	0.0	5	4778	2833	0.0	0.0
2	3722	4222	0.0	0.0	6	5722	2500	0.0	0.0
3	4222	3722	0.0	0.0	7	6444	3444	0.0	0.0
4	4333	3278	0.0	0.0	8	6500	3944	0.0	0.0

METEOROLOGICAL DATA : Newcastle Ausplume Met File Surface Roughness 0.5 m

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Peak values for the 100 worst cases (in Odour_Units)
Averaging time = 1 hour

Rank	Value	Time Recorded hour,date	Coordinates (* denotes polar)
1	1.17E+01	05,14/01/95	(5000, 4500, 0.0)
2	1.04E+01	22,22/06/95	(5500, 4000, 0.0)
3	1.03E+01	04,24/10/94	(5500, 4000, 0.0)
4	1.01E+01	02,02/02/95	(5000, 4500, 0.0)
5	9.86E+00	01,17/04/94	(5000, 4500, 0.0)
6	9.42E+00	21,28/05/95	(5500, 4000, 0.0)
7	9.26E+00	04,14/01/95	(5000, 4500, 0.0)
8	9.26E+00	21,20/04/95	(5000, 4500, 0.0)
9	8.48E+00	22,19/05/95	(5500, 4000, 0.0)
10	8.41E+00	03,02/02/95	(5000, 4500, 0.0)
11	7.78E+00	21,06/07/94	(5000, 4500, 0.0)
12	7.69E+00	04,06/04/94	(5000, 4500, 0.0)
13	7.39E+00	23,19/05/95	(5500, 4000, 0.0)
14	7.32E+00	22,26/12/94	(5500, 4000, 0.0)
15	7.08E+00	01,26/04/95	(5000, 4500, 0.0)
16	6.73E+00	04,15/08/95	(5500, 4000, 0.0)
17	6.67E+00	02,06/04/94	(5000, 4500, 0.0)
18	6.52E+00	04,22/11/94	(5500, 4000, 0.0)
19	6.52E+00	22,17/04/95	(5500, 4000, 0.0)

20	6.36E+00	02,06/02/95	(5500,	4000,	0.0)
21	6.32E+00	20,03/10/94	(5000,	4500,	0.0)
22	6.26E+00	02,15/08/95	(5500,	4000,	0.0)
23	6.26E+00	05,16/02/94	(5000,	4500,	0.0)
24	6.26E+00	04,31/12/95	(5000,	4500,	0.0)
25	5.89E+00	02,16/08/95	(5500,	4000,	0.0)
26	5.82E+00	24,16/03/95	(5500,	4000,	0.0)
27	5.75E+00	20,15/06/94	(5500,	4000,	0.0)
28	5.75E+00	21,19/05/95	(5500,	4000,	0.0)
29	5.48E+00	01,15/08/95	(5500,	4000,	0.0)
30	5.42E+00	01,10/04/94	(5000,	4500,	0.0)
31	5.40E+00	05,08/02/95	(5000,	4500,	0.0)
32	5.37E+00	02,07/06/94	(6000,	4500,	0.0)
33	5.32E+00	01,23/03/94	(5500,	3500,	0.0)
34	5.20E+00	02,23/04/94	(5500,	4000,	0.0)
35	5.08E+00	03,16/10/95	(5500,	3500,	0.0)
36	5.03E+00	22,15/04/95	(5000,	4500,	0.0)
37	4.94E+00	22,18/03/95	(5500,	4000,	0.0)
38	4.91E+00	01,09/07/95	(5500,	4000,	0.0)
39	4.91E+00	05,15/04/95	(5500,	4000,	0.0)
40	4.86E+00	04,02/02/95	(5000,	4500,	0.0)
41	4.84E+00	24,16/02/95	(5000,	5000,	0.0)
42	4.83E+00	03,14/01/95	(5000,	4500,	0.0)
43	4.82E+00	23,01/02/95	(5000,	4000,	0.0)
44	4.81E+00	03,21/12/94	(5000,	5000,	0.0)
45	4.79E+00	01,11/07/95	(5500,	3500,	0.0)
46	4.77E+00	22,13/06/95	(5500,	4000,	0.0)
47	4.73E+00	04,17/04/94	(5500,	4000,	0.0)
48	4.69E+00	22,02/09/94	(5000,	4500,	0.0)
49	4.63E+00	22,03/10/94	(5500,	4000,	0.0)
50	4.62E+00	02,23/04/95	(5500,	4000,	0.0)
51	4.61E+00	01,08/02/95	(5000,	4500,	0.0)
52	4.58E+00	03,25/06/95	(5500,	3500,	0.0)
53	4.55E+00	04,29/11/95	(5000,	4500,	0.0)
54	4.53E+00	03,07/06/94	(5500,	4000,	0.0)
55	4.53E+00	21,03/08/94	(5500,	4000,	0.0)
56	4.49E+00	03,26/06/95	(5500,	3500,	0.0)
57	4.44E+00	05,26/08/94	(5500,	3500,	0.0)
58	4.42E+00	24,22/04/94	(5000,	4500,	0.0)
59	4.40E+00	05,10/04/94	(5500,	3500,	0.0)
60	4.23E+00	01,06/10/94	(5000,	4500,	0.0)
61	4.19E+00	01,02/02/95	(5000,	5000,	0.0)
62	4.17E+00	01,15/10/94	(5000,	4500,	0.0)
63	4.16E+00	01,21/08/95	(5000,	4500,	0.0)
64	4.15E+00	21,08/07/95	(5500,	4000,	0.0)
65	4.15E+00	22,08/07/95	(5500,	4000,	0.0)

