



8. Operation of the Intake

8.1 Summary of the Environmental Assessment

The assessment of impacts on water quality and aquatic ecology considered aquatic ecosystems, recreation, aquaculture and visual amenity. The intake would be located on rocky reef in the Tasman Sea remote from swimming beaches or sensitive marine areas.

Marine water quality was assessed against the Proposed Marine Water Quality Objectives for NSW Coastal Waters (EPA, 2002) using relevant indicators from the Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).

8.2 Summary of issues related to the operation of the intake

Submissions raised issues related to the operation of the seawater intake. The quality of water at the seawater intake, including the impacts of sewage outfalls and runoff from the Caltex oil refinery on water quality, were raised in submissions.

The effects of the intake on aquatic ecology were also raised in submissions. The potential impacts that the intake may have on whales were identified as were considerations related to intake design.

8.3 Response to issues related to the operation of the intake

8.3.1 Issue: Concern about intake water quality

There is insufficient information relating to background water quality and potential discharges in the vicinity of the intake and outlet structures to provide for a robust assessment of impacts

Sydney Water commenced a sampling program in April 2005, collecting and analysing seawater samples at the proposed intake location. The objectives of the Seawater Quality Assessment Study are:

- To characterise seawater quality, determining seasonal variations, the influence of freshwater flows and the effect of hydrodynamic conditions; and
- To prepare an inventory of point and diffuse pollution sources (e.g. nearby industry, agricultural run-off, frequency of shipping or other marine activities etc.) and to determine any impacts on water quality.

The Seawater Quality Assessment Study Program is following ASTM D4195 – 88 Standard Guide for Water Analysis for Reverse Osmosis Application (Volume 11.02 of Annual Book of ASTM Standards). Additional parameters would be added in the future according to the latest design experience with reverse osmosis. Sampling and analysis is divided into the following programs:

- Physical and aggregate parameters (temperature and salinity);
- Cations and anions (scaling prediction etc);
- Pollution assessment (e.g. oil and grease); and
- Marine effects - to determine impact of marine conditions on water quality.

Sydney Water has undertaken a survey to identify discharges in the vicinity of the proposed intake location. The survey showed that the key inputs were from locally treated industrial wastewater and sewage effluent outfalls including the Cronulla Sewage Treatment Plant Potter Point outfall, and Tabbagai Gap and Yena Gap associated with the Kurnell Oil Refinery. Modelling indicates that the impact of these outfalls at the Kurnell Peninsula is low because outflows are highly diluted (Environmental Assessment Appendix A2).

On a broader scale, inputs to the coastline and oceanic waters off Sydney include stormwater and sewer overflows during major storms from Botany Bay, and sewage effluent from the deep ocean outfalls. There is some influence of the flood and ebb tide from Botany Bay around the northern end of the headland on the Kurnell peninsula, however, modelling of storm flows from Botany Bay indicate that these are likely to bypass the intake. The deepwater ocean outfalls discharge approximately 1,000 ML/day through three outfalls at North Head, Bondi and Malabar between 2.2 and 3.7 kilometres offshore in water depths between 50 and 80 metres.

The primary goal of Sydney's desalination project is to produce drinking water that is safe, hygienic and pleasant to drink. To achieve this, the entire reverse osmosis desalination plant is designed as a multi-barrier system to remove pathogenic agents such as bacteria, viruses, and protozoa comprising the following steps:

- Dual media filtration;
- Cartridge filtration;
- First pass desalination through reverse osmosis membranes;
- Second pass desalination through brackish water reverse osmosis membranes; and
- Final disinfection by chloramination.

The use of high rejection reverse osmosis membranes would produce drinking water of a very high and consistent quality. The membranes are capable of removing practically all contaminants in the source water; turbidity, taste, odour, colour, viruses, salts etc. Substantial removal of natural organic matter by the membranes would limit disinfection by-product (DBP) formation and results in very low DBP concentrations in the drinking water.

Target drinking water quality is the key driver in desalination design. The reverse osmosis desalination system meets the target levels for total dissolved solids concentration (TDS), bromide, chloride and other constituents. Reverse osmosis product water (permeate) is adjusted for pH, alkalinity and hardness (referred to as potabilisation) and also to protect downstream water supply infrastructure from corrosion. The water is also disinfected and fluoridated in accordance with current Sydney Water practices.

