LAKE ILLAWARRA ENTRANCE WORKS (STAGE 2)

Director-General's Report Section 115C of the Environmental Planning and Assessment Act 1979

November 2005

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FOREWORD

The Lake Illawarra Authority (LIA) proposes to undertake improvement works at the entrance of Lake Illawarra which include channel dredging, creation of a northern training wall off Perkins Beach and extension of the existing southern training wall. The primary aim of the project is to create a lake entrance that remains open for longer periods of time than currently occurs. This would allow increased tidal flushing of the lake, encourage fish and prawn migration between the lake and ocean, and potentially result in improved water quality of the lake and the overall amenity of this recreational area.

The proposal is subject to assessment under Division 4, Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the approval of the Minister for Planning is required. Consequently, the Proponent has sought the Minister's approval for the proposal under Section 115B of the EP&A Act. This report was prepared in accordance with Section 115C of the EP&A Act, which requires that the Minister obtain a report from the Director-General prior to making a decision.

The purpose of the Director-General's report is to review the proposal's environmental impact statement (EIS), issues raised in representations to the EIS's public exhibition, the Proponent's response to the representations and any other information identified by the Department concerning the proposal's potential environmental impacts. The report documents an independent assessment of the proposal.

A particular concern raised in the representations is the potential impact of the proposed northern breakwater on a prime wavesailing site at Perkins Beach. This potential impact, however, needs to be balanced against the broader benefits that could result from the scheme. Nevertheless, the Department considers there may be opportunities to reduce these impacts, by lowering the height of the breakwater, if feasible. It therefore recommends that the LIA investigate the practicality of this prior to commencing construction.

Overall, there are a number of benefits that could result from the proposal such as maintaining a more consistent water level in the lake and improvements in water quality and recreational amenity. To ensure the benefits are maximised, the recommended conditions require a detailed monitoring program, along with a response mechanism, to deal with any issues that arise. These conditions, together with the other recommended conditions, should ensure that the potential impacts of the proposal are minimised.

The Department notes that the project was endorsed by the State Government-established Independent Review Panel and government funding has already been committed for this project.

On the basis of the above considerations, the proposal is recommended for approval subject to the recommended conditions.

Sam Haddad Director General Department of Planning

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GLOSSARY AND ABBREVIATIONS

AEP	Annual Exceedence Probability
AHD	Average Height Datum
ARI	Average Recurrence Interval
DEC	Department of Environment and Conservation
Department, the	Department of Planning
DIPNR	former Department of Infrastructure, Planning and Natural Resources (separated into the Department of Planning and Department of Natural Resources on 29 August 2005)
Director General	Director General of the Department of Planning
DNR	Department of Natural Resources
DPI	Department of Primary Industries
EMP	environmental management plan
EP&A Act	Environmental Planning and Assessment Act 1979
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (C'wealth)
FM Act	Fisheries Management Act 1994
IRP	Independent Review Panel
LIA	Lake Illawarra Authority

MSL	Mean sea level
Minister	Minister for Planning
POEO Act	Protection of the Environment Operations Act 1997
Proponent	Lake Illawarra Authority
Proposal	Lake Illawarra Entrance Works Project (Stage 2)
Sensitive receivers	Residence, education institution (e.g. school, TAFE college), health care facility (e.g. nursing home, hospital) and religious facility (e.g. church)
SLR	Sea level rise
TSC Act	Threatened Species Conservation Act 1995

EXECUTIVE SUMMARY

Background

Lake Illawarra is a coastal lagoon located some 8 kilometres south of Wollongong on the NSW south coast. The entrance to the lake is unstable, and has closed when constricted with sand and sediments carried into the entrance by wave and tidal action and also from sedimentation caused by urban development along its foreshores. Frequent constriction has restricted the lake's natural tidal flushing of pollutants.

In 2001, the Lake Illawarra Authority (LIA) completed works to stabilise the entrance north of Windang Island. The works (now referred to in the EIS and in this assessment report as Stage 1 entrance works), included the construction of a southern rock training wall/breakwater and an entrance channel. The entrance functioned well until the drought of 2002 which, along with other unfavourable conditions, resulted in the transport of large volumes of sand into the entrance and its eventual closure in August 2002.

Community concerns about the lake's condition led LIA to commission a study investigating options for a northern wall off Perkins Beach to improve the performance of the entrance. The Options Report, prepared by coastal engineering consultants (Lawson & Treloar) considered nine alternative entrance configurations. The report was reviewed by an Independent Review Panel established by the NSW Government who recommended that Option 9 be accepted and developed as a preferred project proposal. Option 9 was subsequently developed by the same consultants and Patterson Britton & Partners to achieve a number of project objectives for the proposal.

The Proposal

The overall aim of the Stage 2 proposal, as stated in the EIS, is to create a permanent entrance condition that allows increased tidal flushing of the lake and provides a more sustainable estuarine system while at the same time encouraging fish and prawn migration between the lake and ocean.

To achieve this objective, the LIA proposes the following works:

- construction of a breakwater/training wall on the northern side of the entrance;
- extension of the existing breakwater/training wall on the southern side of the entrance by way
 of a spur wall;
- dredging of a substantial channel within the lake's entrance;
- creation of a small island for use as a compensatory bird habitat;
- sand nourishment of Warilla Beach utilising the dredged material from the entrance;
- minor improvements to the existing southern training wall through the provision of spur wall extensions at the upstream and downstream gaps; and
- minor extension of the rock groyne on the northern side of the entrance to Elliot Lake.

The estimated capital cost of the main works (first five items) is \$4 million. The latter two items are not considered critical to the scheme and may or may not be constructed, subject to the availability of additional funds.

EIS Exhibition and Approval Process

The LIA as Proponent determined that the proposal would require an Environmental Impact Statement (EIS) in accordance with the Environmental Planning and Assessment Act (EP&A Act).

As the LIA is both the Proponent and a determining authority for the proposal, and an EIS was prepared, the proposal is subject to assessment under Division 4, Part 5 of the and the approval of the Minister for Planning is required.

The EIS for the proposal, entitled *Lake Illawarra Entrance Works Project (Stage 2)* prepared by Patterson Britton & Partners Pty Ltd (dated January 2005), was publicly exhibited from 29 January 2005 to 4 March 2005. Forty-one representations were received. The project justification and impact of works on water quality, lake ecology, lake flooding, coastal processes and wavesailing activities at Perkins Beach were the primary issues of concern.

The LIA sought the Minister's approval for the proposal in a letter received by the Department on 20 June 2005. This Report has been prepared in accordance with Section 115C of the EP&A Act which requires the Director-General to assess and report to the Minister for Planning on the proposal.

Changes to the Proposal after EIS Exhibition

The Proponent did not identify any changes to the proposal following the exhibition of the EIS.

Proposal Justification

The EIS indicated that the Lake Illawarra community is strongly dependent upon the lake (and its entrance and nearby coastline) as an important ecological and social resource. The increase in urbanisation around the foreshores of the lake has contributed to the deterioration of its water quality in recent years and nutrient concentrations have frequently been above acceptable levels. This problem threatens to adversely impact the ecological and recreational value of the lake and could become worse with future development.

The LIA's primary justification for the proposal is that the entrance works would increase the magnitude and frequency of tidal flushing of the lake and consequently improve the lake's overall water quality and ecological health over time.

A second justification is the benefit to the recreational amenity of Lake Illawarra due to the creation of healthier conditions for water-based users, nourishment of Warilla Beach and improvement in beach safety with the stabilisation of the lake entrance.

A third justification is the benefit to the economy within the greater Illawarra community as a result of the improvements to the environmental and recreational amenity.

Environmental Impact Assessment

The key issues found in the assessment are the project justification, impact on wavesailing at Perkins Beach, and some uncertainties about the long term effectiveness and impacts of the proposal.

The Department and government agencies' main concerns involve the following:

- whether the entrance works will be effective in keeping the lake open in the long term;
- the likely effect of structures on coastal processes in the long term; and
- the scale of the water quality improvements.

Wavesailing issues, raised by wavesailors using Perkins Beach, relate to the potential significant wind shadow that could result from the proposed northern breakwater, resulting in significant adverse impact on a prime wavesailing location.

Summary of Findings

The Department's assessment found that construction impacts of the proposal could be properly managed with normal mitigation and management measures.

The Department acknowledges that there are a number of benefits that could result from the proposal such as maintaining a more consistent water level in the lake and improvements in water quality and recreational amenity. However, the coastal environment involves dynamic and often unpredictable processes and there remains some uncertainty over the long term outcomes and effectiveness of the proposal. Nevertheless, the recommended conditions will minimise the risks associated with the proposal.

As requested by the agencies, the LIA has developed performance indicators as a means of measuring the success or otherwise of the proposal. The indicators will be supported by a focussed monitoring program to be developed by the LIA, in consultation with government agencies and other stakeholders.

Conditions of Approval have been recommended requiring the Proponent to prepare a Monitoring Plan that addresses the performance indicators as well as key aspects of the proposal (coastal and estuarine processes, ecology, water quality and flooding). The Monitoring Plan is to include a response framework that clearly describes how the Proponent will address the outcomes of the monitoring plan and need for mitigation measures.

The recommended Conditions of Approval also require a program of reporting on the outcomes of monitoring for three time periods (ie first, third and fifth year of project operation) which would provide an indication of the performance of the project and provide early warnings of any potential risks.

One particular concern that was not addressed in the EIS but has come from the representations is the likely adverse impact of the proposed northern breakwater on wavesailing activities at Perkins Beach. The Department acknowledges the likely significant impact and thus recommends that the LIA investigate the practicality of a lower breakwater before commencing construction. The Director-General's approval will be required for the investigation report.

The Department notes that the project was endorsed by an Independent Review Panel established by the NSW government to examine options for improving the lake entrance. Government funding has also been committed for the project.

On the basis of the above considerations, the proposal is recommended for approval subject to the recommended conditions.

1 INTRODUCTION

1.1 Background

Lake Illawarra is a coastal lagoon located on the NSW south coast some 8 kilometres south of Wollongong. It occupies a surface area of 35km^{2,} with 37km of foreshores. The lake averages less than 2m in depth although much of the lake is less than 1m deep. Some 90,000 people now live in the catchment.

The lake is characterised by a coastal sand barrier and shallow bed which is connected to the ocean by a narrow shoaled channel. The entrance to the lake has been unstable in the past and has intermittently closed when constricted with sand and sediments carried into the entrance by wave and tidal action and also from sediment loads generated by increasing urbanisation within the catchment.

In 1988, the NSW government established the Lake Illawarra Authority (LIA) to improve the environment of Lake Illawarra and to revive and restore the lake so that it continues to provide an attractive recreational and tourism resource. Since its formation, the LIA has been meeting its obligations through the implementation of a program of improvement works.

In 2001, the LIA constructed an entrance channel and a training wall on the southern side of this channel to help keep the lake entrance open. The works (now known as Stage 1 improvement works) were aimed at increasing tidal penetration and reducing the retention time of nutrients and pollutants in the lake body. The entrance functioned reasonably well for the first few months following the completion of the works. However, subsequent drought combined with prolonged calm sea conditions gradually created sand shoals within the entrance which led to its eventual closure in August 2002.

In response to community concerns, the LIA engaged the project team of Lawson and Treloar and Patterson Britton to investigate and consider options for a northern training wall and associated works. Nine options were identified and investigated to a conceptual level. An Independent Review Panel was subsequently established by the NSW Government to examine and report on the options developed to improve the Lake Illawarra entrance.

1.2 The Proposal

Figure 1 shows the location of the proposal. As outlined in the EIS, the proposal consists of:

- construction of a breakwater/training wall on the northern side of the entrance;
- extension of the existing breakwater/training wall on the southern side of the entrance by way
 of a spur wall;
- dredging of a substantial channel within the lake's entrance;
- creation of a small island for use as a compensatory bird habitat;
- sand nourishment of Warilla Beach utilising the dredged material from the entrance;
- minor improvements to the existing southern training wall through the provision of spur wall
 extensions at the upstream and downstream gaps; and
- minor extension of the rock groyne on the northern side of the entrance to Lake Elliot.



Figure 1: Location of the Proposal

Source: EIS Figure 1.1

The proposal has been budgeted to cost \$4 million. However, the Elliot Lake groyne extension and reduction in the width of the gaps in the existing southern training wall, although part of the proposal, have not been costed and are not covered by the \$4 million budget.

Up to 55,000 tonnes of rock would be required to build the training walls/breakwater. A large quantity of suitable rock has been sourced from the construction of the North Kiama Bypass. Approximately 50% of the rocks required has already been transported and stockpiled on the northern side of the entrance.

The estimated duration of the construction works is about 61 weeks.

1.3 Approval Process and EIS Exhibition

1.3.1 Statutory Provisions

The Proponent for the proposal is LIA, a government agency under the Department of Natural Resources which until recently was part of DIPNR. The LIA is subject to Part 5 of the EP&A Act by virtue of the provisions of the LIA Act 1987.

Under clause 26 of the LIA Act 1987, the carrying out of the development is an activity for the purpose of the EP&A Act and the LIA is a determining authority for those purposes. Therefore, development works by the LIA are subject to environmental assessment under Part 5 and would not require consent by the relevant councils under Part 4.

The LIA determined that the proposal has the potential to result in significant environmental impacts and accordingly prepared an environmental impact statement (EIS). As the LIA is both the Proponent and a determining authority for the proposal, and an EIS was prepared, the proposal is subject to assessment under Division 4, Part 5 of the EP&A Act¹ and the approval of the Minister for Planning is required.

In addition to the Minister's approval, the approval of other determining authorities will be required before the relevant components of the project can commence:

- Department of Environment and Conservation an Environment Protection Licence under the Protection of the Environment Operations Act 1997 for dredging works;
- Department of Lands a licence under the Crown Lands Act 1989 for the proposed sand nourishment of Warilla Beach and the groyne extension at Elliot Lake, these works being on Crown land.

1.3.2 Commonwealth

The LIA referred the proposal to the Commonwealth Department of Environment and Heritage (DEH) under the *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act) due to potential significant impact of the proposed entrance works on matters of national environmental significance (ie Little Terns, an endangered ecological community listed under the EPBC Act). The DEH determined that the proposed activity does not constitute a 'controlled action' and consequently, does not require its approval. However, it has specified that the proposal is to be undertaken in a specified manner pursuant to section 77(3) of the EPBC Act.

1.3.3 EIS Exhibition

An EIS for the proposal was publicly exhibited from 29 January 2005 to 4 March 2005. Forty-one representations were received. About half of the representations came from wavesailors who objected

¹ Part 3A of the Environmental Planning and Assessment Act does not apply to the proposal because exhibition of the project EIS, including request for the Minister's approval, has occurred prior to the commencement of the Part 3A legislation.

mostly to the northern breakwater. A review of these representations is contained in Section 3.2. The remaining representations raised various issues about the proposal.

1.4 Request for Approval of the Minister for Planning

The LIA sought the approval of the Minister for the proposal in a letter received by the Department on 20 June 2005. This report has been prepared in accordance with Section 115C of the EP&A Act which requires the Director General to examine the EIA and the Representations Report and report to the Minister for Planning on the proposal.

1.5 Purpose of this Report

The purpose of this report is to review the project EIS, issues raised in representations to the public exhibition of the EIS, the Proponent's response to the representations and other matters pertinent to the potential environmental impact of the proposal.

This report was prepared in accordance with section 115C of the EP&A Act which requires that the Director General of the Department assess and report to the Minister for Planning on the proposal. The report documents the outcome of an independent environmental assessment by the Department accounting for all key issues of the proposal.

2 PROPOSAL DESCRIBED IN THE EIS

This section provides a description of the Proposal described in the EIS for which approval is being sought. It provides an overview of the information presented in the EIS and does not necessarily represent the views of the Department. The Department's consideration of the Proposal is provided in Sections 4 to 6.

2.1 The Proposal

The following improvement works are proposed, and illustrated in Figure 2:

- construction of a breakwater/training wall on the northern side of the entrance;
- extension of the existing breakwater/training wall on the southern side of the entrance by way of a spur wall;
- dredging of a substantial channel within the lake entrance;
- creation of a small sand island on the north side of the entrance channel for bird habitat;
- undertaking sand nourishment of Warilla Beach utilising the dredged material from the entrance;
- minor improvements to the existing southern breakwater/training wall through the provision of spur wall extensions at the upstream and downstream gaps;
- minor extension of the rock groyne on the northern side of the entrance to Elliot Lake (also knows as Little Lake).



Figure 2: General arrangements – Stage 2 entrance Works.

Source: EIS Figure 6.6

Design details and construction methodology are described in the EIS. Design features of the proposed development are summarised in **Table 1**. Below is a brief description of the project components.

Northern and southern breakwaters/training walls

The northern and southern breakwaters would extend some 200 m offshore in an east north-easterly direction into a water depth of 2.5m at mean tide. The breakwaters are separated by a distance of 90m.

The northern breakwater would commence from the edge of the vegetated dune at the southern end of Perkins Beach. The total length of the northern breakwater is 350 m with a crest level ranging from 2.5m AHD at the shoreline to 4.0m AHD at the head of the structure. The crest width would be 5m to facilitate access for construction plant and equipment.

The breakwaters would comprise of a rock core, rock underlay and a rock armour layer of randomly placed basalt rocks placed on a side slope of 1 in 1.5 (vertical to horizontal). The size of the primary armour rock ranges from a median mass (M_{50}) 4.0 tonnes near the shoreline to 6.0 tonnes at the head.

The southern breakwater would commence from the end of the existing southern training wall. The total length of the southern breakwater is 250m with a crest level ranging from 3.0m AHD to 3.5m AHD at the head. The crest width would be 5m to facilitate access for construction plant and equipment.

The size of primary armour rock ranges from a median mass (M_{50}) 4.0 tonnes near the shoreline to 5.0 tonnes at the head.

Some 55,000 tonnes of rock would be used in the construction of the breakwater structures.

Channel Dredging

The main entrance channel is proposed to be widened and deepened by dredging to a depth of 2 m at mean tide level over a width of 100m tapered to a width of 70m at the mouth of the entrance.

Approximately 200,000m³ of clean marine sand is required to be removed to obtain the design channel profile.

Bird Habitat Island

The EIS proposes that a bird island be constructed for bird roosting and nesting. The bird island would be comprised of marine sand. The long dimension of the island would be 220m and the short dimension 50m in length. Between 5,000m³ and 10,000m³ of marine sand would be required for the island.

The island would be shaped like a dome with a base level of 0.5m to 1.0m AHD and a crest level of 1.0m to 1.5m AHD. The island would be susceptible to flood flows and may require yearly maintenance.

The final location of the island would be subject to the location of shoals at the time of construction.

Warilla Beach Nourishment

The beach has a long history of problems associated with erosion primarily as a result of extensive and ongoing sand extraction from the entrance channel for three decades from the mid 1940s. It is proposed that the marine sand from the dredging of the entrance channel be used for the nourishment of the

southern portion of Warilla Beach. Nourishment would be conducted over an 850m length of beach from a point 50 m north of the entrance to Elliot Lake extending approximately 100m offshore.

Elliot Lake Groyne Extension

The existing rock groyne at the mouth of Elliot Lake is proposed to be extended by 20 m to provide additional sand storage capacity and to reduce the potential for sand from Warilla Beach to rework into the entrance of this lake under north easterly swell conditions. The groyne would comprise of rock armour of 3.0 tonnes median mass and have a crest level of 3.5m AHD.

Minor improvements to the existing southern training wall

Minor works are also proposed to reduce the width of the upstream and downstream gaps in the existing southern training wall.

Table 1: Design Features of the Proposed Works

Project component	Key features
Northern training wall	 length – 200 m offshore in an east north easterly direction
	(total length 350 m from southern end of Perkins Beach)
	crest level - 2.5 m at the shoreline to 4m at the head of breakwater at
	mean tide
	 crest width – 5 m
	 side slope – 1 in 1.5 (vertical to horizontal)
	 rock armour median mass – 4 to 6 tonnes
	 separation distance from southern wall – 90 m
Southern spur wall	 length – 250 m total
	 crest level – 3 m to 3.5 m AHD at the head
	 crest width – 5 m
	 side slope – 1 in 1.5 (vertical to horizontal)
	 rock armour median mass – 4 to 5 tonnes
Channel dredging	 volume to be dredged – 200,000 m³ of marine sand
	 depth – 2 m at mean tide level
	 width – 100 m tapered to 70 m at mouth of entrance
Bird habitat island	 shape – dome like, base level of 0.5 to 1 m AHD, crest level of 1 to 1.5 m
	 Iong dimension – 220 m
	short dimension -50 m
Nourishment of Warilla	evtent – 850 m long extending approx 100m offshore
Reach	 buffer zone – 50 m north of entrance to Elliot Lake
Extension of Elliot Lake	 length of extension – 20 m
rock arovne	 crest level – 3.5 m AHD
	 rock armour median mass – 3 tonnes
	• buffer zone north of Elliot Lake entrance $= 50 \text{ m}$
	build zone north of Elliot Eake childrice – of m

2.2 Need and Justification for the Proposal

The overall aim of the project is to create a permanent entrance condition that allows increased tidal flushing of the lake and provides a more sustainable estuarine system while at the same time encouraging fish and prawn migration between the lake and ocean.

