PP 207

INTERIM REPORT

DESALINATION

(PORT STANVAC)

SIXTY THIRD REPORT OF THE

ENVIRONMENT, RESOURCES AND DEVELOPMENT COMMITTEE

Published pursuant to s17(7) and s17(8) of the Parliamentary Committees Act 1991

Hon JJ Snelling, Speaker 16 December 2008

Third Session, Fifty-first Parliament

COMMITTEE'S FORWARD

The Environment, Resources and Development Committee commenced its inquiry into the environmental impacts of the proposed desalination plants at Port Stanvac and Port Bonython in August 2008. As part of the inquiry, 37 submissions were received and 11 witnesses were heard. Submissions and witnesses included key players from state and local government, industry, academics, non-government organisations and community groups, providing a cross-section of views, ideas and information on environmental issues arising from the proposed development of the desalination plants at Port Stanvac and Port Bonython.

The Committee extends its thanks for the effort made by those involved in preparing and presenting evidence to the Committee. It provided Committee members with a better understanding of the process of desalination, and highlighted some of key environmental issues facing the proposed development of desalination in both Spencer Gulf and Gulf St Vincent.

Due to the release of the Environmental Impact Statement by SA Water for the proposed plant at Port Stanvac, this report will be an interim report focusing on impacts in Gulf St Vincent. Further comment on Gulf St Vincent may be included in the final report.

The final report will be completed in 2009 following the release of the Environmental Impact Statement for Spencer Gulf by BHP Billiton.

The Committee thanks the staff of the Committee for their assistance in its day-to-day functions and for the completion of this report.

Ms Lyn Breuer, MP
Presiding Member

12 December 2008

COMMITTEE SUMMARY OF FINDINGS

Our knowledge of environmental impacts from desalination is largely based on limited research from relatively small plants operating in relative isolation from each other across the globe. Cumulative impacts, both over time, and including other inputs in a particular region, are only now beginning to be investigated.

Complicating our lack of knowledge here in South Australia, are the site specific conditions of building a large scale desalination plant in an inverse estuary where the lack of adequate circulation could amplify impacts on marine ecosystems.

None of the submissions received or any of the witnesses that appeared were totally opposed to desalination *per se*, but were concerned with the issue of adequate dispersal conditions in Gulf St Vincent and many suggested alternative siting.

The release of the Environmental Impact Statement by SA Water addressed a number of design questions raised during the inquiry. The construction design of the full tunnel option appears to provide the method of least environmental damage and intrusion into the marine environment. Strategies have been designed to prevent impingement of marine organisms. The only strategy to prevent entrainment of larvae, eggs and plankton is the use of a low speed intake. Backwash sludge will be dewatered and disposed of on land, and modelling has been used to design the diffuser system to ensure that dispersion of brine will occur efficiently.

The Committee believes that desalination can be a beneficial technology if established and used in a sustainable and environmentally aware way. Due to the paucity of information, the Committee has concerns regarding the dispersive behaviour of the brine stream during the twice monthly event of dodge tides, and recommends stringent monitoring take place during these periods to obtain actual live data to validate the modelling that has been used as the basis for the current plant design.

The Committee is also of the opinion that all monitoring regimes should be designed to include provision for measuring cumulative impacts as Gulf St Vincent is already considerably impacted by industrial, stormwater and waste water discharges.

Given the likely increase in interest in desalination plants the Committee also believes that reforms are needed to environmental legislation and policies to ensure that proponents have clear directions as to appropriate locations and operation of future desalination plants in SA.

COMMITTEE RECOMMENDATIONS

Term of Reference 1: The introduction of additional salts and chemicals into the marine environment.

1. The Committee recommends that Schedule 1 of the *Environment Protection Act 1993* be amended to include desalination plants as a licensable activity under the Act to ensure that brine discharge can be regulated regardless of whether a particular plant would be caught by any existing provision of Schedule 1

2. The Committee recommends that the Environment Protection (Water Quality) Policy 2003 be amended to include specific requirements for desalination plants including provisions relating to mixing zones and limits beyond which measurable impacts should not occur

3. The Committee recommends that the Government implement a monitoring program to validate the plant is achieving the discharge concentrations stated.

4. The Committee recommends that the Government implement a long term targeted monitoring regime to monitor movement of the brine stream over time.

Term of Reference 2: The adequacy of tidal movements to disperse brine and chemicals.

5. The Committee recommends that the Government works with modellers from Flinders University using the "live" monitoring data recorded during dodge tides to validate dispersion modelling.

6. The Committee recommends that the Government include monitoring parameters to account for cumulative environmental impacts over time.

Term of Reference 3: The potential impact on a range of marine flora and fauna.

7. The Committee recommends that the Government work with Flinders University and Reefwatch using the baseline data already collected to continue to monitor local reef areas and seagrass beds within the area. Utilising the before and after desalination data for comparison, this should include a trigger point for the local populations for the operation to stop if impacts are detected on local populations at these sites.

8. The Committee recommends that the Government develop a strategy to minimise the amount of eggs, larvae and plankton that will be trapped on the intake screens or taken into the plant.

Term of Reference 4: The potential impact on commercial and recreational fishing sectors.

9. The Committee recommends that the Government collect data from the intake screens of the species being caught on the screens and the larvae and eggs of local species that are actually taken into the plant with the intake water.

10. The Committee recommends that the Government regularly monitor at the discharge site for phytoplankton blooms.

Term of Reference 5: The potential impact of contamination leachate from the location.

11. The Committee recommends that the Government ensures secure containment of sludge during de-watering, and during transport to land fill.

Term of Reference 6: Any other matter

12. The Committee recommends that the Government prepare a comprehensive water security strategy for Adelaide incorporating all water supply and demand options.

13. The Committee recommends that the Government works within the energy guidelines of the SA Strategic State Plan, and sources all energy for the desalination plant from renewable energy sources, including acquiring renewable energy certificates.

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THE ENVIRONMENT, RESOURCES AND DEVELOPMENT COMMITTEE

The Environment, Resources and Development Committee (the Committee) is appointed pursuant to the *Parliamentary Committees Act 1991* (the Act) on 27 April 2006. Its membership during the reporting period was:

Ms Lyn Breuer MP, Presiding Member
Hon Michelle Lensink MLC
Hon Mark Parnell MLC
Hon Dr Bob Such MP
Mr. Ivan Venning MP
Hon Russell Wortley MLC

Executive Officer to the Committee: Mr Philip Frensham

Research Officer for the Inquiry: Ms Val Day

FUNCTIONS OF THE COMMITTEE

Pursuant to section 8 of the Act, the terms of reference for the Committee are:

(a) to inquire into, consider and report on such of the following matters as are referred to it under this Act:

- (i) any matter concerned with the environment or how the quality of the environment might be protected or improved;
- (ii) any matter concerned with the resources of the State or how they might be better conserved or utilised;
- (iii) any matter concerned with planning, land use or transport;
- (iv) any matter concerned with the general development of the State;

(b) to perform such other functions as are imposed on the Committee under this or any other Act or by resolution of both Houses.

REFERRAL PROCESS

Pursuant to section 16(1) of the Act, any matter that is relevant to the functions of the Committee may be referred to it in the following ways:

(a) by resolution of the Committee’s appointing house or Houses, or either of the Committee’s appointing Houses;
(b) by the Governor, or by notice published in the Gazette; or
(c) of the Committee’s own motion.

THE INQUIRY

The Inquiry was referred to the Committee by the Legislative Council on 23 July 2008.

Pursuant to section 16(1) (a) of the Parliamentary Committees Act 1991 the Committee has been called on to inquire into the environmental impacts of the proposed desalination plants at Port Stanvac and Port Bonython, and in particular—

1. the introduction of additional salts and chemicals into the marine environment;
2. the adequacy of tidal movements to disperse brine and chemicals;
3. the potential impact on a range of marine flora and fauna;
4. the potential impact on commercial and recreational fishing sectors;
5. the potential impact of contamination leachate from the location; and
6. any other matter

ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACWS	Adelaide Coastal Waters Study
AMLR NRM	Adelaide Mount Lofty Ranges Natural Resources Management
BHP	Broken Hill Proprietary
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EIS	Environment Impact Statement
EPA	Environment Protection Authority
GL	Gigalitre (1,000 Megalitres)
KL	Kilolitre (1,000 Litres)
ML	Megalitre (1,000 Kilolitres)
MOU	Memorandum of Understanding
PPT	Part per thousand (salinity)
SA	South Australia

INTRODUCTION

The demand for potable water has become a major issue worldwide. Over one third of the world's population is already facing problems due to poor water quality, and fresh water being either unavailable or extremely limited (Danoun 2007).

