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1 Introduction

This Response Document has been prepared in accordance with Section 46B (8) of the South Australian Development Act 1993 as the South Australian Water Corporation’s formal response to matters raised during the public notification period for the proposed Adelaide Desalination Plant Environmental Impact Statement.

1.1 Background to Project

The proposed Adelaide Desalination Plant will be located at Port Stanvac, approximately 30 kilometres south of the Adelaide Central Business District. The proponent is the South Australian Water Corporation (SA Water) and the proposal is to establish a seawater Desalination Plant comprising the following elements:

- A Desalination Plant based on reverse osmosis technology, with an initial capacity of 50 GL of drinking water per annum (or 150 ML/day) incorporating infrastructure for 100 GL of drinking water per annum (or 300 ML/day); and
- Intake and outfall pipelines and structures to draw seawater into the facility and return saline concentrate to Gulf St Vincent.

1.1.1 Need for the Project

The primary objective of the proposed Desalination Plant is to secure and diversify the sources of metropolitan Adelaide’s water supply by delivering a climate independent supply of water. As discussed throughout the EIS, the security of Adelaide’s water supply is a matter of critical concern to the South Australian community, particularly in light of the substantially reduced flows into metropolitan Adelaide’s water reservoirs and the Murray-Darling Basin experienced in recent years as a result of climate change and severe drought. Based on analysis of the most recent and reliable information available, the dramatic reduction of inflows into the Murray-Darling Basin catchment is expected to worsen and result in an average decline of 30 GL per annum.

The South Australian (SA) Government established the Desalination Working Group (DWG) in March 2007 to investigate water security options including the feasibility of developing a Desalination Plant to augment metropolitan Adelaide’s water supply. The DWG study recommended that a Desalination Plant be built to increase the security of metropolitan Adelaide’s water supply system with the SA Government subsequently announcing its decision to construct the proposed Desalination Plant in December 2007.

A number of submissions to the EIS have queried the need for the proposed Desalination Plant and called for a greater consideration of other potential water sources to secure Adelaide’s water supply into the future. SA Water’s response to this issue is discussed in detail in Section 3.1, although it is worth noting that the SA Government announced a suite of water security measures that have been carefully developed to improve the reliability and diversity of water sources and avoid reliance on any one source. For instance, the Water Proofing Adelaide Strategy and the Four-Way Water Security Strategy both seek to increase the reliability and security of Adelaide’s water supply while reducing our reliance on the Mount Lofty Ranges and River Murray systems which are currently experiencing severe stress after a period of prolonged drought. The Four-Way Strategy in particular involves measures to diversify Adelaide’s water supply as follows:
• **Demand management:** Reducing the overall demand for water through a host of water conservation measures, a water pricing regime that encourages people and households to use less water, water efficiency plans for industry and a $24 million rebates package;

• **Recycling:** Increasing the amount of treated stormwater and wastewater used for irrigation, watering of parks and gardens, flushing of toilets and other non-drinking uses;

• **Catchment management:** Improving the health of our river systems and water catchments, including the River Murray, is a key element in enhancing Adelaide’s water supply. SA Water is also investigating the potential to increase the storage capacity of the Mount Lofty Ranges.

• **Desalination:** Ensuring that there is at least one climate independent water source to better manage, diversify and secure Adelaide’s water supply into the future.

This suite of water supply measures demonstrates the SA Government’s commitment to ongoing investment and upgrade of Adelaide’s water supply system in order to reduce dependence on any one source. This will ensure that Adelaide’s residents and businesses continue to benefit from a secure, reliable and balanced water supply system well into the future.

**1.2 Public Notification of the Proposed Development**

The project was gazetted as a Major Development on 17 April 2008 and an Environmental Impact Statement (EIS) was prepared by SA Water outlining the proposal and providing detailed and comprehensive information of its potential impacts and management/mitigation strategies to address these impacts. The EIS was lodged by SA Water on 11 November 2008 and was publicly notified in accordance with the provisions of Section 46 of the South Australian (SA) *Development Act 1993*. The public notification process provided the public and Government agencies with an opportunity to examine the EIS and provide a submission to SA Water over a 6-week period between 12 November and 24 December 2008. This Response Document summarises the issues and questions raised in the submissions and provides SA Water’s response to these issues and questions.

**1.3 Submissions Received**

A total of thirty nine (39) submissions were received in response to the proposed Adelaide Desalination Plant Environmental Impact Statement. These submissions comprised:

• Thirteen (13) SA Government agency submissions.

• Twenty Six (26) Public submissions.

The submissions are listed in the Table 1.1 below with ‘G’ and ‘P’ signifying Government and Public submissions respectively.
Table 1.1 Submissions received

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<tr>
<th>ID Number</th>
<th>Source of Submissions</th>
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<tr>
<td>G1</td>
<td>Department for Environment and Heritage</td>
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<tr>
<td>G2</td>
<td>Department of Planning and Local Government</td>
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<tr>
<td>G3</td>
<td>City of Marion</td>
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<td>G4</td>
<td>City of Onkaparinga</td>
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<td>South Australian Research and Development Institute</td>
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<td>P2</td>
<td>South Australian Recreational Fishing Advisory Council Inc</td>
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<td>P3</td>
<td>Roger Grund, Butterfly Conservation South Australia Inc</td>
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<td>P5</td>
<td>Joy Forrest</td>
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<td>Patricia Walsh</td>
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<td>Christopher Stain</td>
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<td>Kim Thomson</td>
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<tr>
<td>P10</td>
<td>Ralf Grandison</td>
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<tr>
<td>P11</td>
<td>Peter Tapley</td>
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### 1.4 Structure of the Response Document

The Response Document has been structured to provide a readily accessible and easy to follow account of the submissions received on the proposed Adelaide Desalination Plant EIS as well as SA Water’s response to those submissions. A brief description of each chapter is presented below:

- **Chapter 1: Introduction** provides background information about the proposed Desalination Plant and details the number of public and Government agency submissions received during the 6-week public notification period.

- **Chapter 2: Project Status** details the EIS assessment process and clarifies the role of this Response Document in the assessment of the proposed development. This chapter also provides an update of the project, details additional reports of studies undertaken to support the project and discusses the Environmental Management Plans to be implemented during construction and operation of the proposed Desalination Plant.

- **Chapter 3: Response to Major Issues** provides SA Water’s response to terrestrial environmental, social, economic and management issues raised in the submissions received from Government agencies and the public.

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<tr>
<td><strong>P12</strong></td>
<td>Viv Rayner</td>
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<td>Daniel Drew</td>
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<td><strong>P14</strong></td>
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<td>Dr Kirsten Benkendorff</td>
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<td><strong>P16</strong></td>
<td>Trevor Pearce</td>
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<td><strong>P17</strong></td>
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<td>S.A. Ward</td>
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<td><strong>P19</strong></td>
<td>Mark Parnell MLC (Australian Greens)</td>
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<td><strong>P20</strong></td>
<td>Save Our Gulf Coalition (Peter Laffan)</td>
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<td><strong>P23</strong></td>
<td>Lenore Bienert</td>
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<tr>
<td><strong>P24</strong></td>
<td>Alison Rawling</td>
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<td><strong>P25</strong></td>
<td>J R Lewis</td>
</tr>
<tr>
<td><strong>P26</strong></td>
<td>Friends of Willunga Basin</td>
</tr>
</tbody>
</table>
• **Chapter 4: Response to Marine Issues** provides SA Water’s response to concerns raised in the submissions received from Government agencies and the public on the potential marine impacts of the proposed Desalination Plant.

• **Chapter 5: Conclusion** concludes the Response Document.

• **Appendix A** summarises the issues raised in the submissions and details how these issues are cross-referenced in Chapters 3 and 4 of the document.

• **Appendix B** contains the draft Construction Environmental Management and Monitoring Plan (CEMMP).

• **Appendix C** contains a copy of the Independent Technical Review Panel’s formal statement on the EIS.

• **Appendix D** contains a copy of the EPBC Notice from the Commonwealth Government confirming that the proposed Desalination Plant is not a controlled action under the *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999*.

• **Appendix E** contains a copy of Artists Impressions of the proposed Desalination Plant

• **Appendix F** contains a copy of the Ecotoxicology Report.

• **Appendix G** contains a copy of the Marine Ecological Characterisation Study – Final Report.

• **Appendix H** contains a copy of the Water Quality Characterisation Study.

• **Appendix I** contains a copy of an additional Habitat Survey.

SA Water greatly appreciates the efforts made by respondents to the EIS and would like to thank agencies and members of the public for their input.

Within this document, every attempt has been made to respond to all of the issues and questions raised by those making submissions to the EIS. However, some submissions have raised issues that were either unrelated to the proposed development and/or were beyond the scope of the Guidelines for the EIS. In view of this, SA Water is unable to address the unrelated comments. Any such matters have been recorded in Appendix A.
2 Project Status

2.1 The EIS Process

On 17 April 2008, the SA Minister for Urban Development and Planning declared, by notice in the Government Gazette, that the proposed Desalination Plant would be assessed as a Major Development in accordance with Sections 46, 46B and 48 of the SA Development Act 1993.

The Minister’s declaration triggered a comprehensive and coordinated State-run assessment process that can be summarised as follows:

- SA Water prepared and lodged the Development Application for the proposed Desalination Plant to the Minister for Urban Development and Planning on 24 June 2008.

- The Development Application was then referred to the SA Development Assessment Commission (DAC) who determined that the proposed development would be subject to an EIS, as announced by the Minister on 13 September 2008. An EIS is the highest and most rigorous assessment process available within Section 46 of the Development Act 1993 and, in the case of the proposed Desalination Plant, involved extensive investigations of the potential impacts arising from the proposed development and consideration of appropriate mitigation measures to address these impacts.

- The Minister subsequently issued a set of draft assessment guidelines (Guidelines) to SA Water outlining the key environmental, social and economic issues the EIS was required to address. These Guidelines were referred to the following State Government agencies for comment and amendment:

  - Environment Protection Authority (EPA). As the proposed Desalination Plant involves works or activities of environmental significance as defined by the SA Environment Protection Act 1993, the draft Guidelines were referred to the EPA for a prescribed period of 15 business days;

  - Department for Environment and Heritage (DEH) including the Coast Protection Board (CPB);

  - Department of Health;

  - Department of Premier and Cabinet (DPC) including the Aboriginal Affairs and Reconciliation Division (AARD);

  - Department for Transport, Energy and Infrastructure (DTEI);

  - Primary Industries and Resources SA (PIRSA) including the SA Research and Development Institute (SARDI);

  - Department of Water, Land and Biodiversity Conservation (DWLBC);

  - Native Vegetation Council; and

  - Adelaide Mount Lofty Ranges Natural Resource Management (AMLRNRM) Board.
On finalising the Guidelines, the Minister for Urban Development and Planning provided a copy to SA Water and publicly issued the final Guidelines on 13 September 2008. SA Water's compliance with these Guidelines was detailed in Chapter 11 of the EIS document.

The EIS was prepared to address the requirements of the Guidelines and was lodged with Planning SA on 11 November 2008. Planning SA (which has since become the Department of Planning and Local Government) initiated the formal agency referral and public notification process which involved the following activities:

- Referral to the EPA for comment and assessment pursuant to the South Australian Environment Protection Act 1993;
- Referral to the agencies noted above for comment and assessment;
- Referral to the Cities of Onkaparinga and Marion for comment and assessment;
- Placement of the EIS on public exhibition for 30 business days, inviting interested persons to make written submissions on the EIS;
- Conducting a public meeting to inform the public of the EIS assessment process and the key elements of the EIS at the Hallett Cove Baptist Community Centre on 17 November 2008; and
- SA Water held further information sessions and issues workshops in the local area during the public notification period with the Cities of Onkaparinga and Marion, local interest groups and the community. These meetings were not a statutory requirement of the Development Act, however allowed SA Water to provide responses to specific concerns and better understand community concerns.

The public notification period ended on 24 December 2008, with all submissions received passed on to SA Water to prepare a written response to matters and issues raised within these submissions. This Response Document is effectively the outcome of this process.

The Response Document has been submitted to the Department of Planning and Local Government who will prepare an Assessment Report (on behalf of the Minister for Planning and Urban Development) that documents the Minister’s assessment of the proposed Desalination Plant, the outcomes of the public notification period, SA Water’s response to submissions and any other comments that the Minister may require.

The Assessment Report will be made publicly available and, together with the EIS and this Response Document, will then be forwarded to the Governor of SA for a final decision in accordance with Section 48 of the SA Development Act 1993. The Governor may either approve the proposed development, approve the proposed development with conditions or refuse the proposed development. There are no appeal rights to the Governor’s decision.