The specific objectives for the proposal, as identified in the EIS are:

- provide a self-scouring entrance channel that will remain open more often than in the past;
- improve the ability of the entrance channel to convey more water during flood events;
- reduce the amount of sand being carried by coastal processes from Perkins Beach to the entrance that could cause the entrance to close;
- provide additional benefits to the region through the improvement of Warilla Beach; and
- fall within funding constraints estimated at \$4 million.

2.3 Alternatives Considered

Historical proposals

Various development proposals for entrance works at Lake Illawarra have been put forward by government agencies and private consortiums over the years. These were described in the EIS.

Works to stabilise and/or create a permanent entrance to Lake Illawarra have been considered as far back as the late 1800s (Illawarra Harbour & Land Corporation Proposal). In 1982, the then NSW Public Works Department completed a report, "Lake Illawarra Entrance Study", which developed a range of entrance management options.

When the LIA was established in 1988, works to stabilise the entrance to the lake were seen as a high priority to achieve its aims of improving the lake environment.

In 1992, Australian Water and Coastal Studies (AWACS) completed an options study for entrance works. The preferred option involved the construction of a southern training wall and channel dredging. AWACS (1992) indicated that future periodic dredging of the entrance channel and/or the construction of a northern breakwater/training wall off Perkins (Windang) Beach might be desirable for the entrance to remain open for longer periods after completion of the southern training wall.

In 1994, Mitchell McCotter completed an EIS for the above preferred option which led to the construction of the existing southern training wall and associated channel dredging (completed in early 2001). These works, now referred to in the EIS as Stage 1 improvement works, were aimed at increasing tidal penetration and reducing the retention time of nutrients and pollutants in the lake body. The entrance functioned reasonably well for the first few months following the completion of the works. However, subsequent drought combined with prolonged calm sea conditions gradually created sand shoals within the entrance which led to its eventual closure in August 2002.

Due to community concerns about the performance of the works, LIA engaged Lawson & Treloar to consider alternative schemes for a northern training wall/breakwater.

Options for a Northern training wall

A total of nine options were identified and investigated by Lawson & Treloar to a conceptual level of detail. Options were assessed for structural stability, tidal flow, beach changes, conveyance of flood flow, closure potential, and cost.

The Independent Review Panel (IRP) established by the NSW Government examined these options. and chose Option 9 as the best option.

Half of the \$4m budget was committed by the State government and the remaining half by Wollongong and Shellharbour City Councils.

Do Nothing Alternative

The non-development or do nothing alternative was considered in the EIS. It was not adopted as this would not resolve the current problems within Lake Illawarra (continued deterioration of water quality) and would not be acceptable to the community.

Periodic, on going dredging

The LIA indicated that the option of maintaining the entrance channel footprint and profile through ongoing dredging was considered in lieu of the northern training wall/breakwater. While it would save significantly on capital cost, it was not considered feasible in the long term. On-going maintenance costs to retain the desired channel profile are expected to match the costs saved by avoiding construction of the rock structures in a relatively short time frame. Dredging in isolation without protection of a northern wall would also be difficult to sustain in the long term.

2.4 Impacts Identified in the EIS

The EIS considers that environmental impacts during construction would be minimal subject to the implementation of proposed mitigation measures.

Following completion of the entrance works, the EIS predicts positive results through the creation of a more stable entrance and greater tidal flushing, and consequently improved water quality, and enhanced recreational amenity for the local community.

The identified impacts are summarised below:

During construction

Ecology – construction activities would have a number of short-term ecological impacts associated with direct disturbance of the channel seabed, entrance channel, ocean beach sands and rocky reef habitat (the existing rock wall). Aquatic bird species would potentially be disturbed but this would not be significant provided the proposed mitigation measures in the EIS are implemented.

The major concern is to limit disturbance on the northern side of the entrance channel shoal over the Little Tern breeding season. LIA commits to cease construction work on the northern training wall during the summer nesting/breeding season (between October to March inclusive), if there is evidence that construction is impacting upon bird breeding.

An aquatic bird roosting island would be constructed during the channel dredging as compensation for the removal of the existing sand shoal currently used as a high-tide roosting area.

Noise and vibration – noise levels from the entrance works were determined to be below accepted noise criteria. Noise mitigation strategies proposed involve controlling noise at the source and controlling the transmission of noise, as suggested by the NSW Industrial Noise Policy.

To reduce the transmission of noise from the southern construction compound to residences along Reddall Parade, a 2.5m high acoustic screen would be erected.

Traffic – the Traffic Management Assessment concluded that traffic impact from rock transport on the local road network would be minimal due to the low number of truck movements and the relatively short

duration of this activity. Transportation of rocks would be restricted to Monday to Friday only (between 7am and 5pm).

Air quality – smoke and fumes from plant and equipment (trucks, excavators and dredgers) could adversely affect air quality. Dust, principally in the form of sand, could be generated from stockpiling of rock, excavation of sand to generate design profiles for the rock structures, general vehicle movements within and around the site, and wind erosion of exposed areas. Mitigation measures include confining truck loading/unloading areas, upgrading existing unsealed haulage roads to gravel/ballast covered roads, and shut down procedures if operating plant and equipment cause unacceptable levels of smoke or fumes.

Water quality – in the construction of the breakwaters, the dumping and placement of rocks to form the structures will result in a localised disturbance to the sea bed resulting in a slight increase in turbidity. Similar increase in turbidity will result from the dredging works. Turbidity curtains are proposed to be placed around the dredge operation to minimise disturbance effects on fish and crustacean movements through the channel.

The dredging activity will be subject to a licence from the DEC.

Recreation - minimal restrictions to a proportion of recreation areas in the vicinity of the entrance have been identified. The areas restricted to recreational users are relatively small and these users can relocate their activities elsewhere within the entrance to Lake Illawarra.

Visual - the most affected would be some residents of Reddall Reserve whose vistas across the entrance during the construction period would be affected.

Waste – waste materials would be generated from the site establishment and clean-up, construction of the rock structures, dredging of the entrance channel and beach nourishment. A relatively low quantity of waste is expected to be generated during construction works. A preliminary waste management plan was presented.

Following construction

Coastal processes - likely changes to the southern end of Perkins Beach would be a gradual widening of the beach near and north of the proposed northern wall, causing some beach realignment. Beach variability will be no greater than it is at present.

Following flood events, there will be a gradual transport of sand from the entrance on to the beach areas south and north of the proposed entrance. Some entrance sand will be transported by wave action back on to these beach areas rather than into the entrance.

Water quality - by creating a self-scouring entrance through the proposed training walls, tidal exchange between the lake and the ocean and flushing potential would be increased. This would assist the discharge of pollutants and consequently lead to a significant improvement of the lake's water quality from its current condition. The LIA anticipates that a 30% reduction in nutrient pollutant retention time in the lake would be achieved.

Flooding and tidal hydrodynamics – based on the flood modelling carried out in the EIS, the proposed entrance works would result in negligible changes to peak flood levels within the estuary and the lake. The overall range in lake water levels due to tides would also not change significantly. At the

1:100 year flood level (1% AEP), the lake level of 2.3m AHD (as determined by LIA from past records) would not be increased.

Lake ecology - the overall area of suitable habitats for aquatic birds would not be significantly altered as a result of the proposal. An area of beach that provides suitable habitat for Little Terns would be removed to construct the northern breakwater/training wall. Construction of the proposed bird habitat island would offset this impact.

Changes in water levels, salinity and lake ecology would likely occur as a direct result of the proposal. The long-term implications of such changes are difficult to predict and are also linked to other pressures and management regimes within and beyond Lake Illawarra.

Tourism and Commercial opportunities – once completed, the proposed works would contribute to the following lake improvements: improvements in water quality of the lake, increasing beach safety and amenity through the stabilisation of the entrance, and reducing the shoaling in this area. These are expected to encourage greater recreational use of the lake entrance and lead to increased tourism and commercial opportunities.

3 SUMMARY OF REPRESENTATIONS

This section summarises the issues, concerns or comments made in representations to the public exhibition of the EIS.

3.1 Summary of EIS Representations Received

Forty-one representations were received in response to the EIS's public exhibition. Copies of all Representations were forwarded to the Department by LIA.

The sources of the representations are summarised in Table 2 below.

Representation type	Number of representations
Commonwealth Government	1
 Department of the Environment and Heritage 	
NSW Government Departments	4
 Department of Environment and Conservation 	
 Department of Primary Industries (Fisheries) 	
 Department of Lands 	
 former Department of Infrastructure, Planning and 	
Natural Resources	
Local Government	1
 Shellharbour City Council 	
Community and Recreation Groups	2
Save Illawarra Action Group	
NSW Wavesailing Association	
Individuals	33
Total	41

Table 2: Summary of Representations

Forty-one representations were received. Twenty-seven of these, from wavesailors who use Perkins Beach, specifically objected to the proposed northern training wall. A few other individuals opposed the project on environmental grounds. Only one submission expressed support. The remaining representations provided comments without expressing support or opposition to the project.

3.2 Issues Raised in Representations

 Table 3 summarises the type and frequency of the issues raised in representations.

Table 3: Summary of Issues in the Representations

Issue	Points Raised	No of representations
Design	 reduce height of northern training wall – proposed 4m high wall will ruin Perkins Beach as a wavesailing location. A wall height of 2m may be sufficient to serve LIA's purpose; low crest levels of training wall - would be overtopped during storm events, raises public safety issues; length of two new walls do not project far enough into the ocean 	30

Navigation	no strategies against any adverse impacts associated with	1
recreational fishers	the EIS.	
and	 consequent impacts upon commercial and recreational fisheries of increased salinity in the lake were not adequately considered in 	1
change	assessed.	1
Climate	 ICOLL to an estuary system which is open more often to the ocean. effect of climate change and predicted sea level rise should be 	1
processes	 lake entrance; lake is currently classified as an Intermittent Closed Open Lake and Lagoon (ICOLL). Works will result in lake changing from an 	
Coastal	concerns over likely long term impacts of proposed changes to the lake antrance;	3
Lake flooding	 scant detail on detention function of lake in reducing peak outflow and the impact of flow rate on scour rates; what is the impact of the entrance works on the lake level? 	2
Lake ecology	 works will result in increased salinity in the lake – likely consequences of a saline environment are not adequately considered in project justification; consider implications of wide ranging ecological changes that may result from the works. 	3
	 EIS assumes proposed Stage 2 works are expected to improve water quality; EIS does not adequately address the habitat issues of water quality; a detailed water monitoring program is required to be prepared in consultation with the DEC; recommends further modelling studies of likely water quality and salinity be undertaken; human habitation problem in Lake Illawarra – more effective to tackle water quality problem in the catchment. 	2
Environmental Imp Water quality	 limited numerical modelling and poor quantification of water quality improvements; 	5
Project Budget	 greater certainty is needed about future management, monitoring and maintenance of this island project is being built to a budget of \$4M and not to a design that would be the final solution to the blocking of the lake entrance; some components of the project proposal are not part of the costed option (ie Lake Elliott groyne extension, reducing gaps to existing southern wall). What work will be completed for \$4M? all proposed works should be completed in their entirety. 	5
Construction of bird island	 proposed entrance is too straight – southern wall should be curved so swell will not go straight up the lake entrance; wall should be extended to Windang Island; why is dredging not proposed for the full length of the blocked channel? Removal of sand up to Windang Bridge is imperative; effectiveness of proposed nourishment on southern part of Warilla Beach without the groyne extension. proposed bird island will be blown/washed away in a big flood. What measures are proposed to stop island from disappearing? 	4
	to stop sand migrating into the entrance:	

	increase in boaters accessing the sea via the lake entrance. LIA should liaise with the NSW Maritime Authority.	
Recreation and public access to entrance	 request to LIA that public access to Windang Island and the swimming areas south of the southern training wall not be restricted during construction works; 	2
area	 Impacts on recreation and waterways use from beach nourishment activities on Warilla Beach were not considered. 	
Tourism and recreation	 improved surfing and swimming conditions at the entrance were not demonstrated; proposed works will turn the whole entrance into a stormwater drain and render it unusable for recreation. 	2
Roads and car park damage	 concerns from Shellharbour City Council that rock transportation to the site could cause road and carpark damage. 	1
Project Justification	 justification for the works is not sustained by the investigations in the EIS; EIS does not demonstrate any benefit and actually suggests some harm. 	2
Miscellaneous		
Monitoring	 a detailed monitoring program should be developed/undertaken of erosion deposition patterns within the entrance; a monitoring program needs to be developed by a qualified saltmarsh expert to monitor saltmarsh distribution and health in the lake. 	3
HRC Inquiry in coastal lakes	 how does the EIS proposal fit into the management frameworks for coastal lakes established by the Healthy River Inquiry in Coastal Lakes? 	1
Heritage items	 should an Aboriginal object be discovered during project works, all works should cease immediately and the DEC notified; not clear if Stage 2 works will affect the relic railway line and train wheels in and around Windang Island. 	1

4 ASSESSMENT OF THE PROPOSAL'S KEY ISSUES

This Section of the Report provides an assessment of the proposal's key environmental issues. Those issues were identified from an examination of the EIS and issues raised in representations made during the exhibition period together with the Proponent's response in its Representations Report.

This Section should be read in conjunction with the Proponent's Representations Report to understand how <u>all</u> issues raised in representations were addressed.

4.1 **Project justification**

4.1.1 Background

The lake and surrounding foreshores provide an important ecological and social asset for the Illawarra Region. In particular, it provides an important habitat for wildlife, supports a number of recreational activities, and is a valuable recreational and commercial fishing ground.

The need for the proposed entrance works was driven by a combination of factors:

- intermittent closure of the lake and associated water quality problems brought about by sedimentation and increasing urbanisation;
- community concerns and expectations regarding the lake's water quality and overall environmental and recreational amenity;
- results of various investigations² that identify the construction of the entrance works as a key strategy for increasing the flushing of the lake and reducing pollutant retention time.

The EIS indicates that environmental, social (recreational) and economic benefits can be expected to result from the project. The primary benefit will come from the increased magnitude and frequency of tidal flushing of the lake which is claimed to consequently improve the overall water quality and ecological health of the lake. A secondary benefit is recreational amenity within the lake area due to the creation of healthier conditions for water based users and also improved safety for users of the nearby beaches due to stabilisation of the entrance. A tertiary benefit would be provided to the local economy as improvements to the environmental and recreational amenity would generate increased tourism, commercial opportunities, and employment.

4.1.2 Issues

Representations from the DEC, DPI and the former DIPNR raised concerns that the overall justification for the proposed works rely heavily on the anticipated improvements to water quality leading to better ecological health. Essentially, the agencies consider that the EIS has not convincingly demonstrated this outcome on account of identified deficiencies in the EIS:

- inadequate definition of water quality issues and insufficient quantification of likely improvements in ecological integrity;
- inadequate consideration of water quality issues affecting aquatic communities and habitats;

² These include the: Options Study for Entrance Works (Australian Water and Coastal Studies,1992); Floodplain Risk Management Study and Plan for Lake Illawarra (LIA, 2005); and the Independent Inquiry into Coastal Lakes (Healthy Rivers Commission, 2002).

- computer modelling provided information for only the short-term effects of the designed works and not its long-term effectiveness;
- lack of study on the impact of increased salinity on lake ecology;
- possible alternative actions to improve water quality in the lake were not considered in the EIS.

Some representations also criticised the project as being cost–driven, ie work is designed to meet the \$4 million budget, and questioned the implications of not completing the proposed work in its entirety in the event of cost-blow outs.

4.1.3 Consideration

The above issues are discussed in detail in the sections on coastal processes (sec 4.2), water quality (sec 4.3), lake ecology (sec 4.4) and lake flooding (sec 4.5).

Department and agencies view

The Department notes that the proposal has been the subject of an Options Report which has been evaluated by an Independent Review Panel (IRP) and endorsed by the NSW Government. The IRP's Report endorsed the need to build two training walls based on the observed success of dual entrance walls along the coast which have remained open, ie Lake Macquarie, Wallis Lake and Wagonga Inlet.

There has been a good level of support for the proposal from the 103 people who attended the Public Open House in February 2005. The LIA stressed this community support and expectations about project delivery as an important consideration in implementing the proposal. The LIA also argued that while improvements in water quality were the main justification for the project, the proposal alone would not achieve this outcome. A combination of entrance works and catchment works which it has developed, would be required to meet its objectives of improving the environment of the lake.

Although the three agencies raised various issues in their representations, none of these objected to the proposal. In further consultation with these agencies, the Department obtained a collective view that the proposal could result in improvements to water quality and recreational amenity in the short term. However, the long term impact and effectiveness of the works are uncertain due to the very complex nature of coastal and climatic processes and other factors affecting the lake environment. Further computer modelling could not guarantee a clear long term outcome.

The former DIPNR (Coastal Group) considered that the LIA should have justified the entrance works on the grounds of other than the claimed improvement in water quality and ecological health. One suggested justification is reducing the potential for extreme low water levels during drought conditions. A cost-benefit analysis would also have been helpful in justifying the project but this was not done.

In terms of potential risk that could ensue from the proposed entrance works, the DPI considers that there could be wide ranging ecological changes (eg increased salinity in the lake) which are likely to have consequent impacts on ecological communities and fish types and population.

Overall, the agencies agree that as there is no identifiable serious or irreversible damage that could result from the proposed works, the project could be treated as a valuable experiment. The outcome would remain to be seen over time.

As a means of measuring the success or otherwise of the project, the agencies have required the LIA to provide performance indicators, supported by a focussed monitoring program of various aspects of the

project. These are discussed in section 4.8 and incorporated in Condition of Approval No 25. The monitoring program would also enable early warning of any adverse effects that may occur as a result of the project.

Project budget

The preliminary cost estimate of \$4 million in the EIS does not include the construction of two identified components of the proposal (ie reducing gaps in the existing southern training wall; extension of the Elliot Lake groyne). The Department questioned whether the proposed scheme would work if only parts of the proposal are undertaken.

In response, the LIA clarified that the key components of the project are the twin training walls and channel dredging (including disposal). Provided these components are carried out, the scheme is expected to perform satisfactorily.

The dredged material must be placed somewhere and Warilla Beach was identified as the most sensible site, apart from the possible effects at the entrance to Elliot Lake. The nourishment of Warilla Beach is not critical to the performance of the scheme but will provide added beach amenity and added protection to the existing seawall along the frontage of Little Lake Crescent.

Reduction in the width of the gaps in the existing southern training wall would be expected to slightly improve the performance of the scheme. Extension of the groyne at Elliot Lake may prevent potential sand migration from Warilla Beach into this little lake. These two items could be undertaken after completion of the key components.

The groyne extension at Elliot Lake is also not considered crucial to scheme performance.

Creation of the bird habitat island will not affect the hydraulic performance of the scheme but is necessary to meet legislative requirements to offset potential habitat loss due to the construction of the northern breakwater.

The LIA indicated that if the available funds from current State and Local Government commitments are insufficient to complete all identified proposed works, then it will commit additional funds from its annual Restoration Program allocation.

In addition, the LIA has committed to fund maintenance dredging of the channel within the first three years after the works are completed, if required. In the future, channel dredging may be required from time to time until estuarine processes gradually transport sand from the entrance to Perkins Beach and the beach south of the southern breakwater. The LIA will consider funding on an as needed basis.

Conclusion

The LIA justifies the project as the key strategy for keeping the lake open and achieving improvements in water quality and recreational amenity which would meet the local community's expectations. The Department and other agencies are concerned that such improvements and the long term effectiveness of the proposal have not been clearly demonstrated in the EIS. However, they recognise that the project could well be justified on other grounds such as maintaining more consistent water level in the lake (ie reducing the potential for extreme low water levels as had occurred in the past) and possibly reducing the frequency of flooding in the lake. The agencies consider that the project could be treated as an experiment and the long term outcome would remain to be seen over time. Important aspects of the project would be monitored and measured, as discussed in section 4.8, which would provide an indication of the performance of the entrance works as well as early warnings of any potential risk.

4.2 Coastal processes

4.2.1 Background

Coastal processes affecting the lake entrance are caused by a complex interaction between ocean swells, wind action, tides and freshwater events. Of principal concern to the lake entrance is how the coastal processes affect shoaling and the stability of the entrance position.

The EIS discusses the prevailing wave climate, the longshore sediment transport (or littoral drift)³ from Perkins Beach and Warilla Beach, and sediment movement at the entrance. It then analyses the effects of the entrance works.

A conceptual model of sediment movement at the existing lake entrance was described and illustrated in the EIS. Briefly, the main process elements which characterise the sediment circulation are:

- sand is transported into the entrance channel by flood tides and wave action and deposited as shoals;
- after prolonged dry periods, the entrance is heavily choked by a sand spit projecting southward from Perkins Beach. Tidal flows are greatly reduced and the entrance bar is located close to and often forms part of the deltaic beach system;
- during significant freshwater events, scouring of the entrance channel and shoals occurs and sand is deposited in the nearshore region as an incipient entrance bar;
- wave radiation stresses cause these nearshore deposits to work onshore primarily along a swash bar system towards Perkins Beach;
- local reversal from the northerly sand drift of the longshore transport, at the southern end of Perkins Beach (primarily due to prevailing north easterlies that exist during the warmer months, which produces a southerly sand feed towards the entrance-estimated 3,500 m³/year on average);
- this southerly sand feed causes sand to be carried onto the sand spit before being subsequently reworked into the entrance, and upstream along the entrance channel, by wave and current action. There is a much smaller onshore movement of sand from the southern side of the entrance bar;
- there is a small leakage of sand (estimated at around 450 m³/year) through/over the existing groyne caused by wind-driven processes on the non-vegetated sand dunes.