66	4.15E+00	23,08/07/95	(5500,	4000,	0.0)
67	4.15E+00	24,08/07/95	(5500,	4000,	0.0)
68	4.13E+00	04,27/01/94	(5000,	4500,	0.0)
69	4.10E+00	21,16/04/95	(5000,	4500,	0.0)
70	4.10E+00	02,16/10/95	(5000,	4500,	0.0)
71	4.08E+00	02,22/02/95	(5500,	4000,	0.0)
72	4.01E+00	03,05/02/95	(5000,	3500,	0.0)
73	4.01E+00	05,19/12/94	(5000,	5000,	0.0)
74	4.00E+00	24,07/02/95	(5000,	4500,	0.0)
75	4.00E+00	20,05/06/94	(5000,	4500,	0.0)
76	3.99E+00	20,16/04/95	(5000,	3500,	0.0)
77	3.99E+00	03,15/08/95	(5500,	4000,	0.0)
78	3.89E+00	01,06/01/94	(5000,	4500,	0.0)
79	3.89E+00	05,05/02/95	(5000,	3500,	0.0)
80	3.89E+00	20,18/04/95	(5000,	3500,	0.0)
81	3.89E+00	24,05/02/94	(5000,	4500,	0.0)
82	3.88E+00	01,28/08/94	(5000,	4500,	0.0)
83	3.88E+00	23,22/02/95	(5000,	4500,	0.0)
84	3.86E+00	04,22/04/94	(5500,	3500,	0.0)
85	3.85E+00	01,16/10/95	(5000,	4500,	0.0)
86	3.83E+00	21,26/11/95	(5000,	4500,	0.0)
87	3.83E+00	03,09/02/95	(5000,	3500,	0.0)
88	3.83E+00	20,20/04/95	(5000,	3500,	0.0)
89	3.83E+00	02,08/02/95	(5000,	4500,	0.0)
90	3.78E+00	02,04/03/94	(6000,	4500,	0.0)
91	3.71E+00	01,09/02/95	(5000,	3500,	0.0)
92	3.70E+00	22,25/10/94	(5000,	4500,	0.0)
93	3.69E+00	23,10/07/95	(6000,	4000,	0.0)
94	3.67E+00	20,02/11/95	(6000,	4500,	0.0)
95	3.65E+00	05,14/12/94	(5000,	4500,	0.0)
96	3.65E+00	22,26/04/95	(5000,	4500,	0.0)
97	3.64E+00	02,09/02/95	(5000,	3500,	0.0)
98	3.59E+00	21,24/03/95	(5500,	3500,	0.0)
99	3.57E+00	21,07/07/95	(5500,	4000,	0.0)
100	3.54E+00	03,08/02/95	(5000,	4500,	0.0)

9.3.2 Site 2 open barge with geotextile bag

Site 2 open barge with geotextile bag

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	No
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.500 m
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Sigma-theta
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.500m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	No
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients given by the hourly met. file, a value from the following table (in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

Site 2 open barge with geotextile bag

SOURCE CHARACTERISTICS

INTEGRATED AREA SOURCE: OB1

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
3778	5500	0m	40m	6m	33deg	0m	0m