Increasing population and increasing global industrialization, particularly in coastal regions in different countries around the world has lowered ground water tables, and erratic weather patterns linked to global climatic changes seem to have affected rainfall volume and patterns causing drought conditions in many parts of the world, including Australia.

Seawater is freely available and exists close to coastal lands where around 39% of the world's population reside, hence desalination of sea water can be an attractive and logical option for an alternative potable water supply.

Desalination is a widespread technology that has been used to address water scarcity in many countries around the world. Historically, desalination on a small scale has been used by ships at sea since the early 1800's, and more recently, numerous countries worldwide have commissioned desalination plants where natural good quality water is insufficient or is extremely limited.

Many countries in the Middle East, North Africa and Central Asia rely almost entirely on desalination for their potable water needs, and this proven technology has helped alleviate freshwater scarcity in the Middle East for more than 20 years. Despite the many benefits the technology has to offer, concerns arise over the potential negative impacts on the environment.

Negative effects on the marine environment can occur, especially when high waste water discharges coincide with sensitive ecosystems (Lattemann & Hoepner 2008). Enclosed and shallow sites with abundant marine life can generally be assumed to be mores sensitive to desalination plant discharges than exposed, high energy, open-sea locations which are more capable to dilute and disperse the discharges (Lattemann & Hoepner 2008).

Although negative impacts have been reported at existing plants, equally positive aspects exist in that desalination aids and maintains industry, agricultural production, and helps preserve natural water resources.

History has shown in the last 50 years that Australia has experienced a widespread drought throughout the country, such that has never before been seen (Danoun 2007). All states in Australia are facing similar water scarcity problems, and the clear inability to cope with the present shortages, has led Queensland, Western Australia and New South Wales to build large desalination plants, even though they have been opposed by a number of environmental groups.

These environmentalists argue that desalination is relatively expensive, pollutes the environment and the long term impacts of the pollutants are yet unknown.

Two large plants are currently proposed for South Australia, one commissioned by SA Water in Gulf St Vincent at Port Stanvac, and one commissioned by BHP Billiton in Spencer Gulf at Port Bonython. Due to the release of the Environmental Impact Statement (EIS) for the Port Stanvac region, this is a preliminary report to investigate the possible impacts the plant proposed for Port Stanvac may have on the marine environment of Gulf St Vincent.

The final report will be completed in 2009 following the release of the EIS for Spencer Gulf by BHP Billiton.

1.1 Principles of Desalination

Desalination of seawater refers to the removal of salt from seawater so that it is drinkable (potable) (Water Proofing Adelaide 2008). This can be achieved by either condensation or reverse osmosis.

1.2 Reverse Osmosis

Reverse osmosis is the system most commonly used and is the system proposed for the two desalination plants at Pont Stanvac and Port Bonython.
The process consists of four main stages:

- The incoming seawater is pre-treated to remove suspended solids, such as plankton, sand, shells or seaweed, which would clog the membranes. the PH is adjusted, and an inhibitor is used to control the scaling caused by the chemical content of the water.

- This feedwater is then pressurised to an appropriate pressure for the separating membranes being used.

- The permeable membranes prevent the passage of salts whilst allowing the desalinated water to pass through. This results in two streams, a freshwater product stream and a concentrated brine stream.

- The freshwater produced using this method, usually requires a pH adjustment to decrease the acidity resulting from the removal of the alkaline salts, before it can be released for use as drinking water.

The permeable membranes require frequent cleaning due to fouling.

CONTEXT

2.1 South Australia

South Australia (SA) is regarded as the driest state in one of the driest continents, where a reliable supply of potable water has become a concern.

Australian Bureau of Statistics (ABS) 2002 data shows that more than 85% of South Australians live within 25 km of the coast. This has led to increased urban development, leading to increased stormwater and treated wastewater discharges into the marine environment, and an ever increasing requirement for fresh water that annual rainfall and the Murray River are no longer able to provide.

In order to address this problem, the SA Government has recently committed to the building of a large desalination plant at Port Stanvac, south of Adelaide, to provide a reliable, non climate dependent, potable water source for metropolitan Adelaide.

2.2 SA State Strategic Plan

South Australia's Strategic Plan is a Government commitment to make this state "prosperous, environmentally rich, culturally stimulating", and consists of targets that reflect the Plan's priorities.
Objective 3, "Attaining sustainability" targets a Sustainable water supply at T3.9 (Government of South Australia 2007:2008), stating that "South Australia's water resources are managed within sustainable limits by 2018." The first strategy from the Plan being to "Implement Water Proofing Adelaide……and develop additional water sources such as stormwater, recycled wastewater and desalination, including a 50 gigalitre (GL) desalination plant for Adelaide."

2.3 Waterproofing Adelaide

Water Proofing Adelaide is the South Australian Government's 20 year blueprint for a sustainable water supply in our state (Waterproofing Adelaide 2008). It contains "63 specific strategies aimed at fostering responsible water use, better managing existing resources and securing additional water supplies."

Strategy 59 states "The SA Government will develop a State policy towards desalination that addresses planning issues, access to saline water, disposal of brine and management of other environmental impacts", with SA Water the lead agency responsible for this strategy.

Strategy 60 states that "The SA Government will ensure that it's long-term water infrastructure plans remain flexible enough to enable the integration of desalination plants as and when they become viable in the future."

The SA Government Desalination Working Group examined the impact of the drought on water supply, the feasibility of desalination, the preferred size and location, and recommended Port Stanvac as the most suitable site because of relatively deep seawater, marine dispersion characteristics, better access to water supply network, suitable land availability and lower construction costs.

The current proposal is for the construction of a metropolitan desalination plant that will supply Adelaide with 50 GL of water per year, with the capability to later expand this capacity to 100 GL per year. Originally proposed to be operational in 2012, this has now been brought forward and tenders have been called for the construction of the plant to be operational by December 2010.

A pilot desalination plant is currently operating at this site, testing water quality, filtration and the pre-treatment technology that will be required for the proposed 50 GL plant. The second stage of this pilot plant will involve up to 6 months of reverse osmosis membrane testing, as this will be the process adopted by the new plant to supply fresh water.

On the 18th September, 2008, the Development Assessment Commission issued *Guidelines for the preparation of an Environmental Impact Statement for the Port Stanvac (Adelaide) Desalination Plant Proposal at Lonsdale* in order to ensure sensitive issues such as the potential impact on the marine environment and global warming "are thoroughly addressed as part of a rigorous assessment process."

2.4 Gulf St Vincent

Gulf St Vincent is an inverse estuary which has only limited exchange with the Southern Ocean (Gaylard 2004), due to the location of Kangaroo Island across the mouth of the gulf (Tanner 2005). The tides flow northwards, parallel to the shoreline, with a period of no flow at the turn of the tide until the flow of water is reversed and heads southwards. The movement of gulf water is further impeded by the occurrence of "dodge" tides every two weeks, when there is a period of relatively slack water for 2 to 3 days. This has ramifications for water quality, leading to a longer residence time for gulf waters when compared to the open ocean, which in turn has implications for the dilution and mixing of any discharges into the gulf.

Along Adelaide's metropolitan coastline, water quality is generally considered to be of a lower quality particularly when compared to non-urban areas, with stormwater and wastewater treatment plants likely to be significant contributors (Gaylard 2004).

It is widely accepted that this has resulted in the decline of seagrass coverage along the metropolitan coast over the past 50 years, resulting in a loss of over 5000 hectares (ha) of seagrass. This figure has recently been updated to 9000 ha in the *Natural History of Gulf St Vincent* (Scoresby *et. al.* 2008). This is now seen as a major cause for concern in the marine environment off metropolitan Adelaide, due to increased sand erosion, loss of biodiversity and valuable habitat (Gaylard 2003).

The Adelaide Coastal Waters Study (ACWS) was initiated in 2001 in response to concerns about declining coastal water quality, as well as the massive loss of seagrass along the Adelaide metropolitan coastline. The aim of this study was to develop an understanding of the coastal ecosystem of the Adelaide near-shore coastal environment in order to better manage this area. The report produced by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) for the Environment Protection Authority (EPA) in 2007, found that "water circulation patterns and the physical shape of the Adelaide coastline combine to keep discharges to the coast close to shore thereby exacerbating seagrass loss and water quality problems".

Recommendation #1of this report states *"as a matter of priority, steps must be taken to reduce the volumes of wastewater, stormwater and industrial inputs into Adelaide's coastal environment. This should be done within the context of an overarching strategy designed to remediate and protect the metropolitan coastal ecosystem."*

Recommendation #14 of the report states that "*Adelaide's coastal marine environment must be managed as a component of a system that integrates catchment management, urban and rural land use, demographics, urban and industrial development, climate change/climate variability and water re-use*."