The EIS stated that the longshore transport of sediment from Perkins Beach is predominantly in the northerly direction at an annual net rate of 24,000 m³. However, there is a local reversal of long shore transport at the southern end of Perkins Beach producing a southerly sand feed estimated at 3,500 m³ per year as a result of waves propagating from the east north-east direction.

The EIS considers that the construction of a northern breakwater/training wall would intercept and modify the natural dynamic circulation of sand moving southwards along Perkins Beach. By preventing the southern feed of sand, the entrance could maintain relatively strong tidal flows and consequently,

³ Littoral drift is the movement of sediment longitudinally along the littoral zone of a coastline as a result of oblique wave attack and nearshore currents.

the tendency for a southerly-tending sand spit to choke the entrance would be reduced initially and eliminated with time.

Based on the results of the modelling conducted (short term only), no potential adverse risk is foreshadowed and the expected outcomes are as follows:

- variability of Perkins Beach will be no greater than it is at present;
- entrance currents occurring during a major flood will remain as they presently occur, except that the training walls would prevent entrainment of sand from Perkins Beach;
- little or no gain or loss to/from Perkins and Warilla beaches;
- the design and stability of the rock structures would withstand predicted peak-flood velocities near the mouth of the entrance and future sea level rise.

4.2.2 Issues

Several representations raised concerns about the long term impact of the training walls on coastal processes along Perkins Beach. The former DIPNR (Coastal Group) considers that the EIS should have addressed the longer-term prospect of continued sand feed into the entrance. Specific questions that should have been addressed include:

- What will be the long-term changes to the beach morphology, slope, alignment orientation, rotation and degree of variability?
- How will the entrance currents change the wave climate and associated near shore sediment transport and deposition?
- What is the long-term littoral movement of sand within the beach compartments and around Windang Island and how will the new entrance works change this?
- What is the impact of climate change on the design life of the entrance works?

In the short term, concerns were raised about erosion of the southern part of Perkins Beach following construction of the breakwaters and dredging of the lake entrance.

4.2.3 Consideration

The LIA considers that the northern breakwater would have no identifiable effect on Perkins Beach, other than very locally, because the volumes of sand moving past the proposed breakwater would be very small compared with Perkins Beach itself. However, it expects that the entrance bar would be affected by flood flows, and over time, some sand is expected to be accumulated on the northern side of the breakwater forming a fillet and a slight realignment of the beach in the locality.

In its Representations Report, the LIA provided the following response to the above listed questions.

Long-term changes to the beach morphology

The likely changes to the southern end of Perkins Beach would be a gradual widening of the beach near and north of the proposed northern wall, causing some beach realignment. Beach variability will be no greater than it is at present. The changes will be very similar to those observable on the northern side of the Swansea channel entrance.

Impact of entrance currents on wave climate and sediment transport and deposition

Entrance currents occurring during a major flood will remain as they presently occur, except that the training walls would prevent entrainment of sand from Perkins Beach. The entrance currents would have only a minor effect on local wave climate.

Impact of long-term littoral sand movement on beach compartment and around Windang

Windang Island and the groyne that connects it to the mainland separate Warilla and Perkins Beaches into individual beach compartments. These beaches are essentially closed systems held within headlands at their southern and northern ends. Hence, there is little or no gain or loss to/from these beaches. During a significant storm event, some sand will be lost from Warilla Beach by wind-blown transport over the Windang Island groyne crest and leakage through the small gap that exists between the groyne and Windang Island.

Impact of climate change

The EIS provided limited consideration of climate change issues. The former DIPNR (Coastal Group) considers that the impacts of climate change may influence the long term effectiveness of the proposal and the diverse range of physical processes. Predicted sea level rise (SLR) will affect average water levels within the lake directly if the lake entrance remains open.

In response, the Representations Report indicated the extent of SLR is not definitive and predictions rely on a range of global atmospheric models driven by various greenhouse emission scenarios. The Inter-governmental Panel on Climate Change (an authoritative source on global climate change)⁴ indicated in its 2001 publication a broad range of possible predictions of SLR from 1990 to 2100 ranging from 9 cm to 88 cm. Of the six illustrative green house gas and sulphur emissions scenarios presented in the publication, the highest SLR at 2100 was 0.5 m.

A mean sea level (MSL) rise of 50 cm would result in a higher mean lake level and consequently, higher flood levels. The current mean lake level is about 0.25 m AHD, so a 50 cm rise in mean sea level should equate to a similar increase in mean lake level (ie up to 0.75 m AHD when the entrance is open). Such an increase would occur regardless of the proposed entrance works. However, the lake setup level of 0.25 m may change slightly with a higher MSL.

The LIA indicated that the design of the rock structures, including the size of rock required from a hydraulic stability aspect, has taken into account sea level rise by way of the conservative approach undertaken in the design (ie sizing of the rock armour relative to breaking wave height). If SLR predictions as indicated by the IPCC eventuate and overtopping becomes a concern to the stability of the breakwater structures, the crest levels can be increased at a later time.

Conclusion

The Department considers that the EIS modelling provided information about the short-term effects of the proposed works, but not its long-term effectiveness and impacts on sediment transport and morphological processes. However, it recognises that the long term outcomes would be difficult to predict due to the complex nature of coastal processes affecting the lake. The impacts of the proposal will be monitored by way of a monitoring plan and reporting arrangements covering three periods (first, third and fifth year of operation), as discussed in section 4.8. The monitoring plan will require the Proponent to include a decision making framework that clearly describes how the outcomes of monitoring would be responded to, including need for mitigation measures. Recommended Conditions of Approval Nos 25 and 26 reflect these requirements.

⁴ This Panel was jointly established by the World Meteorological Organisation and the United Nations Environmental Program in 1988.

4.3 Water quality

4.3.1 Background

The EIS stated that the water quality within Lake Illawarra is not as good as it should be and is currently tending towards eutrophication (excessive concentration of nutrients and macroalgal growth). It identified nutrients and turbidity as the principal areas which fall below acceptable levels for recreational use, edible fish and crustacean production and the maintenance of a healthy aquatic ecosystem. The water quality parameters that most exceed the recommended guideline values are phosphorous, nitrogen and sometimes chlorophyll-a. The nutrient concentration is manifested with visual sightings at times of algal blooms within shallow regions of the lake.

The EIS describes the factors affecting water quality in the lake. It considers general trends in lake water quality over the past thirty years and reviews the effects of the entrance works (including the Stage 1 works) on future water quality in the context of total catchment management. It has sourced much of this information from the water quality assessment conducted for the Stage 1 entrance improvement works EIS (*ERM, 1994*), and from the report *titled Lake Illawarra Estuary Processes Study – Final Report* (WBM Oceanics Australia, February 2003).

The proposal is aimed at creating a self-scouring entrance channel so that the entrance remains open more frequently and thus increases the tidal exchange between the lake and the ocean. By increasing the tidal exchange and flushing potential, the EIS considers that discharge of pollutants would be assisted and consequently lead to a significant improvement of the lake's water quality from its current condition.

4.3.2 Issues

Government agencies (DEC, DPI and the former DIPNR (Coastal Group)) in their representations raised common concerns and issues about the assessment of water quality in the EIS. The key concerns are:

- the EIS did not adequately define issues of water quality and did not relate the anticipated better tidal exchange to quantifiable improvements in water quality;
- no further numerical modelling of water quality improvements was undertaken since Stage 1 EIS in 1994;
- many aspects of water quality are independent of entrance conditions. Predicted changes to the tidal exchange will have limited influence to the water residence times in the lake and may not result in 'significant' improvement in water quality or the claimed 30% reduction in pollutant concentrations;
- need for focussed and effective monitoring of the anticipated improvements.

The DPI suggested that the \$4 million budget could perhaps be better spent on alternative water quality control measures in the lake catchment.

4.3.3 Consideration

Agency concerns and LIA response

Deficiencies in water quality assessment

The DEC considers that issues of water quality have not been adequately defined. The term 'water quality' is frequently used in the EIS but the only issue addressed is eutrophication which has

manifested as macro-algal blooms and elevated phytoplankton concentrations in the lake water. Other than eutrophication, the water-related issues that the DEC considers important in terms of the proposal are clarity and colour, salinity regime and water depth regime.

The DEC agrees that eutrophication is a continuing (if not increasing) issue in Lake Illawarra. However, it does not regard nutrient concentrations in the water as a reliable indicator of incipient eutrophication in coastal lakes. Adequate 'proof' of an improvement in eutrophic status would be a sustained decline in the chlorophyll-a concentration at a range of sites in the Lake and a continuing absence of excessive macro-algal growths.

DEC's further concern relates to the lack of a detailed analysis of the anticipated flushing characteristics and effective exchange of lake and ocean water. It considers that the EIS has not attempted to relate the anticipated better flushing to quantifiable improvements in water quality or ecosystem health.

The LIA has not directly addressed these concerns in the Representations Report.

Numerical modelling of water quality improvements

The DPI expressed concerns that the EIS assumes the proposed Stage 2 works would be expected to improve water quality based on the limited numerical modelling carried out for Stage 1 works in 1994. At the time of the Stage 1 EIS, the former NSW Fisheries was of the opinion that the water quality improvement benefits were both insufficiently quantified and relatively insignificant. The purported water quality improvements from the current proposal remain poorly quantified. The DPI recommended that further modelling studies of likely water quality and salinity changes be undertaken to confirm the predicted outcome of the new entrance works.

The EIS considers that the 1994 water quality modelling is still valid for assessing water quality improvements for Stage 2 works. The current proposal is designed to meet essentially the same objective as the Stage 1 works. In its Representations Report, the LIA indicated that it has reviewed the water quality modelling referred to in the EIS. The 1994 Lawson & Treloar 2D lake modelling demonstrated that a more open lake entrance would increase lake flushing in relative terms by about 30% even though flushing would remain low in absolute terms. It considers the modelling to be adequate in predicting outcomes. Although extensive detailed water quality modelling would quantify the changes in detail, the work would entail detailed catchment modelling, 3D wind driven currents, evaporation and nutrient dynamics. The LIA considers that the improved understanding and detail would not provide a more substantial basis for assessing the importance of the proposed works. It thus determined the further modelling studies are not necessary.

The Department questioned the level of confidence in the previous modelling, given that the Stage 1 works failed to keep the lake entrance open. The LIA maintains the view that the Stage 1modelling is still valid and has a greater expectation that that the current proposal with twin walls would be effective in keeping the entrance open and enabling better tidal flushing.

Influences on water quality

The former DIPNR (Costal Group) considers that many aspects of water quality are independent of entrance conditions and are linked to the shape and depth of the lake, the mixing and circulation patterns and nutrient sources, loads and recycling process.

The LIA acknowledges this, and indicated that a combination of catchment and lake works are required to meet its objectives of improving the lake environment. It argues that although improvements in water quality is the main justification for the project, the EIS clarified that the proposed works alone will not achieve such improvements but are part of the LIA's larger strategic plan to implement total catchment management. The LIA has been working closely with Wollongong and Shellharbour City for the past 17 years to address a range of problems to improve the environment of the lake and its foreshores. Its improvement works include algae harvesting, stormwater runoff control and treatment and construction of wetlands. Since it was established in 1988, approximately 40% of the major drains (> 225mm diameter) have been treated with some form of pollutant control. It commits to continue the work on stormwater pollution control in the lake as part of its ongoing works program.

More recently, the LIA has been working with the Southern Rivers Catchment Management Authority (SRCMA) to address catchment issues that affect water quality in the lake. The chair of the SRCMA is a member of the LIA and is well aware of the huge task facing the LIA to address a range of issues, including water quality.

The LIA claims that provision of water quality improvement measures in the catchment is expensive – expected costs of the order of \$100 million would be required for the whole catchment (about 7 times the size of the lake).

Monitoring to measure water quality improvements

The agencies collectively consider that monitoring of important aspects of water quality should accompany the works. The DEC, in particular, recommended that LIA prepare a detailed monitoring program with precise objectives, sampling schedule and a reporting strategy in consultation with the agency.

As requested by the DEC in 2005, the LIA has already started sampling of lake waters from 3 sites around the lake for nutrients and Chlorophyll-a. The sites are Griffins Bay, Bevans Island and Kanahooka. The LIA intends expanding this program to include the 10 sites previously monitored so that results pre and post entrance works (including stage 1) can be assessed over the longer term.

Construction impacts

The EIS considers that there will be insignificant impact on water quality during construction.

During construction of the breakwaters, the dumping and placement of rocks to form the structures will result in a localised disturbance to the sea bed causing sand particles to 'cloud' the water (ie slight increase in turbidity). The expected increase in turbidity will be similar to the natural effect of waves breaking within the beach swash zone area.

During dredging works, the removal of sand from the entrance channel by cutter suction dredge (or other) will also result in a slight increase in turbidity which will be similar to the natural effect of 'entrainment' due to ebb and flood tide flows. Placement of turbidity curtains around the dredge operation is proposed to minimise disturbance effects on fish and crustacean movements through the channel.

The Department considers that the water quality impact of construction activities would be minimal. To ensure that soil erosion/sedimentation and water quality during construction works are properly managed, Conditions of Approval Nos 41 and 42 are recommended which require the preparation of a soil and water management plan as part of the Construction Environmental Management Plan.

It is noted that the dredging activity will also be subject to a licence from the DEC.

Conclusion

The Department notes that the EIS claims a 30% reduction in nutrient load within the lake as a result of the proposal. The LIA clarified that this outcome would not be achieved by the entrance works alone but in combination with other major works in the catchment. For this reason, the LIA has not included the reduction in nutrient concentrations as a performance indicator – it claims that results cannot be linked directly to the proposal, as discussed in section 4.8. Instead, it proposes to measure the pollutant retention time in the lake because flushing time can be estimated from the tidal prisms and salinity readings from the existing water stations in the lake.

Without a clear demonstration of the nature and extent of expected improvements, the predicted water quality benefits would remain to be seen.

4.4 Lake ecology

4.4.1 Background

Lake ecosystems

The ecological assessment in the EIS was based on previous studies, including those undertaken for the Stage 1 works, and field assessments undertaken in 2004.

The key habitats affected by the proposal are shown in **Figure 3.** Terrestrial vegetation is sparse, dominated by she-oak (*Casurina spp.*). Areas of sand dune scrub and grassland also occur. None of the flora species or communities within the vicinity of the proposal is listed under the *Threatened Species Conservation Act 1995* (TSC Act). The terrestrial vegetation supports a range of common fauna species, including several rodent species and terrestrial birds. Domestic dogs and cats are common in the general locality, as are foxes.

Extensive seagrass beds are present around the entire perimeter of Lake Illawarra. The EIS notes that the total seagrass area is approximately 786 ha comprising three species:

- Zostera capricorni (~565 ha);
- Ruppia megacarpa (~167 ha); and
- Halophila ovalis (~54 ha).

Around 56 species of fish are known to occur in Lake Illawarra, of which 24 species are of significance to commercial and/or recreational fisheries.

A diverse range of aquatic birds utilise the shores and in-shore coastal waters. Several threatened species (under the TSC Act) are known from the entrance channel, including the Large Sand-plover, Hooded Plover, Sooty Oystercatcher, Pied Oystercatcher, Sanderling, Great Knot, Black-tailed Godwit, Latham's Snipe, Terek Sandpiper and Little Tern.

Of these threatened species, the Little Tern is known to breed in the immediate vicinity of the northern stockpile site and the Hooded Plover could potentially breed at the entrance. There had not been any observed breeding of the Little Tern within the entrance channel area since the 1960's until the summer of 2003/04 where successful nesting and fledging occurred as shown in **Figure 3**. In 2004/05, breeding occurred again, however eggs were predated by Silver Gulls and Foxes and nests were disturbed by

humans. The remaining threatened aquatic bird species are migrants, visitors or residents that utilise the entrance channel only for feeding or roosting.

Construction impacts

Construction of the proposed works would have a number of short-term ecological impacts associated with direct disturbance of the channel seabed, entrance channel, ocean beach sands and rocky reef habitat (the existing rock wall).



Figure 3: Key Habitats in the vicinity of the Proposal

Source: EIS Figure 10.1

Aquatic bird species would potentially be disturbed during construction. However, the EIS concludes that provided the proposed mitigation measures are implemented, this disturbance would not be significant. The proposed construction-related mitigation measures are:

 scheduling the construction program to minimise disturbance to aquatic biota, with the main concern to limit disturbance on the northern side of the entrance channel shoal over the Little Tern breeding season. Construction would cease on the northern breakwater/training wall during summer nesting/breeding season (October to March inclusive) if there is evidence that construction is impacting upon bird breeding;

- an 'expanded' consultation protocol would be implemented to inform stakeholders (including DEC, Illawarra Bird Observers Club, commercial fishers and the Windang Surf Life Saving Club);
- maintaining a 50 m buffer zone between channel dredging/construction works and the existing seagrass beds; and
- use of a cutter suction dredge and turbidity curtains to minimise disturbance to both fish and crustacean movements through the channel.

Aquatic birds and bird habitat island

The EIS indicates that the proposal would not have any medium- to long-term impacts on the aquatic bird species that utilise Lake Illawarra.

Importantly, a key component of the proposal is the construction of an aquatic bird roosting island for use by wading bird populations. The bird island would be an elliptical dome, comprised of marine sand. The LIA would maintain the island on a yearly basis, most likely before the summer breeding season.

The LIA would continue the management of aquatic bird species visiting the entrance, particularly the Little Tern, by providing people fencing, fox control and suitable signage to minimise disturbance to bird populations and nests.

The EIS also notes that the proposal allows for the seaward section of the northern training wall to be built so as not to alter the present contours and sight-lines from Perkins Beach for bird species.

Long-term impacts on lake ecology

The EIS indicates that no significant impacts would be expected to lake ecology. Specifically, the EIS concludes that no significant impacts would be expected to ecology and habitats:

- in the vicinity of the footprint of the proposed new rock structures;
- during or after nourishment of Warilla Beach;
- on the reef of Windang Island;
- of seagrasses and saltmarsh within the estuary;
- of benthic communities; and
- of fish and prawn populations of the lake.

Additionally, the EIS indicates that the increase in the net rate of tidal flushing of the lake and reduction in nutrient levels as a result of the works would assist in bringing the seasonal algal productivity to normal levels and therefore address the associated problems of excessive algal blooms. Algal blooms may kill off seagrass through shading.

Ecological monitoring

The EIS proposes monitoring of seagrass beds, aquatic birds and other biota within the Lake Illawarra estuary and coastal compartments.

The LIA proposes to continue previous monitoring of seagrass beds on an annual basis to identify any changes in seagrass area, depth limits and speciation in the entrance channel.

The current bi-annual (summer/winter) monitoring of aquatic bird populations would be continued by the Illawarra Bird Observers Club on behalf of the LIA. Additionally, the current monitoring of breeding
populations, being undertaken for the rock haulage and storage program, would be continued for subsequent breeding seasons.

Monitoring of fish and benthic communities of the lake and its entrance would also be implemented, based on previous studies.

4.4.2 Issues

Key issues raised in representations and by government agencies included:

- implementation of construction-related mitigation measures, particularly the commitment to cease works during the nesting/breeding season (October to March inclusive);
- lake ecology: both DEC and DPI (Fisheries) raised significant concerns that the EIS failed to indicate that long-term changes to lake ecology would be likely as a result of the proposal. In particular, no information was provided on the impact of increased salinity on lake ecology;
- inadequate definition of water quality issues and insufficient quantification of likely improvements in ecological integrity; and
- lack of certainty regarding the future management, monitoring and maintenance of the bird habitat island to ensure that it does provide suitable compensation for breeding threatened bird species (Little Terns). Additionally, no measures were proposed to stop the island from disappearing from winds and a big flood.

4.4.3 Consideration

Construction impacts

The Department considers that the construction-related impacts could be managed provided the mitigation measures proposed were implemented.

The Department sought clarification on the potential for construction works to occur during the bird breeding season. In response, the LIA committed to not carrying out work on the northern breakwater section (between chainage 0m to 150m) during the summer bird breeding season despite any lack of evidence that construction is impacting upon bird breeding. The Department supports this precautionary approach.

Aquatic birds and bird habitat island

The overall area of suitable habitats for aquatic birds would not be significantly altered as a result of the proposal. An area of beach that provides suitable habitat for Little Terns would be removed to construct the northern breakwater/training wall. However, construction of the proposed bird habitat island would more than offset this impact.

The proposed bird habitat island would provide an attractive area to encourage both roosting and nesting of aquatic birds, including threatened species.

Concerns were raised that the proposed bird island could be significantly damaged or lost in a major flood due to its location. In response, the LIA stated that it would not be practical to prevent damage to the bird island as a result of natural events. However, it reiterated its commitment to ensuring sufficient bird habitat is provided at the entrance for bird breeding. Annual renourishment, including the provision of coarser shell grit material on the crest of the island, would be carried out by the LIA before mid November each year.