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_3.1	3.1_5.1	5.1_8.2	8.2_10.8	>10.8
Stability A:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability B:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability C:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability D:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability E:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00
Stability F:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00

No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: DS

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
3790	5486	0m	10m	10m	33deg	0m	0m

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability B:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability C:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability D:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability E:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00
Stability F:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00

No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: OB2

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
6056	4278	0m	40m	6m	33deg	0m	0m

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability B:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability C:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability D:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability E:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00
Stability F:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00

No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: OT

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
6077	4264	0m	5m	2m	33deg	0m	1m

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00

Stability B:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability C:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability D:	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00	8.39E+00
Stability E:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00
Stability F:	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00	7.72E+00

No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: BT

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
5278	3833	0m	50m	50m	33deg	0m	0m

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00
Stability B:	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00
Stability C:	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00
Stability D:	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00
Stability E:	1.65E+00	1.65E+00	1.65E+00	1.65E+00	1.65E+00	1.65E+00
Stability F:	1.65E+00	1.65E+00	1.65E+00	1.65E+00	1.65E+00	1.65E+00

No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: DWG

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
4889	4111	0m	400m	200m	33deg	0m	0m

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	1.26E+00	1.26E+00	1.26E+00	1.26E+00	1.26E+00	1.26E+00
Stability B:	1.26E+00	1.26E+00	1.26E+00	1.26E+00	1.26E+00	1.26E+00
Stability C:	1.26E+00	1.26E+00	1.26E+00	1.26E+00	1.26E+00	1.26E+00
Stability D:	1.26E+00	1.26E+00	1.26E+00	1.26E+00	1.26E+00	1.26E+00
Stability E:	1.16E+00	1.16E+00	1.16E+00	1.16E+00	1.16E+00	1.16E+00
Stability F:	1.16E+00	1.16E+00	1.16E+00	1.16E+00	1.16E+00	1.16E+00

No gravitational settling or scavenging.

1

Site 2 open barge with geotextile bag

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
0.m 500.m 1000.m 1500.m 2000.m 2500.m 3000.m
3500.m 4000.m 4500.m 5000.m 5500.m 6000.m 6500.m
7000.m 7500.m 8000.m 8500.m 9000.m 9500.m

and these y-values (or northings):
0.m 500.m 1000.m 1500.m 2000.m 2500.m 3000.m
3500.m 4000.m 4500.m 5000.m 5500.m 6000.m 6500.m
7000.m 7500.m 8000.m 8500.m 9000.m 9500.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	3000	4667	0.0	0.0	5	4778	2833	0.0	0.0
2	3722	4222	0.0	0.0	6	5722	2500	0.0	0.0
3	4222	3722	0.0	0.0	7	6444	3444	0.0	0.0
4	4333	3278	0.0	0.0	8	6500	3944	0.0	0.0

METEOROLOGICAL DATA : Newcastle Ausplume Met File Surface Roughness 0.5 m

1 Peak values for the 100 worst cases (in Odour_Units)
Averaging time = 1 hour

Rank	Value	Time Recorded hour,date	Coordinates (* denotes polar)		
1	9.37E+01	05,09/02/95	(5000,	4000,	0.0)
2	9.33E+01	01,10/02/95	(5000,	4000,	0.0)
3	9.33E+01	04,10/02/95	(5000,	4000,	0.0)
4	9.31E+01	23,22/04/94	(5000,	4000,	0.0)
5	9.26E+01	23,16/04/95	(5000,	4000,	0.0)
6	9.26E+01	04,10/04/94	(5000,	4000,	0.0)
7	9.25E+01	23,10/07/95	(5000,	4000,	0.0)
8	9.25E+01	23,08/02/95	(5000,	4000,	0.0)