The Governor’s decision is then published in the South Australian Government Gazette which generally concludes the Major Development assessment process. The Major Development assessment process is shown in Figure 2.1.
2.2 Purpose of the EIS

The purpose of the EIS is to ensure that matters significantly affecting the environment, the community or the economy as a result of the proposed Desalination Plant are fully examined and taken into account in the assessment of the proposal. The EIS assessment process is the most complex and rigorous form of assessment process stipulated in the SA Development Act 1993, and has been explicitly developed to provide the maximum level of public scrutiny of the proposed development.
Accordingly, the EIS has identified and evaluated a wide range of potential impacts of the proposed Desalination Plant and detailed how these impacts are to be mitigated, monitored and managed in ways to avoid any detrimental impacts arising from the construction and operation of the Plant. While the evaluation of these potential impacts has been based on a concept design prepared by SA Water’s technical specialists, Connell Wagner, the concept provides sufficient information on which to conduct such an evaluation. This is normal practice for the assessment of a Major Development under Section 46 of the Development Act 1993.

To provide further assurance that the final design of the proposed Desalination Plant will not have any adverse social, environmental and economic impacts, the EIS specifies a comprehensive and holistic set of environmental and engineering performance objectives and criteria (presented in Table 3.1 of the EIS) with which the successful Contractor building and operating the Plant will need to comply.

2.3 Project Update

Since lodgement of the EIS, a number of scientific and technical studies that were used to inform the EIS have continued. These studies have been undertaken to further validate our understanding of the marine environment in and around Port Stanvac and to ensure that the proposed Desalination Plant will not have adverse impact on marine ecosystems and the environment in general. The results of these studies will be used to inform the final design of the Plant so that the environmental and engineering performance objectives and criteria are met. These studies are listed in Section 2.3.1.

SA Water has also received bids and is progressing the selection of the Adelaide Desalination Project DBOM Contractor (the ‘Contractor’).

2.3.1 Additional Reports

Studies that have been ongoing and/or have been completed during the course of the EIS assessment period include:

- Further ecotoxicological investigations based on analysis of results from the temporary Pilot Desalination Plant. These studies are expected to continue through to the end of March 2009. A copy of the most recent ecotoxicological investigations is attached at Appendix F.

- Ongoing monitoring of the baseline marine environment with the results of the spring ecological characterisation study expected during January 2009. Appendix G contains a copy of the Marine Ecological Characterisation Study - Final Report.

- Further marine water quality characterisation has occurred with a copy of the Water Quality Characterisation Study attached at Appendix H.

- Further marine Habitat Survey work presented in Appendix I.

2.4 Environmental Management Plans

A draft Construction Environmental Management and Monitoring Plan (CEMMP) has been developed by SA Water and is presented in Appendix B following a request by the Department of Planning and Local Government. The CEMMP represents SA Water’s commitment for minimum acceptable standards to be adopted by SA Water’s Contractors for the construction of the Desalination Plant.
It should be noted that this draft CEMMP has been based on the concept design for the proposed Desalination Plant and that a detailed CEMMP is to be developed by the successful Contractor before the commencement of any construction works. As highlighted throughout the EIS, SA Water will require the Contractor’s CEMMP and Operation Environmental Management and Monitoring Plan (OEMMP) to comply with the full range of environmental and engineering performance objectives and criteria listed in Chapter 3 of the EIS.

A significant number of environmental investigations and baseline studies have been undertaken to provide a basis for the planning of the proposed Desalination Plant. Future monitoring programs are also proposed during the construction and operation of the Plant. These programs are intended to continue to build on the baseline monitoring work undertaken by SA Water and to ensure that the environmental objectives of the proposed Desalination Plant are being achieved.
3. Response to Major Issues

3.1 Need for Desalination

Many submissions queried the need for the proposed Desalination Plant, believing it to be an option of last resort and that other water supply options have not been adequately explored. One submission claimed that there is sufficient water in the Murray-Darling Basin system and that scientific evidence should be presented to justify the need for the Plant. Another submission argued that there has never been a full-scale assessment of the needs and possibilities to watering Adelaide sustainably in the future and that no timetable for reducing Adelaide’s dependence on existing vulnerable supplies has been presented.

One submission queried the need for the Desalination Plant and, referring to the precautionary principle, sought reassurance that it will not cause environmental harm. Another argued that there is no point in trying to beat nature with a Desalination Plant that is not climate dependent.

3.1.1 Need for Desalination Plant

The need for the proposed Desalination Plant is discussed in Section 1.1.1.

In addition, the current extreme drought situation has caused us to assess previous assumptions about the reliability of the River Murray as a source of Adelaide’s water supply. Following many years of water over-allocation upstream, river regulation and drought there has been an alarming decline in the environmental health of the River. Furthermore, as the storage capacity of the Mount Lofty Ranges catchments is less than Adelaide’s yearly demand, these catchments have to be continually topped up from the River Murray. The reliability of the River Murray in providing a secure supply for Adelaide is no longer assured. However, the River Murray will still continue to be an important part of Adelaide’s water supply.

In light of this situation, the SA Government has put in place an active and rigorous program to address water security issues, especially as a secure and long-term sustainable supply of water is fundamental to the growth of metropolitan Adelaide and the future prosperity of SA more generally. In implementing this program, SA Water has considered a combination of the following:

- Sound management of existing water resources - including initiatives to improve the ecological health of the River Murray and other catchments;
- Responsible water use and fostering innovation - including a range of demand management measures as well as ongoing development of stormwater and wastewater reuse schemes; and
- Development of additional water supplies.

The proposed Desalination Plant is an important component of the need to develop additional water supplies to supplement and diversify the sources of Adelaide’s water and so ensure water security into the future. It represents a responsible and considered approach to the increasing unreliability of traditional water sources and likely impacts of drought and ongoing climate change. For this reason, the climate independent source of drinking water provided by the proposed Desalination Plant is not an attempt to ‘beat’
nature per se, but rather to supplement and diversify the water provided by nature through rainfall.

The increased supply and water security provided by the project will generate a number of benefits to the community. These benefits include:

• Increased security of the economic output of businesses.
• Social benefits to householders from domestic water use.
• Economic benefits arising from agricultural and horticultural produce.
• Potential availability of additional water to the River Murray and Mount Lofty Ranges catchments from environmental flows.

It is also important to re-emphasise that the proposed Desalination Plant has been designed to avoid harm to the marine and terrestrial environment (refer to Section 3.12 and Chapter 4).
3.2 Consideration of Other Water Sources

A number of submissions argued that there are other water supply options which should be investigated and used before considering desalination. Stormwater in particular was seen to be under represented in Adelaide with respect to supplying water for reuse schemes and some claimed it to be cheaper and quicker to establish than desalination. The potential for greater reuse of treated wastewater was also queried.

Submissions also discussed the findings of the report produced by Richard Clark and Associates (2008).

3.2.1 Alternatives to Desalination

The SA Government’s water security strategy considers a range of initiatives through which to secure Adelaide’s future water supply. Four key sources of water have been identified, namely stormwater, recycled wastewater, purchase of water licences from the River Murray and desalination as additional options for securing water supplies into the future.

3.2.1.1 Stormwater

There are a range of initiatives being implemented across metropolitan Adelaide by both local governments and the State Government that seek to increase our reuse of stormwater. SA Water is implementing and/or actively supporting many of these initiatives and will continue to do so in the future in order to supplement our traditional water sources. A few examples include:

- Mawson Lakes – SA Water is partner with the City of Salisbury, Land Management Corporation and developers delivering recycled treated effluent and stormwater to the suburb for toilet flushing and park and gardens watering;
- Lochiel Park – SA Water is partner with the City of Campbelltown and Land Management Corporation to supply treated stormwater for use in toilet flushing, garden and parks watering and washing machines to the new development; and
- Water Proofing the South – SA Water is partner with the City of Onkaparinga and the Willunga Basin Water Company to substitute fit-for-purpose alternative water sources such as recycled water and stormwater for traditional sources such as mains drinking water and groundwater.

The proposed Desalination Plant will not diminish SA Water’s commitment to developing the stormwater initiatives outlined above, those described in the Water Proofing Adelaide Strategy and other initiatives that may be developed in the future.

Our capacity to harvest and reuse stormwater remains fundamentally dependent, however, on rainfall. Stormwater is a climate dependent water source that will always be vulnerable to the kind of drought conditions experienced throughout SA over the past 5-7 years. Stormwater also requires a complex, time-consuming and land-intensive treatment process before it is safe to drink, making it comparable to the cost of desalinating seawater, per kilolitre of water produced, if considering whole-of-life costs.

It is important to recognise that stormwater harvesting schemes generally source water from an urban catchment which usually contains a variety of contaminants. Stormwater is often detained and treated in wetlands or reed bed basins which reduce most of the contaminants to levels that enable storage within suitable aquifers. As stormwater occurs in greater abundance during the winter months, it needs to be stored for use...
throughout the year. This is referred to as aquifer storage and recovery (ASR). Water treated and stored in this manner is suitable for non-potable use but is not always safe for drinking purposes.

For instance, in a potable stormwater/ASR scheme there can be high potential for private bores to intersect the source aquifer and cross-contaminate the water supply, especially over multiple ASR bore fields. Accordingly, the only way to ensure safe drinking water supply is to provide advanced water treatment techniques to protect the health of consumers.

Notwithstanding the above, localised stormwater recycling schemes that provide non-potable water can be a very important adjunct to water supply by relieving demand on other potable sources, especially for the watering of public spaces and in new developments where dual reticulation infrastructure can be installed by developers.

In the Metropolitan Adelaide Stormwater Management Study (MASMS; Kellogg Brown Root, 2004) it was recognised that the potential for stormwater harvesting within the current urban growth boundary was likely to be around 25 GL/annum. This number is consistent with the stormwater and rainwater reuse target in Water Proofing Adelaide of 20 GL/annum. The 20-25 GL/annum target is likely to be cost effective and achievable through localised reuse schemes.

The MASMS report includes a preliminary assessment of how large-scale stormwater harvesting could be employed within the Adelaide metropolitan area. The MASMS concluded that a large number of individual ASR sites would be the best method of achieving a significant amount of stormwater reuse. In order to capture and store a large quantity of stormwater (such as 50 GL per annum) many ASR sites would be required and each of these sites would need to have a catchment area of approximately 650 hectares and a works area of approximately 4 hectares. In order to achieve large quantities of stormwater reuse, therefore, a significant investment in infrastructure and land acquisition would be required, particularly in urban areas.

Non-potable stormwater use will reduce potable water consumption where stormwater harvesting schemes operate. However, stormwater is a climate dependent water source. In drought years sufficient volumes of stormwater may not be available and, in extreme cases, affected stormwater users may need a back-up supply from the mains water supply system. In such circumstances, there is limited benefit to Adelaide’s water security.

The Water Proofing Northern Adelaide Strategy is a good example of how stormwater resources should be integrated into the urban water environment. It is estimated that around 12 GL of potable water can be substituted by stormwater for non-potable uses from this project that is supported by SA Water.

3.2.1.2 Recycled Wastewater

SA currently leads the nation in re-using treated wastewater and SA Water is committed to increasing this water source via the expansion of existing recycling schemes and the introduction of new schemes. In 2006/2007, 28.6% of the available treated effluent for SA was recycled, and in 2007/2008 this increased to 31.1%.

The Christies Beach Wastewater Treatment Plant is being expanded and SA Water is also currently building a pipeline to transfer treated wastewater from the Glenelg Waste Water Treatment Plant to the Adelaide Parklands for irrigation purposes. In addition, the Bolivar Wastewater Treatment Plant provides treated wastewater to Virginia and an
expansion of the Virginia pipeline is nearing completion to deliver additional treated waste water to the northern Adelaide plains horticulture industry. Existing and currently planned projects are anticipated to achieve a total reuse target of around 45%. The Government is seeking to further increase the use of recycled wastewater for non-drinking purposes as a means of reducing reliance on the River Murray.

The cost of Indirect Potable Reuse (IPR) is comparable to seawater desalination when upstream storage and detention is included.

3.2.1.3 Other Initiatives

A number of other projects are currently being investigated to improve and diversify Adelaide’s water sources.

Water Licences

Purchasing additional water licences to extract water from the River Murray could potentially ensure additional water allocation to SA, but only during non-drought conditions and when all users would be subject to restrictions.

Assessing the reliability of additional permanent water sourced from the River Murray is therefore difficult. A more reliable supply can be achieved by purchasing a greater volume of water than is needed on average. For example, purchasing an additional 200 GL from the River would provide, in most years, 50 GL of usable water. At present, this level of allocation would only yield 36 GL under the allocations announced in January 2009 for the River Murray. In the worst case scenario, however, there might be no water available from the allocation.