The Department and the other agencies recognise that it is unlikely that the proposal would result in any negative impacts on aquatic bird species or their habitats.

The DEH determined that the proposed activity, in relation to the Little Terns, is not a 'controlled action' ⁵under the EPBC Act, as advised in its letter to the LIA of 14 March 2005. However, it specified that the proposal be undertaken in a specified manner relating to construction times to avoid impact on the breeding season of the Little Terns, creation of a bird island, and continuation of the aquatic bird surveys being undertaken by the Illawarra Bird Observation Club. These requirements form part of the proposal and LIA commitments.

Long-term impacts on lake ecology

The proposed entrance works are expected to increase the tidal flushing of Lake Illawarra and thereby improve the water quality of the lake. However, the Department considers that changes in lake ecology are likely to be more closely linked to water quality changes associated with inputs from the surrounding catchment and the frequency of extreme climate events (such as drought).

Government agencies (DEC, DPI and former DIPNR's Coastal Group) have expressed caution in promoting the proposed entrance works as the solution to water quality problems in the lake and improving ecological conditions. Whilst the proposed entrance opening to allow a more regular exchange of lake and sea water could have positive water quality implications, it could also affect lake conditions over time, changing the lake from an Intermittently Closed Open Lake and Lagoon (ICOLL) to an estuary system which is more open to the ocean and subject to greater tidal influences. Of particular concern was the likely change, increase or 'smoothing out' of salinity and water levels within the lake. DEC and DPI (Fisheries) considered that changes to salinity and water level would have long-term ecological consequences, such as changes in seagrass type and distribution, an increase in more marine type fish species, and the potential establishment of mangroves.

With regards to salinity and water levels, the LIA expects that there would be very minor changes to the long-term average entrance and lake water levels, and to long-term average salinity. However, it stated that the changes would be well within the normal range of these parameters measured over the long-term and the lake and entrance channel would continue to experience water level and salinity changes from other influences within the present range of these factors.

The Department notes that the lake would still be expected to experience a range of water level and salinity variations. The entrance works would likely result in an overall 'smoothing out' of water level and salinity variations with fewer hypersalinity events and less water level drawdown due to evaporation. The potential smoothing out of the range of variation would have ecological implications that can not be described as negative or positive – they are simply changes. It is likely that ecological communities such as seagrass beds and saltmarsh would change over time as they adapt to new conditions. The probability that the entrance would remain open during a prolonged period of dry weather is positive in terms of seagrass survival. Significant lowering of the water level in recent years has exposed vast areas of sea grass and mud flats around the margin of the lake. Seagrass meadows damaged by the drought conditions are only now showing signs of recovery.

The Department, DEC, former DIPNR's Coastal Group and DPI recognise that it is unlikely that the proposal would result in any significant overall negative impacts on lake ecology, but there could be adverse impacts on some species, with benefits to others.

Department of Planning

⁵ A controlled action is an activity that requires approval from the DEH under the EPBC Act.

Ecological monitoring

The Department supports the proposed ecological monitoring, but notes the difficulties in attributing ecological change to the proposed entrance works. Monitoring undertaken by the LIA is considered an essential component in the management of Lake Illawarra and would assist in the implementation of adaptive measures to achieve management objectives.

In its representations, the DPI requested that its concurrence be sought for the design of the monitoring program prior to its commencement.

Monitoring of the proposed bird island must be undertaken to measure its success in providing secure habitat.

Conclusions

Construction could be managed to avoid or minimise potential impacts on aquatic birds and aquatic ecosystems provided all reasonable mitigation measures, as described above, were implemented. The Department's recommended Condition of Approval No 27 would require the preparation of a Flora and Fauna Management Plan to ensure appropriate management during construction.

Construction and management of the proposed bird island represents an opportunity to provide a secure roosting and potential breeding habitat for the Little Tern and other aquatic birds. This and other measures, such as predator control and protection from human disturbance, would assist in improving suitable habitat for aquatic birds, including threatened species. Ongoing management measures are included as part of the proposal and also required by the Department's recommended Condition of Approval No 28.

Changes in water levels, salinity and lake ecology would likely occur as a direct result of the proposed works. The long-term implications of such changes are difficult to predict and are also linked to other pressures and management regimes within and beyond Lake Illawarra. The Department supports an ongoing ecological monitoring program that is able to direct the adaptive management of lake habitats. The Department's recommended Condition of Approval No 25 requires the development and implementation of a monitoring plan for ecological and other key aspects of the lake system. The Plan would be prepared in consultation with the DEC, DPI, DNR, Relevant Councils and other stakeholders.

4.5 Lake flooding

4.5.1 Background

Prior to the construction of the Stage 1 entrance improvement works, Lawson & Treloar (2001 conducted a flooding investigation of Lake Illawarra to evaluate peak flood level estimates for a range of design rainfall events under catchment and lake conditions. The design rainfall events evaluated were 50%, 20%, 10%, 5%, 2% and 1% Annual Exceedence Probability (AEP) events, along with an extreme event.

The flood study was undertaken by refining mathematical models developed for the Lake Illawarra Entrance Improvement Study – Hydraulic Numerical Modelling (Lawson & Treloar, 1994) and calibrated to the June 1991 flooding event (a major flood - 1.8m AHD). The 36 hour storm was found to be the

critical duration for peak lake water levels. The 1:100 year flood level (1% AEP) for the main body of the lake was determined to be 2.3 m AHD.

The results of the hydraulic model reflect the observed flooding regime of the lake body and entrance area. Floodwaters within the lake body are characterised by slow velocities and a near horizontal water surface. Closer to the lake entrance inlet, the floodwater accelerates into the entrance channel to pass under the Windang Road Bridge and out to the ocean.

Under existing conditions, the high velocities in the entrance resulting from significant flood events have a scouring effect, widening and deepening the channel as the flood progresses. However, the entrance has a tendency to close through the creation of shoals by tidal and wave processes when there is a substantial time period between flood events.

Computer modelling undertaken for the Stage 2 entrance works is discussed in detail in the EIS. The modelling investigated the following components, among others:

- changes to entrance bathymetry for long-term tide and wave conditions;
- changes to entrance bathymetry and flood levels for a variety of ARI flood events;
- post-flood sediment recovery behaviour (tides and waves).

The flood investigations initially determined the minimum separation distance between the northern and southern training walls needed to convey flood waters without increasing the current flood levels in the estuary. The optimum separation distance was found to be between 90 and 100 m at mean sea level, taking into account self-scouring potential and the impact of peak flood levels (approximately equivalent to the 10 year ARI event). A 90 m separation distance was adopted for the project.

Post-flood recovery simulations were undertaken to determine how much of the jetted sediment moved back into the entrance after a flood event and how much was moved to the north and south of the entrance, and hence potentially removed from the entrance system.

Water level rise in the lake depends upon a number of factors including rainfall duration, the volume of stormwater runoff and the degree of shoaling at the lake entrance. The investigations concluded that changes to peak flood levels within the lake would be negligible as a result of the proposed entrance works.

4.5.2 Issues

A few representations indicated that the proposed works may result in an increase in flooding to surrounding foreshore areas. One suggested that the solution lies in addressing the flood prone areas. Lake Illawarra has a problem due to caravan parks and houses being located in flood prone areas.

The former DIPNR Coastal Group noted that while the flood modelling undertaken appears to be appropriate, this was based on a 100m wide channel and not the 90m width of the final design. Also of concern is the magnitude of the modelled peak flood velocities, in the order of 3 to 3.8m/sec which are in the high range. Such velocities may lead to excessive scouring along the channel and at the breakwater head. This would also pose a risk to public safety.

One detailed private representation raised concerns about the methodology used to model flood behaviour. It sought clarification on flood-related matters such as the inflow and outflow hydrographs for

the lake storage potential, variation in scour rates and volumes in different flood events, and adoption of the 1:100 year flood level as the 'planning flood' for this particular development.

4.5.3 Consideration

Effect on flood levels

The key issue for the flood assessment is the impact of the proposal on existing flood levels, velocities, and extents of such impacts.

The flood investigations for the proposal found that an 80 m wide entrance (or narrower) would adversely affect the flooding behaviour by increasing the flood levels during the more severe freshwater events. However, a separation distance of 100 m would result in negligible changes to peak flood levels within the estuary and Lake Illawarra. A wider entrance would not be self-scouring and would be affected by shoaling.

Although a 90 m separation distance between the two training walls was not specifically modelled in the EIS, velocities were predicted for the 80 m, 100 m and 120 m separation distances for different flood events (ie 5, 10 and 100 year ARI), and from these, 90 m was adopted as a suitable distance, taking into account self-scouring potential and impact on peak flood levels.

Based on the results of the modelling, the LIA considers that the proposed entrance works (at the 90 m separation distance) would result in only negligible changes to peak flood levels within the estuary and the lake. The overall range in lake water levels due to tides would also not change significantly. At the 1% AEP flood level, the lake level of 2.3 m AHD (based on observed flooding regime) would not be increased. The LIA also indicated that the design of the breakwaters took account of the expected peak velocities at the centre of the channel for combinations of wall separation (ie) and flood intensity.

The Department considers the LIA's response to be reasonable. It also notes that the Representations Report has adequately responded to the questions raised by the private representation.

To further justify the proposal, the LIA indicated that in 2005, it completed (in conjunction with Wollongong and Shellharbour City Councils) a Floodplain Risk Management Study and Plan for Lake Illawarra. The study examined a range of structural and non-structural solutions, including the proposed entrance works. Among the recommendations of the study are continued maintenance of the entrance channel and continuation of the LIA's entrance opening policy should the lake entrance close, ie mechanically open the lake when water levels reach 0.8 m AHD as measured at the Cudgeree Bay automatic water level station.

Conclusion

The Department notes the conclusion reached by the EIS flood modelling and considers it unlikely that the proposed works will significantly increase flood levels and any changes would therefore be within acceptable limits.

The impact of the proposed works on lake flooding will be monitored by the LIA as part of the performance monitoring and reporting program recommended in Conditions of Approval No 25 and 26. The performance indicators are discussed in section 4.8.

4.6 Design of structures

4.6.1 Background

Figure 2 shows the general arrangements of the proposed entrance works. The design of the structures resulted from a number of refinements made to the original conceptual design ('Option 9').

Lawson & Treloar undertook detailed morphological investigations to determine the effectiveness of this option in reducing sediment inflow and to optimise the location of the breakwater/training walls. The approach for the project design development includes the establishment of design parameters for the site (including the existing coastal and estuarine processes) and confirmation of the constructability of the proposal. Details of the following design parameters are discussed in the EIS: elevated ocean water level, wave climate, geotechnical conditions, entrance morphology, existing entrance processes, tidal hydrodynamics, freshwater flood events, and entrance sediment processes.

4.6.2 Issues

The 4m height (crest level) of the proposed breakwater was the main issue raised by the NSW Wavesailing Association and many individuals who wave sail and wind surf at Perkins Beach. They complained that at this height, the wind patterns that occur around Windang Island and off Perkins Beach could be adversely affected. Most representations requested that the height be reduced from 4m to 2 m, to minimise the impact on wind circulation patterns at Perkins Beach.

Representations from the former DIPNR's Coastal Group and its South Coast Region differed in opinion about the appropriate breakwater height. One suggested that crest levels are low and would be overtopped during storm events, which may affect public access and safety along the walls. The other suggested that the walls could be lowered to 3m.

Other design issues raised in the representations relate to the following components of the proposal:

- breakwater length proposed length of 200 m is not long enough and is still in the active zone of littoral transport;
- breakwater toe apron capacity of the breakwaters to withstand collapse as sand is washed away in high flood velocities; concerns about effectiveness of the rock structures without the foundation being in a trench;
- channel dredging suggestions that the channel be dredged over the full length of the blocked portion of the channel or to the deep channel near Windang Bridge to ensure that water flows more quickly than proposed. Another suggestion is the placement of the dredged sand on Perkins Beach rather than Warilla Beach;
- nourishment of Warilla Beach impact of proposed nourishment on recreational beach users and on the entrance to Elliott Lake if the groyne is not extended as part of the proposed works;
- shape of seawall suggestion that the proposed alignment of the entrance rock structures is too straight and that the southern wall should be curved so that the ocean swell would not propagate directly up the entrance channel and deposit sediment;
- existing training wall groyne suggestion that the groyne be completely extended to Windang Island to reduce bypassing of sand around this structure and the sand movement into the entrance;
- Elliot Lake entrance rock groyne concern that the proposed 20 m extension is not long enough to prevent deposited sand on Warilla Beach from migrating into the Elliot Lake entrance. Also, a comment the crest height of 3.5 m AHD is excessively high in terms of purpose and cost.

4.6.3 Consideration

Breakwater height

While the representations from wavesailors strongly opposed the northern training wall/breakwater, some of these requested that the breakwater height be reduced from 4 m to 2 m.

The LIA in its Representations Report stated that the impacts of the proposed rock structures on local wind behaviour are expected to be relatively minor.

The LIA considers that lowering the crest of the rock structures by 0.5 to 1 m would have a negligible effect on reducing the zone of wind influence. The rock structures have been designed for overtopping and the proposed height of 4m AHD (at head) has already been lowered from an initial level of 5 m AHD during a peer review process for the project. This crest is relatively low by comparison to other similar structures located along the NSW coast. Eight examples of exposed river entrances were presented which showed that the crest level at the head of these structures is typically between 5.5 to 6 m AHD.

The LIA claimed that based on the monitoring of the Stage 1 works, a crest level of 3 m AHD is too low for sand storage at the northern wall and may result in leakage over the crest. A level of 4 m AHD offers a better sand storage potential for the trapping of sand. The crest of the rock structure would also serve as a working platform for the construction plant. The Contractor for the Stage 1 works has confirmed that the 4 m AHD height would be the lowest safe level of the working platform at which they would be prepared to operate.

For the above considerations, the LIA determined that there would be no net benefits in modifying the proposed breakwater height (also see section 4.7).

Breakwater length

The proposed breakwaters will be positioned so that the heads of the northern and southern breakwaters extend to a depth of about - 2.5 m AHD.

The Representations Report noted that the sediment transport modelling showed that longshore sediment transport along Perkins Beach occurs out to a depth of - 8m AHD. However, the majority of transport takes place landward of the - 3.5 m AHD contour. While the LIA considers it desirable for the northern breakwater to extend out to this distance, the seaward extent of this structure was reduced to - 2.5 m AHD due to cost implications. An additional 70m of breakwater is required to - 3.5 m AHD which equates to an estimated additional cost of \$315,000. The cost would double if the proposed southern spur wall needs to be extended as well. The LIA indicated that this breakwater could be extended at a future date following its construction if unacceptable by-passing of sand is occurring.

Breakwater toe apron

A toe apron has been incorporated along the head of both the northern and southern breakwaters and along the more exposed portion of the trunk, to prevent excessive scour caused by currents and/or extreme wave attack from endangering the foundations of the rock structures. As foundation material is scoured from the toe by hydrodynamic processes, the rock toe would settle/readjust to the new level and protect the integrity of the main structure.

The LIA considered that the rock structure could be placed directly on the existing bed surface as the scour potential during construction would be minimal along a large portion of the structures' length.

Further, during construction of the more exposed sections of these structures (eg through the surf zone), the scour/erosion effects are localised. Upon construction, the toe apron would be adequate to reduce the threat to the structural integrity of the foundations. The LIA noted that many of the existing structures along the NSW coast have adopted this approach.

Channel dredging

The EIS proposal is to widen and deepen the channel by dredging from the upstream limit of the existing training walls adjacent to Reddall Reserve to the -2 m AHD contour over a width of 100 m tapering to around 70m at the eastern end of the channel. The removal of approximately 200,000 m3 of marine sand is required to obtain the desired entrance channel profile.

The footprint of the proposed channel dredging targets the more dynamic zone of the entrance where sediment is most active as a result of tidal and coastal processes. The main aim is to lock up as much of this more active material as practicable.

Based on the modelling results of sediment behaviour, the LIA determined that there would be little benefit in extending the dredging footprint over the full length of the currently blocked upstream portion of the channel. After completion of the Stage 2 works, there would be a natural scouring of a channel between Windang Bridge and the upstream extent of the proposed dredging footprint due to tidal and coastal processes.

The southern portion of Warilla Beach is the most depleted of sand compared to its natural state and the LIA considered it appropriate to target this beach for a nourishment program. However, it does not rule out the possibility that maintenance dredging of the channel may be necessary to keep the entrance open and would need to consider suitable disposal options at that time, including Perkins Beach.

Nourishment of Warilla Beach

To minimise the risk of large quantities of sand being reworked into the Elliot Lake entrance by coastal processes, the EIS proposes to bias the distribution of the 200,000 m³ dredged sand to the northern section of the beach nourishment footprint. 85% of the dredged sand would be placed along the beach between Woodford Avenue and Bucknell Street, and the remaining 15% between Bucknell Street and 50 m north of the existing rock groyne that defines the entrance to Elliot Lake. **Figure 2** shows the extent of the proposed sand nourishment along Warilla Beach.

The LIA advised that Shellharbour Council's preference is to proceed with the proposed beach nourishment even if the groyne at Elliot Lake is not extended as part of the proposed work. Council is prepared to wait and see what impact, if any, results to the entrance of Elliot Lake. In the interim, Council will pursue additional government grant funding for extending the groyne. If sand does rework into the lake entrance, then Council would consider sand removal as an interim measure.

The LIA confirmed that geosynthetic groynes will not be placed on the beach. The use of this device to help stabilise beach nourishment works was highlighted as a possibility in the EIS but without an environmental assessment of its impact.

Shape of seawall

The general arrangement of the twin training walls was developed based on analytic and numerical modelling, along with experience with similar structures along the NSW coastline. The proposed

alignment was chosen to optimise the ability of the entrance to self scour during tidal events and minimise the migration of sediment into the entrance channel from coastal processes.

The Representations Report noted that sediment build up is mainly caused by the action of the dominant prevailing north-easterly swell moving sand southwards along Perkins Beach and into the entrance. Modelling results showed that the proposed alignment of the northern training wall would adequately lock-up sand on the southern portion of Perkins Beach (preventing sand migration into the entrance) while also creating a permanent entrance that would be scoured of sediment during a flood event. They also showed that although a portion (approximately 50% for a 5 year ARI event) of the sand bar formed some distance seaward of the breakwaters would be gradually worked into the entrance, the remainder would be trapped behind the northern training wall or within the pocket beach created by the southern spur wall.

Existing training wall groyne

The LIA considers that sand leakage into the entrance compartment would be significantly reduced by the construction of the southern spur wall and formation of the pocket beach. However, it acknowledges that it would also be prudent to connect the groyne to Windang Island to reduce the leakage of sand from Warilla Beach. It would consider closing the gap at a later time, after entrance works are complete, if deemed necessary and subject to funding and other project priorities.

Elliot Lake entrance rock groyne

The proposed length of the rock groyne (20 m) was chosen based on a concept design for the extension contained within a report prepared by the Australian Water and Coastal studies (AWACS) in 1991 titled Warilla Beach Coastal Hazards Assessment Study.

The study details management options for addressing the erosion problems along Warilla Beach and one of these options is a program of beach nourishment (with up to 200,000 m³ of sand) in conjunction with the extension of the Elliot Lake entrance rock groyne. The investigations recommended that the groyne be extended by 30 m.

The reduction of the recommended length from 30 to 20 m was justified by the LIA on the basis that the current volume of sand proposed for nourishment is only 200,000 m³ and an additional 50 m buffer between the southern end of the nourishment zone and the entrance to Elliot Lake is to be provided.

The crest of the groyne extension adopted the 3.5 m AHD crest height of the existing groyne. The LIA determined that the crest level of the proposed extension could not be reduced without compromising the constructability of the structure within an active surf zone. It also considered that the additional quantity of rock needed to achieve the proposed level is not significant (ie only a minimal cost saving would be gained by reducing the crest). Maintaining a consistent crest level would also create better sand storage and an aesthetic appearance.

Conclusion

The Department considers that the approach adopted in the project design development, including the modelling studies undertaken, is sound and provides a firm basis for the design of the structures. However, there are some deficiencies which the LIA itself recognises, eg the breakwaters should be longer as recommended by Lawson & Treloar for more effective sand trapping but funding is an issue. In addition, the potential adverse impact of the proposed 4 m high northern breakwater on wavesailing at Perkins Beach is a significant concern of the wavesailing community, as discussed in section 4.7

The Department notes that the design development for the proposal was overseen by a Technical Working Group comprising of representatives from the former DIPNR and both Wollongong and Shellharbour City Councils.

4.7 Impact on wavesailing at Perkins Beach

4.7.1 Background

The EIS identified the main recreational areas at the entrance waterway and foreshores of Lake Illawarra and considered the impact of the proposal during construction and following its completion.

Wavesailors as a group of recreational users were not mentioned in the EIS. No consideration of the impact of the proposed breakwaters on local wind behaviour along Perkins Beach was given in the EIS.

4.7.2 Issues

Most of the representations received on the EIS came from wavesailors and members of the NSW Wavesailing Association. Many of these are totally opposed to the proposed northern breakwater and consider that it will ruin Windang (Perkins) Beach as a prime wavesailing site. Others consider that a reduced height of 2 m could serve the project purpose without adversely affecting wind circulation and their activities.