9	9.24E+01	02,10/02/95	(5000,	4000,	0.0)
10	9.21E+01	03,10/02/95	(5000,	4000,	0.0)
11	9.20E+01	24,08/02/95	(5000,	4000,	0.0)
12	9.20E+01	04,09/02/95	(5000,	4000,	0.0)
13	9.18E+01	02,09/02/95	(5000,	4000,	0.0)
14	9.17E+01	03,09/02/95	(5000,	4000,	0.0)
15	9.17E+01	20,20/04/95	(5000,	4000,	0.0)
16	9.16E+01	03,05/02/95	(5000,	4000,	0.0)
17	9.15E+01	20,16/04/95	(5000,	4000,	0.0)
18	9.15E+01	05,14/01/95	(5000,	4000,	0.0)
19	9.14E+01	05,05/02/95	(5000,	4000,	0.0)
20	9.14E+01	20,18/04/95	(5000,	4000,	0.0)
21	9.14E+01	01,09/02/95	(5000,	4000,	0.0)
22	9.13E+01	04,05/02/95	(5000,	4000,	0.0)
23	9.13E+01	24,09/02/95	(5000,	4000,	0.0)
24	9.13E+01	22,16/04/95	(5000,	4000,	0.0)
25	9.13E+01	23,07/02/95	(5000,	4000,	0.0)
26	9.12E+01	24,07/02/95	(5000,	4000,	0.0)
27	9.12E+01	02,02/02/95	(5000,	4000,	0.0)
28	9.12E+01	03,02/02/95	(5000,	4000,	0.0)
29	9.12E+01	04,14/01/95	(5000,	4000,	0.0)
30	9.12E+01	21,20/04/95	(5000,	4000,	0.0)
31	9.10E+01	24,10/07/95	(5000,	4000,	0.0)
32	7.86E+01	19,17/04/95	(5000,	4000,	0.0)
33	7.70E+01	19,16/04/95	(5000,	4000,	0.0)
34	7.70E+01	04,16/03/94	(5000,	4000,	0.0)
35	7.65E+01	01,26/04/95	(5000,	4000,	0.0)
36	7.65E+01	21,06/07/94	(5000,	4000,	0.0)
37	7.62E+01	02,17/04/94	(5000,	4000,	0.0)
38	7.61E+01	01,17/04/94	(5000,	4000,	0.0)
39	7.60E+01	20,05/06/94	(5000,	4000,	0.0)
40	7.03E+01	01,10/07/95	(5500,	4000,	0.0)
41	7.02E+01	24,17/04/95	(5500,	4000,	0.0)
42	7.02E+01	24,18/04/95	(5500,	4000,	0.0)
43	6.71E+01	04,24/05/95	(5000,	4000,	0.0)
44	6.63E+01	20,05/02/95	(5000,	4000,	0.0)
45	6.61E+01	23,04/02/95	(5000,	4000,	0.0)
46	6.60E+01	23,31/05/94	(5000,	4000,	0.0)
47	6.59E+01	22,08/02/95	(5000,	4000,	0.0)
48	6.57E+01	01,10/04/94	(5000,	4000,	0.0)
49	6.55E+01	02,06/04/94	(5000,	4000,	0.0)
50	6.54E+01	04,06/04/94	(5000,	4000,	0.0)
51	6.52E+01	23,27/03/94	(5000,	4000,	0.0)
52	6.52E+01	23,09/02/95	(5000,	4000,	0.0)
53	6.41E+01	23,13/08/95	(5500,	4000,	0.0)
54	6.30E+01	04,26/08/94	(5500,	4000,	0.0)