2.5 Port Stanvac

Port Stanvac has been selected by the Desalination Working Group as the preferred site for the construction of the proposed $1.1 billion desalination plant to provide a reliable water supply for metropolitan Adelaide. Previously operated as an oil refinery by Mobil Australia, the site was closed in 2004 and has recently been under construction for the $10 million desalination pilot plant, developed to trial the technical requirements for the proposed plant.

The large 50 GL per year desalination plant that has been proposed to supply the Adelaide metropolitan area is expected to be operational by 2010, and will have an upgrade capacity for 100 GL per year when the need arises. The product water from the plant will be piped to the Happy Valley reservoir for storage.

The provision of 50 GL per year equates to 150 megalitres (ML) per day supply of fresh water. To supply this will require the extraction of approximately 400 ML per day, with around 250 ML of brine stream with a salinity of approximately 65 ppt returned to be mixed with the gulf waters on a daily basis. This brine discharge will generally have a high total alkalinity due to the increase of alkaline salts returned in the stream.

There has recently been a lot of publicity around the proposed development of this plant, with many of the population concerned about the impact of the brine being discharged directly into the Gulf, which is recognised as an inverse estuary, having a limited flow regime and an estimated turnover time of three to six months (Kampf *et al* 2008). Changes in salinity, alkalinity and temperature are thought to impact on marine life in the area of brine disposal, and therefore knowledge of the tolerance limits of species to different salinity concentrations is important when assessing possible impacts on local populations.

Recent studies on the intertidal reefs in the Port Stanvac region have revealed "species rich hot spots for molluscs, echinoderms and red algae" (Dutton & Benkendorff, 2008). Rare and endemic molluscs and echinoderm species were found, including the rare endemic bivalve *Neotrigonia margaritacea.*

An Environmental Impact Statement (EIS) has been released by SA Water for the Port Stanvac region, and has been reviewed by this Committee.

THE PROCESS

Pre-treatment of the intake water includes coagulation and filtration and requires the addition of chemicals to remove suspended solids and other particles in the feedwater. Algae and bacteria can grow on the membranes, requiring the addition of a biocide (usually chlorine, but sometimes ozone or ultraviolet light) which then has to be neutralised. Because of the highly corrosive nature of salt, metals are also found in the discharge water, the concentration varying with what was already in the feedwater, and the amount of corrosion in the pipes.

The filters used for pre-treatment must be cleaned every few days, by backwashing, to clear accumulated sand and solids. Alkaline cleaners are used to remove organic fouling, and acid to remove scale and inorganic particles. Scaling and corrosion of pipes is caused by the high salt content of the water, and generally this will increase with temperature.

3.1 What are the potential impacts?

- Energy use and resulting green house gas production – the energy used in the desalination process is primarily electricity and heat. Large amounts of greenhouse gasses can be produced by desalination plants due to the high energy requirements.

- Entrainment (sucking in) or impingement (sucked up against screens at the intake area) of marine life: molluscs, weeds, algae, fish. Fish eggs, larvae and juveniles as well as plankton are especially susceptible to entrainment. Impinged organisms, typically juvenile or adult fish, usually die or suffer injury as a result of starvation, exhaustion, descaling by screen wash sprays, or asphyxiation.

- Waste – a heavily concentrated brine solution that generally sinks to the sea floor. After the brine solution is discharged into the sea, it has the potential to kill marine organisms through pollution (chemical and metal content) as well as through the consequent rise in the salinity and temperature of coastal waters near the outlet.

3.2 Energy

Desalination is recognised as an energy intensive process, and can have an indirect impact on the environment by using energy from the local grid. The burning of fossil fuels and increased energy consumption allows more air pollution and gas emissions to occur. Significant energy consumption in the desalination process would lead to greenhouse gas emissions into the atmosphere. These would include carbon monoxide, nitric oxide, nitrogen dioxide and sulphur dioxide (Younos 2005).

3.3 Entrainment & Impingement

The impacts of the brine discharge are widely known, but very little consideration is given to the loss of larvae and small organisms that are contained within the vast amounts of seawater extracted to feed the plant on a daily basis. Recent analyses suggest that impingement and entrainment of marine life associated with intake screens may represent the most significant direct adverse environmental impact of seawater desalination (Pankratz 2004).

Entrainment occurs when smaller organisms pass through an intake screen and into the processing equipment resulting in mortality. Fine mesh screens are usually deployed to minimise this, but these do tend to require frequent cleaning due to the build up of eggs and larvae and other matter.

Impingement occurs when marine organisms are trapped against the intake screens by the velocity and force of the water flowing through them which usually results in the death of the organism.

3.4 Waste

Sabine Lattemann on the Clean Ocean website explains "the process of desalination is not per se environmentally friendly and seawater desalination plants also contribute to the wastewater discharges that affect coastal water quality. This is mostly due to the highly saline brine that is emitted into the sea, which may be increased in temperature, and contain residual chemicals from the pre-treatment process, heavy metals from corrosion, and intermittently used cleaning agents. The effluent from desalination plants is a multi-component waste, with multiple effects on water, sediment and marine organisms. It therefore affects the quality of the resource it depends on."

Salinity is approximately doubled in the brine stream.

Temperatures are generally higher in the brine stream.

Also, pH is generally higher in the brine steam.

Density is correlated with salinity, and will enable the salinity to have its largest effect on benthic communities, as the brine will sink to the sea floor.

Oxygen depletion in the brine stream can have devastating effects on marine organisms. With increased temperature and salinity, oxygen (which has already decreased during the separation process) becomes less soluble in seawater, and if sodium bisulfite is used to neutralize the chlorine, there will be even less dissolved oxygen available in the brine stream.

Chlorine is a strong oxidant and a highly effective biocide, often used to prevent biological growth in the desalination process, but this will depend on the type of membranes used as some membranes are sensitive to chlorine. Residual levels of chlorine in the brine stream can be toxic to marine life, however this is often neutralised by the addition of sodium bisulphate.

Heavy metals are often contained in low amounts in the brine, as they can pass into the stream when the interior surfaces corrode. The brine stream can contain traces of copper, iron, nickel, chromium and molybdenum, although levels are generally low. Heavy metals tend to accumulate in the sediments, and the many benthic invertebrates that feed here are at risk of accumulating low levels of heavy metals, that are then passed through the food chain by their predators.

Antiscalants such as sodium hexameta phosphate are commonly added to the feedwater to prevent scale formation. Although risks from antiscalants are low for marine life due to their low toxicity, they have long residence times in the environment due to a poor degradability.

Coagulants and flocculants such as ferric chloride and aluminium chloride are used to remove suspended material from the feedwater. This matter is discharged to the sea usually as filter backwash, and although not generally toxic, tends to increase turbidity in the outlet area.

Sulfuric acid or hydrochloric acid are used to adjust the pH of the intake seawater.

Cleaning chemicals are used every couple of months for the removal of silt deposits and biofilms, metal oxides and scales. Detergents, oxidants and biocides such as citric acid, ethylenediaminetetraacetic acid (EDTA) and sodium polyphosphate are also used for disinfection. Most cleaning agents are harmful to marine life whether acidic or alkaline, and need to be closely monitored.

Crystalline acid EDTA is used to remove the carbonate deposits from the desalination facilities.

Turbidity, can be caused by the disturbance of sediment at the outflow, and can coincide with algal blooms at the outlet. This can inhibit the amount of light available for seagrass to photosynthesise.

Terms of Reference

4.1 The introduction of additional salts and chemicals into the marine environment.

The desalination process produces large quantities of brine at generally twice the concentration of the receiving environment. The brine stream will also contain residues of chemicals used for treatment against biofouling, suspended solids, scale deposits, and traces of heavy metals due to corrosion. Whether alone or cumulatively, these products can have a negative impact on the species residing within the vicinity of the waste product outflow.

It is widely recognised that enclosed shallow systems can generally be assumed to be more sensitive to desalination plant discharges than exposed, high energy, open-sea locations, which are more capable of diluting and dispersing discharges (Lattemann & Hopner 2008). The impacts from any discharges into an ocean site "will not produce measurable effects", whereas discharge into an area with limited exchange will need to be considered on an ecosystem basis, and include cumulative impacts of other local discharges along with the brine discharge (Hoepner & Lattemann 2002).