To achieve the same reliability as the proposed Desalination Plant, purchasing additional water allocations would need to be combined with an option for additional balancing storage, such as an increase in storage capacity in the Mount Lofty Ranges.

Underground Aquifers for Storage

The use of underground aquifers provides a water storage option which reduces the loss of water harvested from the Mount Lofty Ranges and the River Murray through evaporation. The water harvested and stored in underground aquifers is a climate dependent resource.

Domestic Rainwater Tanks

Domestic rainwater harvesting initiatives supported by the SA Government include providing subsidies to homeowners to purchase rainwater tanks and plumb these into homes. In addition, rainwater tanks must now be incorporated into all new dwellings pursuant to the requirements of the Building Code of Australia.

Demand Management

SA Water has implemented a range of demand management measures to reduce the overall demand for water. These include:

- Industrial users water efficiency plans and audits;
- $24 million rebates package to decrease indoor household water use; and
• Implementation of water restrictions and permanent water conservation measures (PWCM).

SA was the first State in Australia to introduce PWCM. Since the introduction of restrictions, water use has fallen significantly, from about 178 GL in 2002-2003 to 139.6 GL in 2007-2008 for all water users.

Initiatives to harvest stormwater and use recycled wastewater are currently being, and will continue to be implemented. Desalinated water produced by the proposed Desalination Plant will remain the sole source of water that is independent of climate and so unaffected by drought conditions that are likely to become more and more frequent in the face of ongoing climate change. One of the key recommendations of the Desalination Working Group – formed by the SA Government to investigate the feasibility of developing a Desalination Plant for Adelaide – was the need to diversify metropolitan Adelaide’s water sources and reduce our reliance on rainfall, which has become an increasingly unreliable source of drinking water. The proposed Desalination Plant will effectively and efficiently meet this requirement by creating an additional source of drinking water that is climate independent and that reduces our reliance on flows into the River Murray and Mount Lofty Ranges catchment.

3.2.1.4 Sustainable Water Options for Adelaide

A report produced by Richard Clark and Associates (2008) assesses the sustainability of water options for metropolitan Adelaide and claims that demand management, stormwater harvesting, wastewater reuse, existing catchments and rainwater tanks could supply all of metropolitan Adelaide’s water requirements. The report also states that the speed at which these water supply options can be brought into effect is of critical importance.

As indicated above, SA Water is currently supporting a raft of measures to increase the water available from sources other than the River Murray and Mount Lofty Ranges.

The time required to fully advance these initiatives is considerable and cannot be guaranteed to produce the necessary volumes of water required to secure metropolitan Adelaide’s water needs in the short and medium term.

In addition, all of these other initiatives remain climate dependent. In taking a risk-averse approach to securing the supply of Adelaide’s water, it is considered that the Desalination Working Group’s recommendation to proceed with the development of a climate independent source of water through the proposed Desalination Plant is a responsible and necessary option.

During development of the Water Proofing Adelaide Strategy a comprehensive list of water supply and water conservation options were assessed. Please refer to the website www.waterproofingadelaide.sa.gov.au.

The recently established Office for Water Security will coordinate water policy development across Government in the following areas:

• South Australia’s negotiations on the National Plan for Water Security;
• Driving South Australia’s commitments under the National Water Initiative; and
• Developing a comprehensive State-wide water security plan that builds on and incorporates Water Proofing Adelaide.
3.3 Economic Issues

Submissions about the economic issues associated with the proposed Desalination Plant can be summarised into five broad categories as follows:

1. Costs and water price increases – The cost of the Desalination Plant is too high and may put the State’s finances under pressure or commit the SA Government to onerous arrangements with private operators. There were also concerns that the cost of the Plant will lead to increases in the price of water to customers, that subsidies will be needed to ensure the basic right to potable water, that the employment generated by the Plant may not offset its cost and that water price rises should be included in the economic modelling.

2. Local development and employment opportunities – Both the City of Marion and the City of Onkaparinga are keen to engage with SA Water to maximise the potential benefits of the proposed Desalination Plant for local industry and vocational employment and to complement a number of strategic local projects.

3. Additional costs for Plant expansion – There is no account of the additional costs of constructing a 100 GL Desalination Plant and what the opportunity costs might be if the additional Plant capacity is not utilised.

4. Volume of water for various operational scenarios – Submissions queried the capacity of the Plant to produce water under a range of operational scenarios based on the climate change scenarios used by CSIRO.

5. Shut down costs – Will the Contractor be paid for water that is not needed?

3.3.1 Costs and Water Price Increases

Building the proposed Desalination Plant is an expensive undertaking which will result in an increase in the price of water to customers. The SA Government introduced a new water pricing structure in December 2007.

In December 2008, the Government announced a further rise in the price of water that will see the cost of water rise in real terms by 17.9% on average (before inflation) from July 1 2009. This new set of price rises is structured to encourage households to be more water wise as less water consumption will result in lower costs for water. The new price rises will see the average household water bill increase by 90 cents a week, while households consuming more than 520 kilolitres and less than 700 kilolitres per annum will see their water bill rise by an average of $4.07 per week. Concessions will continue to be available for pensioners and low income customers. Further information on these price rises is available on: www.sawater.com.au/SAWater/YourAccount

These new water price increases are required to fund a range of critical water security initiatives and infrastructure, including the accelerated Desalination Plant, currently being developed by SA Water, as well as provide an incentive for residential customers to minimise their discretionary use of water.

The additional water security initiatives include the ongoing support for the Water Proofing Adelaide Strategy to meet increases in demand for water arising from population growth while implementing a suite of demand-reduction measures.

The economic modelling carried out for the 50 GL Desalination Plant and associated works indicated that the positive effects of stimulating the economy through additional capital expenditure would result in a net positive impact on the SA economy. Water price increases have been considered as part of this EIS economic modelling.
The costs of the proposed Desalination Plant have been included in the SA Government’s budgetary calculations and will not, as a result, place State finances under undue pressure. The economic modelling also demonstrated the cost efficiency of the project over the 20-year life of the Plant.

As the Desalination Plant is to be delivered through a Design, Build, Operate and Maintain approach, the Government is effectively passing on an appropriate level of financial risk associated with the project to experienced Contractors who will be engaged to build and operate the Plant. This complements one of the key objectives of the project being to enable an optimum allocation of risks between SA Water and the private operator to provide SA Water with a value for money outcome. Accordingly, the SA Government has not and will not enter into onerous arrangements with private operators.

3.3.2 Local Development and Employment Opportunities

SA Water recognises the potential benefits to strategic projects in southern metropolitan Adelaide and to local economic development and employment arising from the proposed Desalination Plant. SA Water wishes to enhance these economic benefits in consultation with the Cities of Marion and Onkaparinga and the Department of Planning and Local Government, and will work with the Contractor to maximise opportunities for local industry and employment.

The EIS discussed the direct employment opportunities likely to be generated during the construction phase of the project. Approximately 500 full time equivalent (FTE) jobs in the construction, engineering, transport and related services will be generated by the Plant’s development for over two years. These employment opportunities will be available to local residents. The indirect effects of this substantial employment boost will be to create opportunities for local businesses and service providers in a range of industries (e.g. catering, personal and health services, entertainment) which will benefit the local community.

There will be a strong economic incentive for the successful Contractor to engage local businesses, industries and service providers for subcontracting opportunities as a means of minimising the costs of the development.

The Contractor will be required to develop a comprehensive Stakeholder Engagement Strategy to be approved by SA Water to ensure that Councils, stakeholders and local communities remain fully informed of the project's development. This Strategy will provide for ongoing communication between SA Water, the Contractor, local government and vocational providers such as the Australian Technical College to facilitate the ongoing involvement of local businesses and industries in the proposed development. It will also provide opportunities for the alignment of key Marion and Onkaparinga Council projects with the development of the proposed Desalination Plant in ways which are likely to benefit the local community.

The Contractor will also be required to contribute to the development of a number of community assets listed in the environmental objectives and performance criteria (presented in Table 3.1 of the EIS), including the enhancement of the Tjilbruke trail, habitat restoration and revegetation of key sites and the establishment of interpretive resources.

3.3.3 Additional Costs for Plant Expansion

The cost estimate of $1,374 million (nominal dollars) reported in the EIS is for a 50 GL Desalination Plant that incorporates essential infrastructure so that the 50 GL Plant can
be augmented to a 100 GL capacity Plant in the future, without major disruption to the operating (50 GL) Plant. This infrastructure includes:

- Seawater intake and outfall systems;
- Power supply infrastructure;
- Transfer pipeline system;
- Drainage and wastewater system; and
- Layout provision for additional buildings, seawater pumps and outfall conduit energy recovery device.

Construction of a 50 GL Desalination Plant is considered to be a minimum essential climate independent water security response. Without the capability to augment the Plant to 100 GL, the State would be required to enter the market to purchase additional water entitlements to meet future demand requirements.

An economic assessment was undertaken by the SA Government to determine the relative merits of expanding the Desalination Plant to a capacity of 100 GL against the purchase of additional water entitlements. This assessment found that an estimated additional cost of expanding the Plant, to be less expensive and a more secure option than purchasing additional water entitlements, which would be dependent on the market availability of water entitlements. The final cost of expanding the Plant to 100 GL capacity remains subject to the contractual arrangements between SA Water and the selected Contractor.

In addition, the Federal Government has stated its support for the SA Government’s suite of water security initiatives, including the Desalination Plant.

3.3.4 Volume of Water for Various Operational Scenarios

The proposed Desalination Plant will have the capability to be operated continuously at the full design flow capacity or at the minimum flow capacity of 30 ML/d or any flow in between. Should there be surplus drinking water from future rain events, the Plant will also have the capability to be shut-down for any period of time, provided the specified minimum notification is given prior to the shut-down and to the ensuing start-up.

3.3.5 Operations and Maintenance Arrangements and / or Shut Down Costs

The proposed Desalination Plant Operating and Maintenance Contract does not include ‘Take or Pay’ provisions. SA Water will not be required to take a set volume of water in any operating period. The quantity of water produced by the Desalination Plant will be what is required and ordered by SA Water through a forward-looking planning process.

If the proposed Desalination Plant is required to shutdown (particularly due to lack of demand for water) then there will be a reduction of costs incurred by SA Water. The cost reduction will occur in the area of electricity usage, chemicals usage, consumables and Operator involvement for Operation and Maintenance activities. The extent of cost reduction will depend on the length of the shutdown.

During a shut down, SA Water will incur some costs associated with keeping the proposed Desalination Plant in a state of readiness to ensure the plant is properly preserved from a ‘whole of life’ perspective and that no equipment is allowed to rundown so that manufacturers’ warranties are preserved. It is an important requirement in
SA Water’s specification for the proposed Desalination Plant to be capable of being restarted to produce drinking water in a pre-approved and defined period.

SA Water is undertaking a competitive bid process to achieve the most optimum ‘whole of life’ cost that balances equipment life, durability, restart response time and capability to meet safe drinking water at all times. This competitive bid process will achieve the most competitive costs for Operation and Maintenance Arrangements including the shut down costs.
3.4 EIS Process

A number of submissions queried the validity of the EIS process on the basis that the design of the proposed Desalination Plant presented in the EIS is a concept design and that not all studies and investigations have been completed. One submission argued that it was a ‘fait accompli’ that the proposed development would go ahead while others argued that the approval process was flawed due to ‘undue haste’ and the Government deciding on the proposal without an independent judge.

Specific questions related to whether approval was being sought for a 50 GL or 100 GL Desalination Plant, whether the project would be a ‘controlled action’ under the EPBC Act and whether the Technical Review Panel should have been independent of SA Water, reporting directly to the Minister for Urban Development and Planning.

3.4.1 Assessment of EIS

The EIS is based on the concept design for the proposed Desalination Plant that has been developed to provide a sound basis for the technical, engineering and environmental performance outcomes for the project.

The project is to be delivered through a Design, Build, Operate and Maintain approach. This means that the Contractor will undertake the final design of the Plant, as well as build and operate the Plant. This Contractor will be selected on the basis of a competitive bid process, allowing the State Government to maximise value for money whilst also requiring the Contractor to comply with a detailed and extensive set of environmental and engineering performance objectives and criteria (as presented in Table 3.1 of the EIS). The Contractor’s final design must comply with these objectives and performance criteria which aim to protect the environment while providing for a range of social and economic benefits to the metropolitan Adelaide community.