55	6.23E+01	18,18/04/95	(5000,	4000,	0.0)
56	6.21E+01	05,10/02/95	(5000,	4000,	0.0)
57	6.14E+01	19,18/04/95	(5000,	4000,	0.0)
58	6.13E+01	05,20/04/95	(5000,	4000,	0.0)
59	6.12E+01	04,17/10/94	(5000,	4000,	0.0)
60	6.02E+01	04,02/02/95	(5000,	4000,	0.0)
61	6.02E+01	22,12/08/95	(5000,	4000,	0.0)
62	6.01E+01	05,08/02/95	(5000,	4000,	0.0)
63	6.01E+01	03,26/02/94	(5000,	4000,	0.0)
64	6.01E+01	04,26/02/94	(5000,	4000,	0.0)
65	6.01E+01	23,14/04/95	(5000,	4000,	0.0)
66	6.01E+01	02,31/08/94	(5000,	4000,	0.0)
67	6.00E+01	04,08/02/95	(5000,	4000,	0.0)
68	6.00E+01	03,08/02/95	(5000,	4000,	0.0)
69	6.00E+01	02,08/02/95	(5000,	4000,	0.0)
70	6.00E+01	21,16/04/95	(5000,	4000,	0.0)
71	6.00E+01	02,16/10/95	(5000,	4000,	0.0)
72	6.00E+01	01,08/02/95	(5000,	4000,	0.0)
73	6.00E+01	03,14/01/95	(5000,	4000,	0.0)
74	5.85E+01	19,20/04/95	(5000,	4000,	0.0)
75	5.85E+01	20,07/05/94	(5500,	4000,	0.0)
76	5.85E+01	21,04/07/95	(5500,	4000,	0.0)
77	5.80E+01	02,25/06/95	(5000,	4000,	0.0)
78	5.76E+01	24,04/02/95	(5000,	4000,	0.0)
79	5.76E+01	01,17/01/95	(5000,	4000,	0.0)
80	5.75E+01	01,15/10/94	(5000,	4000,	0.0)
81	5.74E+01	02,05/02/95	(5000,	4000,	0.0)
82	5.73E+01	19,05/02/95	(5000,	4000,	0.0)
83	5.73E+01	20,03/10/94	(5000,	4000,	0.0)
84	5.71E+01	22,09/02/95	(5000,	4000,	0.0)
85	5.70E+01	22,02/09/94	(5000,	4000,	0.0)
86	5.60E+01	23,31/08/94	(5000,	4000,	0.0)
87	5.57E+01	20,17/04/95	(5500,	4000,	0.0)
88	5.47E+01	21,16/07/95	(5000,	4000,	0.0)
89	5.40E+01	23,20/08/95	(5000,	4000,	0.0)
90	5.33E+01	22,03/02/95	(5000,	4000,	0.0)
91	5.30E+01	03,25/06/95	(5000,	4000,	0.0)
92	5.26E+01	01,04/03/94	(5000,	4000,	0.0)
93	5.24E+01	24,29/03/94	(5000,	4000,	0.0)
94	5.16E+01	01,17/02/95	(5000,	4000,	0.0)
95	5.15E+01	21,26/08/95	(5000,	4000,	0.0)
96	5.14E+01	24,10/04/94	(5000,	4000,	0.0)
97	5.14E+01	23,06/06/94	(5000,	4000,	0.0)
98	5.13E+01	02,31/10/94	(5000,	4000,	0.0)
99	5.12E+01	18,16/04/95	(5000,	4000,	0.0)
100	5.11E+01	24,16/12/94	(5000,	4000,	0.0)

9.4 NSW EPA Environment Protection Authority Requirements for Environmental Impact Statement: Proposed Dredging of Contaminated Material in South Arm of Hunter River (attachment of NSW EPA letter dated 27 Nov 2002)

FAXED 29/11/02

Your Reference : S01/00533
Our Reference : 273128A1
Contact : Rebecca Scrivener, 4908 6830

EPA

Coastal Regions

Major Development Assessment
planningNSW
GPO Box 3927
SYDNEY NSW 2001

27 NOV 2002

Attn: Mr Gordon Kirby

Dear Sir

DIRECTOR GENERAL'S REQUIREMENTS: DREDGING OF HUNTER RIVER (SOUTH ARM) TO EXPAND PORT BERTHING FACILITIES

I refer to your letter of 14 November 2002 requesting the EPA to provide its requirements for the Environmental Impact Statement for this development proposal. I also refer to the planning focus meeting on 6 November 2002 to discuss the scope of this development proposal.

The requirements provided in attachment A to this letter taken into account the scope of works described in your letter and the issues discussed at the planning focus meeting. These requirements also replace the requirements submitted by the EPA on 11 May 2001 for the original project.

The proponent should be aware that the bed sediments of the Hunter River within 120 metres of the shoreline of Lot 221 DP1013964 known as the Closure Area of the former BHP steel works site are declared a Remediation Site under Section 21 of the Contaminated Land Management (CLM) Act. The whole of Lot 221 DP 1013964 and the bed sediments of the Hunter River within 120 meters of the shoreline of this land known as the Onesteel Site is declared an Investigation Area under the CLM Act. Consequently, any investigations or work proposed in the Environmental Impact Statement (EIS) that is associated with the land and the sediments described above should be directed towards developing appropriate remediation strategies.

In summary the key issues that will need to be addressed in the EIS to enable the EPA to adequately assess the proposal and if appropriate to issue General Terms of Approval include:

- Noise emissions associated with sheet piling, dredging and onshore materials handling and remediation activities;
- Noise and vibration associated with blasting of hard rock from the river bed;
- Assessment of the chemical, physical and toxicology characteristics of the soils and sediments impacted by the development works;
- Potential for dredging operations and the land based activities to pollute waters;
- Emission of odours and other air pollutants associated with the dredging and onshore remediation activities;
- Identification of feasible remediation or disposal strategies for the quantity of contaminated soil and sediments to be removed or disturbed to construct the swing basin and the navigation channel; and

03 DEC 2002

- Procedures that will be implemented to mitigate significant impacts and to monitor the effectiveness of the mitigation works.