The desalination technology proposed would be able to cope with some fluctuations in intake quality without affecting treated water quality. The impact of discharged seawater concentrate on water quality at the intake site was also modelled. This showed that for a seawater concentrate of 65 ppt discharging into seawater of 35 ppt, the salinity elevation at the intake would be less than 0.25 ppt. This is within the natural levels of salinity variation. A detailed seawater sampling program for the Kurnell intake location has been ongoing since mid-2005 with results for six months showing little variation in seawater quality for process parameters.

Potential impact of algae on inlet water quality

Excessive growth of phytoplankton (algae, dinoflagellates etc.) can occur in coastal seawater and estuaries. Most marine algal blooms are harmless, resulting only in a discolouration of the water. However, some blooms can be toxic to aquatic organisms and humans or potentially harmful by decreasing oxygen levels in the water.

Of the two main algal species that might be expected at Kurnell, *Trichodesmium* occurs predominantly in spring, summer and early autumn and is particularly prevalent in calm and stable weather conditions. *Noctiluca* occurs predominantly in spring and summer especially after heavy rainfall. Blooms tend to peak in December through to March although the frequency is very difficult to predict. *Noctiluca* feed voraciously off diatoms. These blooms can contain up to 10⁶ dead cells/L but are generally present only as surface slicks of dead cells. After storms and large weather variations blooms tend to die off.

The seawater intake point for the desalination plant would be approximately 20 to 25 metres deep. It is not expected to be impacted by algae near the water surface.

Amended Statement of Commitment 17 identifies further seawater quality sampling to confirm the adequacy of intake water quality.

Potential impact of radionuclides from ANSTO discharges at Potter Point

ANSTO has a trade waste agreement with Sydney Water and as such the Cronulla STP system licence addresses discharge of radionuclides. Part of the licensing regime considers the impact of all deleterious elements in the waste stream. This obligation also extends to Sydney Water's licence with the DEC. Modelling of point source discharges showed that any effluent drawn into the desalination inlet would be subject to further dilution, ensuring adequate quality of incoming seawater.

Appendix A2 of the Environmental Assessment indicates that discharges from the Potter Point outfall would be diluted by greater than 320 times for 99 per cent of the time, and 1,350 times for 90 percent of the time. The desalinated water would be of a quality which meets the NSW Health requirements and the Australian Drinking Water Guidelines published by the NHMRC.

The potential for discharges from the Caltex Oil Refinery to be drawn into the intake?

The treatment processes proposed are extremely robust and capable of providing appropriate drinking water quality under a variety of seawater conditions. Nonetheless, this issue was considered as part of the Ocean Modelling report presented in Appendix A2 of the Environmental Assessment. Discharges from the Caltex Oil Refinery at Tabbagai Gap and Yena Gap, have some impact on the intake. These intermittent, licensed discharges are highly dilute at the point of intake, with dilutions in the order of 200 to 500. The intake would draw from the lower part of the water column whereas the discharges are surface based.

Ongoing water quality sampling at the intake location (refer to amended Statement of Commitment 17) would be used to validate these modelling predictions. The water quality sampling to date shows water quality with little variation.

The potential impact of the ebb tide from Botany Bay on water quality at the inlet

One of the influences on water quality at the intake location may be the tidal emptying of Botany Bay.

The ebb tide discharge from Botany Bay is well mixed over the entrance depth. As it leaves Botany Bay, these waters mix with the surrounding ocean waters which are generally moving southward or northward. This mixing process could be expected to dilute waters from Botany Bay with the surrounding seawater by a factor between 2 and 10 by the time they reach the proposed intake.

Preliminary modelling of a plume from Botany Bay indicated dilution of around 10. A worst case scenario for dilution at the intake would be on the peak of the ebb discharge with slow oceanic currents moving southward, for which there may be no dilution of the Botany Bay discharge. However, given that this is only likely to occur right on the peak discharge from the Bay and the oceanic currents are generally sweeping more water past this area, then the percentage occurrence of low dilutions would be small. The treatment process would be sufficiently robust enough to accommodate variations in water quality.