The EIS identifies and considers all potential impacts of the proposed Desalination Plant and details how these impacts are to be mitigated, monitored and managed in ways to avoid any detrimental impacts arising from the construction and operation of the Plant. The concept design provides sufficient information on which to assess these potential impacts and, with the inclusion of the objectives and performance criteria, provides additional assurance that the final design of the proposed Desalination Plant reduces, removes or mitigates any adverse environmental, economic and social impacts.

Whilst it is acknowledged that the Adelaide Desalination Project (ADP) completion date has been brought forward by the SA Government, the approvals process has been undertaken with careful consideration to fulfilling all of the statutory consultation timelines, including early consultation with a range of stakeholders, local councils and Government agencies. The approval process has not been rushed and has followed the requirements of the Major Development process, which provides for the highest level of public scrutiny of the proposed Desalination Plant and its potential impacts under the SA Development Act 1993.

The EIS is a public document and it has been on public exhibition for comment (closing 24 December 2008). The EIS has also been referred to State Government agencies and local governments for comment. It should be noted that all of these agencies and bodies were consulted throughout the development of the EIS to ensure their views have been taken into account during the development of the concept design and the performance objectives and criteria.

The Governor, who will make the final decision on whether to approve the development of the proposed Desalination Plant, will have access to all this information as well as the views of the various assessment bodies and people making submissions to the EIS.
Accordingly, the validity of the EIS and the assessment process more generally can be assured.

SA Water has implemented a number of measures to further validate the integrity of the assessment process. These include the following:

- An Independent Technical Review Panel (ITRP) was engaged by SA Water to ensure that the objectives of the EIS process were achieved, and to verify the transparency and appropriateness of the process applied to the marine environmental investigations. The Panel’s role included providing independent technical feedback and advice to SA Water to ensure that all the major marine environmental issues were identified and addressed and the technical interpretation of investigation outcomes could be supported. The Panel’s advice was not sought to justify the project, as this advice had already been provided through the Desalination Working Group’s investigations and report. Refer to Appendix C for the ITRP’s formal statement on the EIS and the EIS Response Document.

- The ADP was subject to scrutiny by the SA Parliamentary Public Works Committee (PWC). The PWC Enquiry and Report 314 on the Desalination Project can be accessed from the website: www.parliament.sa.gov.au/Committee/Standing/HA/PublicWorksCommittee.htm

- In addition, an Independent Verifier is being engaged to ensure ongoing compliance with the environmental and engineering objectives and performance criteria (presented in Table 3.1 of the EIS).

As noted in the EIS, SA Water has undertaken a comprehensive suite of investigations and studies, involving several hundred technical experts and more than 40 scientific and technical organisations demonstrating its commitment to the EIS process.

SA Water is committed to continuing studies and investigations related to engineering processes and operations, marine processes, marine modelling and water quality, all of which will be subject to ongoing peer review. The ITRP’s formal statement on the EIS (Appendix C) confirms that the EIS and the EIS Response Document addresses all the relevant marine environmental issues.

In addition, the environmental objectives and performance criteria that will apply to all aspects of the proposed Desalination Plant design, construction and operation require the Contractor to ensure that the marine environment will not be harmed by the proposed development. All studies undertaken will also inform the development of a suite of Construction and Operational Environmental Management and Monitoring Plans. The objectives and performance criteria, as well as the array of management plans that the Contractor will implement, will not only be reviewed as part of the EIS assessment process, but will also require approval from the EPA.

The EIS was lodged with the Department of Planning and Local Government on 11 November 2008. SA Water received notification from the Commonwealth Department for the Environment, Water, Heritage and the Arts (DEWHA) confirming that the proposed Desalination Plant would not require further assessment and is considered to be a ‘non-controlled action’ requiring approval under the Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth) on 11 November 2008 (Appendix D).
3.5 Planning and Environmental Legislation

Submissions about planning and legislative issues associated with the proposed Desalination Plant can be summarised into the following categories:

1. Assessment of the Desalination Plant - Additional provisions of the Onkaparinga (City) Development Plan concerning setbacks, fencing and protection of natural resources should be considered as part of the assessment of the proposed Desalination Plant and that the proposal is contrary to the Development Plan provisions. Supporting infrastructure associated with the proposed Desalination Plant should be addressed as part of the EIS process.

2. Impacts of Plant on adjacent uses - The scale of the Desalination Plant relative to existing development in the locality may have impacts on the amenity of the residential area to the north (within the City of Marion) and industrial uses to the east of the proposed Desalination Plant.

3. Proposed Coastal Conservation Zone - The City of Onkaparinga’s Environment Development Plan Amendment (yet to be authorised) proposes to rezone a section of the subject site to Coastal Conservation Zone and so any Desalination Plant structures should be located as far as possible from the cliff area to avoid any potential land use conflicts.

4. Desalination Plants as a prescribed activity - Desalination Plants should be prescribed as an activity of environmental significance pursuant to Schedule 1 of the Environment Protection Act.


6. Adelaide and Mount Lofty Ranges Natural Resources Management Plan (NRM Plan) Plan - The relationship of the proposed Desalination Plant with the NRM Plan should be further clarified.

3.5.1 Assessment of the Desalination Plant

Prior to lodgement of the EIS, SA Water lodged a development application with the SA Development Assessment Commission (DAC) that provided a detailed assessment of the proposed Desalination Plant against the relevant provisions of the Onkaparinga (City) Development Plan and the Land Not Within a Council Area (Metropolitan) Development Plan. This assessment concluded that the proposed development would be able to be managed in such a way as not to cause any environmental harm to the marine and terrestrial environments in and around the development site. The planning assessment of the proposal contained within the EIS reached the same conclusion with the benefit of additional analysis based on a more advanced concept design.

The City of Onkaparinga has agreed with and confirmed the validity of the planning assessment contained within both the development application and the EIS in its submission to SA Water.

In relation to the additional Development Plan provisions noted in the submissions, it is considered that the proposed Desalination Plant complies with these provisions. The proposed structures are to be located at least 50 metres from the Coastal Zone boundary (allowing a building height of 33 metres according to Council Wide Industrial Development PDC 3) and at least 200 metres from the City of Marion boundary. Hence, the proposed development is consistent with provisions relating to setbacks. Furthermore, the proposed Desalination Plant will be bounded by standard security
fencing, which will be screened by landscaping, as per Council Wide Industrial Development PDC 9.

The Contractor will be required to adhere to objectives and performance criteria established by SA Water (presented in Table 3.1 of the EIS), which require the Contractor to protect the amenity of the locality and minimise noise during construction and operation, including from marine noise and vibration. As part of the criteria, it is required that a Noise and Vibration Management Plan be developed. In addition, it is required that visual amenity, including landscape and amenity values of the coastline, are protected. Hence, the amenity of the residential land to the north and industrial land to the east of the subject site will be protected as a matter of priority.

SA Water’s environmental objectives and performance criteria also require the Contractor to protect natural resources, including the coastal environment, native flora, fauna and ecosystems, and develop appropriate stormwater management systems.

The electricity and ancillary infrastructure associated with the proposed Desalination Plant is subject to an alternative development approval process. Electricity infrastructure is exempt from approval under Section 49A of the SA Development Act 1993 and is also excluded from the Major Development process. Nonetheless, it is worth noting that the design of all supporting infrastructure must comply with the objectives and performance criteria listed in Table 3.1 of the EIS, which address concerns raised regarding potential vegetation loss, visual impact of structures, importance of appropriate screening and impacts on surrounding residents and traffic.

3.5.2 Impacts of the Plant on Adjacent Uses

SA Water notes that the proposed Desalination Plant development is appropriately located within an industrial zone, which encourages large or heavier industries. Furthermore, the proposed structures will be located considerable distances from residential development to the north, which will minimise any possibility of noise pollution or impacts on visual amenity. The proposed structures will be designed to blend in with the natural landscape. In addition, the proposed development will be screened from view by existing oil refinery structures to the south and existing and proposed mounding and landscaping with indigenous plant species. Accordingly, the proposed Desalination Plant is considered to be of a scale and nature appropriate to the Industry Zone, General Industry Policy Area and the locality.

3.5.3 Proposed Coastal Conservation Zone

The City of Onkaparinga’s Development Plan Amendment (DPA) has not yet been authorised by the Minister for Urban Development and Planning and so is not applicable to the assessment of the proposed Desalination Plant.

Nonetheless, the key objective of the DPA is to conserve the biodiversity values of the coast which would facilitate rehabilitation of remnant coastal vegetation along the coast at Port Stanvac. This objective aligns with the requirements of the environmental objectives and performance criteria established by SA Water for the proposed Desalination Plant (presented in Table 3.1 of the EIS) which provide for the protection of the coastal cliffs as well as the protection of biodiversity values of the site. As noted in the EIS, the Contractor engaged to build and operate the Plant must comply with these objectives and performance criteria.

In addition, the CEMMP to be developed by the Contractor will identify areas of existing ecological significance. These will be classified as ‘no go’ zones, and will include the cliff
zone. The CEMMP will also address biodiversity protection, including flora and fauna management at the site.

Accordingly, it is considered that any potential land use conflicts between the proposed Desalination Plant and the proposed Coastal Conservation Zone will be effectively mitigated.

### 3.5.4 Desalination Plants as a Prescribed Activity

As specified in Section 5.4.2 of the EIS, the proposed Desalination Plant will be licensed for the activity of discharge to marine waters pursuant to Schedule 1 of the Environment Protection Act, as well as other prescribed activities including dredging, earthworks, drainage, and storage and warehousing of chemicals.

SA Water understands that the SA Government has been reviewing the need to make Desalination Plants an **Activity of Environmental Significance** in Schedule 1 of the *Environment Protection Act 1993* and therefore make them licensable by the EPA.

### 3.5.5 Objectives of Fisheries Management Act and Marine Parks Act

The proposed development is consistent with the objectives of the SA *Fisheries Management Act 2007* and SA *Marine Parks Act 2007* in that considerable care has been taken during the concept design of the Desalination Plant to ensure that any impacts to the marine environment are minimised and will not cause environmental harm, particularly to aquatic ecosystems and features of natural or cultural heritage significance.

The environmental objectives and performance criteria provide a degree of assurance in this regard as the Contractor engaged to build and operate the Plant must comply with the requirements to protect marine flora and fauna and associated habitats, protect the ecological integrity of the marine environment, protect marine mammals, avoid the introduction, spread and establishment of marine pests and protect sites of Aboriginal and non-Aboriginal heritage significance.

The SA Government has committed to designating a suite of 19 marine parks in State waters by 2011. The marine park boundaries are currently in the process of being finalised and are likely to be announced in the next few months.

As noted above, the proposed Desalination Plant would not be in conflict with the values and conservation principles of the Marine Parks Act should a marine park be designated within Gulf St Vincent. The basic principle in the development of the SA marine parks is the recognition of multiple uses within marine parks. Multiple use marine parks will provide for ecological sustainable use, whilst at the same time providing for conservation and protection of the marine environment. Most activities, including recreation, commercial fishing and industrial activities such as the proposed Desalination Plant, will still be allowed within a marine park boundary, although there will be particular zones or periods of time where some activities (such as fishing) will not be permitted.

The nearest existing marine conservation zones are the Port Noarlunga Reef Aquatic Reserve and the Onkaparinga Estuary Aquatic Reserve. The EIS highlighted that the activities of the proposed Desalination Plant are unlikely to impact on the ecological values of these areas.
SA Water acknowledges that i) the visions and goals of the Adelaide and Mount Lofty Ranges Natural Resources Management Plan (NRM Plan) should be recognised as being those of the broad community and the Minister, and ii) the NRM Plan works towards achieving the goals of the State Natural Resource Management Plan.

In securing and diversifying metropolitan Adelaide’s water supply, the proposed Desalination Plant will contribute to enhancing sustainable water use, and therefore contribute to achieving Target T3 of the NRM Plan. As indicated above, metropolitan Adelaide’s water supply remains highly dependent on the River Murray and Mount Lofty Ranges systems, both of which are experiencing significant stress. By providing the sole climate independent water source, therefore, the Desalination Plant will enhance the sustainability of metropolitan Adelaide’s water supply system.

The Contractor engaged to build and operate the proposed Desalination Plant will be required to comply with the environmental objectives and performance criteria presented in Table 3.1 of the EIS. These objectives and performance criteria provide for the protection of biodiversity values at the proposed site as well as the ecological integrity and values of the marine environment and include the following:

- The requirements of the SA Native Vegetation Act 1991 must be adhered to;
- No removal of native vegetation is to be undertaken at the site without prior approval of SA Water;
- Design to ensure that impacts to terrestrial flora and fauna are avoided or minimised;
- Design to ensure that site stormwater management is in accordance with a Soil Erosion Drainage Management Plan (refer to Section 3.8.9);
- Protect waterways and surface water quality;
- Protection of marine flora and fauna;
- Saline concentrate discharge must comply with EPA licence conditions and any other regulatory requirements (including water quality guidelines); and
- Design that minimises the impacts to habitats and risk to marine biota.