Typically, the brine product stream will be low in oxygen, higher in alkalinity and considerably heavier than the surrounding seawater, causing it to sink to the seafloor and generally spreading out into a broad plume, depending on the geography and physical oceanography of the region. Most organisms can adapt to minor changes in their environment, and some can tolerate extreme changes, but not to continuous exposure to unfavourable conditions (Lattemann & Hopner 2008). Due to the distribution of the brine plume on the seafloor, the benthic organisms that live there will be affected by the brine discharge. Impacts can range from metabolic stress, to the death of the organism, and can have impacts across a whole range of life stages, which can have grave implications for the survival of species endemic to an area selected for brine disposal. A recent study of the movement of the desalination plant saline plume in Cockburn Sound, Western Australia, found that the brine plume spread across the seafloor permanently filling the shipping channel to two to three metres above the bed (Okely *et a*l., 2007).

The discharge of the brine product into the marine environment was the main area of concern for many of the witnesses who appeared before the Committee, and for the majority of submissions that were received. From the 37 submissions received, only five did not list this as their main concern.

Impacts to Gulf St Vincent were the focus of 26 submissions, with The City of Onkaparinga stating "concerns exist regarding the impact of this discharge on the local marine and coastal environments, particularly given the local tidal and marine characteristics", followed by "location of the plant at Port Stanvac would mean that the disposal options would need to avoid impact on the southern reefs and marine environments."

Dr. Kirsten Benkendorff from the Flinders University School of Biological Sciences spoke to the Committee on the impacts from the various constituents contained in brine discharge (Hansard p33), and the potential impacts that may be experienced on local invertebrate communities at both of the proposed sites. She then went on to discuss the biodiversity importance of Port Stanvac in both the intertidal and subtidal regions. This was followed by a discussion of the hypersalinity tolerance research conducted by her laboratory on local squid species *Sepioteuthis australis,* which has demonstrated a high mortality in squid eggs when exposed to salinities ranging from 45ppt to 55ppt, after only two hours exposure. Her recommendations included applying the "Precautionary Principle" to brine disposal in both gulfs, and setting in place some very clear monitoring regimes prior to any brine release.

The Adelaide and Mount Lofty Ranges (AMLR) Natural Resource Management (NRM) Board suggested that "investigations conducted by the Board as part of its State of the Region report and coastal planning indicate the regional importance of the Stanvac site for marine habitat and remnant vegetation", and went on to discuss the importance of considering the "potential accumulative impacts of desalination and other marine discharges to marine environments".

Many submissions quoted key recommendations from the Adelaide Coastal Waters Study, with particular reference to Recommendation #1 "*As a matter of priority, steps must be taken to reduce the volumes of wastewater, stormwater, and industrial inputs into Adelaide's coastal environment. This should be done within the context of an overarching strategy designed to remediate and protect the metropolitan coastal ecosystem."*

Lattemann & Hopner (2008) discuss the issue of site selection with reference to minimizing impacts on the environment, and stated "Ecosystems or habitats should be avoided, if they are unique within a region or worth protecting on a global scale, inhabited by protected, endangered or rare species, important in terms of their productivity or biodiversity, or if they play an important role as feeding or reproductive areas in the region." Tsiourtis (2008) discusses criteria and site selection addressing all requirements for a desalination plant, and includes within the recommendations "*Plant site must not be within environmentally sensitive areas:"* explaining that plants should not be located in regions with a limited capacity to flush with the open ocean.

Mr Peter Dolan, the Director of Science and Sustainability at the Environment Protection Authority (EPA) informed the Committee that both proposed plants would require a licence under the Environment Protection Act as they would be discharging chemicals into the marine environment with the discharge exceeding 50,000 litres per day (Hansard p47). However, the EPA could only monitor and measure within the "mixing zone" of 100 metres, but without the definition of the "mixing zone", the EPA was unable to set standards for this at this stage. Mr Dolan went on to explain that currently the EPA has no standards for brine, only the chemicals that are added for cleaning and anti scaling, but that is was difficult to set standards as there are no know plants "that are discharging into shallow, narrow areas like the upper Spencer Gulf."

The Committee noted that operation of a desalination plant is not a "prescribed activity of environmental significance" under the Environment Protection Act. There are also currently no standards under the Environment Protection Act or any relevant Environment Protection Policy for the discharge of brine to the marine environment. As a consequence, proponents of desalination plants have little legislative or policy guidance as to appropriate or maximum levels of discharge or impact. Given the likely increase in applications for approval for both large and small desalination plants, the Committee believes that appropriate regulatory standards should be developed. This will provide certainty to future proponents as to the expected standards of environmental performance.

A submission from three Councillors from the City of Onkaparinga, concerned with the detrimental effect the brine discharge posed to Gulf St Vincent, stated “we feel that should the Desalination plant proceed, there should be a zero brine discharge”.

Salinity alteration is thought to play a significant role on marine species size, population and behaviour (Danoun 2007), with a number of studies showing a direct negative correlation between the number of marine species and the salinity increment in seawater.

SUMMARY

Water desalination should be considered as a manufacturing process, subject to quality and environmental standards. Clearly a framework will be required within which to conduct monitoring activities in order to investigate the environmental impacts on gulf ecosystems, and the establishment of criteria for evaluating and assessing the monitoring data. The responsibility for this would sit with the EPA as within the *Environment Protection Act* there is an obligation under the Act to “prevent, reduce, minimise and, where practicable, eliminate harm to the environment”.

The monitoring framework should be developed to the satisfaction of the EPA prior to the commencement of the operation of the plant, and should:

- utilise before and after data,
- have suitable control sites for comparison, and
- include a trigger for the operation to stop if there is other than negligible impact detected on the localised marine environment.

To monitor the brine composition and movement/diffusion over the seafloor over time, a long term monitoring regime will need to be developed that will target temperature, salinity, dissolved oxygen and pH within:

- the discharge zone
- at Near Field
- Mid Field and,
- Far Field

Recommendations:

1. The Committee recommends that Schedule 1 of the *Environment Protection Act 1993* be amended to include desalination plants as a licensable activity under the Act to ensure that brine discharge can be regulated regardless of whether a particular plant would be caught by any existing provision of Schedule 1.

2. The Committee recommends that the Environment Protection (Water Quality) Policy 2003 be amended to include specific requirements for desalination plants including provisions relating to mixing zones and limits beyond which measurable impacts should not occur.

3. The Committee recommends that the Government implement a monitoring program to validate the plant is achieving the discharge concentrations stated.

4. The Committee recommends that the Government implement a long term targeted monitoring regime to monitor movement of the brine stream over time.

4.2 The adequacy of tidal movements to disperse brine and chemicals

The issue of adequate tidal movement to disperse brine and chemicals for both proposed plants was addressed by several of the witnesses and by 29 of the submissions received.

Dr Jochen Kaempf, Oceanographer, School of Chemistry, Physics and Earth Sciences, Flinders University, demonstrated to the Committee hydrodynamic computer modelling for both Spencer Gulf and Gulf St Vincent (Hansard p42). Based on currents, tides and density differences, the model demonstrated the movement of pollutants up and down along the metropolitan coast of Gulf St Vincent rather than dispersing directly into the body of the gulf. This has implications for cumulative impacts when combined with the many other pollutants released in this area.

Mr John Ringham, Chief Operating Officer for SA Water, discussed some of the issues surrounding the proposed desalination plant for Port Stanvac in Gulf St Vincent, and assured the Committee that hydrodynamic modelling investigations were being undertaken to “inform design requirement for the diffuser to ensure that the discharge will mix rapidly with the surrounding seawater to minimise any impacts”, and that the work so far had shown that there would be “no measurable changes in salinity in the Gulf St Vincent from the operation of the plant.” (Hansard p54)

Lattemann & Hopner (2008) when discussing site selection to minimise impacts, state that the site selected should “provide sufficient capacity to dilute and disperse the salt concentrate and to dilute, disperse and degrade any residual chemicals.” They continue to discuss the obvious mitigating factors, “the load and transport capacity of a site will primarily depend on water circulation and exchange rate as a function of currents, tides, surf, water depth and shoreline morphology.” They recommend siting plants in areas with strong currents, surf and exposed coastlines rather than in “shallow sheltered sites with little water exchange.”

Lattemann & Hopner continue with the fact that “oceanographic conditions will determine the residence time of residual pollutants and the time of exposure of marine life to these pollutants,” and reiterating that site selection “can keep the impacts of the desalination plant on the environment at a minimum.”

SUMMARY

Kampf, Brokensha & Bolton (2008) employed the hydrodynamic model (COHRENS) to predict the fate of desalination brine in both gulfs. Using a salinity gradient twice that of the ambient seawater, the model showed that flushing times for Gulf St Vincent were between three to six months.