During flooding from the Georges River, a freshwater discharge would be included with the ebb tide discharge from Botany Bay. The presence of winds or waves is likely to mix this freshwater from the upper 10 metres of the ocean waters through the water column. However, there has been no measurements made of a freshwater plume leaving Botany Bay in a 1 in 1 year flood or greater and it is likely that winds or waves would occur at the same time as floods. One of the main aims of the ongoing Seawater Quality Assessment Study Program is to determine the impacts of storms on water quality. Whilst the present understanding is that the plant would adequately cater for this natural variability, this would be confirmed during detailed design. This is reflected in the amended Statement of Commitment 17.

Concern that the intakes may draw in the discharges from STP outfalls, effectively meaning that the plant would be recycling treated effluent

Sewage Treatment Plant (STP) discharges have some potential to influence water quality at the intake location. The Ocean Modelling Report prepared by the Water Research Laboratory (2005) as part of the Environmental Assessment (Appendix A2) considered the potential for discharges from point sources of pollution to impact on the quality of water drawn into the intake. This included point sources such as the Cronulla, North Head, Bondi and Malabar STP outfalls.

The impact at the Kurnell intake from the deepwater ocean outfalls from the North Head, Bondi and Malabar STPs is negligible with extremely high dilutions in all but a small percentage of the time. The Potter Point Outfall does impact this site up to 26 per cent of the time but dilutions are high and the STP effluent is treated to a tertiary level.

Plumes from these point sources were simulated for a 12 month period, 1 January 1995 to 31 December 1995. For 99 per cent of the time the deepwater ocean outfall effluent would be diluted more than 1,500 times before reaching the Kurnell intake. The tertiary treated effluent from the Cronulla STP outfall at Potter Point would reach the intake for a greater percentage of time, however, the dilution is greater than 1,350 times for 90 per cent of the time and 320 for 99 per cent of the time. The design would safely cater for such diluted feedstock and ensure there would be no danger to health from harmful organisms.

Amended Statement of Commitment 17 identifies further investigations to consider the potential impacts of STPs on water quality.

8.3.2 Issue: Impacts on aquatic ecology due to impingement and entrainment of biota

What sort of screens will be installed on the intakes to minimise the entrainment and entrapment of marine organisms?

Amended Statement of Commitment 16 states that measures would be developed to ensure that there are no significant impacts on aquatic ecology from the seawater intake during operation. This includes refining the location of the intake and developing design measures to minimise as far as practicable the amount of biota that are impinged on intake screens or entrained into the plant.

The following sections outline options that may be considered in the design of screens for the intake.

Passive Screens

There are a number of intake designs that can be incorporated into a large desalination facility. Most designs stem from a long history of electric power facility intake designs.

Recent advances in offshore intake screens include Cylindrical Wedgewire Screens, also known as Passive Screens, which avoid high levels of impingement and entrainment. These are designed to enable large water intakes at low velocity and physical exclusion of marine biota with screen mesh sizes ranging from 0.5-10mm.

Passive Screens have a proven ability to reduce impingement and entrainment. Their effectiveness is related to their slot width and low through velocity. It has been demonstrated that 1mm openings are highly effective for larval exclusion and to reduce entrainment (Pankratz 2004).

If screens of this type can be used there is potentially no need for further protection upstream of the intake.

Velocity caps and travelling screens

A velocity cap consists of a cover placed over a vertical terminal of an offshore intake pipe. The aim of the cover is to convert vertical flow surrounding the intake pipe to horizontal flow. It has been noted that fish would avoid rapid changes to horizontal flow and velocity cap intakes have been shown to provide 80 to 90 per cent reduction in fish impingement at two California power stations. However, velocity caps do not reduce the entrainment of eggs and larvae.

Travelling screens are equipped with revolving wire mesh panels that rotate through the water and are cleaned by a high-pressure water spray. These technologies are designed to prevent debris from entering the system rather than to minimise impingement and entrainment.

Screen maintenance

There have been incidences of single intake structures being completely blocked (e.g. by an abandoned fishing net followed by a mass of dead kelp). If there is no periodical cleaning of the screens, the slot-holes would block within a relatively short period of time, thus increasing the velocity and energy requirements of the intake waters.