In adhering to these requirements, the proposed Desalination Plant will i) assist in the conservation of native species, ii) ensure proper management of on-site stormwater, iii) avoid land based impacts on coastal waters, iv) ensure water quality discharge meets water quality guidelines, and v) prevent any decline to the marine environment, and therefore contribute to achieving Targets T9, T1, T10, T12 and T11 of the NRM Plan respectively.
3.6 Site Selection

Submissions concerned with the site selection process can be summarised as follows:

1. Site selection process - Some submissions were critical of the site selection process and the selected site for the proposed Desalination Plant.

2. Proximity of Plant to cliff edge – Concerns were raised about the proximity of the proposed Desalination Plant to the cliff edge.

3.6.1 Site Selection Process

The site selection process involved first identifying potential locations along the Adelaide coast of Gulf St Vincent and the South Coast. The identification of potential sites considered broad environmental and risk evaluation criteria, including existing land use and zoning, potential environmental impacts of constructing intakes and outfalls, site vegetation, presence or absence of threatened flora and fauna species, and cultural (Aboriginal and non-Aboriginal) heritage. The evaluation process included broad desktop assessments relating to these criteria. Twelve sites were identified as meeting the environmental and risk criteria.

A multi-criteria analysis of these twelve sites was undertaken which assessed a range of environmental, social and economic factors including:

- Proximity to the coastline, site size and elevation;
- Availability of suitable land for a full-scale Desalination Plant;
- Availability of suitably zoned land for a Desalination Plant sufficiently distant from residential areas;
- The nature of the offshore marine environment, seawater depth and dispersion characteristics;
- Potential heritage (both European and Aboriginal) and environmental issues associated with the site;
- Availability and accessibility of power to the site;
- Expected energy use associated with Plant and transfer pumping; and,
- Ease and cost of integration with the existing water supply system.

Based on this assessment, the following three sites were considered for further analysis:

- Pelican Point;
- West Beach (near Adelaide Airport); and
- Port Stanvac.

The results of the analysis indicated that Port Stanvac offered a number of advantages over the other sites owing to its relatively deep seawater, superior marine dispersion characteristics, ease of integration into the metropolitan water supply network, suitable industrial land use zoning, less impacts to vegetation at the site and lower life cycle costs.
The Port Stanvac site was also seen as desirable for its secure coastal location, available vacant land, its accessibility by sea and by road and the fact that the use of the site for developing and operating a desalination plant would cause minimal disruption to existing beach and marine users. For a range of environmental, economic and social reasons, therefore, Port Stanvac was chosen as the preferred site for the proposed Desalination Plant.

In relation to the issue of seawater depth, the analysis demonstrated that seawater depth decreases significantly north of Port Stanvac along the Gulf coast. Not only is the water shallower north of Port Stanvac, it also demonstrates poorer dispersion characteristics. Potential sites at West Beach and Pelican Point, for instance, were found to exhibit both shallow water and poor dispersion, which would have required the construction of significantly longer pipes in order to achieve the necessary dispersion of the seawater concentrate produced by the proposed Desalination Plant. In addition, the sites north of Port Stanvac were identified as having sensitive marine habitats containing extensive seagrass meadows and important nursery areas for particular fish species. For these reasons, locations north of Port Stanvac were considered to present too many environmental and economic impacts to warrant selection.

While seawater depths south of Port Stanvac are generally greater, the additional distance and related costs of constructing the necessary infrastructure to transfer water north to the metropolitan water supply system were considered to be excessive and would have led to a significant increase in the cost of water to Adelaide residents and energy use for the Plant.

In summary, the key advantages of the location at Port Stanvac for the proposed Desalination Plant include:

- The marine impacts are likely to be lower than at the other sites;
- The environmental impacts of the outfall are likely to be less than at the other sites;
- A significant cost advantage over the other short-listed sites;
- Potential land available for expansion should this be necessary;
- A buffer zone is readily available to protect nearby residents from potential impacts associated with the construction and operation of the Plant; and
- There is relatively efficient and safe access to the site for construction traffic.

### 3.6.1.1 Port Stanvac Location Options

Two possible locations within Port Stanvac were considered for the proposed Desalination Plant, in two land parcels positioned adjacent to the existing Mobil Oil Refinery. The identified land parcels are owned by Mobil Oil Australia (‘Mobil’) and negotiations for their acquisition were undertaken between SA Water and Mobil. The two sites are presented in the EIS and described below;

**Southern Site**

This site is located within the existing refinery site. Any works relating to excavations in this area would need to be undertaken to address possible contamination and disposal of surplus soil. This site is located adjacent to a well established residential district which would require the implementation of a specifically developed construction strategy to minimise disruption to the residents within the neighbourhood and a sound proofing strategy within the final Plant design and construction configuration to minimise Plant
operational noise. This land parcel is generally flat with gentle slopes and abuts the coast on the western side.

**Northern Site**
This site has never been used by the refinery for process related needs. It has been used for general grain farming. This area slopes up from west to east and is traversed by a drainage gully. It is currently surrounded by light industry on the eastern side and abuts the coast on the western side.

Both of the possible land parcels are located within the Mobil land holding and are accessible with existing roads and services from the eastern side (Figure 3.1).

**Preferred Location**
The Northern Site was considered to be the preferred location for the Plant. The likely contamination issues on the Southern Site and the proximity of residences make the Northern Site significantly more attractive, particularly if the refinery becomes operational in the future. A Heads of Agreement has been signed with Mobil to purchase the land for the proposed Desalination Plant. This land is of a sufficient area to accommodate the Plant, associated structures and the required buffer areas, there is no provision on site for additional industrial activities.

SA Water will acquire the northernmost part of this site, with Mobil retaining the land to the south of the natural drainage line (creek bed). SA Water will lease the southern portion from Mobil during construction of the proposed Desalination Plant as a construction ‘lay-down’ area. The natural drainage line will be a ‘no-go zone’ during construction prohibiting the Contractor from using this area for construction or development purposes. However, a temporary bridge will be constructed to allow the movement of vehicles between the leased area and the Desalination Plant site. The Contractor will be required to ensure that this temporary bridge will not adversely impact on the natural drainage line.

In addition, there are two exclusion zones within the leased area. These include the revegetated wind break in the southeast corner of the leased area and the southwest corner of the leased area which has been identified as potentially containing Aboriginal heritage artefacts (Figure 3.1). Upon completion of construction activities, the leased area will be returned to Mobil and the drainage line will be managed to provide a buffer between the Mobil refinery land and the Desalination Plant site.

3.6.2 **Proximity of Plant to Cliff Edge**
A key consideration in the positioning and design of the proposed Desalination Plant is the need to protect the integrity of the cliff. To this extent, a 10 metre exclusion zone behind the cliff edge has been imposed to ensure sensitive vegetation and the integrity of the cliff is protected.

While most structures of the proposed Desalination Plant are expected to be some distance from the cliff edge, the intake and outfall systems and associated shafts will be situated closer to the edge in order to minimise tunnel lengths.

The cliff consists of proterozoic sedimentary rock units consisting of quartzite and siltstone overlain with argillites which is considered overall to have high rock strength. Wave action at the cliff base can be anticipated to marginally increase coincident with sea level rise. The cliff is not, however, expected to erode quickly or in any significant manner due to its geology and the slow rate of increase in sea level. The cliff zone can
also be monitored during the project life and any protection measures implemented if necessary.
Figure 3.1 Location of proposed Desalination Plant
3.7 Energy and Carbon Neutrality

Submissions about energy issues associated with the proposed Desalination Plant can be summarised into the following categories:

1. Energy requirements - The total greenhouse footprint of the Plant, including the need to provide an updated Table 6.3, estimates of energy requirements to construct a 75 GL or 100 GL Plant. One submission argued that the proposed Desalination Plant should be zero net emissions on a life-cycle basis and that it is not compatible to the recent White Paper on Carbon Pollution Reduction Scheme. Ensuring supplies to local households and businesses are not unreliable and whether energy efficient and or low emission options for back up generation were investigated.

2. Carbon neutrality – Submissions were concerned with the definition of ‘carbon neutrality’, SA Water’s approach to achieving carbon neutrality and the need for a statement of key commitments and actions relating to the achievement of carbon neutrality over the life of the project. One submission raised the potential impacts of multistage flash (MSF) thermal pollution on the environment.

3. Renewable energy – The proposed Desalination Plant should attract new renewable energy investment in SA. The need to use ‘real’ and additional renewable energy was also raised. One submission argued that the use of Green Power for the Plant enabled pollution levels to be increased by ‘deferred means’. The implications for other businesses to access and purchase green energy was raised in one submission. The use of on-site power generation and whether Cape Jervis would be a better location than Port Stanvac for opportunities such as wave power.

4. Climate Change – Concerns over an energy-intensive project within the context of climate change and the potential for cliff-face erosion from sea-level rises.

5. Sustainability - Issues regarding the consistency of the project with SA Water’s corporate objectives were raised.

3.7.1 Energy Requirements / Greenhouse Footprint

Table 6.3 in the EIS (Section 6.7.3) summarises the estimated greenhouse gas emissions and includes data on construction steel, concrete, excavation quantities and other inputs. The greenhouse footprint for the final design is anticipated to be within these estimates or better (i.e. lower emissions) through use of innovative desalination processes and improved membrane recovery rates. SA Water has specified in its procurement specifications that the Desalination Plant Contractor must consider designs and initiatives that reduce the greenhouse footprint and achieve lower than 4.5kWhr/kL of drinking water produced.

Table 6.3 of the EIS has been updated and details the preliminary potential greenhouse gas emissions estimates. The updated table is provided in Table 3.1 and shows estimates of possible greenhouse sources involved in the Plant and delivery pipeline. In this table there is reference to the scope of emissions as described by the National Greenhouse and Energy Reporting System – Reporting Guidelines (2008), which is summarised in Figure 3.2.
Figure 3.2 Emissions described under the National Greenhouse and Energy Reporting System
## Table 3.1 Preliminary potential greenhouse gas emissions estimates for the 50 GL plant

<table>
<thead>
<tr>
<th>Resources</th>
<th>Resource Quantity</th>
<th>Yearly Construction greenhouse emissions annualised over 2 years (construction timeframe)</th>
<th>Yearly Greenhouse gas emissions annualised over 20 year asset life</th>
<th>Scope of Emissions</th>
</tr>
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<tr>
<td><strong>Operations</strong></td>
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<td></td>
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<tr>
<td>Electricity - Treatment (MWh)</td>
<td>250,000 per year</td>
<td>245,000</td>
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<td>Electricity - Pipeline (MWh)</td>
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<td>2&amp;3</td>
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<td>Chemicals (T)</td>
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<tr>
<td>Membranes (MWh)</td>
<td>9045 every 5 years</td>
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<tr>
<td>Diesel (kL)</td>
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<td><strong>Construction - Main Plant</strong></td>
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<tr>
<td>(Once off Resource needs)</td>
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<tr>
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<td>2&amp;3</td>
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<td><strong>Construction - ETSISA Power Facilities</strong></td>
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<tr>
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<td><strong>Construction - Other</strong></td>
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<tr>
<td>Minor and Unknown GHG emissions</td>
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<tr>
<td><strong>Total emissions potential</strong></td>
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<td>40,081</td>
<td>307,885</td>
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3.7.1.1 Energy Requirements to Construct a 75 GL or 100 GL Plant

Although Table 6.3 of the EIS provides estimates of energy requirements for the 50GL Plant, the Plant has been designed to increase to full capacity (up to 100GL), so there would be minimal additional construction energy required to expand the Plant from 50GL to 100GL. Additional buildings for process equipment will be required, but intake and outfall structures, buildings and pipelines will be sized for the ultimate capacity of 100GL.

The key area of difference relates to operations. In particular, energy and other ongoing resource inputs would be doubled to operate a 100GL Plant. Chemical and membrane requirements would also increase proportionately, but overall represent a much smaller energy contribution.

3.7.1.2 Reliability

Electricity for the proposed Desalination Plant will be supplied from the 66kV electricity grid and the proposed Desalination Plant will require upgrades of ETSA infrastructure from Port Stanvac to Morphett Vale East, Sheidow Park to Port Stanvac and a new ETSA substation to accommodate the large power base required. This new infrastructure will ensure that ETSA’s network can reliably supply energy to the proposed Desalination Plant and existing electricity users with no impact on network security.