4.7.3 Consideration

In response to the wavesailors' concerns, the Representations Report indicated that the impact of the proposed rock structures on local wind behaviour is expected to be relatively minor. This assessment was based on adaptation of wind tunnel test data carried out by Sydney University in 1987 for moorings in the Sydney area. The wind tunnel results imply that for structures such as those currently proposed and at the proposed design heights above water, there is only about a 50 m zone of influence (wind shadow).

The LIA argued that the 4m height of the northern breakwater was chosen for a number of reasons including constructability and beach sand storage. It has considered a lower wall height of 3 m but determined that this would increase the risk of down time during construction (as the working platform would be below a safe level), decrease the beach sand storage capacity and increase wave overtopping. The proposed design height of 4 m had already been reduced from 5 m following a peer review process.

Review of wind shadow effect

The initial assessment provided by the LIA was considered to be limited as it did not demonstrate the applicability of the wind shadow effect to the particular conditions of Perkins Beach. There was also no supporting illustration of the location and extent of the prime wavesailing area and the wind shadow influence relative to the proposed breakwaters. The Department requested the LIA to consult further with the NSW Wavesailing Association to discuss the impact of the proposed breakwaters.

Patterson Britton reviewed the methods they adapted from Sydney University to determine the 50 m zone of influence on wind behaviour surrounding the proposed breakwaters. The study involved two dimensional modelling and wind tunnel testing to determine the wind shadow effects of various landforms adjoining a bay. The 'ridge' landform was chosen to best represent a breakwater, and a linear

relationship between the distance downwind where 90% of incident wind is not influenced (x), and the height of the breakwater (h), was assumed. Adaptation of the previous modelling results suggested that the 4 m high breakwater would have an influence of 28 m but applying a conservatism factor of approximately 2, the impact would be limited to about 50 m. Patterson Britton considered that lowering the breakwater by 0.5 m or even 1 m would have a negligible effect on the size of the wind shadow.

The LIA acknowledged that the above analysis contains a number of limitations, these being: the lack of consideration of 3 dimensional effects, the relationship between x and h is uncertain, and the 'ridge' landform adopted does not exactly represent the shape of the breakwater.

The 50 m shadow zone associated with the breakwaters is illustrated on Figure 4.



Figure 4: Impact of Proposed Works on Wavesailing at Perkins Beach

Source: LIA

Representation from the NSW Wavesailing Association

A further representation was received from the NSW Wavesailing Association as a result of recent consultation by the LIA, indicating that it had not changed its views. The Association claims that the current system creates ideal and unique sand banks for wave formation in a southerly wind and that there is no other location to hold wavesailing competitions in such wind conditions. Annual wavesailing events (both National and State competitions) are held in Perkins Beach because of its 'world class' conditions and reliability. In the Association's view, construction of the northern breakwater would mean the end of 20 years of wavesailing competition in the area.

In response, the LIA considers that the degree of impact is debatable. Within the 50 m wind shadow zone, some wind transmission would still occur, increasing with distance from the breakwater structures. It also noted that under the NSW Wavesailing Association's website, other popular sites in a southerly wind in the South Coast region include Peggy's on the northern side of Bulli Point, Towradgi reef (southern end of Corrimal Beach), Pool Bombie at Shellharbour and the North Gong Beach Bombie.

The Association considers that these sites would be ruled out as contest venues because they do not have reliable wind, can be dangerous and would prove difficult to gain permission from local councils and the NSW Waterways Authority.

Independent assessment by WBM Oceanics

To better understand the wind shadow impact and to explore options for minimising this impact, the Department engaged WBM Oceanics Australia to review the validity of the LIA's assessment and also to investigate the feasibility of lowering the crest level of the breakwaters to overcome any significant adverse impacts.

As part of WBM's review, a two-dimensional Computational Fluid Dynamics (CFD) model of the proposed breakwater configuration was set up using the FLUENT software to further assess the impact of the breakwaters on local wind behaviour. WBM's report is in Appendix C.

The key findings of the consultant's investigations are:

- results of the CFD modelling suggested that the proposed breakwaters would have a significant impact on local wind behaviour. Wind shadow (where 90% of incident wind is returned) would be about 150 m. This is significantly greater than the 50 m wind shadow identified by Patterson Britton;
- lowering the northern breakwater crest from 4 m to 2 m (at its seaward end) would reduce the wind shadow effect, to about 120 m. This is still much greater than the LIA estimate. However, 50% of wind would return much quicker – almost immediately, as against 35 m for the 4 m high breakwater;
- a lower northern breakwater may be feasible in terms of structural stability and integrity of the structure but more detailed design consideration would need to given to issues of constructability and public safety (due to expected greater wave overtopping);
- the northern breakwater could be designed to have a sloping crest, ie a crest height of RL 2.5 m AHD between chainage 0 m and 150 m, reducing to RL 2.0 m AHD by chainage 200 m, then fixed at RL 2 m AHD to the end of the structure to maintain sailboarding/wavesailing activities on Perkins Beach. However, design and construction would be subject to a number of key issues being addressed relating to constructability, structural integrity, sand leakage and public safety/risks.

On the basis of the consultant's findings, the Department met with the LIA and proposed that the feasibility of constructing a lower northern breakwater (crest level between 2 m - 2.5 m) be investigated. The Department recommended that the tender process include both conventional and non-conventional construction methods.

LIA response

The LIA's primary concerns with lower structures are: public risk issues associated with a breakwater subject to regular overtopping; and unconventional breakwater design based on construction technologies not currently practised along the NSW coast. An additional concern is the long-term performance of an unconventional structure with sand leakage and long term maintenance requirements.

Conclusion

The Department accepts that Perkins Beach is a unique area for wavesailing and sailboarding that is likely to be significantly affected by the proposed breakwaters. The interests of the wavesailing/sailboarding community should be given due consideration against the other objectives of the project which reflect the concerns and expectations of the wider community. This is particularly so where there is potential for an alternative (ie low crest height breakwater) that may address their concerns and yet still achieve the primary objective of the proposal which is to keep the entrance open and maintain flushing. It is also possible that a lower crest height sea wall would use significantly less rock and hence, could be cheaper to construct.

Based on advice from WBM, the Department considers that the functionality of the lower height crest level is likely to be similar to the high crest level proposal. In many ways, the key issue is the "unconventional" nature of constructing a low breakwater and to some extent residual safety concerns, rather than necessarily an issue of functionality. Whilst the Department acknowledges that a low crest breakwater would be "unconventional" in terms of local experience, it does not necessarily accept this with respect to international experience as identified by WBM.

Notwithstanding, the Department accepts that any unconventional design may have serious implications for budget and residual safety concerns and would not want to compromise the primary objective which is to maintain an open lake entrance and achieve more consistent flushing. However, this cannot be truly known until commercially tested through the tendering process. In this regard, the Department considers that LIA should further investigate the feasibility of constructing a lower northern breakwater, including consideration of any cost implications. The Department recommends Condition of Approval No 24, which will require the LIA to engage an independent expert to report on the feasibility of constructing a lower northern breakwater. The Director-General's approval will be required for the report.

4.8 Performance indicators and monitoring

4.8.1 Background

As discussed in other sections of this report, the Department and other agencies raised concerns that the stated benefits of the proposal are not adequately demonstrated through quantifiable objectives. They, therefore, requested that the LIA develop performance indicators (PIs) against which the effectiveness of the project could be measured or assessed.

The PIs developed by LIA are summarised in **Table 4** with baseline conditions and identified means of collecting information. Further supporting information for the indicators is contained in a submission from the LIA (**Appendix A** to this report).

In the EIS, a monitoring program is proposed to be established after the completion of the entrance works to assess the impact of the proposal over time. This would involve the following components:

- ecology seagrass beds, aquatic bird populations, fish and benthic communities;
- coastal/estuarine processes coastal erosion/beach recession, water level variation in the lake;
- flood levels rainfall, catchment runoff, water level variation in the lake;
- water quality physical and chemical properties of the lake's water.

4.8.2 Issues

The agencies questioned the relevance or value of some of the PIs. In particular, the DPI questioned the value of an indicator that involves reducing the nutrient retention time and considers that a more relevant indicator is actual nutrient concentrations. With flooding, it considers that the indicator should be related to extent or depth of flooding, not frequency of flooding occurrences.

4.8.3 Consideration

Performance indicators

The LIA indicated that there is a wealth of information available on Lake Illawarra to quantify performance indicators. However, there are limitations to the quality and consistency of the available data sets and information.

As listed in the table below, the indicators were framed in simple quantitative terms as a target percentage to make comparisons against measurements/observations recorded since 1988. The LIA used 1998 as a reference year for two reasons: it was the time that it was formed and more importantly, most of the relevant/useful baseline data for the lake has been captured post formation of the LIA.

Performance Indicators	Baseline condition/ target outcome	Methodology
 reduce the period of lake closure by 50% in the longer term as observed/recorded since 1998 taking into account artificial openings. 	 since 1988, the lake has been closed 21% of the time. reduce incidence to 10.5% of the time 	 continue monthly aerial photographs of entrance area; bathymetry surveys; water level recordings from Cudgeree Bay
2. reduce the amount of sand infeed to the entrance from Perkins Beach by 50% as observed since 1988.	 approx. 91,000m³ of sand feeds into the lake from Perkins Beach annually reduce annual sand feed to 45,500m³ 	 continue monthly aerial photographs of entrance channel; regular surveys (including photogrammetry, if necessary, of the shoaled areas
3. increase the tidal prism in the lake by 30% as measured since 1988.	 tidal prism for a shoaled/constricted entrance varies between 0.5 to 1 million cubic metres during each flood or ebb tidal cycle. achieve an average tidal prism between 0.65 to 1.3 m. 	 tidal plane analysis; analysis of time series of salinity – measured from two monitoring stations; tidal gauging of the entrance channel downstream of Windang Bridge.

Table 4: Performance Indicators

1			
	4. reduce nutrient (pollutant) retention time in the lake by 30% as measured since 1988.	 average tidal flushing capacity of the lake in a shoaled/constricted condition is between 50 to 100 days. reduce to 35 to 75 days. 	 tidal prism and salinity readings from existing water stations in the lake.
	5. reduce the frequency of macro-algal blooms in the lake by 30% as observed/recorded since 1988.	 macro-algae biomass (between 38,000 to 71,000 tonnes) in the lake has dropped considerably since LIA commenced harvesting in 1989. from 1989 to 1999, at least one major macro-algal bloom occurred in the lake annually. from 1999 to 2005, there have been a number of small macro-algal blooms. 	 surveys at selected locations to determine biomass and aerial extent of blooms
	6. no net change in the recreational and commercial fish (and prawn) catch over and above the annual variation as measured since 1988.	 Fisheries data – between 1984 and 2002, total reported annual commercial catch in Lake Illawarra has fluctuated between 200 and 90 tonnes. between 1997 and 2002, average reported commercial catch of finfish, prawns and blue swimmer crabs was 120, 17 and 12 tonnes respectively. no data on recreational fish catches for Lake Illawarra but previous DPI (Fisheries) reports have suggested that recreational fish catch for other similar estuarine lakes is 60% of commercial fish catch. 	• DPI data
	 reduce the potential of foreshore flooding by 10% as observed/recorded since 1988. 	 a flood greater than 1.5m AHD could result in significant disruption to traffic flow and increased risk to life and property damage. since 1988 – 4 flood events where water levels have exceeded 1m AHD and LIA has opened the lake on 6 occasions (4 times in the last 2 years) to prevent foreshore flooding. 	 water level readings at the Cudgeree Bay recorder.
	 increase visitation to the entrance area by 30% as measured against tourism statistics (if available) since 1988. 	 no sufficient or usable statistics against which future visitation numbers could be compared. based on the 2001 Illawarra Regional Information Service (IRIS) survey of 512 housheholds within the Shellharbour LGA, over 50% visited during the summer months and 27% during the other months. achieve 65% local visitation to the area (between daily to every 2 weeks) during the summer months and 35% during the other months. 	 arrange for IRIS to conduct a new survey after entrance works are completed. Consult with Shellharbour City Council regarding foreshore usage and patronage.

9. no net change in shore bird species and populations in the entrance channel area over and above the annual variation as observed/recorded since 1988.	 entrance channel is home to over 55 species of water bird. between 1981 and 2003, the Illawarra Bird Observers Club (IBOC) conducted four periods of systematic population surveys within the 104 ha area east of Bevans Island. since 1999, IBOC has conducted regular surveys of the lake entrance to monitor the effects of Stage 1 works. 	 arrange for IBOC to repeat the survey of shorebird populations within the 104 ha east of Bevans Island.
10. no significant change in distribution, floristics, extent or health of any aquatic communities present in the lake prior to completion of the Stage 2 works.	 total seagrass area in 2000 - 786 ha distribution of 3 seagrass communities – Zostera capriconi (72%), Ruppia megacarpa (21%) & Halphila ovalis (7%). summary of seagrass condition as measured in 2000: shoot density: 462 – 1916 number of leaves: 2.77- 3. 81 leaf length (cm): 12.10 – 54.19 biomass (g dry wt/m²): 6.03 -165.95 	 whole lake surveys/mappings on a 3 - 4 year basis.
11. increase the area of the sub-aerial extent of Warilla Beach by 5% from 1988.	 between 1948 and 1988, sub-aerial sand reserves of Warilla Beach were depleted by 800,000m³. sets of aerial photographs of Warilla Beach from 1988 are available for analysis. proposed works to replace 200,000m³ of sand onto the beach. increase (and maintain) the average sub-aerial sand reserve along the beach by 40,000m³ from the volume that existed in 1988 	 continue monthly aerial photographs of entrance area and adjacent beach areas.

The agencies support the indicators, except for two relating to nutrient retention time and flooding which the DPI regarded to be inappropriate or irrelevant.

The LIA considers that a PI on nutrient retention time will give an indication of the effectiveness of tidal flushing which is expected to assist in discharging pollutants. On the other hand, a PI on nutrient concentration/load would be difficult to measure because improvements could not be attributed to the entrance works alone but in combination with other major works in the catchment (eg control of stormwater runoff).

Nonetheless, the long term goal is to reduce the nutrient load in the lake by 30%. For the period 1996 to 2001, the LIA carried out a detailed water quality program at 10 sites throughout the lake to assess amongst other things nutrient concentrations and chlorophyll 'a'. The LIA has already started to sample lake waters from 3 sites around the lake (Griffins Bay, Bevans Island and Kanahooka) for nutrients and chlorophyll 'a', as suggested by the DEC. The LIA intends expanding this program to include the 10 sites previously monitored so that results pre and post entrance works (including Stage 1) can be assessed over the longer term. However, it argues that results can not be linked directly to entrance works.

Regarding the PI on flooding, the LIA expects a reduction from about 1 in 2 years ARI to about 1 in 3 ARI which equates to a reduction in height of about 10% AEP (50% AEP to 40% AEP). The Flood Study (2003) determined that the flood level for a 50% AEP (1 in 2 yr ARI) is 1.11m AHD and for a 20% AEP (1 in 5 yr ARI) is 1.4m AHD. Foreshore areas start to become inundated when water levels rise above 1.0 m AHD. With entrance works in place, the LIA expects that inundation of foreshore areas will reduce by 10%.

The Department considers that the proposed PI, which would measure the frequency of flooding can be equated to defined water levels in the lake, and therefore would be adequate for monitoring lake flooding. The LIA could also map the the extent and depth of inundation (within ground contour limitations) as part of this PI.

The Department considers the LIA comments in relation to PI Nos 4 and 7 to be valid and should remain for monitoring purposes.

Proposed monitoring program

The EIS proposes a monitoring program that addresses the key issues of the proposal. Details of the program are outlined in **Appendix B** to this report.

The Department considers that the proposed monitoring program is not fully developed and is unclear in some areas, ie implementation of recommended monitoring, responsibilities for monitoring and analysis, methodology, frequency and duration, etc. It also needs to address the matters identified in the PIs.

To ensure that the monitoring program is properly framed and developed and integrated with the performance indicators, the Department recommends Conditions of Approval Nos 25 and 26. The condition requires that the Proponent prepares, as part of the Operational Environmental Management Plan (OEMP), a monitoring plan that further develops the EIS monitoring program and addresses the Pls, in consultation with nominated agencies and Relevant Councils. It also requires the Proponent to prepare Monitoring Reports of the outcomes of monitoring (including the Pls) covering the first, third and fifth year of project operation. The reports are to:

- incorporate a decision making framework that clearly describes how the proponent will respond to the outcomes of monitoring; and
- address the application of the decision making framework, need for mitigation measures, progress with implementation of mitigation measures, and effectiveness of the mitigation measures.

Conclusion

The Department considers that an informed data collection and monitoring program would increase understanding of the lake and its coastal environment. Recommended Conditions of Approval Nos 25 and 26 require the Proponent to prepare and implement a detailed Monitoring Plan that addresses key aspects of the proposal, including the Pls. The Plan must include a response framework that describes how the Proponent will respond to the outcomes of the monitoring and address the need for mitigation measures.

The recommended conditions also require the Proponent to prepare monitoring reports on the outcomes of monitoring for three time periods of the project operation (ie first, third and fifth year) and any other period required by the Director-General.

As the monitoring program will be conducted over a reasonably long time frame, the Department expects that this would provide a clear indication of the effectiveness of the scheme.

5 CONSIDERATION OF OTHER ISSUES

This Section of the Report provides the Department's assessment of the Proposal's other environmental issues. The assessment is based on an examination of the EIS and issues raised in representations made during the exhibition period together with the Proponent's response presented in its Representations Report.

It is important that this Section be read in conjunction with the Representations Report to understand how <u>all</u> issues raised in representations were addressed.

5.1 Noise and Vibration

5.1.1 Background

The EIS evaluated the expected noise and vibration impact on the surrounding environment during the construction phase for both construction work and associated traffic. The noise emissions for construction work were compared to appropriate noise criteria for sensitive locations using the DEC's Industrial Noise Policy (2000).

The noise level assessment undertaken for construction work and construction traffic for the Stage 1 works were used as a basis of comparison with the Stage 2 works. The EIS assumed that the background noise level of the nearest residences (on the southern section of Reddall Reserve) and the equipment to be used for the current proposed works (including sound power levels at the source, location and duration of the activity) would be similar to those of Stage 1 entrance works

On the northern side of the entrance, the nearest residents to the construction area for the northern breakwater are located in the Windang Beach Tourist Park. A similar noise level to those along Reddall Reserve is expected within the tourist park.

The EIS concluded that noise impacts from Stage 2 construction works would be minimal.

5.1.2 Issues

No noise issues were raised in the representations received.

5.1.3 Consideration

The objectives of the noise assessment are to:

- control intrusive noise impacts for the nearest residences during the construction period; and
- maintain noise level amenity for residents and visitors of the affected area.

Under the DEC's Industrial Noise Policy, the intrusiveness criterion is L90 (background noise level) + 5. In terms of maintaining noise level amenity, a recommended acceptable noise level for an urban residence is 60 dB(A).

Construction activities

The previously measured daytime background noise level (L90)⁶ at three residences at Reddall Parade between View and Ocean Streets in the Stage 1 EIS (ERM 1994) was 52dB(A). The equivalent intrusive noise criterion is 57 dB(A).

The equipment expected to be used for the proposed works and the assumed sound power levels at the source and location are shown below in **Table 5**.

Equipment	Noise Level dB(A) at source	Working location
Hydraulic excavator	110	Along rock structures at entrance
Trucks, loading and	110	Near rock structures at entrance
dumping rocks		
Plant start-up and	110	At site construction compound
traffic		(Reddall Reserve)
Cutter-section dredge	106	Within entrance dredge area
	•	•

Table 5: Noise sources and location

Source: EIS Table 11.1

The noise levels have been adopted from the Stage 1 assessment assuming that excavators will be fitted with good-quality residential class mufflers and will not exceed the sound power levels shown. The computer-based noise prediction model took account of the noise attenuation by distance, atmospheric absorption, topographic shielding and the ground effect.

Table 6: Calculated Noise Levels

Equipment	Stage 2 Distance to Nearest Residence (m)	Stage 1 Distance to Nearest Residence (m)	Stage 1 Predicted Noise Level at Nearest Residence (m)	Noise Level Criterion dB(A)
Hydraulic excavator	400	150	57	57
Trucks, loading and dumping rocks	300	150	57	57
Plant start-up and traffic	150	150	57	57
Cutter suction dredge	150	150	52	57

Source: EIS Table 11.2

The EIS noted that only one noise complaint was recorded during the Stage 1 construction period.

Table 6 shows that on the basis of similar plant and equipment being used for the proposed works and distances between the noise sources and residences being greater for the proposed Stage 2 works, it can be expected that noise impacts from the proposal would be minimal.

Construction traffic

Residences along the traffic route to the northern and southern stockpile sites (Peterborough Avenue, Boronia Avenue, Waratah Street, Fern Street) will experience traffic noise associated with construction

⁶ The background noise level represents the A-level noise level which is exceeded 90% of the time.

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activities and rock transport. The DEC recommends a traffic noise goal of Leq (24 hour) = 55 dB(A) for existing low volume roads.