To protect the intake from large debris, piled structures can be constructed around single intakes.

Depending on final design, some form of air or water blasting may be periodically used to assist in screen maintenance. Air blasting is common on large screens to prevent marine build up.

An air blasting system can be installed through pipes placed in the intake screen system.

Providing several separate risers would reduce the risk of total blockage. For the intake for a 500 ML/day plant to be effective, it would require five (four duty, one reserve) inlet tubes, or risers.

Concluding summary

Examples of technology described above indicate that screens for low velocity intake of seawater and/or physical exclusion of marine biota are potentially suitable for a desalination plant at Kurnell. Final design of the intake structure would be subject to data collected from pilot testing and final detail designs.

The need for further studies to assess impingement and entrainment indicates deficiencies in the existing assessment

The Environmental Assessment included a desktop review of the potential impacts of the project on aquatic ecology and site inspections undertaken by The Ecology Lab. Issues considered included impacts due to the impingement and entrainment of fish, fish larvae and plankton. However, the assessment of impacts was restricted by a lack of information on local fish and plankton and more generally a lack of similar projects within Australia which might provide data on marine habitats and biota.

To address this issue, amended Statement of Commitment 18 requires a preliminary plankton study to be undertaken as part of pilot plant trials to further investigate potential impacts and allow the development of a refined and feasible monitoring program.

A smaller-scale pilot plant intake located close to the proposed intake for the main desalination plant provides an opportunity to fill some of the gaps required to predict the impacts of a 500 ML/day plant on aquatic ecology, particularly those related to optimal screen sizes and abundance, composition of planktonic communities in the area and water quality. The preliminary plan for the plankton study would comprise two parts: in situ sampling using plankton nets towed by boats and/or divers using underwater scooters, and collecting plankton samples from an access port in the water intake stream from land.

[Has the potential for whales to collide with the intake and outlet structures been considered in the assessments for the Environmental Assessment?](#)

The Environmental Assessment recognised that during migration some species of whale can pass near the shore at Kurnell where the intake and outlet for the desalination plant would be located. The Environmental Assessment concluded that whales would potentially be disturbed during construction but there would be no adverse effects of ongoing operations.

The weight of evidence suggests that if whales were to swim at a depth where they could potentially collide with the intake and outlet structures, it is likely that they would be able to navigate around (or over) the structures in the same way as they are known to do around stationary man-made objects such as boats or oil drilling platforms, or natural raised area of isolated reef (bomboras). Bomboras would be common (in similar depths as proposed for the outlet and inlet) along whale migratory routes.

[Has the potential for whales to become entangled been considered in the assessments for the Environmental Assessment?](#)

Entanglements have led to the development of alarms (acoustical protection of fishing gear) that enhance the echo and visual characteristics of the gear (Lien et al. 1989, in Volgenau et al. 1995). Such alarms are used in NSW to help prevent entanglement of whales in the Beach Meshing (Shark Exclusion) Program (Internet Reference 1).

There is potential for these types of alarms to be used on any buoys connected to the inlet and outlet structures of the desalination plant, but at this point they are considered unnecessary due to the relatively small potential for entanglement. It is considered that entanglement would be unlikely to occur, due to the compact design of the structures and it is unlikely that there would be ropes or other linear extensions attached to the structures during ongoing operations.

8.3.3 Issue: What chemicals would be used to clean the intake pipes?

Chlorine would be the active ingredient in any chemical used to clean intake pipes, most likely in the form of sodium hypochlorite. This would be dosed into the intake so as to suction it into the desalination plant i.e. the solution would not be discharged to ocean. This type of treatment is similar to that used to keep swimming pools clean.

8.3.4 Issue: Is there a need for exclusion zones?

Factors such as protection of structures drive the necessity to have exclusion zones. Maritime structures (including the intake and outlet) would be designed to minimise impacts on navigation, fishing and recreation where practicable. This would include consideration of Engineering Standards and Guidelines for Maritime Structures (NSW Maritime, 2005), notification procedures, navigation signs and confirmation of the need for no anchoring zones and/or fishing exclusion zones in consultation with NSW Maritime and Sydney Ports Corporation (refer to amended Statement of Commitment 61).