In addition to the work being undertaken by ETSA on the electricity distribution system, ElectraNet (the high voltage transmission system operator) is planning network upgrades to the high voltage system from Torrens Island to the city to strengthen electricity supply to the southern suburbs. The ElectraNet project was already planned to meet growth in the demand for electricity in Adelaide’s southern suburbs and is not being undertaken as a direct result of the proposed Desalination Plant. The ElectraNet project is planned for completion in December 2011, in line with the Electricity Supply Regulations which requires an upgrade to electricity supply in Adelaide no later than December 2011.

The Electricity Supply Industry Planning Council (Planning Council) has been established to monitor the electricity supply industry in SA. As such, the needs of new infrastructure and growing communities feed into State electricity supply planning processes, of which both ETSA and ElectraNet have input. The additional load and transmission requirements for the proposed Desalination Plant have been included in these planning processes.

To further ensure protection of electricity network security to other electricity customers the proposed Desalination Plant may be required to curtail load under certain circumstances. This includes emergency situations or loss of generator capacity. In addition, prior to completion of ElectraNet’s upgrade project in December 2011, SA Water may be required to operate the proposed Desalination Plant with reduced power load for some hours on very high electricity demand days during summer so that network security can be maintained. SA Water has requested in its specifications for the Contractor to consider opportunities to utilise these curtailment periods to undertake planned/ preventative maintenance of equipment. This will ensure load curtailment will not impact on the proposed Desalination Plant’s ability to deliver 50 GL of drinking water into the SA Water network.

3.7.1.3 Back-Up Energy

As discussed in Section 3.3.5.2 of the EIS, the concept design allows for back-up power in the form of diesel generation to be provided only for a small, intermittent electrical load of less than 1 Megawatt for essential services and is a requirement of the DBOM Contract.
Natural gas fuel supply was considered by the Desalination Working Group (DWG) during concept design for the entire proposed Desalination Plant electrical load and would have required the development of a dedicated gas pipeline to the facility only for infrequent use.

3.7.2 Carbon Neutrality

3.7.2.1 Energy Required to Operate the Plant

The State Government has committed the proposed Desalination Plant to be ‘carbon neutral’, including requirements to operate the Plant and delivery pipeline with renewable energy or the purchase of carbon permits and/or offsets. It is the ongoing electricity requirement that makes up the largest potential source of greenhouse gas emissions.

Strategies are being developed to manage the greenhouse gas emissions associated with the construction and operation of the proposed Desalination Plant. For the operation of the proposed Desalination Plant it is anticipated that emissions will be managed through the purchase of accredited renewable energy such as Green Power or through the purchase of carbon permits and/or offsets.

3.7.2.2 Renewable Energy Options and Carbon Neutrality

SA Water has issued a Request for Expressions of Interest (EOI) seeking responses from companies to provide electricity, accredited renewable energy / carbon permits and carbon offsets for the proposed Desalination Plant and SA Water additional energy requirements. In regard to acquiring accredited renewable energy sources, there is a preference for the renewable energy requirements to be obtained from a clearly identifiable and sustainable generating source in the National Electricity Market.

SA Water is also continuing discussions with the Federal Government on standards and the voluntary mechanisms that would enable carbon neutrality to be achieved. Following this the contractual arrangements for the supply of power can be further developed. SA Water will be in a position to outline the key commitments and actions to achieve carbon neutrality following the end of the EOI process and finalisation of discussions with the Federal Government.

3.7.2.3 Alternative Water Sources

As discussed in Section 2.4.4 of the EIS and Section 3.2 of this Response Document, through the Government’s water security strategy a range of initiatives to ensure reliable water supplies for the future are being progressed.

The need to provide a Desalination Plant for Adelaide arises from recognition that the current prolonged period of drought and low flows caused by natural climate variability and climate change has placed Adelaide’s water reliability at such risk that an additional climate independent supply is required within a relatively short timeframe.

Desalination is an energy intensive way to produce water. The least energy intensive water supply comes from natural rainfall in hills catchment areas gravitating to water filtration plants and into the distribution network. Pumping from the River Murray also requires considerable energy.

SA Water is committed to and involved in developing and supporting other potential water sources such as increasing wastewater recycling, stormwater harvesting and aquifer storage and recovery (ASR). These alternative water sources have the potential
for treatment to drinking water standards which would also require additional energy for the treatment and pumping into the headworks of the water distribution system.

A number of stormwater initiatives are currently being implemented across metropolitan Adelaide, many of which are led or supported by State, local governments and SA Water.

There are however challenges associated with creating a diverse number of alternative water supply systems, each of which would be relatively smaller in scale. Each would present unique planning issues and greater potential water quality risks that would need to be managed before water could be provided safely into SA Water’s distribution network.

The Desalination Working Group identified a compelling need to provide security for Adelaide’s water supply in a shorter timeframe than would be achievable by creating stormwater harvesting with ASR and additional treatment and other alternative sources at the volume required.

Unlike seawater, stormwater is also reliant on rainfall and, as such, is a climate dependent water source. The proposed Desalination Plant is the only climate independent water source and is therefore essential to providing long-term security to Adelaide’s water supply.

3.7.2.4 Impacts of Thermal Pollution

The proposed Desalination Plant will be based on reverse osmosis (RO) membrane technology and not thermal desalination. Multistage flash is a type of thermal desalination.

Thermal desalination is more energy intensive and requires significant amounts of low grade waste heat (such as in the form of steam). Co-location of the Adelaide Desalination Plant with local power generation plants was considered, but found to be costly, with respect to integration requirements. Most thermal desalination plants are coupled with power generation facilities, such as in the Middle East, where oil and gas reserves are significant. Some of these facilities use both thermal and reverse osmosis membrane desalination processes to maximise energy efficiency of the desalination plant.

For Adelaide, seawater reverse osmosis desalination was established as the most cost-effective process. This is consistent with international trends in the developed world.

3.7.3 Renewable Energy

3.7.3.1 On-Site Power Generation

As noted in the EIS documents, the DWG considered as part of its preliminary scoping estimates, the potential for ‘on-site renewable energy’. The scale of the infrastructure required for ‘on-site’ generation is excessive and rules out the possibility of meeting the operational energy requirements of the proposed Desalination Plant. Additional energy sources are required from the transmission grid. Where renewable energy options are offered, this would include other sources and mechanisms to manage intermittency.

The need for reliable power supply requires SA Water to enter into contracts for renewable energy projects from any location, and for SA Water’s renewable energy needs to be met from renewable energy developments at locations that provide the best
value for money, flexibility of operation, grid connectivity and meets SA Water’s project objectives.

On site opportunities

At the Port Stanvac site, there are opportunities to incorporate limited on-site renewable energy generation to provide power for some ancillary services (e.g. office lighting and cathodic protection systems) as part of the Plant design. Such technologies would include a range of solar and low impact wind sources.

In addition, an energy recovery hydro turbine will also be considered in the seawater concentrate return pipe to recover residual energy, if possible.

Large scale wind turbines have not been considered on site due to area constraints, less than ideal wind conditions, close proximity to human settlements that may be affected by shadow flicker and the need for the development to meet visual amenity requirements for the area generally.

Renewable Energy to Manage Operational Electricity Emissions

SA Water has issued an EOI to provide electricity, renewable energy / carbon permits and carbon offsets for the proposed Desalination Plant and SA Water additional energy requirements. In regards to acquiring renewable energy sources, there is a preference for the renewable energy requirements to be obtained from a clearly identifiable and sustainable generating source in the National Electricity Market.

3.7.3.2 Off-Site Power Generation / Location at Cape Jervis

SA Water is committed to supporting South Australia’s greenhouse gas reduction and renewable energy targets.

In the preliminary scoping estimates, the Desalination Working Group considered existing local / state-based wind farm opportunities, and acknowledged that additional energy sources would be required and grid transmission connection to link to additional sources and a firming up mechanism included in renewable energy contracts (to manage the intermittent availability of renewable energy).

As outlined in Section 6.5.2 of the EIS, direct on-site renewable energy generation at the scale required for the proposed Desalination Plant is not feasible due to the limited site area available and proximity to human settlements. The need for grid connection requires SA Water to enter into contracts for renewable energy projects from any location, and for SA Water’s renewable energy needs to be met from developments at locations that provide the best value for money, flexibility of operation, grid connectivity and meets SA Water’s project objectives.

For the major electricity requirements supply contracts will be arranged to cover the standard electricity and the intended renewable energy supply components.

Renewable energy would be purchased through a retail contract arrangement that includes a firming up mechanism to deal with intermittency of renewable energy supplies. When renewable energy sources are generating more energy than is required, the surplus goes to the grid and is used by other customers. When renewable energy sources are not generating enough power, the firming up mechanisms allows energy to be drawn from other contributing sources that feed into the grid. The total annual amount of renewable energy (MWh) assigned to the proposed Desalination Plant would be matched annually.
3.7.3.3 The Implications for Other Businesses to Access and Purchase Green Energy.

Options to purchase accredited renewable energy include energy from a renewable energy project or projects. Should this option be adopted, the project would add to the available pool of renewable energy and is unlikely to cause upward pressure on renewable energy prices in general or remove the availability of renewable energy from the market.

3.7.4 Climate Change

As discussed in Section 2.4.4 of the EIS, through the Government’s water security strategy a range of initiatives to ensure reliable water supplies for the future are being progressed.

As outlined in Section 6.8.4 of the EIS, climate change is a major threat facing coastal areas throughout Australia and careful planning of coastal infrastructure is required.

3.7.4.1 Current Projections of Sea Level Rise

As outlined in Section 6.8.4 of the EIS, the Coast Protection Board recommends that on top of the 100 year average recurrence interval (ARI) extreme water level (calculated by taking into account site specific factors such as wave set-up, run-up and stormwater heights during extreme tides), a mid-range sea level rise of 0.3 metres by the year 2050 be adopted for most coastal planning and design, which represents a continuation of the present rate rise (and is not additional to it).

Notwithstanding the uncertainties of sea level rise projections, the Board has adopted a further rise of 0.7 metres (i.e. 1.0 metre total) to the year 2100, for development that cannot be reasonably protected by the further rise in sea level.

Similarly, as referenced in the EIS, the Inter Governmental Panel on Climate Change in its fourth assessment suggests that sea level rise of approximately 0.5 metres is plausible by 2100.

3.7.4.2 Likelihood of Revised Estimates

SA Water is well aware that anthropogenic climate change is likely to cause sea level rise in this century and centuries that follow, and that projections of sea level rise to 2100 are now regularly reviewed and are only likely to be revised upwards due to the increasing heat being absorbed into the oceans and the inertia of such a large heat sink.

3.7.4.3 Planning Impact on this Project

The nominated design, build, operate, maintain Contract for the proposed Desalination Plant is 20 years during which time there is unlikely to be a substantial increase in risk. Noting that such infrastructure is often maintained and refurbished for a much longer asset life, and that some individual asset components are designed for an asset life of 80 years or more, there is merit in assuring that where possible, the system can continue without the need for relocation.

The 3.0 metre buffer (safety margin) allowed for in the design of the Plant inlet structures is greater than current planning guidelines suggest is necessary and will go a long way to ensuring that the system can continue to operate with rising sea levels, across its nominated asset life and across the asset life of longer life components.
In regard to cliff face erosion, this will be taken into account in the detailed design of the intake and outfall pipelines with consideration of local geo-technical data. This will ensure recognition of potential changes in erosion rates and stability.

Coastal asset protection systems are regularly provided for buildings and infrastructure exposed to the high energy conditions coastal environments are exposed to, including where structures are located near cliff faces and wave cut platforms. If necessary, at a later date, additional protection measures could be added to further protect the intake and outfall structures.

The proposed Desalination Plant is located at least 30 metres above sea level and no impacts to the Plant’s process infrastructure are expected to occur due to predicted sea level increase.

3.7.5 **Sustainability**

3.7.5.1 **SA Water’s Corporate Objectives**

SA Water’s Objectives for the proposed Desalination Plant are outlined in Section 2.2.1 of the EIS. This includes achieving South Australia’s Strategic Plan targets within SA Water’s strategic objectives particularly in respect to sustainability, obligations to the owner (the State), customers, water quality and security. SA Water will also require the achievement of the highest standards of safety compliance with the aim of zero harm.

SA Water is committed to the environment and its sustainability policy which allows for an energy procurement plan including opportunities for renewable energy for the operation of the ADP. The development of the proposed Desalination Plant is in accordance with SA Water’s corporate objective to provide a sustainable and secure water supply for the future.