They concluded that “owing to a sheltered nature and associated slow flushing and given that the marine ecosystems in adjacent marine regions are already under stress, discharge of desalination brine into South Australian gulfs might have severe and irreversible negative impacts on the marine and benthic environments.”

Recognising that the dodge tide regime appears to be when the dispersion qualities of the water column will be limited, dispersion of the brine stream will obviously require monitoring during these fortnightly events. Current work by Flinders University should be built upon using “live” monitoring data taken from fixed sites in Near field, Mid field and Far field sites during dodge tide conditions to verify that the plant is achieving targeted diffusion/dispersion targets during these periods of low mixing.

Due to the highly impacted nature of the marine environment along the metropolitan coastline, a monitoring regime that includes cumulative impacts over time will need to be designed incorporating the brine stream with industrial, storm and wastewater inputs, and measure cumulative environmental impacts over time. This should include fixed sites in the Near field, Mid field and Far field zones, and should also include a site outside of Gulf St Vincent, such as Port Moorowie, at the foot of York Peninsula, to be used as a control site for comparison of changes with other sites.

Recommendations:

5. The Committee recommends that the Government works with modellers from Flinders University using the “live” monitoring data recorded during dodge tides to validate dispersion modelling.

6. The Committee recommends that the Government include monitoring parameters to account for cumulative environmental impacts over time.

4.3 The potential impact on a range of marine flora and fauna

Our knowledge of impacts is largely based on limited research from relatively small plants operating in relative isolation from each other. Cumulative impacts, both over time, and including other inputs into a particular region, are only now beginning to be investigated.

It has been suggested that adverse impacts on species from both impingement and entrainment on the intake screens can cause direct depletion of species that rely on a region for breeding purposes. Seawater is also a habitat, and contains an entire ecosystem of phytoplankton, fishes and invertebrates (Dickie 2007). The impacts of the brine discharge are widely known, but very little consideration is given to the loss of larvae and small organisms that are contained within the vast amounts of seawater extracted to feed the plant on a daily basis. Clearly this issue must also come under scrutiny when considering the environmental assessment.

The potential impact on a range of flora and fauna in both gulfs was discussed by several of the speakers, and was foremost in the concerns of 27 of the submissions.

Dr Kirsten Benkendorff, a Senior Lecturer from the School of Biological Sciences at Flinders University, spoke to the Committee about recent research conducted by the University in Gulf St Vincent, focused on the potential impacts a brine stream may have on local species around the Port Stanvac area (Hansard p35). The area is one of unusually high biodiversity and Dr Benkendorff has suggested that this may have arisen due to the public exclusion in the area whilst operating as a fuel depot. Impacts discussed included the effects of: increased salinity, low oxygen, alkalinity changes, habitat changes, antifouling and antiscaling chemicals, and the stresses that all of these factors can have on the many life stages of the local biota.

The comment has been made a number of times that although there have been a number of studies conducted overseas on the impacts from brine discharges, all have only been short term, and none conducted in the same type of environmental conditions that exist in both of the gulfs. Several studies have shown that the seagrass *Posidonia* has been impacted within a 500 metre radius from outlets in the Mediterranean. There are a number of *Posidonia* species within both gulfs, though not the same species that was monitored at these particular sites.

Dr Benkendorff has conducted salinity tolerance studies on the local southern calamari species, *Sepioteuthis australis* (Hansard p35), similar to the work conducted by Adelaide University on the giant Australian cuttlefish, *Sepia apama,* and has found very similar results. Concerning is the fact that this species, like the cuttlefish, breeds once and then dies, however the species does not lay its eggs only in one area, so the risk of losing the entire population in this particular case is unlikely.

Mr John Ringham, representing SA Water, assured the Committee that "a key consideration for the diffuser structure has been to ensure that adequate mixing can be achieved under all tidal and plant flow conditions to minimise any risk associated with saline plume pooling on the seabed and impacting marine organisms within this zone." (Hansard p55)

15 of the submissions received were concerned with the impacts emanating from the inlet pipes. With the volumes of water required approximately 400 ML on a daily basis, concerns have arisen surrounding the "significant number of eggs, larvae and phytoplankton that will be removed from the region, and the impacts this could have on the species that breed in this area, and the possible ongoing food chain effects.

A submission from the Adelaide Mount Lofty Ranges Natural Resources Management (AMLR NRM) Board expressed concern around "the need to ensure protection of seagrass meadows". The area of seagrass along Adelaide's coastline has declined significantly, with a combination of factors attributed to this, including urban runoff, treated wastewater outfalls and industrial discharge. These inputs have led to increased nutrient loads, salinity changes and loss of light through turbidity and/or sedimentation, all of which are impacting on local seagrass beds. Both gulfs contain three *Posidonia* species, which play a key role in stabilising the sediment and providing nursery/breeding habitat for the species that inhabit gulf waters. "For the *Posidonia* to thrive, two essential conditions are required: sun, for which it needs to grow in low-depth waters close to the coast, and a constant level of salinity" (Dickie 2007).

A study monitoring the brine discharge of a desalination plant at Alicante in Spain, found that "significant increases of salinity at the bottom were observed several kilometres away from the discharge point", and this was found both in deep areas (20m) and the more shallow (16m) areas (Fernandez-Torquemada et al 2005). It was also found that echinoderms had disappeared from the seagrass meadow in front of the desalination plant, and this was attributed to the fact that these organisms are not able to regulate their osmotic pressure and are therefore only able to tolerate a narrow range of salinities.

Lattemann & Hoepner (2008) state that "most organisms can adapt to minor deviations from optimal salinity and temperature conditions, and might even tolerate extreme situations temporarily, but not a continuous exposure to unfavourable conditions." And furthermore "the constant discharge of reject streams with high salinity and temperature levels can thus be fatal for marine life, and can cause a lasting change in species composition and abundance in the vicinity of the discharge site."

Einav *et al* (2002) discuss the "continuous damage to the biota within the plume's vicinity" and advise "it is therefore desirable to place the point of brine discharge far away from the beach and from rocky areas which are rich in organisms".

The role of Natural Resource Management Boards in marine matters has been raised by AMLR NRM with regard to the potential environmental impacts that may occur within the region. Desalination activity should be integrated into Natural Resource Management plans on a regional scale, which then raises the issue that a MOU will be required between the NRM regions that have regional boundaries within the gulfs.

SUMMARY

The paucity of information on the direct effects of the brine concentrate on marine ecosystems requires that monitoring and further research based on site conditions will be required to assess the potential impacts that this may have on local species and their habitats in this area. The area selected for brine outlet is over the sandy sea floor, which supports a range of invertebrates, including the rare bivalve shell *Neotrigonia margaritacea,* which occurs in sand under fast flowing water (Dutton and Benkendorff 2008). This family of shells are descendants of prehistoric molluscs and are represented by only this one remaining genus, occurring off Port Stanvac, and it is not known what effects the brine discharge may have on this only known population.

It is therefore vital that monitoring of the desalination discharge is ongoing, as the cumulative long term effects of the brine on the receiving environment is not known.

The effect of impingement and entrainment require baseline ecological assessment and careful monitoring. The impact on plankton, (including larvae and fish eggs) from being compressed against the screens, should be monitored, as well as how much plankton actually enters the plant. This can have implications for the ongoing fecundity of local populations that use the area for breeding. Data should be collected with regard to breeding seasons of such species as prawns, blue crabs and fish species that use the area.

Recommendations:

7. The Committee recommends that the Government work with Flinders University and Reefwatch using the baseline data already collected to continue to monitor local reef areas and seagrass beds within the area. Utilising the before and after desalination data for comparison, this should include a trigger point for the local populations for the operation to stop if impacts are detected on local populations at these sites.

8. The Committee recommends that the Government develop a strategy to minimise the amount of eggs, larvae and plankton that will be trapped on the.

4.4 The potential impact on commercial and recreational fishing sectors

The AMLR NRM Board in their submission noted the close association between seagrasses and fisheries production, and highlighted the importance of preserving seagrass meadows from impacts that may occur from the brine discharge, suggesting that the nominal value of seagrasses in this area to be around $7.5 million.

Mr John Ringham, representing SA Water explained to the Committee that a review of commercial and recreational fisheries in the Port Stanvac area had been undertaken, and that this area “is not listed as an important coastal fisheries habitat or a significant nursery region for commercial or recreational fisheries.” (Hansard p55)

Dr. Kirsten Benkendorff informed the Committee that she had researched related commercial and recreational species overseas, and found that salinities above 38 ppt had increased mortality and compromised immunity to disease in abalone, clams, prawns and lobsters (Hansard p38), and from her own work in Gulf St Vincent, illustrated high impacts from increased salinity in local southern calamari.