The Stage 1 works with a maximum of 50 car movements and 70 trucks per day was calculated to have a 51 dB(A) Leq(24hour) which is within the acceptable noise level amenity of 60 dB(A). The EIS assumed similar traffic conditions for the Stage 2 works (ie average traffic speed of 40 km/hour for both light and heavy vehicles and zero road gradient) and lesser numbers of vehicle movements for Stage 2 works. On this basis, it concluded that the noise impacts from the proposed works would not be significant.

To reduce the noise transmission from the southern construction compound to residences along Reddall Parade, a 2.5 m high acoustic screen would be erected surrounding its western, southern and northern boundaries.

Conclusion

The Department considers that construction noise and vibration would be minimal provided the recommended measures in the EIS and Representations Report during the construction phase are implemented. These measures include:

- ensuring construction work adheres strictly to the set working hours;
- scheduling the use of particularly noisy equipment at the least sensitive time of day;
- where there are several noisy pieces of equipment, scheduling operations so they are used separately rather than concurrently;
- keeping equipment well maintained and positioning idling trucks in appropriate areas;
- where a particular component of the works is causing a particularly unacceptable noise level, that work should be stopped until measures have been taken to control the offensive noise.

To manage construction noise and vibration impacts, the Department recommends Conditions of Approval Nos 33 to 40 which cover the following requirements:

- preparation of a detailed Construction Noise and Vibration Management Sub Plan;
- definition of construction noise and vibration objectives;
- restrictions on construction hours, including limits on noisy construction activities such as rock breaking.

5.2 Air quality

5.2.1 Background

Construction activities associated with the proposal would have the potential to generate smoke/fumes, odours and dust.

The EIS identified that during construction works, smoke and fumes from plant and equipment (trucks, excavators and dredgers) could adversely affect air quality. Dust, principally in the form of sand, could be generated from the following activities:

- excavation of sand to generate design profiles for the rock structures;
- general vehicle movements within and around the site;
- stockpiling of rock; and

• wind erosion of exposed areas.

The EIS indicated that the nearest residential areas to the haulage roads and construction site are not expected to be impacted by wind-borne sand due to the distance to these areas and the implementation of appropriate controls.

Unacceptable odours from entrance dredging are also not expected because the sediment is expected to be relatively clean marine sand and the dredged material would be pumped hydraulically for beach nourishment.

Smoke and fumes could be emitted by some plant and equipment and adversely affect air quality. However, this could be managed through shut down procedures until the impact is no longer noticeable.

5.2.2 Issues

No air quality issues were raised in the representations received.

5.2.3 Consideration

Rates of dust generation from construction sites can vary substantially from day to day, depending of the level of activity, the specific operations and meteorological conditions. Since the proposed rock structures are located in an exposed environment, the natural wind-borne movement of sand would be inevitable at times.

Measures to mitigate dust generation were identified in the EIS. This include confining truck loading/unloading areas and upgrading existing unsealed haulage roads to gravel/ballast covered roads or similar to ensure all weather access.

The Department noted that the potential exists for short-term air quality impacts to occur during construction. It recommends the inclusion of Conditions of Approval Nos 44 to 46 to manage air quality during construction. These conditions include a requirement for the Proponent to prepare a detailed Dust Management Plan and to ensure that all plant and equipment used be maintained and operated in a proper and efficient manner.

5.3 Traffic

5.3.1 Background

Approximately 50,000 tonnes of rock are required for the construction of the twin entrance training walls. Two separate stockpile areas are proposed, one on the northern side of the entrance (40,000 tonnes), the other on the southern side (10,000 tonnes). The proposed local transport routes to the northern and southern stockpile sites are shown on Figure 11.3 of the EIS.

Approximately 50% of the rock for use in the breakwaters has already been stockpiled on the northern side of the channel. The construction of the haul road and rock transport to the stockpile site was subject to a Review of Environmental Factors (REF) and a separate approval granted by LIA in August 2004. The haul road is proposed to be removed and the sandy pedestrian track reinstated on completion of the works.

The remaining rock is currently stockpiled at Shellharbour City Council's Waste Depot at Dunmore. The proposed southern stockpile site is at the south of the lake entrance and would be accessed along

the existing carpark on the southern end of Reddall Reserve. A haul road is proposed to be constructed adjacent to the eastern end carpark to gain access to the southern site.

5.3.2 Issues

No issues were raised in the representations about the rock transport and associated noise and traffic impact resulting from this activity.

Approximately 25,000 tonnes of rock are yet to be transported to the stockpile sites. Aspects of the transport and placement of the rocks to the two stockpile sites are unclear at this stage and would likely be determined by the contractor chosen for the project.

5.3.3 Consideration

The Traffic Management Assessment estimated (using semi-trailers with an average load capacity of 20 tonnes) that the rock transport would involve approximately 2,500 truck movements – 2,000 movements to the northern stockpile site, and 500 movements to the southern stockpile site. Accounting for the 50% remaining rocks to be transported, this would mean roughly 1, 250 truck movements.

Of the 25,000 tonnes to be transported from the Dunmore tip, approximately 15,000 tonnes are to go to the northern stockpile site and 10,000 tonnes to the proposed southern stockpile site.

The LIA expects that:

- the rocks will be removed in semi-trailers (20 tonnes capacity);
- the contractor would commence transporting rock to the northern stockpile site at the entrance shortly after establishing on site and creating the initial stage of the 'working platform'. This would allow the rock to be directly end tipped for placement (in lieu of the need to stockpile);
- it will take 750 and 500 truck loads to deliver the rocks respectively to the northern site and southern site;
- all of the rock should be delivered to the northern site within 2-3 months after establishing on site based on up to 20 truck loads a day (peak) or 2-3 truck loads per hour;
- all of the rock should be delivered to the southern site within 2-3 months of commencing work on the southern breakwater, based on up to 20 truck loads per day (peak) or 2-3 truck loads per hour.

To minimise impact on recreational users of the lake foreshores and nearby beaches during weekends and public holidays, transportation of rock would be confined to Monday to Friday only between the hours of 7am and 5pm. This is reflected in Condition of Approval No 35.

The Department considers that the traffic impact of the rock transport and other construction activities can be properly managed through a Construction Traffic Management Plan. Recommended Condition of Approval No 52 requires the preparation of this Plan, in consultation with the relevant roads authority. Also recommended is Condition of Approval No 51 which requires the preparation of road dilapidation reports to monitor construction traffic effects on public roads. Where damage has occurred, LIA is required to repair the damage at its cost.

5.4 Heritage

5.4.1 Background

Aboriginal

An Aboriginal archaeological survey and assessment was undertaken by Navin Officer Heritage Consultants as part of the heritage assessment. This included site register and database searches, literature review, field studies and consultation with the following local Aboriginal groups:

- Illawarra Local Aboriginal Land Council (LALC);
- Wodi Wodi Elders Corporation;
- Wadi Wadi Coomaditchie Corporation; and
- Korewal Elouera Jerrungarugh Tribal Aboriginal Elders Corporation.

The archaeological assessment found that there are no previously recorded Aboriginal sites or objects occurring in the proposed entrance works study area. However, there are many recorded sites in the Windang area in general, and in the vicinity of the Surf Club/Illawarra Holiday Park in particular. These sites include middens, burial and artefact scatters and an Aboriginal Keeping Place, incorporating at least six Aboriginal re-burials.

The field studies conducted by the survey team (attended by representatives of the above Aboriginal groups) also did not identify any Aboriginal sites or objects within the study area. The impact of the proposed entrance works on the Aboriginal cultural significance of Windang Island is considered acceptable by the participating Aboriginal representatives as there will be no direct impact to the island.

Non-Aboriginal

The EIS indicated that there are no items of non-Aboriginal heritage listed in local planning instruments and the Illawarra Regional Environmental Plan within the area of the proposed works.

5.4.2 Issues

The DEC indicated the possibility of subsurface Aboriginal cultural deposits being present within sections of the (already constructed) northern haul road. It requested that the recommendations in Navin Officer's Archaeological Assessment (outlined in section 5.4.3) be incorporated in conditions of approval, should the project be approved.

The former DIPNR (South Coast Region) advised that previous archaeological studies have found railway line and train wheels in and around Windang Island which are classified as 'relics' under the Heritage Act. It is not clear whether the Stage 2 works will affect these relics.

5.4.3 Consideration

To minimise the possibility of inadvertently disturbing any possible Aboriginal cultural deposits, the Archaeological Assessment recommended the following actions:

- project personnel should be made aware of the culturally sensitive environment;
- should an Aboriginal object be discovered during project works, work should cease immediately in the subject area and the DEC notified;

 to avoid inadvertent churning of (possible) cultural deposits, vehicles should remain on formed surfaces (eg sealed asphalt road and the haul road) and should be excluded from locations that were identified as having potential cultural deposits.

The LIA in the Representations Report agreed to comply with these recommendations.

In response to the heritage relics issue at Windang Island, the LIA stated that the Heritage Office has previously advised (Stage 1 works) that no approval will be required for their relocation and that burial of the items would be acceptable. The LIA does not expect that the proposed works would disturb these relics as they are outside the area required for the current proposal. It also commits to providing the project contractor appropriate instructions to follow if a heritage item (Aboriginal and non-Aboriginal) is encountered during the construction works. This involves stopping the work, contacting the Heritage Office and/or DEC and engaging a qualified maritime archaeologist to assess the significance of any identified remains.

The Department considers that potential impacts on Aboriginal and non-Aboriginal heritage items will be insignificant provided the stated measures and procedures are implemented. To ensure the protection of these items, Conditions of Approval Nos 29 and 31 are recommended which require the preparation of Indigenous Heritage and Historical Relic Management Plans as part of the CEMP. Where Aboriginal or heritage relics are uncovered during trenching works, Conditions of Approval Nos 30 and 32 impose 'stop work' provisions and requirements for notification of the DEC or the Heritage Council, as relevant.

5.5 Acid sulfate soils

5.5.1 Background

An Acid Sulfate Soil (ASS) and Geotechnical Investigation were commissioned by Patterson Britton on behalf of LIA as part of the project's environmental assessment. The report, prepared by Coffey Geosciences (2004), is entitled *Preliminary Acid Sulfate Soil and Geotechnical Assessment – Proposed Improvements to the Entrance of Lake Illawarra.* The investigation was conducted to:

- assess if potentially acid generating soils are present within the footprint of the proposed entrance channel dredging, and suggest appropriate management measures, if necessary; and
- confirm the nature and character of the marine sediments contained within the dredge footprint.

Vibrocoring was conducted in the lake bed at three locations across the proposed dredge footprint to a depth ranging between -1 and -1.5 m AHD. The nominated soil samples were then photographed and analysed in the laboratory.

Results of laboratory analysis found that there are low amounts of oxidisable sulphur in the sediments (an indicator of the presence of ASS) and concentrations are below the trigger levels for the preparation of an ASS Management Plan. In terms of marine sediments, the analysis found the subsurface conditions from the sampling locations to be predominantly fine to medium grained sands with shell fragments and little or no fines.

Based on the results of the ASS investigation, the EIS expects that the likelihood of ASS disturbance would be low during the proposed dredging/nourishment works,

5.5.2 Issues

No issues were raised about acid sulfate soils in the Representations.

5.5.3 Consideration

The Department notes the findings of the ASS investigation and the low possibility of ASS disturbance. However, to address any possibility of unexpected discovery of greater concentrations of oxidisable sulphur, Condition of Approval No 43 is recommended which requires the preparation of an ASS Management Plan, including a contingency plan.

5.6 Commercial and recreational fishing

5.6.1 Background

During the construction period, the EIS states that potential disruption to commercial and recreational fishing and prawning activities in the entrance channel would be minimal. Construction of the rock walls may disrupt the rings set into the present southern wall to hold commercial prawning nets in the entrance channel. However, the disruption would be minimised through the staging of the work components.

The long term impacts of the works on fish and prawn populations of the lake, according to the EIS, are likely to be either neutral or marginally beneficial. This is because a more stable entrance is expected to allow better access for fish to get in and out from the lake and that there would be no large changes to overall lake habitat availability.

5.6.2 Issues

The DPI raised concerns that the proposal will change the ecology of the lake with consequent impacts upon commercial and recreational fishers.

5.6.3 Consideration

In response to the DPI's concerns, the LIA argued that:

- as the expected changes to lake water level and salinity are small and within historic natural variation, there would be no significant change to the lake ecology. Therefore, potential impacts on commercial and recreational fishers would likely be negligible;
- there may be beneficial impacts for fishers arising from the entrance being open for longer periods on average than the current situation. When the entrance channel is closed for long periods, fish and prawns cannot run to the sea and larvae and juveniles of fish and invertebrate marine biota cannot be brought back into the lake. This can lead to changes in fish and invertebrate stocks in the lake which do not benefit either fishers or the overall estuarine ecology. The problem of impediments to fish passage is recognised by the Department of Primary Industries Fish Habitat Management Guidelines as a major problem for fish ecology.

The implications of the wide ranging ecological changes that could result from the proposed works and their consequent impact on fish and prawn communities are unclear. The long term changes and implications are not addressed in the EIS. The Department in discussion with other agencies agree that performance monitoring is necessary to determine and measure the actual changes that would occur. This is discussed in section 4.8.

5.7 Recreation and Waterway Use

5.7.1 Background

The EIS identified five main recreational areas that would be affected in varying extent during the construction period. These are:

- Reddall Reserve, along the foreshores of the lake entrance, southern side;
- Windang Foreshore Reserve, on the northern side of the entrance;
- the entrance waterway itself including a shallow swimming area;
- an area of sand shoals on the northern side of the lake entrance waterway area; and
- the existing southern training walls.

Upon completion of the entrance works, the EIS expects that a more stable entrance would be created and consequently safer surfing conditions. The waterway east of Perkins Beach is heavily used for water-based activities but is currently constrained by shoaling and potentially dangerous tidal floes in the entrance channel.

Improving the navigability of the entrance is not a primary objective of the proposed works. However, the EIS acknowledged that some vessels (eg sailing craft, windsurfers, canoes, small fishing boats) are taken through the entrance on occasion. A bar will form at the entrance as a result of the proposed works which could make navigation in this water dangerous.

An analysis of post-construction tidal conditions indicates that entrance peak velocities would not increase compared to existing conditions. However, peak current speeds of 0.7 meters per second would be encountered more often due to the entrance being open more frequently. The EIS nonetheless expects that safety for users of the entrance channel would not be significantly compromised.

5.7.2 Issues

Recreation issues raised by some representations involve:

- request to LIA that public access to Windang Island and the swimming areas south of the southern breakwater are not restricted during construction works;
- concerns about navigation safety through the new entrance.

5.7.3 Consideration

During the construction period, a number of recreation areas will be closed to the public effectively restricting the recreation activities on these areas. The impacts on the major recreational areas are outlined below:

<u>Reddall Reserve</u>

During the construction of the southern spur wall, a site compound will be erected near the eastern carpark along this reserve. Access will be restricted within this part of the reserve but access to the entrance swimming area and Reddall Reserve and the remaining amenities will essentially not be impacted.

Waterway area east of Windang Bridge

During the channel dredging, the waterway area available for recreational activities will be generally reduced. However, people can go to other nearby waters or suitable areas within Lake Illawarra during this activity.

Sand Shoals on the Northern side of the entrance (Windang Spit)

This area will be affected during the stockpiling of rock on the northern side of the entrance and during the construction of the rock structures. Access to the dune area within the rock stockpile and haul road footprint will be restricted. However, access to the waterway will still be accessible from nearby locations.

The Department notes that while certain recreational areas will be restricted, this will be short term and that there are other nearby areas where activities may be relocated during the construction period.

In response to navigation concerns, the LIA stated that it will be consulting with the NSW Maritime Authority about entrance safety provisions such as warning signs, etc. The Department considers that safety signs and other provisions are essential and must be provided.

5.8 Visual and Aesthetics

5.8.1 Background

Visual impacts during the construction period are unavoidable. The most significant impacts are expected during the construction of the training walls. The most affected would be the residences along Reddall Parade as their existing views of an open waterway will be obstructed by the work compound and security fences in Reddall Reserve. There will also be movement of plant and equipment such as trucks, excavators and front-end loaders that would be observed by these residences and visitors of the lake and its foreshores.



Figure 5: Artist impression of Stage 2 Entrance Works

Source: EIS Figure 11.4

The twin breakwaters, once constructed, will add significant features to the visual landscape of the lake entrance. **Figure 5** provides an artist impression of the aerial view of the lake entrance post-construction. In addition, new pockets of sand would form at the southern end of Perkins Beach

Department of Planning November 2005 (adjacent to the new northern wall) and also between the new southern spur wall and the rock groyne attached to Windang Island.

5.8.2 Issues

No representations were received regarding the visual impact or appearance of the proposed training walls/breakwaters on the coastal landscape.

5.8.3 Consideration

The EIS considers that given the distance of the construction activities (of the order of 200 m) from local residences, the visual impact of the construction works is not expected to cause concern. It also envisages that the construction activities would offer an attraction or focus of interest for some members of the community.

Once built, the Department considers that the rock structures may diminish the scenic quality of this coastal area and permanently change the current open, unobstructed coastal landscape. However, the local community may view the rock structures as a normal feature along the coast and an acceptable design solution to overcome the identified problems of the lake.

5.9 Administrative and Miscellaneous Conditions

The Department recommends a series of other Conditions of Approval as follows:

- Conditions of Approval Nos 1 to 12. These cover administrative, compliance and auditing requirements;
- Conditions of Approval Nos 13 to 18. These require the preparation of a construction environmental management plan and specify the requirements for an Environmental Management Representative;
- Conditions of Approval Nos 19 to 23. These cover broad communication and consultation with the community including advertising the construction activities and establishing a complaints management system;
- Condition of Approval No 47 requires that the Proponent use at least 50% of the site's electrical energy requirements from a renewable energy source;
- Condition of Approval No 48 to 50 covers property access;
- Condition of Approval No 53 covers hazard and risk management;
- Condition of Approval No covers 54 waste management and recycling;
- Condition of Approval No 55 requires the Proponent to manage alterations to utilities and services; and
- Condition of Approval No 56 presents location criteria for ancillary facilities such as construction compounds.

6 CONCLUSION AND RECOMMENDATIONS

The entrance to Lake Illawarra has frequently constricted and closed in the past which has restricted the lake's natural tidal flushing and contributed to the deterioration of its water quality. The proposal is the LIA's key strategy for keeping the lake entrance open to achieve more consistent flushing which is expected to consequently result in improvements to the lake's water quality and recreational amenity.

The assessment has found that the physical construction works would not have significant impacts and could be managed through normal mitigation and management measures.

Keeping the lake open more frequently than now is likely to provide some benefits such as maintaining a more consistent water level in the lake and improvements in water quality and recreational amenity. However, the coastal environment involves dynamic and often unpredictable processes and there remains some uncertainty over the long term outcomes and effectiveness of the proposal.

The Department and agencies' main concerns involve the following:

- whether the entrance works will be effective inkeeping the lake open in the long term;
- the likely effect of structures on coastal processes in the long term; and
- the scale of the water quality improvements.

As a means of measuring the success or otherwise of the proposal, the LIA developed performance indicators, as requested by the agencies. The indicators will be supported by a detailed monitoring plan to be developed by the LIA, in consultation with nominated agencies and stakeholders. The monitoring plan will also address the key issues affecting the lake environment - ecology, coastal/estuarine processes, flooding and water quality.

Three periods of reporting on the outcomes of monitoring (first, third and fifth year of project operation) will be required of the Proponent. The Monitoring Plan is to include a decision making framework that clearly describes how the Proponent will respond to the outcomes of monitoring. Recommended Conditions of Approval reflect the requirements for the development and implementation of monitoring and reporting programs.

A significant issue that has come from the public exhibition of the proposal is the potential adverse impact of the proposed northern breakwater on wavesailing activities at Perkins Beach. An independent assessment commissioned by the Department found that the northern breakwater's proposed height of 4m AHD would create a substantial wind shadow on a prime wavesailing location.

To address this concern, the Department recommended that the LIA investigate the feasibility of a lower breakwater before commencing construction. The LIA accepted this approach but with reservations concerning public safety issues associated with low crest structures and unconventional breakwater design and construction technologies.

The recommended Conditions of Approval will require the LIA to engage an independent expert to review the feasibility of a lower breakwater. The Director-General's approval will be required for the report.

Overall, the Department considers that the proposed scheme is a compromise, reflecting available funds, and is likely to meet the local community's expectations for a response to the lake closure

problem and associated amenity issues. The five year time frame for monitoring and reporting on the performance of the completed works is considered reasonably long enough to provide an indication of the effectiveness of the project. Recommended conditions provide for a further review by the Director-General, if required.

The Department notes that the project was endorsed by the State Government-established Independent Review Panel and government funding has already been committed for this project.

Against these considerations, the Department concludes that the proposal could be recommended for the Minister's approval subject to the recommended Conditions of Approval being adopted.

7 RECOMMENDED CONDITIONS OF APPROVAL

This Section provides the Department's' recommended Conditions of Approval for the Activity under section 115B(2) of the EP&A Act. The recommended conditions were developed from the Department's assessment of the EIS, the Representations made to the EIS, the Proponent's Representations Report and any further supplementary investigations, studies or advice.