In addition, SA Water has prepared detailed environmental performance criteria. These criteria must be adhered to by the Contractor and will provide a sustainable and secure water supply aligned with SA Water’s Corporate Objectives. Also, the Contractor is required to prepare separate sustainability management plans for each of the design, construction and operation phases of the Desalination Plant, outlining the commitments to sustainability issues and measures to be adopted to ensure compliance.

SA Water is committed to supporting the Government’s greenhouse gas reduction targets by actively managing its own gas emissions and by influencing the behaviour of others.
3.8 Management Strategies

A number of issues regarding the development and finalisation of the Environmental Management and Monitoring Plans associated with the proposed Desalination Plant were received in submissions as follows:

1. Management arrangements - A copy of the CEMMP and OEMMP should be provided to Councils and Government agencies for review, and made publically available for wider comment and review. The OEMMP should include monitoring, evaluation and reporting requirements while the provision of a draft CEMMP in the Response Document will avoid the imposition of a reserve matter.

2. CEMMP and OEMMP preparation criteria - That the proposed CEMMP have regard to the criteria outlined in the EIS.

3. Contamination management - Assessment and management of contaminated soil and management of construction to ensure any potential to contaminate groundwater is managed.

4. Waste management arrangements - Development of a waste minimisation and management plan including detailed descriptions of onsite waste storage facilities, waste loading and off loading areas, routes that will be taken by waste disposal vehicles and locations of offsite waste disposal.

5. Storage and Spill Plans - The development of storage or spill plans in consultation with relevant emergency response agencies.

6. Native vegetation - Measures to protect adjoining areas of native vegetation from site works be identified in the relevant management plans, including access and stormwater controls and that mitigation strategies are identified to control weeds, introduced and existing.

7. Council-infrastructure - Any works undertaken on Council infrastructure are carried out in consultation with Council and any damage to Council infrastructure is repaired at the cost of SA Water.

8. Cliff face management - That a large buffer be created along the cliff line of the proposed site. The ongoing active management of this area should aim to maintain and improve its condition and should be supported by appropriate monitoring programs.

9. Soil Erosion and Drainage Management Plans - Submissions were primarily concerned with stormwater management, surface water management and design criteria.

3.8.1 Management Arrangements

Since submitting the EIS, SA Water has prepared a draft CEMMP (refer to Appendix B) which is presented for review and endorsement, as part of the Major Projects approval process. The Contractor is required to develop a final CEMMP based on the draft presented and the performance criteria specified in Table 3.1 of the EIS.

Specific plans (as described in this Management Strategies Section) that form part of the CEMMP and the OEMMP will be prepared in consultation with relevant stakeholders as required by the performance criteria in Table 3.1 of the EIS. It is likely that a condition of approval will require appropriate sections of the final draft CEMMP and OEMMP to be made available to relevant government agencies and councils for review and endorsement. No other consultation on the final draft is planned.
Once the CEMMP and OEMMP have been finalised, copies will be made available to state government agencies and councils.

The compliance, specific monitoring, evaluation and reporting requirements have been specified in Table 3.1. In addition, the Contractor is required to ensure that the CEMMP and OEMMP are being adhered to at all times. This will be undertaken through monitoring, evaluation and audit.

### 3.8.2 CEMMP and OEMMP Preparation Criteria

The Contractor must comply with the requirements specified in the EIS document including Table 3.1. In addition to this, the Contractor must comply with all relevant legislative requirements, including obtaining appropriate statutory authorisations (i.e. native vegetation clearance approval, water affecting permits, etc).

The draft CEMMP (Appendix B) further details the minimum requirements on the Contractor.

### 3.8.3 Contamination Management

SA Water’s draft CEMMP (Appendix B) which addresses the issue of soil contamination management and provides a minimum acceptable standard that the Contractor will be required to adopt including procedures to assess soil and the management of contaminated soil. These procedures will also include the requirement for undertaking analysis of the soil to ensure that the soil was suitable for reuse on site or, if required, that the soil is disposed off-site to an EPA licensed landfill able to receive the soil.

It is likely that during deep excavations dewatering may be required. Further groundwater investigation work will be undertaken prior to construction to further inform the development of management requirements during construction and operation and to ensure the potential contamination of groundwater is managed.

The Contractor’s final CEMMP will include procedures to manage groundwater issues associated with construction to ensure the protection of human health and the environment. This will include managing risks associated with dewatering such as disposal of any contaminated groundwater that may be encountered, the potential for leakage from the perched aquifer into the deeper fractured rock aquifer system and introducing external contaminants into the site.

The management plan will address the monitoring, sampling, and potential for treating and disposal of groundwater if dewatering activities are required during construction, including disposal of any contaminated groundwater intercepted. The CEMMP will be designed to ensure compliance with all legal requirements, in particular the Natural Resources Management Act and Environment Protection (Site Contamination) Amendment Bill 2007.

As per standard EPA practice, an appropriately qualified independent environmental consultant will be required to provide a definitive statement confirming the suitability of the site for its intended use.

It is unlikely that Managed Aquifer Recharge will be considered. However if it is, contact will be made with both DWLBC and the EPA to ensure all permitting and licensing requirements are met.
3.8.4 Waste Management Arrangements

Table 3.1 in the EIS document details the environmental objectives with which the successful Contractor must comply. These objectives include; ‘Minimisation of waste production and management of wastes consistent with relevant State waste policies and guidelines.’ In order to meet this objective the Contractor is required to assess waste management options and adopt the waste management hierarchy in order of preference, which includes:

- Waste avoidance and reduction;
- Maximise waste reuse, recovery and recycling;
- Waste treatment; and
- Waste disposal.

In addition the Contractor shall, where possible, design excavation works so that they balance cut to fill to minimise the requirement for offsite disposal.

Waste minimisation and management measures have been included in the Waste Management Plan within SA Water’s draft CEMMP (refer to Appendix B) which will provide a minimum standard to be adopted by the successful Contractor. Sections of the final draft CEMMP and OEMMP will be made available to relevant government agencies and Councils for review and endorsement.

3.8.5 Storage and Spill Management Plans

As noted in Section 8.5.4.1.1 of the EIS a range of chemicals will require storage within the proposed Desalination Plant site for use in the desalination process. Following a risk assessment, the final design of chemical storage areas will need to ensure the containment of potential spills associated with deliveries and process use. This will include ensuring compliance with the relevant Australian Standards, codes and EPA Bunding and Spill Management Guidelines.

For spill containment the Contractor will need to ensure the final design includes the use of impervious surfaces as applicable to the specific storage areas. In addition the drainage system will need to incorporate storage and/or isolation devices to prevent chemical spills from entering stormwater and potentially groundwater networks. The final design will also be required to achieve the specified environmental performance objectives and criteria (refer to Chapter 3 of the EIS).

As detailed Section 4.3.5 of the EIS, SA Water requires the successful Contractor to develop a Safety Management Plan (SMP) that describes the functional requirements, processes and activities relating to safety management. The primary objective is to ensure that risk to personnel, assets and the general public be as low as reasonably practicable. The SMP is to be developed in accordance with the following principles:

- Ensure that activities are carried out in a safe manner and that the construction plant is maintained at all times in a safe and operable condition;
- The Contractor is accredited under the Australian Government’s Occupational Health Safety (OHS) Accreditation Scheme at all times during performance of the Contractor’s activities;
- The Contractor is required to comply with all occupational health and safety policies procedures implemented or adopted by SA Water; and
• Compliance with all SafeWork SA guidelines and regulations.

Additional requirements for the Contractor to comply with include:

• Participation by all parties/stakeholders in a hazard identification and risk assessment meeting prior to any activities being undertaken by the Contractor;

• Completion of Job Safety Analysis; and

• Pre-commencement hazard checks.

Following appointment of the Contractor, the Contractor will prepare the SMP and a Hazard Material Management Plan (incorporating emergency response and contingency plans) and forward it to the relevant stakeholders, including relevant government and emergency response agencies, to ensure the plans are comprehensive and meet all relevant legislative requirements. These management plans will be incorporated into the detailed CEMMP and OEMMP and routine audits will be conducted by SA Water and the Contractor to ensure management measures are being implemented.

3.8.6 Native Vegetation Management

SA Water requires that the successful Contractor develop specific management plans for the proposed Desalination Plant such as a Land Management Plan to address potential impacts to flora and fauna, including protection of adjoining native vegetation and managing impacts from increased access to the site. Further detail on the Land Management Plan is included in the draft CEMMP attached in Appendix B.

A Soil Erosion and Drainage Management Plan will be developed to address potential impacts from changes to the quantity and quality of stormwater runoff including the implementation of appropriate sediment and erosion control measures. These specific management plans will be developed and implemented in conjunction with the CEMMP and OEMMP and will consider potential impacts affecting environmental aspects within and surrounding the site.

In addition SA Water requires that a 10 metre exclusion zone extending from the cliff edge inward, be maintained as a ‘no-go zone’ where access and development are not permitted with the exception of conducting revegetation and rehabilitation works. This coastal cliff area contains the majority of the site’s native vegetation and will be rehabilitated and revegetated using locally indigenous species.

As detailed in Table 3.1 of the EIS, as part of the CEMMP a Pest and Weed Management Plan will also be developed and implemented to include:

• Weed management strategies, hygiene procedures and the control of any declared weeds at the site;

• Management of construction equipment, vehicles and any imported materials (e.g. soil) used during construction to ensure such equipment and imported materials are weed and pathogen free; and

• Compliance with the requirements of SA Water’s Phytophthora Management Guidelines.

In addition, a Land Management Plan will be developed and implemented by the Contractor for the site that incorporates opportunities to improve current biodiversity values at the site through revegetation and ongoing management of weeds.

The OEMMP will also include management strategies to minimise the risk of introducing new weeds and include ongoing weed management measures.
3.8.7 Council Infrastructure

Some aspects of the proposed Desalination Plant may impact upon existing and proposed infrastructure currently maintained and owned by the City of Onkaparinga. If upgrades and/or new infrastructure are required as a result of the proposed Desalination Plant, SA Water will continue discussions with the Council to determine the financial and resource responsibility of both parties.

Preparation of the final design of the proposed Desalination Plant will require significant input from a variety of stakeholders. The successful Contractor is required to develop and implement a Stakeholder Engagement Strategy and Action Plan to ensure community and stakeholder engagement is undertaken to inform the stakeholders about the project during all project stages. As a condition of the Stakeholder Engagement Strategy, the Contractor will consult with the Council regarding proposed development or changes to any infrastructure owned or maintained by the Council.

3.8.8 Cliff Face Management

Table 3.1 of the EIS identifies environmental objectives which the successful Contractor must comply with. These objectives include, 'Protecting the biodiversity values of the site and avoiding impacts to native vegetation and fauna.' Measures to protect the site’s biodiversity values including flora and fauna populations will be addressed in the CEMMP and implemented by the preferred Contractor.

As stated above in the Native Vegetation Management Section, this plan must identify 'no-go zones' including the cliff zone which comprises the area at the top of the cliff still influenced by coastal instability and erosion (approximately 10 metres back from the cliff edge). SA Water has stipulated that this area is not to be developed and disturbance of the coastal cliff area, within the ‘no-go zone’, be restricted to restoration and rehabilitation of the native flora and fauna.

Another objective with which SA Water requires the successful Contractor to comply includes the rehabilitation of the site, specifically to; ‘Restore and rehabilitate disturbed areas including incorporating opportunities for enhancing site environmental values.’ Measures will need to be undertaken by the successful Contractor to meet this objective including revegetating the degraded coastal cliff zone with locally indigenous species.

The detailed CEMMP and OEMMP will be designed to require continual monitoring of the terrestrial and marine environments to identify any real or potential impacts to the environment from construction and operation of the proposed Desalination Plant. This includes monitoring the native vegetation within the site to ensure the proposed Desalination Plant is not further degrading these areas which will be revegetated and rehabilitated with local indigenous species. Monitoring detailed within the plans will enable an adaptive management approach to be taken to respond to any unforeseen issues that emerge.

3.8.9 Soil Erosion and Drainage Management Plan (SEDMP)

3.8.9.1 Stormwater Management

With regard to the desalination site, in order to comply with the Environment Protection (Water Quality) Policy 2003, SA Water has prepared a draft CEMMP (refer to Appendix B) which provides minimum acceptable standards that the Contractor will need to adopt to ensure appropriate management and prevention of pollution entering the drainage line. All discharge into the drainage line will be managed in such a way as to ensure that...
the natural flow regime of the drainage line is not affected and measures to improve the quality of runoff prior to discharge to the drainage line, including vegetated swales and sedimentation basins, will be implemented on site.