Based on the information provided the dredging works and sediment storage/treatment/remediation activities are scheduled activities under the Protection of the Environment Operations Act and as such are required to be licensed by the EPA. If development consent is granted the applicant will need to obtain the appropriate licences from the EPA before any work on these activities commences.

The EIS should not propose remediation strategies or pollution mitigation systems or procedures that are either poorly defined, impractical or beyond the financial viability of the applicant to implement and/or maintain.

The EPA requests that three (3) copies of the EIS to be provided with a copy of the development application to the EPA's Regional Manager, Hunter.

If you require clarification on the EPA's requirements please contact me on 49086815.

Yours sincerely

GRAHAME CLARKE
A/Regional Manager, Hunter

Attachment A

ENVIRONMENT PROTECTION AUTHORITY REQUIREMENTS FOR ENVIRONMENTAL IMPACT STATEMENT:– PROPOSED DREDGING OF CONTAMINATED MATERIAL IN SOUTH ARM OF HUNTER RIVER

GENERAL REQUIREMENTS

The EPA suggests that the Planning NSW's EIS Guideline (draft) Remediation Works be used as a guide to the preparation of the EIS.

The EIS must provide sufficient information for the EPA to be able to fully assess the development in so far as the impacts relate to the EPA's statutory responsibility under the provisions of the environmental legislation administered by the EPA and, if appropriate, to provide its general terms of approval. The requirements of Section 45 of the Protection of the Environment Operations Act (1997) must be addressed.

SPECIFIC REQUIREMENTS

<u>Characterisation of contamination levels in the sediments</u>

The EIS must present the results of the detailed chemical and toxicity investigations conducted on the sediments in the South Arm of the Hunter River for Newcastle Port Corporation by the CSIRO's Centre for Advanced Analytical Chemistry.

Given that the level of Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH) in the sediments is known to vary with depth and spatially within the development site the EIS must provide a detailed analysis and description of the concentrations and distribution of PAHs and TPHs in sediments that will be disturbed or dredged. If it is proposed to vary the method of removing and/or remediating/disposing of the sediments based on a logical system of grouping the sediments according to the level of toxicity or other characteristics the EIS must explain the rational for this procedure and clearly identify the location and estimated quantity of each group of sediments on a suitable map or diagram.

<u>Dredging works</u>

The EIS must include a detailed description and justification for the dredging methodology(s) proposed and the systems that will be in place to minimise any impacts associated with the operation of the dredge(s) on water quality and the emission of odours and other air pollutants.

<u>Remediation or disposal of contaminated sediment and soil</u>

The EIS must describe in detail the method(s) proposed to handle, store, pre-treat, remediate or dispose of contaminated soils and sediments and the extent to which the methods proposed are expected to prevent pollutants migrating either directly or indirectly from the development site to air or waters.

If a heat treatment processes such as thermal desorption is proposed the EIS must also provide an assessment of the emissions to atmosphere that could reasonably be expected to be achieved when monitored in accordance with the methods described under the air impact assessment heading of these requirements.

WATER IMPACT ASSESSMENT

If the handling, storage, pre-treatment, remediation or disposal method(s) for contaminated soils or sediments are likely to generate leachate or treated effluents the EIS must provide an estimate of the quantity and an evaluation of the physical, chemical and toxicity characteristic of the leachate or effluents that will be returned to the environment. In addition to PAH's that are known to be present in high concentrations in the sediments the analysis should consider the fate of other pollutants likely to be present in the sediments or soils. For example Petroleum Hydrocarbons (including benzene, toluene, ethyl benzene and xylene), metals, phenol, ammonia and cyanide.

The EIS must assess the potential for shore-based activities such as excavations to construct the swing basin or the storage, treatment/remediation of contaminated soils or sediments to adversely impact on groundwater quality. If the assessment predicts that groundwater quality will be significantly impacted the EIS must propose measures to ameliorate the impacts.