Salinity changes can impact on the growth and size of marine life can alter breeding and life expectancy, which in turn can impact on population density of species in the region. Larval stages are more susceptible than adults to the effects of increases in salinity and this can then impact of future generations.

A number of submissions listed concerns regarding the large quantities of water required by both plants, and the impacts to the species with life stages living within the water column that will be trapped by/on the intake screens for both plants. The Conservation Council of South Australia summed it up by stating that the intake water will contain “significant quantities of plankton, much of which is the eggs and larvae of a wide variety of marine organisms,” and that “if there is a significant reduction in plankton biomass, it will have effects that will ripple throughout food webs within both gulfs, both in terms of a reduction of recruitment into populations (from reduced egg/larvae numbers) and a reduction of populations from a potential reduction in a vital food source.” It was thought that this could have substantial economic impacts as well as ecological ones that may be unforseen until it is too late.

SUMMARY

While the majority of the various chemicals used will be detained in the backwash water, some will still be contained in the waste stream. Most of these will be diluted and undetectable, however it is important to consider cumulative impact. For instance, quite large amounts of ferric chloride will be used, and iron has been shown to be a major limiting trace element for many specie of phytoplankton. As the iron in ferric chloride is bio-available, it will be important to monitor for phytoplankton blooms.

The Committee concludes that the impact on local populations from the removal of eggs, larvae and plankton taken into the plant with the intake water, are largely unknown, and it is therefore prudent to obtain some data in order to assess any impact this might have on fecundity of these species. Data should be collected with regard to the breeding season of species such as prawns, blue crabs and scale fish that use the area as a breeding ground.

Recommendations:

9. The Committee recommends that the Government collect data from the intake screens of the species being caught on the screens and the larvae and eggs of local species that are actually taken into the plant with the intake water.

10. The Committee recommends that the Government regularly monitor at the discharge site for phytoplankton blooms.

4.5 The potential impact of contamination leachate from the location

Brine from the proposed desalination plant will be disposed of directly into the sea. Backwash wastes will have the water removed and the sludge disposed of in land fill. Storage during dewatering, disposal of the dewatering product water and transport of the remaining sludge will require secure containment to prevent risk of contamination from leachate.

Mr John Ringham from SA Water stated that “the proposed site for the desalination plant (at Port Stanvac) has only been used for cropping and grazing”, and that the “contamination issues associated with this historical land use are low.” (Hansard p55) He went on to assure the Committee that “Environmental site assessments, including preliminary soil and groundwater investigations, are being undertaken to better understand potential contamination issues and potential impacts at the Port Stanvac site.”

SUMMARY
The Committee recognises that the disposal of waste as dewatered landfill is a positive environmental outcome, and concludes that the majority of chemicals used in the process for the plant at Point Stanvac, will not enter the marine environment.

Recommendation:

11. The Committee recommends that the Government ensures secure containment of sludge during de-watering, and during transport to land fill.

4.6 Any other matter

The Committee has addressed the Terms of Reference of this inquiry, but a large number of the submissions were concerned with the related issues of stormwater harvesting, the substantial increase in greenhouse gases the plant would produce, and the increase in the size of the carbon footprint that would follow.

Stormwater harvesting was the main suggestion put forward as an alternative water source by 17 of the submissions received, and was presented to the Committee by Ms Pat Harbison on behalf of the Friends of Gulf St Vincent stating “harvesting and reuse of stormwater and waste water, could provide for most of Adelaide’s water needs, with the additional benefit of preventing the current degradation of the gulf by stormwater and waste water discharges.” (Hansard p3) Ms Harbison quoted the SA Government document *Waterproofing Adelaide 2005,* suggesting to the Committee that the total volume of “annual discharge of stormwater and wastewater is similar to Adelaide’s total annual consumption of water”, and therefore reuse of this resource (at one quarter the cost of desalination), could meet most of Adelaide’s water requirements (Hansard p5).

Ms Harbison further iterated that this was also in line with the first recommendation from the Adelaide Coastal Waters Study quoted in many of the submissions: “*As a matter of priority, steps must be taken to reduce the volumes of wastewater, stormwater, and industrial inputs into Adelaide’s coastal environment. This should be done within the context of an overarching strategy designed to remediate and protect the metropolitan coastal ecosystem*.”

The Conservation Council of South Australia considers that “a desalination plant is not the solution to Adelaide’s water “crisis”, and that it “may exacerbate and worsen the situation by re-directing limited funds away from more sustainable and multi-functional options such as stormwater harvesting and aquifer storage and recharge.”

A number of submissions quoted a recently produced policy paper that suggested 89 GL of storm water could be recovered for a cost of $400 million, much less than the cost of constructing a desalination plant. The total volume of stormwater and wastewater discharged into the gulf annually is estimated at around 216 GL, with stormwater ranging from 50 to 160 GL per year (Water Proofing Adelaide, 2005)

Many of the submissions put forward the premise that stormwater harvesting for Adelaide must be given equitable consideration and investment provided for the development of increased water recycling infrastructure, suggesting that the reuse of stormwater and wastewater had the potential to meet most of Adelaide’s water requirements.

The main point of concern from the submissions appeared to be the amount of water currently flowing out to sea that could be captured and stored in Adelaide’s aquifers at a much reduced cost by comparison to the cost of constructing the desalination plant, which was seen as a major environmental impactor when considering the intake/outlet issues and the carbon footprint caused by the amount of greenhouse gases that would be produced to provide the power for the desalination process.

The issues of **greenhouse gases and carbon footprint** were issues raised by 17 of the submissions. Most recognise the fact that desalination is a very energy intensive option, and have concerns that the plant will make a significant contribution to the state’s carbon footprint. This makes achieving the SA State Strategic Plan targets in relation to greenhouse gas emissions more difficult.

It has been quoted on the Arup website for the Port Bonython plant, that to provide 125 ML freshwater will require 30 megawatts electricity.

SUMMARY

Dickie (2007) suggests that desalination plants should only be constructed when they are proven to be “the best and least damaging method of augmenting water supply, after a process which is open, exhaustive, and fully transparent and in which all alternatives, especially demand side and pollution control measures, are properly considered and fairly costed in their environmental, economic and social impacts.”

Desalination plants need to comply with state and national greenhouse targets, and need to be designed as climate neutral, obtaining 100% of their energy needs from renewable energy.

The Committee concludes that there needs to be a balanced multiple approach to guarantee a sustainable water supply where all options are carefully considered and applied where practicable.

Recommendations:

12. The Committee recommends that the Government prepare a comprehensive water security strategy for Adelaide incorporating all water supply and demand options.

13. The Committee recommends that the Government works within the energy guidelines of the SA Strategic State Plan, and sources all energy for the desalination plant from renewable energy sources, including acquiring renewable energy certificates.

Environmental Impact Statement (EIS)

The Inquiry and subsequent report into the environmental impacts of the proposed desalination plant was begun in August, three months prior to the release by SA Water of the EIS for Port Stanvac. The Committee has therefore included a review of the EIS in this section of the report following examination of the EIS, which has addressed a number of the issues raised by both the witnesses and the submissions.

It is evident from the EIS that environmental considerations have certainly been a part of the focus during the design of the proposed desalination plant. Although the final design is yet to be determined, it would appear that sufficient modelling data is available to guide this process.

With an estimated flushing time of 4 months, it has been assumed that the majority of the brine will be dispersed within gulf waters and eventually flushed southwards, leaving very little increase in salinity.

Two options are proposed for the intake/outlet system; a hybrid tunnel option requiring considerable dredging and blasting, and a full tunnel option. The latter is environmentally preferable as this option proposes less dredging and disturbance to the marine environment.

It is accepted that there will be considerable disturbance to the marine environment during construction, but the EIS has outlined strategies to address these issues with the use of management plans, and monitored closely to ensure disturbance is minimised as practicably as possible.

A number of concerns addressed in the EIS, included the following issues, numbered below and followed by comment from the Committee:

5.1 Entrainment of marine biota:

- Entrainment of phytoplankton, zooplankton and fish larvae drawn into the plant.

5.2 Entrapment of marine biota:

- Entrapment of larger organisms against intake.

Comment: Entrapment and entrainment strategies have been provided and an intake velocity of 0.15 ms^{-1} has been proposed for the project to alleviate this issue. This should certainly mitigate entrapment, but does not provide any strategies for the prevention of entrainment of eggs, larvae and plankton. This will need to be closely monitored to ascertain what impact the intake water may have on the fecundity of resident populations.