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DEFINITIONS

Activity	The activity described in Schedule 1 of this Approval
Ancillary Facility	Temporary facility for Construction that does not form part of the Activity. Examples are an office and amenities compound, batch plant (concrete or bitumen), materials storage compound.
Approved Activity Area Conditions of Approval, also Conditions	The footprint of the Activity covered by the Conditions of Approval The Minister's Conditions of Approval for the Activity
Construction	Includes all work in respect of the Activity other than survey, acquisitions, investigative drilling or excavation, building/road dilapidation surveys, minor clearing (except where threatened species, populations or ecological communities would be affected), establishing site compounds (in locations meeting the criteria of the Conditions), or other activities determined by the Proponent to have minimal environmental impact (e.g. minor access roads, minor adjustments to services/utilities, etc.).
Department, the	Department of Planning
Director General, the	Director General of the Department (or delegate)
Director General's Agreement	A written advice from the Director General (or delegate)
Director General's Approval	A written approval from the Director General (or delegate)
	Where the Director General's Approval is required under a Condition the Director General will endeavour to provide a response within one month of receiving an approval request. The Director General may ask for additional information if the approval request is considered incomplete. When further information is requested the time taken for the Proponent to respond in writing will be added to the one month period.
Director General's Report	The report provided to the Minister by the Director General of the

	Department under section 115C of the <i>Environmental Planning and</i> Assessment Act 1979.
EIS	Means the EIS for the Lake Illawarra Entrance Works Project (Stage 2) prepared by Patterson Britton & Partners Pty Ltd (dated January 2005) and its appendices
Minister, the	Minister for Planning
Operation Proponent Publicly Available Reasonable and Feasible	Means the substantial completion of the proposed entrance works Lake Illawarra Authority Available for inspection by a member of the general public (for example available on an internet site or at a display centre) Consideration of best practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. Feasible relates to engineering considerations and what is practical to build. Reasonable relates to the application of judgement in arriving at a decision, taking into account: mitigation benefits, cost of mitigation versus benefits provided, community views and nature and extent of potential improvements.
Relevant Councils	Wollongong City Council and Shellharbour City Council
Relevant Government Departments	A government department with a licensing or approval role for the Activity's Construction or Operation. This refers to the DEC (including EPA and NPWS functions), the DPI (Fisheries), DNR and the Department of Lands.
Representations Report	Representations Report for the Lake Illawarra Entrance Works Project (Stage 2) prepared by Lake Illawarra Authority dated June 2005.
Sensitive receivers Structure	Residence, educational institution (e.g. school, TAFE college), health care facility (e.g. nursing home, hospital) and religious facility (e.g. church). Any fixed, artificial object including residence, farm shed, fence, dam, cable support structure, etc.

ABBREVIATIONS

CEMP	Construction Environmental Management Plan
DEC	Department of Environment and Conservation (formerly the Environment
	Protection Authority, and the National Parks and Wildlife Service)
DNR	Department of Natural Resources
DPI	Department of Primary Industries (formerly NSW Agriculture and NSW Fisheries)
EIS	Environmental Impact Statement
EMP	Environmental Management Plan

EMR	Environmental Management Representative
EP&A Act	Environmental Planning and Assessment Act 1979
LIA	Lake Illawarra Authority
OEMP	Operation Environmental Management Plan

ADMINISTRATIVE CONDITIONS

The Activity

- 1. The Activity must be carried out consistent with:
 - (a) the procedures, safeguards and mitigation measures identified in the EIS, as modified by the Representations Report; and
 - (b) these Conditions.

These Conditions prevail in the event of any inconsistency with the requirements for the Construction and Operation of the Activity arising out of the documents described in (a) above.

2. These Conditions of Approval do not relieve the Proponent of the obligation to obtain all other approvals and licences required under any other Act. The Proponent must comply with the terms and conditions of such approvals and licences.

Compliance

General

- 3. The Proponent must notify in writing the Director General, DEC, DPI, DNR and Relevant Councils of the start of the Activity's Construction and Operation. Such notification must be provided at least four weeks before the relevant start date unless otherwise agreed to by the Director General.
- 4. It is the responsibility of the Proponent to ensure compliance with all of these Conditions and to implement any measures arising from these Conditions of Approval.
- 5. The Proponent must bring to the Director-General's attention any matter that may require further assessment by the Director-General.
- 6. The Proponent must comply with any requirements of the Director General arising from the Department's assessment of:
 - a) any reports, plans or correspondence that are submitted to satisfy these Conditions of Approval; and
 - b) the implementation of any actions or measures contained in such reports, plans or correspondence.

Staging Report

- 7. The Proponent may elect to construct the Activity in discrete work packages or defined stages provided that such stages or work packages are consistent with these Conditions of Approval. Where discrete work packages or defined stages are proposed, the Proponent must submit a Staging Report to the Director General at least four weeks before Construction commences (or within any other time agreed to by the Director General). The Staging Report must:
 - a) describe the work packages or defined stages; and
b) identify how the Conditions will be addressed in each work package or defined stage.

Pre-Construction Compliance Report

8. The Proponent must submit a Pre-Construction Compliance Report to the Director General at least four weeks before Construction commences (or within any other time agreed to by the Director General).

The Pre-Construction Compliance Report must include:

- a) details of how the Conditions of Approval required to be addressed before Construction were complied with;
- b) the time when each relevant Condition of Approval was complied with, including dates of submission of any required reports and/or approval dates; and
- c) details of any approvals or licences required to be issued by Relevant Government Departments or Relevant Council before Construction commences.

Pre-Operation Compliance Report

9. The Proponent must submit Pre-Operation Compliance Reports to the Director General at least four weeks before Operation (or within any other time agreed to by the Director-General).

The Pre-Operation Compliance Report must include:

- a) details of how the Conditions of Approval required to be addressed before Operation were complied with;
- b) the time when each relevant Condition of Approval was complied with, including dates of submission of any required reports and/or approval dates; and
- c) details of any approvals or licences issued by Relevant Government Departments for the Activity's Operation.

Construction Compliance Reports

10. The Proponent must provide the Director General, Relevant Councils and any other government departments nominated by the Director General with Construction Compliance Reports.

The first *Construction Compliance Report* must report on the first six months of construction and be submitted a maximum six weeks after expiry of that period. The second, and subsequent, Construction Compliance Reports must be submitted at maximum intervals of six months from the date of submission of the first Construction Compliance Report (or at any other time interval agreed to by the Director General) for the duration of Construction.

The Construction Compliance Reports must include information on:

- a) compliance with the CEMP and the Conditions of Approval;
- b) compliance with any approvals or licences issued by Relevant Government Departments and Relevant Councils for the Construction phase of the Activity;
- c) the implementation and effectiveness of environmental controls. The assessment of effectiveness should be based on a comparison of actual impacts against performance criteria identified in the CEMP;
- d) environmental monitoring results, presented as a results summary and analysis;

- e) the number and details of any complaints, including a summary of main areas of complaint, action taken, response given and intended strategies to reduce recurring complaints;
- f) details of any review and amendments to the CEMP resulting from Construction during the reporting period; and
- g) any other matter relating to compliance with the Conditions of Approval or as requested by the Director General.

The Construction Compliance Reports must also be made Publicly Available.

Environmental Impact Audits

Environmental Impact Audit Report - Construction

11. An *Environmental Impact Audit Report - Construction* must be prepared and submitted to the Director General a maximum three months after the Activity begins Operation (or at any other time interval agreed to by the Director General). The *Environmental Impact Audit Report – Construction* must also be submitted to other government departments upon the request of the Director General.

The Environmental Impact Audit Report – Construction must:

- a) identify the major environmental controls used during Construction and assess their effectiveness;
- b) summarise the main environmental management plans and processes implemented during Construction and assess their effectiveness;
- c) identify any innovations in Construction methodology used to improve environmental management; and
- d) discuss the lessons learnt during Construction, including recommendations for future Activities.

Environmental Impact Audit Report - Operation

12. An *Environmental Impact Audit Report - Operation* must be submitted to the Director-General a maximum 24 months after the Activity begins Operation and at any additional periods that the Director-General may require. The *Environmental Impact Audit Report - Operation* must also be submitted to other government departments upon the request of the Director-General.

The Environmental Impact Audit Report - Operation must:

- a) be certified by an independent person at the Proponent's expense. The certifier must be advised to the Director-General before the *Environmental Impact Audit Report – Operation* is prepared;
- b) compare the Operation impact predictions made in the EIS, Representations Report and any supplementary studies with the actual impacts;
- c) assess the effectiveness of implemented mitigation measures and safeguards;
- d) assess compliance with the systems for operation maintenance and monitoring;
- e) discuss the results of consultation with the local community particularly any feedback or complaints; and
- f) be made Publicly Available.

ENVIRONMENTAL MANAGEMENT

Construction Environmental Management Plan

13. A Construction Environmental Management Plan (CEMP) must be prepared and implemented in accordance with these Conditions of Approval and all relevant Acts and Regulations. The Proponent must obtain the Director General's Approval for the CEMP before Construction commences or within any other time agreed to by the Director General.

The Proponent must ensure that the mitigation measures identified in the EIS, Representations Report and in these Conditions are incorporated into the CEMP.

The CEMP must:

- a) state how the mitigation measures identified in section 7 of the Representations Report will be implemented;
- b) include a Construction program, identifying/construction activities and their location and timing;
- c) cover any relevant environmental elements identified by the Proponent, or its contractor, from their environmental due diligence investigations;
- d) contain the Construction Sub Plans required by the Conditions of Approval;
- e) be prepared following consultation with Relevant Government Departments and the Relevant Councils;
- f) be Publicly Available;
- g) include a community consultation and notification strategy (including local community, Relevant Government Departments, Relevant Councils), and construction complaint handling procedures;
- h) include environmental management details such as:
 - i identification of statutory obligations which the Proponent is required to fulfil during Construction, including all approvals and licences;
 - ii an environmental management structure indicating the responsibility, authority and accountability for personnel relevant to the CEMP;
 - iii the role of the EMR and identification of Construction activities requiring EMR attendance;
 - iv details of the Construction personnel induction and training program;
 - v emergency response procedures;
- i) include implementation details such as:
 - i. identification of relevant environmental elements;
 - ii. measures to avoid and/or control environmental impacts;
 - iii. the tools to be used to implement the CEMP such as plans, schedules and work instructions;
- j) include monitoring and review details such as:
 - i performance criteria;
 - ii performance monitoring methods;
 - iii auditing and corrective actions procedures;
 - iv CEMP review procedures.

Operation Environmental Management Plan

14. An Operation Environmental Management Plan (OEMP) must be prepared and implemented in accordance with these Conditions and all relevant Acts and Regulations. The Proponent must obtain the approval of the Director-General for the OEMP before Operation commences or within any other time agreed to by the Director-General.

The OEMP must:

- a) identify the Operation activities;
- b) cover relevant environmental elements identified by the Proponent either from its environmental due diligence investigations or required to satisfy any other licence or approval;
- c) include the Operation Sub Plans required under these Conditions of Approval;
- d) be prepared in consultation with Relevant Government Departments and Relevant Councils;
- e) be made Publicly Available;
- f) include environmental management details such as:
 - i identification of statutory obligations which the Proponent is required to fulfil during the Activity's Operation, including all approvals and licences;
 - ii an environmental management structure indicating the responsibility, authority and accountability for personnel relevant to the OEMP;
 - iii details of a personnel induction and training program;
 - iv emergency response procedures;
- g) include implementation details such as:
 - i identification of relevant environmental elements;
 - ii measures to avoid and/or control environmental impacts;
 - iii the tools to be used to implement the OEMP such as plans, schedules and work instructions;
- h) include monitoring and review details such as:
 - i performance criteria;
 - ii performance monitoring methods;
 - iii auditing and corrective actions procedures;
 - iv OEMP review procedures.

If the Proponent has an Operation Environmental Management Plan (for example a certified and operating environmental management system) for its other activities which is applicable to this Activity then that system may be proposed as the OEMP. Details of the existing system must be provided to the Director-General demonstrating its application to this Activity.

Environmental Management Representative

- 15. The Proponent must request the Director-General's Approval for the appointment of an Environmental Management Representative (EMR) at least eight weeks before Construction commences (or within any other time agreed to by the Director-General). In its request the Proponent must provide the following information:
 - a) qualifications and experience of the EMR including demonstration of general compliance with relevant Australian Standards for environmental auditors;
 - b) authority and independence (from the Proponent or its contractors) of the EMR including details of the Proponent's internal reporting structure; and
 - c) resourcing of the EMR role. The EMR must be available:

- i for sufficient time to undertake the EMR role. This timing shall be agreed between the Proponent and the EMR and advised to the Director-General in the request for approval;
- ii at any other time requested by the Director-General;
- iii during any Construction activities identified in the CEMP to require the EMR's attendance; and
- iv for the duration of Construction.
- 16. The Director-General may at any time immediately revoke the approval of an EMR appointment by providing written notice to the Proponent. Interim arrangements for EMR responsibility following the revocation must be agreed in writing between the Director-General and the Proponent.
- 17. The Director-General may at any time conduct an audit of any actions undertaken by the EMR. The Proponent must:
 - a) facilitate and assist the Director-General in any such audit; and
 - b) include in the conditions of the EMR's appointment the need to facilitate and assist the Director-General in any such audit.
- 18. The EMR is authorised to :
 - a) consider and advise the Director-General and the Proponent on matters specified in the Conditions of Approval and compliance with such;
 - b) determine whether work falls within the definition of Construction where clarification is requested by the Proponent;
 - c) review the CEMP;
 - d) periodically monitor the Proponent's activities to evaluate compliance with the CEMP. Periodic monitoring must involve site inspections of active work sites at least fortnightly;
 - e) provide a written report to the Proponent of any non-compliance with the CEMP observed or identified by the EMR. Non compliance must be managed as identified in the CEMP;
 - f) issue a recommendation to the Proponent to stop work immediately if in the view of the EMR an unacceptable impact on the environment is occurring or is likely to occur. The stop work recommendation may be limited to specific activities causing an impact if the EMR can easily identify those activities. The EMR may also recommend that the Proponent initiate reasonable actions to avoid or minimise adverse impacts;
 - g) review corrective and preventative actions to monitor the implementation of recommendations made from audits and site inspections;
 - h) certify that minor revisions to the CEMP are consistent with the approved CEMP; and
 - i) provide regular (as agreed with the Director-General) reports to the Director-General on matters relevant to carrying out the EMR role including notifying the Director-General of any stop work recommendations.

The EMR must immediately advise the Proponent and the Director-General of any incidents relevant to these Conditions resulting from Construction that were not dealt with expediently or adequately by the Proponent.

COMMUNICATION AND CONSULTATION

Advice of Construction Activities

19. Before Construction commences, and then at maximum three monthly intervals, the Proponent must advertise in relevant newspapers the: nature of the works proposed for the next three months; areas in which these works are proposed; Construction hours; and a contact telephone number.

The Proponent must ensure that the local community and businesses are advised of Construction activities that could cause disruption. Methods to disseminate this information must be identified in the CEMP. Information to be provided must include:

- a) details of any traffic disruptions and controls;
- b) construction of temporary detours; and
- c) work approved to be undertaken outside standard Construction hours, in particular noisy works, before such works are undertaken.
- 20. The Proponent must establish an Activity internet site before Construction commences and maintain the internet site until Construction ends. This internet site must contain:
 - a) periodic updates of work progress, consultation activities and planned work schedules. The site must indicate the date of the last update and the frequency of the internet site updates;
 - b) a description of relevant approval authorities and their areas of responsibility;
 - c) a list of reports and plans that are Publicly Available under this Approval and details of how these can be accessed;
 - d) contact names and phone numbers of relevant communications staff; and
 - e) the 24 hour toll-free complaints contact telephone number.

Updates of work progress, Construction activities and planned work schedules must be provided where significant changes in noise or traffic impacts are expected.

Community Liaison Group

21. A Community Liaison Group (CLG) must be formed and hold its first meeting before Construction commences. The CLG must include the EMR and representatives from the Proponent and its head contractor. Community representatives should be identified and selected from relevant community and business groups, individual members of the community adjoining the Activity and representatives from Relevant Councils.

The Proponent must, at its own expense:

- a) maintain the CLG for the duration of Construction unless otherwise approved by the Director-General;
- b) provide a chairperson for the CLG. The chairperson must be independent of the Proponent and may be elected from the CLG membership;
- c) nominate two representatives to attend all CLG meetings;
- d) provide to the CLG regular information on the progress of Construction and related environmental performance;

- e) promptly provide to the CLG information that the CLG Chair may reasonably request concerning the Activity's environmental performance;
- f) provide access for site inspections by the CLG;
- g) provide meeting facilities for the CLG, and take notes of CLG meetings. These meeting notes must be available to CLG members within 14 days of the meeting and should be endorsed by the Chair;
- h) where reasonably required by the Chair, arrange consultant(s) to explain technical information to the CLG; and
- i) where reasonably required by the Chair, invite representatives from Relevant Government Departments or other individuals to attend CLG meetings.

Issues for discussion by the CLG include the dissemination of information to the community, design issues related to the Conditions or mitigation measures, the CEMP and Construction activities. The CLG may make comments about these issues which must be considered by the Proponent. The Proponent must report back to the CLG on its considerations of the comments.

The Proponent may review a CLG's membership and/or the need for the CLG at any time during Construction. The Proponent must seek the Director-General's approval to dissolve a CLG. Any request for dissolution must demonstrate why the CLG is no longer required.

In the event of any dispute between the CLG and the Proponent, the Proponent's decision is final provided it is consistent with these Conditions of Approval.

22. The Proponent must consult property owners about implementing mitigation measures that affect their property. Mitigation measures should be implemented according to a program derived from that consultation if consistent with the Conditions of Approval.

Construction Complaints Management System

- 23. The Proponent must prepare and implement a *Construction Complaints Management System* before Construction commences and maintain the System for the duration of Construction. The *Construction Complaints Management System* must be consistent with AS 4269 "Complaints Handling" and include:
 - a) a 24 hour, toll free telephone number listed with a telephone company and advertised;
 - b) a system to receive, record, track and respond to complaints within a specified timeframe. When a complaint cannot be responded to immediately, a follow-up verbal response on what action is proposed must be provided to the complainant within two hours during night-time works and 24 hours at other times;
 - c) a process for the provision of a written response to the complainant within 10 days, if the complaint cannot be resolved by the initial or follow-up verbal response; and
 - d) a mediation system for complaints unable to be resolved.

Information on all complaints received, including the means by which they were addressed and whether resolution was reached with or without mediation, must be included in the *Construction Compliance Reports* and must be made available to the Director-General on request.

INVESTIGATION OF LOW CREST STRUCTURES

24. Prior to commencement of substantial construction, the Proponent must submit a report to the Director-General, on the potential for reducing the height of the northern breakwater. Unless

otherwise approved by the Director-General, substantial construction may not commence until the report has been approved by the Director-General.

The report must be prepared by an independent coastal structural designer with experience in the design and construction of low-crest structures.

The report must address but is not limited to:

- a) Constructability of a lower northern breakwater;
- b) Cost implications;
- c) Structural integrity of a lower northern breakwater;
- d) Practicality of increasing the height of a lowered northern breakwater, should this be required;
- e) Any additional public safety issues resulting from a lowered northern breakwater;
- f) Any implications for other components of the proposed scheme such as the cumulative effect on the southern breakwater;
- g) Details of the final height proposed for construction.

PERFORMANCE MONITORING

- 25. As part of the OEMP, the Proponent must prepare and implement a detailed Monitoring Sub Plan, in consultation with DEC, DPI (Fisheries), DNR, Relevant Local Councils and the Illawarra Bird Observers Club (as relevant). The Sub Plan must address the matters identified in Appendix A (Performance Indicators) and incorporate and further develop the monitoring program outlined in section 14 of the EIS, as follows:
 - a) ecological monitoring program to assess:
 - i. annual changes in seagrass area, depth limits and speciation;
 - ii. bi-annual (summer/winter) occurrence of aquatic bird populations, behaviour, nests, eggs, successful fledglings, predator incidences and changes in food resources and habitat;
 - iii. changes to fish and benthic communities of the lake and its entrance;
 - iv. condition of the rock reef community on the northern side of Windang Island.
 - b) coastal/estuarine monitoring program to assess changes in coastal/estuarine processes to include:
 - i. erosion or beach recession at Perkins Beach;
 - ii. dune formation on Perkins and Warilla Beaches;
 - iii. creation of sand fillets at either side of the training walls/breakwaters;
 - iv. behaviour of sand shoals within the entrance.
 - water quality monitoring program to include routine measurement of water height, salinity, chlorophyll-a and a measure of clarity (eg turbidity or sechi depth) of the lake's waters at a minimum of three selected sites;
 - d) flood levels within the lake.

The Sub Plan must incorporate a decision making framework that clearly describes how the proponent will respond to the outcomes of monitoring and address the application of the decision making framework, need for mitigation measures, progress with implementation of mitigation measures, and effectiveness of the mitigation measures.

- 26. The Proponent must report Department, DEC, DPI, DNR, Relevant Councils and other stakeholders on the outcomes of the monitoring program implemented under Condition 25. The report must address:
 - a) the first year of operation;
 - b) the first three years of operation;
 - c) the first five years of operation; and
 - d) any other period required by the Director-General.