The EIS must describe the measures to be adopted to manage stormwater from any land based activities associated with the construction of the swing basin, bank stabilisation works or the storage and remediation of contaminated soil and sediments. The EIS should identify the pollutants and the concentration of these pollutants in stormwater that will be discharged from the stormwater system(s) to the environment.

The EPA has adopted the Australian and New Zealand Environment Conservation Council *Water Quality Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000) as a guide for the assessment of environmental impacts on aquatic ecosystems.

AIR IMPACTS ASSESSMENT

The EIS must include an Air Quality Impact Assessment (AQIA). The AQIA must identify and describe in detail those activities or processes with the potential to cause point source or fugitive emissions of dust, fine particulates and other air pollutants that may be present in soils that will be excavated to construct the swing basin or in sediments to be removed from the Hunter River.

The EPA's preferred approach to the AQIA is set out in the document titled '*Approved Methods and Guidance For the Modelling and Assessment of Air Pollutants in New South Wales*'. *This document is* available on the EPA's website at http://www.epa.nsw.gov.au/air/amgmaap.

The AQIA must include a detailed odour impact assessment for all activities associated with the excavation, dredging, handling or remediation of contaminated soils and sediments with a potential to emit odours. The EPA's preferred approach to odour assessment is detailed in the document titled ' *Assessment and Management of Odour from Statutory Sources in NSW*'. This document is available on the EPA's website at www.epa.gov.au/air/odour/htm.

Given that the sediments are known to contain high concentrations of naphthalene and other odour generating substances the methodology described for a level 3 assessment in the above-mentioned document should be followed. Odour source data used in the assessment should be derived in accordance with procedures described in the document titled " *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*" methods OM7 and OM8. This document is available on the EPA's website at www.epa.gov.au/air/amsaap/htm.

The AQIA must describe the methodology used and any assumptions made to predict the impacts and take into account cumulative impacts associated with emissions from any other industrial activities in the area including any developments that have development consent but which have not commenced construction or operations prior to the EIS for this development being exhibited. In particular dust and particulate emissions (PM_{10}) associated with demolition and remediation activities on Lot 221 DP1013964 known as the Closure Area of the former BHP steel works site.

The EIS must describe in detail the measures proposed to mitigate the impacts and quantitatively describe the extent to which the mitigation measures are likely to be effective in achieving relevant assessment criteria.

NOISE IMPACTS ASSESSMENT

The EIS must identify all significant noise sources and describe the extent to which noise emissions associated with the activities proposed to be conducted, and in particular excavation works, sheet piling, dredging and contaminated soil or sediment handling and remediation activities are likely to impact on residential or other sensitive receivers in the vicinity of the development site. The proponent must provide this detail in the form of a noise impact assessment (NIA) prepared in accordance with the EPA's '*New South Wales Industrial Noise Policy (INP)*' (EPA, January 2000).

The NIA should include a location map of the area showing the development site, significant noise sources and residential areas and any specific noise sensitive locations that could be impacted by the development.

The NIA should clearly define the hours of operation and the duration of each noise source activity. If activities are proposed to be conducted between the hours 10pm to 7am the NIA must assess the potential for sleep disturbance in resident areas. Guidance on assessing sleep disturbance is provided in appendix B of the document titled '*Environmental Criteria for Road Traffic Noise', (EPA, June 1999).*

Blasting vibration and overpressure

If blasting is proposed to remove hard rock from the river bed the NIA must include an assessment of the predicted noise and vibration levels. The assessment must also provide information on the period over which blasting is likely to be required, the time of day blasting will take place and the number of blasts anticipated on any day.

If blasting is proposed to be conducted outside the hours 7am to 6pm the NIA must assess the potential for sleep disturbance in resident areas.

The impacts should be assessed against the criteria recommended in the document titled *'Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration' (ANZECC, September 1990.)*

Noise mitigating measures

The EIS must describe in detail the measures proposed to mitigate the impacts and quantitatively describe the extent to which the mitigation measures are likely to be effective in achieving relevant assessment criteria.

WASTE ASSESSMENT

Any wastes proposed to be removed from the site must be identified in the EIS and classified in accordance with the EPA's Environmental Guideline' *Assessment, Classification and Management of Liquid and Non-Liquid Wastes", (EPA, May 1999).*

MONITORING REQUIREMENTS

The EIS should describe the methods and procedures that will be adopted to monitor the performance of the pollution control systems or site management practices to be implemented to control or mitigate the emission of noise and emissions to air and waters for the duration of the development works.