5.3 Salinity:

- Elevated salinity concentrations (60 to 80%) of brine discharge may harm organisms unable to tolerate fluctuations or increases in salinity;
- Elevated salinity levels may deter mobile species from remaining in the area;

- Potential for dense plume to spread across seabed.

Comment: Near field diffuser modelling at a dilution of 50:1 within 30 meters of diffuser ports is proposed to adequately disperse the brine stream. This will certainly require a stringent monitoring regime during fortnightly periods of dodge tides.

There are no long term monitoring studies of the environmental impacts of desalination plants, and although a number of short term studies exist, none of these have involved the siting of a desalination plant in an inverse estuary with an estimated turn over time of around four months. As recognised in the EIS and the ACWS, Gulf St Vincent, and in particular the coastline along metropolitan Adelaide, is already under duress from a number of anthropogenic influences, as indicated through the loss of approximately 9,000 hectares of seagrass (Shepherd *et al* 2008). This would now appear to be an appropriate opportunity to consider cumulative impacts on the gulf, and in particular, not the effect the brine stream would have on its own, but, the cumulative effects, particularly in the future, that all of these inputs (including the brine) may exert on the marine ecosystems of the gulf.

5.4 Temperature:

- Temperature differences may influence the dispersion and mixing characteristics of the discharge;
- Increased temperature may change oxygen saturation levels and availability in the water column.

Comment: According to the EIS, the small temperature difference between the brine stream and surrounding waters is expected to be around one degree and would have very little effect.

5.6 Elements:

- Elevated concentrations of nutrients may increase algal growth in the vicinity of the discharge;
- Elevated concentrations of heavy metals may be toxic to marine biota in the vicinity of the discharge;

Comment: Heavy metals are expected to be removed during the flocculation process and disposed of on land.
It is assumed that Chlorine dosing within the plant should manage nutrient increases, and any cleaning of organic material build up will require prior approval from the EPA and management strategies to minimise impacts on the nearby marine environment.

5.7 Dissolved Oxygen:

- Inadequate mixing could cause dense saline plume to form over the seabed and lead to localised reduction in benthic oxygen;
- Low concentrations of dechlorination agent (acting as oxygen scavenger) may be released intermittently.

Comment: There is the potential, during dodge tide conditions, when the brine may form a salt layer on the seafloor. This salt layer will remain low in oxygen until such time as the brine layer is dispersed, impacting on any benthic organisms in the vicinity. Monitoring will be required to ascertain what impacts, if any, may occur.

5.8 Chemicals from pre-treatment:

- Elevated concentrations of chloride and sulphate may be released;
- Low pH of discharge may result in decalcification of organisms;

- Discharge of iron may encourage algal growth in vicinity of discharge;
- Unreacted chlorine could be released from the intake or outfall with adverse effects on organisms.

Comment: The EIS states that the chemicals used for pre-treatment should remain with the suspended solids for disposal with the solids.

5.9 Chemicals for flushing:

- Residue flushing chemicals may be discharged in brine.

Comment: These are expected to adequately dilute through the diffuser system according to the modelling undertaken during the EIS.

5.10 Chemicals for preserving membranes:

- Chemical residues from preservation of RO membranes may be discharged.

Comment: Chemicals used in the preservation of membranes are expected to be neutralised on site prior to disposal offsite.

Marine pest management and mitigation strategies appear to be adequate

SUMMARY

Gulf St Vincent is a sheltered, inverse estuary already considerably impacted by industrial, stormwater, and waste water discharges. Nitrogen discharges from Bolivar, Penrice and Glenelg have been responsible for the loss of more than 5000 ha of seagrass in Adelaide's coastal waters (ACWS 2007). This figure has recently been upgraded to 9,000 ha (Shepherd *et al* 2008).

Most desalination research has targeted the improvement of desalination technical performance. Little is known about the cumulative environmental effects of large scale desalination, particularly with respect to the cumulative impacts the intake of feedwater will have on marine life, and the behaviour and effects of concentrated brine discharge in a shallow inverse estuary with limited water exchange with the open ocean.

A large number of the submissions have stated that the option of desalination should only be used as a last resort. This was supported by Dr Kirsten Benkendorff during her presentation to the Committee with her recommendation that a "precautionary approach " should be taken towards the development of desalination plants in either gulf, and further research undertaken to determine the flushing ability of each region (Hansard p 37).

A complete monitoring regime was recommended by Dr Benkendorff if the plants were to go ahead, with replicated "Before, After, Control Impact studies", looking at biodiversity, habitat (seagrass distribution), population assessment, phytoplankton and larval entrainment, ecosystem function (primary productivity, recruitment), and at the very least, a baseline study of "before" data should be established.

None of the submissions were totally opposed to either desalination plant, but most, including the people providing evidence, suggested that plants sited within an inverse estuary were inappropriate due to their lack of circulation, and the risk that this served for the species that lived there. A number of submissions suggested that

Cape Jervis would provide more efficient mixing conditions for the proposed Gulf St Vincent plant, and the west coast around the Elliston area was suggested as an alternative site for the Spencer Gulf plant.

Diverting the brine to local salt ponds for harvesting of salt was another option proposed in several of the submissions, but it has been suggested by both BHP Billiton and SA Water that current salt processors would not be able to handle the quantity of water that would be supplied.

Sabine Lattemann stated "I believe that desalination can be a beneficial technology if used in a sustainable and environmental compatible way. To this end, it is necessary that all relevant issues, including the seawater intake, the concentrate and chemical discharge, the emission of air pollutants and energy demand, are addressed in a detailed EIA in order to investigate and minimise negative impacts, and to find a suitable project site where impacts can be kept at a minimum. Furthermore, I believe that desalination activity needs to become an integrated part of regional and national water management plans in order to identify the best water supply option under environmental, socio-economic, energy and human health criteria."

Complicating our lack of knowledge here in South Australia, are the site specific conditions of building a large scale desalination plant in an inverse estuary, where the lack of adequate circulation could amplify impacts on marine ecosystems. Gulf St Vincent contains the second largest area of seagrass meadows, and mangrove forests in South Australia, all of which provide vast fish nursery areas, and also important bird habitat for the gulf. Much of the seagrass meadows consist of *Posidonia* a species already shown overseas to be impacted by changes in salinity. With much of the gulf's seagrass beds already under stress from industrial, storm and wastewater inputs, a long term commitment to monitoring the seagrass beds adjacent to the brine discharge area will be vital to their survival. Recognising that in summer the net movement of water along Adelaide's coast is northward and that in winter the reverse occurs, it will be particularly important that monitoring occurs during and following the fortnightly periods of dodge tide, when the lack of efficient circulatory movement may provide conditions for the brine to form a layer on the seafloor, impacting on the habitats and species that live there.

It has been announced by the Minister for Water Security, Mrs Karlene Maywald that the South Australian Government is committed to the development of the desalination plant at Port Stanvac. Therefore, due to the lack of any available information of any prior plant being constructed in inverse estuarine conditions, the precautionary principal must be applied at all stages of development.

An ongoing monitoring program should be carefully designed to distinguish human impacts from natural temporal variability and other cumulative impacts, such as global climate change, by selecting replicate sites with similar habitat both within and without the refinery area.

It will be necessary to design long term monitoring program for Port Stanvac with appropriate control sites outside the Gulf St Vincent due to the unpredictability in the spatial distribution and magnitude of the brine plume and possible accumulative effect on the gulfs salinity in the long term.

REFERENCES

ABS (2002) Australian Bureau of Statistics

ACWS (2007) *The Adelaide Coastal Waters Study*. Prepared for the South Australian Environment Protection Authority, Government of South Australia, by the CSIRO, the Commonwealth Scientific and Industrial Research Organisation.
www.epa.sa.gov.au/acws_recommendations.html

Carrick, N.A. & Ostendorf, B. (2007). Development of a spatial Decision Support System (DSS) for the Spencer Gulf penaeid prawn fishery, South Australia. *Environmental Modelling & Software* 22 (2007) 137 – 148.

Danoun, R. (2007). Desalination Plants: Potential impacts of brine discharge on marine life. The Ocean Technology Group, University of Sydney, Australia.

Department for Environment & Heritage 2004. *Blueprint for the South Australian Representative System of Marine Protected Areas.* Government of South Australia.
www.environment.sa.gov.au/coasts/pdfs/mpa_blueprint.pdf

Dickie, P. (2007). MAKING WATER. Desalination: option or distraction for a thirsty world? WWF June 2007
www.panda.org/index.cfm?uNewsID=106660

Dutton, A. & Benkendorff, K. (2008). Biodiversity Assessment and Monitoring of the Port Stanvac Intertidal Reef. Report to the Adelaide and Mt Lofty Ranges Natural Resource Management Board. School of Biological Sciences, Flinders University.