Each report must be submitted within two months of the end of the relevant reporting period.

The reports must:

- a) specifically address the results of the monitoring against the identified performance indicators referred to in Condition 25;
- b) address the application of the decision making framework, need for mitigation measures; progress with implementation of mitigation measures, and effectiveness of the mitigation

FLORA AND FAUNA

- 27. A Flora and Fauna Management Sub Plan must be prepared as part of the CEMP. The Sub Plan must be prepared in consultation with DEC, DPI, DNR and Relevant Councils and include:
 - a) plans showing terrestrial and aquatic vegetation communities; important flora and fauna habitat areas; areas to be disturbed; and a 50m buffer zone between channel dredging or Construction works and existing seagrass beds;
 - b) methods to manage impacts on flora and fauna species (terrestrial and aquatic) and their habitat which may be directly or indirectly affected by the Activity. These must include:
 - i procedures for vegetation clearing, soil management and managing other habitat damage (terrestrial and aquatic) during Construction;
 - ii methods to protect vegetation both retained within, and also adjoining, the Activity from damage during Construction;
 - iii measures to minimise turbidity in the channel and minimise disturbance to both fish and crustacean movements through the channel;
 - iv performance criteria against which to measure the success of the methods;
 - c) a construction schedule that minimises disturbance to aquatic biota, with the main objective to limit disturbance on the northern side of the entrance channel shoal over the Little Tern breeding season (October to March inclusive). Construction must cease on the northern breakwater / training wall if there is evidence that construction is impacting upon bird breeding. No Construction must occur on the northern breakwater section (from chainage 0m to 150m) during the summer bird breeding season (October to March inclusive);
 - d) methods for the construction of a bird habitat island;
 - e) a Weed Management Strategy including:
 - i identification of weeds within the Activity and adjoining areas;
 - ii weed eradication methods and protocols for the use of herbicides;
 - iii methods to treat and re-use weed infested topsoil;
 - iv strategies to control the spread of weeds during Construction;
 - f) a program for reporting on the effectiveness of terrestrial and aquatic flora and fauna management measures against the identified performance criteria. Management methods must be reviewed where found to be ineffective.

- 28. As part of the CEMP, an Aquatic Bird Management Plan must be prepared by a suitably qualified expert prior to the completion of construction of the bird island. The Plan must be prepared in consultation with the DEC, DPI, DNR, Illawarra Bird Observers Club, and include:
 - a) management methods and maintenance requirements for the bird habitat island, including ongoing responsibilities for maintenance;
 - b) strategies for predator control and protection from human disturbance on the bird habitat island and in the vicinity of the Lake Illawarra entrance;
 - c) an education program for the local community and stakeholders;
 - d) ongoing monitoring of aquatic bird populations on the bird habitat island and in the vicinity of the Lake Illawarra entrance consistent with Condition 25;
 - e) a program for reporting on the effectiveness of the bird habitat island against identified performance criteria. Management methods and maintenance requirements must be reviewed where found to be ineffective.

HERITAGE

Indigenous Heritage Management

- 29. An Indigenous Heritage Management Sub Plan must be prepared as part of the CEMP. The Sub Plan must be prepared in consultation with all relevant Aboriginal groups and the DEC and include:
 - a) details of the archaeological investigations to be undertaken and any associated licences or approvals required;
 - b) procedures to be implemented if previously unidentified Aboriginal objects are discovered during Construction. If such objects are discovered all work likely to affect the object(s) must cease immediately and the DEC informed in accordance with the *National Parks and Wildlife Act 1974*; and
 - c) an education program for Construction personnel on their obligations for Aboriginal cultural materials.

Aboriginal Objects

30. If during the course of Construction the Proponent becomes aware of any unexpected Aboriginal object(s), all work likely to affect the object(s) must cease immediately and the DEC informed in accordance with the *National Parks and Wildlife Act 1974*.

Historical Relics

- 31. An Historical Relic Management Sub Plan must be prepared as part of the CEMP. The Sub Plan must be prepared in consultation with the Heritage Office and Relevant Councils and include:
 - a) details of any investigations to be undertaken and any approvals required;
 - b) procedures to be implemented if previously unidentified historical relics are discovered during Construction. If such relics are discovered all work likely to affect the relic(s) must cease immediately and the Heritage Council notified in accordance with the *Heritage Act* 1977; and
 - c) an education program for Construction personnel on their obligations for historic relics.

32. If during the course of Construction the Proponent becomes aware of any unexpected historical relic(s), all work likely to affect the relic(s) must cease immediately and the Heritage Council notified in accordance with the *Heritage Act* 1977.

NOISE AND VIBRATION

Construction Noise and Vibration Management Sub Plan

- 33. A Construction Noise and Vibration Management Sub Plan must be prepared as part of the CEMP. The Sub Plan must be prepared in consultation with the Relevant Councils and the CLG and include:
 - a) an education program for Construction personnel about noise minimisation;
 - b) identification of each Construction activity, including Ancillary Facilities, and their associated noise sources;
 - c) identification of all potentially affected Sensitive Receivers;
 - d) the Construction noise objective specified in the Conditions of Approval;
 - e) the Construction vibration criteria specified in the Conditions of Approval;
 - f) determination of appropriate noise and vibration objectives for each identified Sensitive Receiver;
 - g) noise and vibration monitoring, reporting and response procedures;
 - h) assessment of potential noise and vibration from each Construction activity including noise from Construction vehicles and any traffic diversions;
 - i) a description of management methods and procedures and specific noise mitigation treatments that will be implemented to control noise and vibration during Construction;
 - j) justification for any activities outside the Construction hours specified in the Conditions of Approval. This includes identifying areas where Construction noise would not be audible at any Sensitive Receiver;
 - k) procedures for notifying residents of Construction activities that are likely to affect their noise and vibration amenity; and
 - I) contingency plans to be implemented in the event of non-compliances and/or noise complaints.

Construction Hours

- 34. Construction must be restricted to between the hours of 7:00 am to 6:00 pm (Monday to Friday), 8:00 am to 1:00 pm (Saturday) and at no time on Sundays and public holidays except:
 - a) for the delivery of materials required outside these hours by the Police or other authorities for safety reasons; or
 - b) where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm; or
 - c) where the work is identified in the Construction Noise and Vibration Management Sub Plan and approved as part of the CEMP.

Local residents must be informed of the timing and duration of work approved under item (c) at least 48 hours before that work commences.

35. Transportation of rocks must be restricted to between the hours of 7:00 am to 5:00 pm (Monday to Friday) and at no time on Saturdays, Sundays and public holidays.

Construction Noise Objective

- 36. The Construction noise objective for the Activity is to manage noise from Construction activities (as measured by a L_{A10 (15minute)} descriptor) so it does not exceed the background L_{A90} noise level by:
 - a) more than 20 dB(A) for a Construction period of four weeks and under;
 - b) more than 10 dB(A) for a Construction period of greater than four weeks and not exceeding 26 weeks; and
 - c) more than 5 dB(A) for a Construction period greater than 26 weeks.

Background noise levels are those identified in the EIS or Representations Report or otherwise identified in the Construction Noise and Vibration Management Sub Plan.

Any activities that have the potential for noise emissions that exceed the objective must be identified and managed in accordance with the Construction Noise and Vibration Management Sub Plan. The Proponent must implement all Reasonable and Feasible noise mitigation and management measures with the aim of achieving the Construction noise objective.

If the noise from a Construction activity is substantially tonal or impulsive in nature (as described in Chapter 4 of the *NSW Industrial Noise Policy*), 5dB(A) must be added to the measured Construction noise level when comparing the measured noise with the Construction noise objective.

Construction Noise Management

- 37. The Proponent must ensure that public address systems used at any Construction site are not used outside the Construction hours detailed in the Conditions of Approval unless otherwise approved through the Construction Noise and Vibration Management Sub Plan. Public address systems must be designed to minimise noise spillage off-site.
- 38. The Proponent must schedule rock breaking, rock hammering, and any similar activity only between the following hours unless otherwise approved in the Construction Noise and Vibration Management Sub Plan:
 - a) 9 am to 12 pm and 2 pm to 5 pm, Monday to Friday; and
 - b) 9 am to 12 pm, Saturday.
- 39. The Proponent must, where Reasonable and Feasible, erect noise mitigation measures at the start of Construction (or at other times during Construction) to minimise Construction noise impacts.

Vibration Criteria

- 40. Vibration caused by Construction and received at any Structure outside the Activity must:
 - a) for structural damage vibration be limited to German Standard DIN 4150 Part 3 *Structural Vibration in Buildings. Effects on Structures*; and
 - b) for human exposure to vibration be limited to the evaluation criteria presented in British Standard BS 6472 - *Guide to Evaluate Human Exposure to Vibration in Buildings* (1Hz to 80 Hz) for low probability of adverse comment.

These limits apply unless otherwise approved in the Construction Noise and Vibration Management Sub Plan.

PHYSICAL ISSUES

Soil and Water Management

Soil and Water Quality Management Sub Plan

- 41. A Soil and Water Management Sub Plan must be prepared as part of the CEMP. The Sub Plan must be prepared in consultation with Relevant Government Departments and Relevant Councils. The Sub Plan must:
 - a) where relevant, be consistent with the Department of Housing's guideline "Managing Urban Stormwater - Soils and Construction" and the RTA's "Guidelines for the Control of Erosion and Sedimentation in Roadworks";
 - b) identify the Construction activities that could cause soil erosion or discharge sediment or water pollutants from the site;
 - c) describe management methods to minimise soil erosion or discharge of sediment or water pollutants from the site including a strategy to minimise the area of bare surfaces during Construction;
 - d) describe the location and capacity of erosion and sediment control measures;
 - e) identify the timing and conditions under which Construction stage controls will be decommissioned;
 - f) include contingency plans to be implemented for events such as fuel spills; and
 - g) identify how the effectiveness of the sediment and erosion control system will be monitored, reviewed and updated.

Construction

- 42. An appropriately qualified soil scientist or person with similar expertise in soil and water management must be consulted according to a schedule identified in the Soil and Water Management Sub Plan to:
 - a) undertake inspections of temporary and permanent erosion and sedimentation control devices;
 - b) ensure that the most appropriate controls are being implemented;
 - c) check that controls are being maintained in an efficient condition; and
 - d) check that controls meet the requirements of any relevant approval and/or licence condition.

The results of these inspections and any follow-up actions must be reported in the *Construction Compliance Reports* required by the Conditions of Approval.

Acid Sulfate Soils Management

43. An Acid Sulfate Soil Management Sub Plan must be prepared as part of the CEMP. The Sub Plan must be prepared in consultation with Relevant Government Departments. The Sub Plan must:

- a) be consistent with the "Acid Sulfate Soils Manual" (Acid Sulfate Soil Management Advisory Committee, 1998) or update;
- b) include a contingency plan to deal with the unexpected discovery of actual or potential acid sulfate soils; and
- c) include a water quality monitoring program.

Air Quality

Dust Management Sub Plan

- 44. A Dust Management Sub Plan must be prepared as part of the CEMP. The Sub Plan must identify:
 - a) potential sources of dust;
 - b) dust management objectives consistent with DEC guidelines;
 - c) a monitoring program to assess compliance with the identified objectives. Monitoring for dust deposition and particulate concentration must be undertaken according to the DEC Guideline "Approved Methods for Sampling and Analysis of Air Pollutants in New South Wales";
 - d) mitigation measures to be implemented, including measures during weather conditions where high level dust episodes are probable (such as strong winds in dry weather); and
 - e) a progressive rehabilitation strategy for exposed surfaces with the aim of minimising exposed surfaces.

Construction

- 45. Construction vehicles using public roads must be maintained to prevent any loss of load, whether dust, liquid or soils. Facilities must be provided at exit points of all Construction sites/compounds to minimise tracking mud, dirt or other material onto a public road or footpath. In the event of any spillage, the Proponent must remove the spilled material as soon as practicable within the working day of the spillage.
- 46. The Proponent must ensure that all plant and equipment used in connection with the Activity are:
 - a) maintained in a proper and efficient condition; and
 - b) operated in a proper and efficient manner.

Sustainable Energy

47. The Proponent must use electrical energy derived from a renewable energy source accredited by the Sustainable Energy Development Authority (SEDA) for the supply of at least 50% of the onsite electrical energy requirements for the Activity's Construction. Power consumption (green power or other) must be reported in the Construction Compliance Reports.

SOCIAL AND ECONOMIC ISSUES

Property Damage and Access

48. Subject to landowner agreement, property inspections must be conducted on all Structures within:

- a) 200 metres of blasting;
- b) 50 metres of Construction activities that generate vibration impacts;
- c) any other locations identified by the Proponent; and
- d) any other locations identified by the EMR.

The property inspections must be undertaken consistent with AS 4349.1 "Inspection of Buildings".

The owners of all properties on which property inspections are to be conducted must be advised at least two weeks before the inspection of its scope and methodology and of the process for making a property damage claim. A copy of the property inspection report must be given to the owner of each property inspected at least three weeks before Construction that could affect the property commences.

A register of all properties inspected must be maintained by the Proponent indicating whether the owner accepted or refused the property inspection offer. A copy of the register must be provided to the Director-General upon request.

- 49. The Proponent, where liable, must rectify any property damage caused directly or indirectly (for example from vibration or from groundwater change) by the Activity's Construction or Operation at no cost to the property owner(s). Alternatively the Proponent may negotiate compensation for the property damage with the property owner.
- 50. The Proponent must ensure that access to properties is maintained during Construction. The Proponent must ensure that any legal property access affected by the Activity is reinstated to an equivalent standard or that alternative arrangements are negotiated with the relevant property owner.

Traffic

- 51. Road dilapidation reports must be prepared for all roads likely to be used by Construction traffic. These reports must be prepared before Construction commences and after Construction is complete. Copies of the reports must be provided to the relevant roads authority. Any damage resulting from Construction, except that resulting from normal wear and tear, must be repaired at the Proponent's cost. Alternatively the Proponent may negotiate an alternative arrangement for road damage with the relevant roads authority.
- 52. A Construction Traffic Management Sub Plan must be prepared as part of the CEMP. The Sub Plan must be prepared in consultation with the relevant roads authority and include:
 - a) identification of all public roads to be used by Construction traffic, in particular roads proposed to transport large quantities of Construction materials. The expected timing and duration of road usage must be stated;
 - b) management methods to ensure Construction traffic uses identified roads;
 - c) identification of all public roads that may be partially or completely closed during Construction and the expected timing and duration of these closures. Consideration must be given to programming Construction works to minimise road closures during peak hours and/or holiday periods;
 - d) impacts on existing traffic (including pedestrians, vehicles, cyclists and disabled persons);
 - e) temporary traffic arrangements including property access;
 - f) access to Construction sites including entry and exit locations and measures to prevent Construction vehicles queuing on public roads;

- g) a response plan for any Construction traffic incident; and
- h) monitoring, review and amendment mechanisms.

MISCELLANEOUS REQUIREMENTS

Hazards and Risk Management

- 53. As part of the Construction and Operation EMPs, the Proponent must prepare and implement Hazards and Risk Management Sub Plan(s). These Sub Plans must include:
 - a) details of the hazards and risks associated with the Activity; and
 - b) mitigation measures including contingency plans.

Waste Management and Recycling

- 54. As part of the Construction and Operation EMPs the Proponent must prepare Waste Management and Re-use Sub Plan(s). The Sub Plans must address the management of wastes during the Construction and Operation stages respectively in accordance with the NSW Government's Waste Reduction and Purchasing Policy. The Sub Plan(s) must identify requirements for:
 - a) the application of the waste minimisation hierarchy principles of avoid/reduce/reuse/recycle/dispose;
 - b) waste handling and storage;
 - c) disposal of wastes. Specific details must be provided for cleared vegetation, contaminated materials, glass, metals and plastics, hydrocarbons (lubricants and fuels) and sanitary wastes; and
 - d) any waste material that is unable to be re-used, re-processed or recycled must be disposed at a facility approved to receive that type of waste.

Utilities and Services

55. The Proponent must identify the utilities and services (hereafter "services") potentially affected by Construction to determine requirements for diversion, protection and/or support. Alterations to services must be determined by negotiation between the Proponent and the service providers. The Proponent in consultation with service providers must ensure that disruption to services resulting from the Activity are minimised and advised to customers.

Location of Ancillary Facilities

- 56. The sites for Ancillary Facilities must satisfy the following criteria unless otherwise approved through the CEMP:
 - a) be located within the Approved Activity Area;
 - b) have ready access to the road network;
 - c) be located to minimise the need for heavy vehicles to travel through residential areas;
 - d) be sited on relatively level land;
 - e) be separated from nearest residences by at least 200 m (or at least 250 m for a temporary batch plant);
 - f) not be within 100 m of, or drain directly to, SEPP 14 wetlands;

- g) be located above the 20 ARI flood level unless a contingency plan to manage flooding is prepared and implemented;
- h) not require vegetation clearing beyond that already required for the Activity; and
- i) not affect the land use of adjacent properties.

The location of the Ancillary Facilities must be identified in the CEMP and must include an analysis against the above criteria. Where these criteria cannot be met the CEMP must demonstrate there will be no adverse impacts from the Ancillary Facility's construction or operation.

SCHEDULE 1: DESCRIPTION OF ACTIVITY

The Activity is the Lake Illawarra Entrance Works Project (Stage 2) as described in the:

- 1. The Lake Illawarra Entrance Works Project (Stage 2) Environmental Impact Statement prepared by Patterson Britton & Partners Pty Ltd, dated January, 2005 and its Appendices; and
- 2. Representations Report for Lake Illawarra Entrance Works Project (Stage 2) Northern Training Wall, Southern Spur Wall and Channel Dredging dated June, 2005.

APPENDICES

APPENDIX B

SUMMARY OF PROPOSED MONITORING IN THE EIS

Issues	Proposed monitoring	Frequency and Purpose
Ecology	Seagrass beds – survey extent and nature at five sites around Lake Illawarra: Griffins Bay, Koonawarra Bay, Purry Burry Point, Mullet Creek and Duck Creek	Annually To monitor possible changes in the seagrass area, depth limits and speciation in the
	 Avifauna 1. The Illawarra Bird Observers Club (IBOC) to continue monitoring on behalf of the LIA, the aquatic bird populations at the entrance channel and the eastern lake shore. 2. Expand study to distinguish between aquatic bird usage of the ocean beaches around the entrance, the outer marine sand dominated channel and the inner 	entrance channel Bi-annual (summer/winter) To monitor any change in entrance channel and ocean bird communities
	 3. Continue current monitoring of aquatic breeding bird populations being undertaken for the rock haulage and storage program for subsequent breeding programs. 4. Develop an additional program to monitor possible shore-term impacts of construction-related activities on aquatic bird usage: of the outer entrance channel; of the section of the ocean beach around the entrance; of Warilla Beach. 	To provide information for decision making for any additional construction activities that may be required
	 Fish and benthic communities – develop a monitoring program to study changes in fish and benthic communities of the lake and its entrance channel. This could be based on data obtained from a 3-year study of shallow seagrass bed fish communities of Lake Illawarra conducted in 2001, adopting the same sampling sites, methods and frequency as the original study. Rocky reef community - develop a surveillance monitoring program of this community on the northern side of Windang Island, in conjunction with a water quality program for the near shore waters off the entrance channel. 	
Coastal and estuarine processes	Monitor changes to coastal/estuarine processes using aerial photography and water level variation measurements.	To monitor changes to coastal/estuarine processes: - beach recession; - dune formation on Warilla

	Aerial photography - over the past 50 years, photogrammetric analysis has been undertaken of both Warilla and Perkins Beaches to determine rates of beach recession. Aerial photography is currently flown every two to three years by the Department of Commerce as part of a costal surveillance program.	 and Perkins Beaches; creation of sand fillets on either side of the proposed breakwaters; behaviour of sand shoals within the entrance.
	Water level measurements – three automated water level recorders in the lake are maintained by the Department of Commerce. The recorders (one each at Kanohooka Point, Cudgeree Bay and at the ocean end of the entrance channel) have operated continuously since July 1993, January 1991 and July 1991 respectively.	To enable assessment of the impact of the work on the quantity of tidal flushing through the entrance.
	The recorders measure water levels every 15 min and store the information in a data logger. The two recorders in the lake are downloaded daily by computer link to the Manly Hydraulics Laboratory while the entrance instrument is downloaded every six weeks.	
Flood levels	Monitoring of flood levels will be through a combination of rainfall, catchment run-off and water level monitoring. Rainfall data are collected by the Department of Commerce on a daily basis via ten rain gauges in the lake catchment. Two water level recorders are located in the lower catchment on Macquarie Rivulet and Mullet Creek.	To enable assessment ot the impact of the entrance works on flood levels
Water quality	Continue monitoring by the Department of Commerce of the physical and chemical parameters of the lake's water at Cudgeree Bay and Koonawarra Bay. The LIA would also conduct chemical monitoring of the following key parameters at previous monitoring sites within the lake: - total phosphorous and filterable reactive phosphorous; - organic nitrogen, total nitrogen, nitrite and nitrate; - silicate; - chlorophyll a; and - suspended solids. In addition, water quality monitoring in the area of the northern Windang Island rocky reefs is recommended.	One to two monthly

Source: section 14 of the EIS