EconSearch Pty Ltd, (2008). *Economic Indicators for the Spencer Gulf and West Coast Prawn Fisheries* 2006/07, Marryatville South Australia.

Einav, R., Harussi, K., & Perry, D. (2002). The footprint of the desalination processes on the environment. *Desalination* 152 (2002) 141 – 154.

Fernandez-Torquemada, Y., Sanchez-Lizaso, J.L., & Gonzalez-Correa, J.M. (2005). Preliminary results of the monitoring of the brine discharge produced by the SWRO desalination plant of Alicante (SE Spain). *Desalination* 182 (2005) 395 – 402.

Gaylard, S. (2003). The health of subtidal reefs along the Adelaide metropolitan coastline 1996-99. Environment Protection Authority, Adelaide.

Gaylard, S. (2004). Ambient water quality of the Gulf St Vincent metropolitan coastal waters. Report No 2: 1995-2002. Environment Protection Authority, Adelaide.

Government of South Australia (2006) Draft *Spencer Gulf Marine Plan.* Coast & Marine Conservation Branch, Natural & Cultural Heritage, Department for Environment & Heritage, Adelaide.

Government of South Australia (2007) *South Australia's Strategic Plan 2007.* Updated July 2008.
www.stateplan.sa.gov.au/

Henry, G.W.. & Lyle, J. M. (eds.) 2003. The National Recreational & Indigenous fishing survey. A fisheries action program project (National Heritage Trust). FRDC project no. 99/158. Australian Government Department of Fisheries and Agriculture, Canberra.

Hoepner, T., & Lattemann, S. (2002). Chemical impacts from seawater desalination plants – a case study of the northern Red Sea. *Desalination* 152 (2002) 133 -140.

Kampf, J., Brokensha, C., & Bolton, T. (in review). Hindcasts of the fate of desalination brine in large inverse estuaries: Spencer Gulf and Gulf St. Vincent, South Australia. Submitted to *Desalination.*

Lattemann, S. (2008). Clean Ocean foundation.
http://www.cleanocean.org/

Lattemann, S., & Hopner, T. (2008). Environmental impact and impact assessment of seawater desalination. *Desalination* 220 (2008) 1 – 15.

Mohammed I. El-Sabh, Than H. Aung & Tad S. Murty (1997). Physical Processes in Inverse Estuarine Systems. *Oceanography and Marine Biology: an Annual Review* 1997, **35**, 1-69.

Okely, P., Antenucci, J. P., Imberger, J. & Marti, C. L. (2007). Field investigations into the impact of the Perth Seawater Desalination Plant discharge on Cockburn Sound. Centre for Water Research, University of Western Australia.

Pankratz, T. (2004). An overview of Seawater Intake Facilities for Seawater Desalination, the Future of Desalination in Texas Vol 2: Biennial Report on Water Desalination, Texas Water Development Board.

Planning SA, Development Assessment Commission (2008) Guidelines for the preparation of an ENVIRONMENTAL IMPACT STATEMENT For the Port Stanvac Adelaide) Desalination Plant Proposal at Lonsdale. Proposal by SA Water Corporation.
www.planning.sa.gov.au/dac

Shepherd, S. A., Bryars, S., Kirkegaard, I., Harbison, P., Jennings, J. T. (2008). Natural History of Gulf St Vincent. Royal Society of South Australia Inc.
www.adelaide.edu.au/rssa/pub/

Steedman & Associates (1983). Review of northern Spencer Gulf water circulation. Coast Protection Board Technical Report 83/10.

Tanner, J. (2005). Three decades of habitat change in Gulf St Vincent, South Australia. *Transactions of the Royal Society of S. Aust*. (2005) 129(1), 65-73.

Tsiourtis, N. X., (2008). Criteria and procedure for selecting a site for a desalination plant. *Desalination* 221 (2008) 114 – 125.

Tularam, Gurudeo Anand, & Ilahee, Mahbub. (2007). Environmental concerns of desalinating seawater using reverse osmosis. *J. Environ. Monit*, 2007, **9**, 805-813.

Waterproofing Adelaide (2008) Government of South Australia
www.waterproofingadelaide.sa.gov.au

Western Australia Water Corporation 2006, "Desalination' paper prepared for the 2006 Australian State of the Environment Committee, Department of the Environment and Heritage, Canberra.
www.environment.gov.au/soe/2006/publications/emerging/desal/index.html

Younos, T. (2005). Environmental Issues of Desalination. *Journal of Contemporary Water Research & Education.* Universities Council on Water Resources 132 pp 11-18.

Submissions

No	Organisation	Author	Dated	Tabled
1	-	Shea Cameron	5/9/08	12/9/08
2	-	Jana Bradley	9/9/08	12/9/08
3	Windesal Ltd	Barrie Harrop	23/8/08	12/9/08
4	-	Graham Brookman	11/9/08	24/9/08
5	-	Fran Southern	- /9/08	24/9/08
6	Scuba Divers Federation of SA Inc.	Hank van der Wijngaart	11/9/08	24/9/08
7	Molluscan Research Group	Dr Kirsten Benkendorff	16/9/08	24/9/08
8	Flinders Research Centre for Coastal & Catchment Environments	John Goslino	19/9/08	24/9/08
9	-	Sam Taylor	20/9/08	24/9/08
10	City of Onkaparinga	Mayor Lorraine Rosenberg	19/9/08	24/9/08
11	-	Jarred Osborne	29/9/08	8/10/08
12	Mid South Coast Ward Councilors	City of Onkaparinga	29/9/08	8/10/08
13	-	Anna Shepherd	26/9/08	8/10/08
14	-	Lynda Yates	26/09/08	8/10/08
15	Enersalt Pty Ltd	Rob Paterson	29/9/08	8/10/08
16	Greenlime	Graham Dixon	1/10/08	8/10/08
17	-	Colin Campbell	2/10/08	8/10/08
18	-	Robert Lloyd	2/10/08	8/10/08
19	-	Robert Campbell	2/10/08	8/10/08
20	-	Laraine Lerc	3/10/08	8/10/08
21	Axial Filter Systems	Brad Evans	2/10/08	8/10/08
22	Lincoln Marine Science Centre	Dr Toby Bolton	3/10/08	8/10/08
23	Adelaide Mount Lofty Ranges NRM	Tony Flaherty		8/10/08
24	Spencer Gulf & .West Coast Prawn Fisherman’s Association Inc	Karen Hollamby		8/10/08
25	Cuttlefish Coast Coalition	Greg Curnow		8/10/08
26	-	Robert Burke	5/10/08	8/10/08
27	Friend of Gulf St Vincent	Pat Harbison	7/10/08	8/10/08
28	-	Dianne Turner	7/10/08	8/10/08
29	-	Ian Dyson	7/10/08	8/10/08
30	-	John Lewis	3/10/08	8/10/08
31	Power Core National Pty Ltd	Paul Kaethner and Graham Young	15/10/08	29/10/08
32	-	Renee Grootenboer	16/10/08	29/10/08
33	Conservation Council SA	Jamnes Danenberg	14/10/08	
34	Save Our Gulf Coalition	Peter Laffan & Imelda Rivers	8/11/08	12/11/08
35	Friends of Gulf St Vincent	John Caldicott	3/11/08	12/11/08
36	The Elliston Concept	Tom Cheesman	29/10/08	12/11/08
37	-	Warren Godson	26/11/08	26/11/08

Witnesses

Name	Organisation	Date appearing
Pat Harbison	Friends of Gulf St Vincent	8/10/08
Peter Laffan	Save our Gulf Coalition	8/10/08
Dr. Toby Bolton	Marine Biologist (& Director) Lincoln Marine Science Centre	8/10/08
Bronwyn Gillanders	Associate Professor, Southern Seas Ecology Laboratories, School of Earth and Environmental Sciences, University of Adelaide	8/10/08
Karen Hollamby	Executive Officer, Spencer Gulf and West Coast Prawn Fisherman's Association Inc	8/10/08
Kirsten Benkendorff	Senior Lecturer, School of Biological Sciences, Flinders University	8/10/08
Jochen Kaempf	Oceanographer, School of Chemistry, Physics and Earth Sciences, Flinders University	8/10/08
Peter Dolan	Director of Science and Sustainability, Environment Protection Authority	8/10/08
John Ringham, (Tim Kildea, Tara Hage)	Chief Operating Officer, SA Water	8/10/08
Gregg Curnow	Cuttlefish Coast Coalition	8/10/08
Kym Winter-Dewhirst Richard Yeeles	BHP Billiton	15/10/08