As mentioned in Section 8.5.4.1 of the EIS the performance criteria for the proposed Desalination Plant requires the Contractor’s final design to incorporate opportunities to capture and reuse stormwater and roof runoff from the buildings, where feasible, including as an alternative for desalinated water or mains water. This could include using roof runoff and stormwater in Plant operations, site maintenance (such as for wash-down of equipment) and irrigation of landscaping and revegetation areas. In addition, the Desalination Plant design will incorporate Water Sensitive Urban Design (WSUD) principles.

Such design elements may include maximising opportunities for water reuse, the use of grease traps or interceptors to remove pollutants such as oil, as well as sedimentation basins and vegetated swales to remove sediments and improve the quality of any runoff water leaving the site.

Excess stormwater runoff from the site, beyond that which is collected for reuse, will be treated to appropriate standards required by Council and the DWLBC and discharged appropriately. This may include detention storage within basins and slow release to the existing drainage line. Alternatively, subject to EPA approval, treated stormwater may be directed through the outfall duct (with seawater concentrate) and discharged to sea. This is provided that stormwater quality is suitable for sea discharge with respect to EPA requirements for sediments, heavy metals, oil and grease capture and any other licensed parameters. Typical treatment may include vegetated swales, dryland/detention basins, wetlands and/or proprietary treatment devices.

For the concept design, stormwater runoff from roads and hardstand areas is to be collected in vegetated table drains and directed to vegetated swales. This runoff would then discharge into detention basins for further removal of sediments. Vegetated buffer strips located between the roads and table drains would also provide some pollutant removal, in addition to allowing for some infiltration and a reduction in runoff velocity. Water velocity along the drains would be reduced further by the use of rock spalls along the drains. The following diagram illustrates how stormwater is managed based on the concept design.
Figure 3.3 Concept design for stormwater management

The following photos are typical treatment measures employed in water sensitive design.

Figure 3.4 Typical vegetated swale
In the concept design, the stormwater from the detention basins is to be discharged to the outfall structures at a nominal rate of 20 L/s, which for a 1:100 year storm event would require a storage area of approximately 13,000 cubic metres. The final design of the stormwater system prepared by the successful Contractor would need to meet regulatory requirements including any local Council requirements as well as the water quality objectives set out in the *Environment Protection (Water Quality) Policy 2003*. This would include modelling of the proposed design to confirm that stormwater from the site is within these requirements.

For the recycling and reuse of water the Contractor will be required to consider all potential impacts including contamination from surrounding activities that may impact the site. All reuse however will be for non-potable purposes, such as irrigation of landscaped areas, wash-down of chemical delivery and transport vehicles and toilet flushing, and according to the Australian Recycled Water Guidelines (where relevant) thus ensuring the risks to human health and the environment are minimal.

The significant drainage line that runs to the south of the proposed site is owned by Mobil. Prior to seeking any permits from the AMLRNRM Board, all works that are to occur on Mobil land, including the drainage line, will need to be approved by Mobil.

Restoration/rehabilitation of the proposed Desalination Plant site and the protection of on-site ecological assets will be managed through a Land Management Plan (LMP) which aims to protect biodiversity values and existing ecological assets of the site. The LMP will be developed and implemented for the site and will incorporate opportunities to improve current biodiversity values at the site through revegetation and ongoing weed management.

Revegetation of the area of land buffering the drainage line where the land is owned by SA Water will also occur. The location of the revegetation areas will be developed as part of the final design. SA Water is currently reviewing the condition of the drainage line, owned by Mobil. Any proposals to rehabilitate the drainage line and/or to protect the existing ecological assets are subject to Mobil approval.
In response to points raised the following measures will be implemented by the Contractor:

- No sediment or pollutant laden water will be discharged from the site as this would be considered a breach of the *Environment Protection (Water Quality) Policy 2003*. A detailed Soil Erosion Drainage Management Plan will be prepared and implemented to manage surface water runoff. All water that is discharged from the site will be done so in such a manner as to ensure no scouring or erosion occurs and that there is no adverse impact to the natural drainage line. Measures to improve the quality of runoff prior to discharge to the drainage line including vegetated swales and sedimentation basins will be implemented on site.

- Detention basins will be designed to ensure they are above the 25 year annual recurrence interval (ARI) storm event contour. The OEMMP will specify monitoring requirements for the outflow water from the detention basins. Specific management and maintenance requirements for the basins will be included in the OEMMP. The final design of the overall stormwater system will be modelled to ensure the system meets the requirements of the *Environment Protection (Water Quality) Policy 2003*.

- All buildings will be located above the 100 year ARI storm event contour as required. Chemical storage areas will be bunded complying with all relevant EPA and state regulations and Australian Standards. Areas of the site where contaminated runoff may be generated will not be allowed to discharge to the environment. In the event of a chemical spill during a bulk delivery, the spilled chemicals will not be permitted to enter the stormwater system, but contained, neutralised and disposed in accordance with the relevant regulations. All bunds will be appropriately sized or connected to separate containment chambers.
3.9 Risks/Hazards

The following issues have been raised in regards to risks and hazards:

1. Chemicals management – Submissions raised safety concerns over the chemical products that will be used on-site as part of the Plant operations. Specific concern was raised about the potential for chlorine leaks to extend off-site to nearby residences and a Council reserve.

2. Fire Management - Details of mitigation measures that may be used to manage the effects of hydrocarbons if a fire occurred at the refinery, in particular from a crude oil tank.

3. Site Safety - Construction may be dangerous for workers due to location of pump station, requirement for under-sea work required and fault-lines extending across the site.

4. Corrosivity of water - Some submissions have raised concerns that treated desalination water may contain corrosive properties that have the potential to damage domestic concrete, copper and brass fittings.

3.9.1 Chemicals Management

Chemicals are required for operation and maintenance of the Plant and these will be appropriately stored on-site prior to their use. Chemicals will be disposed following their use in conformance with environmental requirements.

Chemicals are required to prevent marine growth within the intake system to assist in the separation of solids from seawater in pre-treatment processes, prevent the build up of scalants in the RO membranes, protect the membranes from chlorine residual by its removal, preserve the membranes when not in use for extended periods and to passivate and disinfect the desalinated water. After their use, antiscalants and membrane clean in place (CIP) chemicals will be neutralised and disposed offsite to a licensed trade waste disposal point or, in some cases, to sea with the saline concentrate subject to assessment against the relevant environmental criteria and performance objectives. Neutralisation involves the addition of acids or alkalis for pH correction, for example sodium hydroxide to increase pH or sulphuric acid to reduce pH.

Chemical storage facilities will be provided in accordance with relevant standards. Process chemicals will be stored in bunded areas to contain any spills. The chemical storage areas are required to comply with relevant standards, codes, acts and regulations, including the EPA Bunding and Spill Management Guidelines and Australian Standard AS/NZS 2927 (Storage and Handling of Liquid Chlorine). The storage and use of chlorine will be such to reduce the risk of chlorine leakage and harm to personnel in accordance with legislated requirements. Chlorine drums will be stored in enclosed areas with extractor fans and scrubber units. Chlorine detectors would raise an alarm and shut down the extractor fans and trigger remedial action in the event of any leak.

The Lloyds Register risk assessment (2008) was conducted to ascertain the risks for the proposed Desalination Plant to the Mobil Oil Refinery and vice versa. Chlorine leakage from handling and operation of the drums was identified as a potential risk, although the risk of an explosion was discounted as chlorine is a non-explosive gas. The toxic impact distance from a chlorine leak with the potential to cause a fatality could extend approximately 660 metres under certain assumed conditions (namely no containment or management of the chlorine storage). The risk of this occurring was considered to be minimal and acceptable when appropriate mitigation measures, such as appropriate enclosed areas with extraction fans and scrubber units.
As with all large treatment facilities, an emergency response management plan will be developed, with input from key stakeholders, including MFS and police.

### 3.9.2 Fire Management

A risk assessment of the risk exposure to the proposed Desalination Plant personnel due to hazards associated with the Mobil Oil Refinery complex has been reviewed. Key impacts were identified and considered including fire hazards. Heat radiation from a refinery fire was not expected to be of concern at the proposed Desalination Plant.

The risk assessment particularly focussed on those activities that have the potential to cause a fatality. In addition, as detailed in Section 4.3.5.1 of the EIS, a hazard identification and risk assessment meeting with participation of key stakeholders will be undertaken by the Contractor. This will include assessing the risk of the potential impact of incidents on the proposed Desalinisation Plant equipment, such as a crude oil tank fire on the refinery site. SA Water will ensure that appropriate / approved mitigation and management measures determined by the risk assessment will be incorporated into the final design of the Desalinisation Plant by the Contractor.

### 3.9.3 Site Safety

As mentioned in Section 3.8.5, the Safety Management Plan (SMP) will be developed by the Contractor to ensure that construction activities are carried out in a safe manner and that all construction plant is maintained in a safe and operable condition at all times. The Contractor must be accredited under the Australian Government’s Occupational Health Safety (OHS) Accreditation Scheme at all times. The Contractor must also comply with all occupational health and safety policies and procedures implemented or adopted by SA Water and all SafeWork SA guidelines and regulations.

The Contractor will be required to comply with all relevant statutory OH&S requirements and the adopted construction methodologies will also be required to comply with the Safety Management Plan developed by the Contractor together with related risk assessments and monitoring actions.

With regards to the pump station the ground conditions involve soil overlying rock, with most of the structure situated in rock. Conventional construction techniques would be adopted to prepare, excavate and construct the shaft, including fit-out. The design of the pump station and related mechanical and electrical equipment will be such as to automate processes where practical and to minimise the need and frequency for access by operational and maintenance personnel. The operator will be required to comply with operational manuals and safety procedures developed specifically for the system.

Any under water construction will be designed to limit personnel involvement. However all work where personnel are required must be undertaken by an appropriately qualified person as specified in SA Water’s Occupational Diving procedure. Diving must not occur without a Diving Operations Manual and a risk assessment has been conducted and documented. All procedures must be documented and comply with Australian Standard AS/NZS 2299.1:2007 (Occupational Diving Operations - Standard Operational Practices).

The risk of undertaking work in proximity to a fault line will need to be assessed in the detailed design phase, including the process of construction. As detailed in Section 4.3.4.2.2 of the EIS, the Australian Standard AS 1170.4-2007 (Structural Design Actions – Earthquake Actions) provides guidance on the design of structures for seismic events. In addition the geotechnical studies will inform the final process of construction and the design of the proposed Desalinisation Plant.
3.9.4 Corrosivity of Water

Current municipal desalination plants around the world practice passivation or remineralisation. The permeate (desalinated water) is rendered non-corrosive and suitable for drinking via the addition of calcium salts, such as lime (or hydrated lime) and carbon dioxide. The concept design is based on the use of lime and CO₂, although alternatives such as calcite (marble chip) filtration may be considered.
3.10 Stakeholder Engagement

Issues raised in submissions concerning stakeholder and community engagement can be summarised as follows:

1. Community and stakeholder issues – Not enough information about issues identified from community and stakeholder feedback has been included in the EIS.

2. Consultation feedback – Submissions asked how feedback from the consultation program will inform the project. One submission called for the establishment of a telephone hotline to respond to issues local residents may have in relation to the Desalination Plant.

3.10.1 Community and Stakeholder Issues

Chapter 10 of the EIS discusses the issues identified from the community and stakeholder feedback review process. Through the course of the project to date, regular information has been provided in relation to feedback from the community and other stakeholders.

This feedback has been important to SA Water in shaping its plans for the project’s design, construct, operate and maintain phases, as well as in the interpretation of the EIS.

Approximately 2,700 people participated in stakeholder and community consultation activities conducted between May and October 2008. This included:

- Public meetings;
- Surveys;
- Feedback forms;
- Local discussion forums;
- Information days;
- Stakeholder meetings, in particular with Government agencies and local government; and
- Briefings for key stakeholders.

Engagement with 42 community and environmental groups from the southern Adelaide metropolitan area commenced with a discussion forum on 16 July 2008 and a follow up forum was subsequently held on 3 December 2008. Key issues identified during the discussion forums included:

- The consumption of energy and the need to use renewable sources or to make the proposed Desalination Plant carbon neutral;
- The importance of other water security strategies, including stormwater capture and reuse, recycled water and rainwater utilisation;
- Waste impact and the aquatic ecology;
- Construction and operational costs; and
- The responsibility for the cleanup of Port Stanvac and the selection of the Port Stanvac as the location for the proposed Desalination Plant.
Issues identified during the engagement process will continue to influence further development of the concept design and decision making processes, where appropriate. In addition, the issues identified by the community have informed the preparation of the detailed performance criteria that form part of SA Water’s requirements in formulating the conditions that the Contractor will need to meet.

The community and stakeholder engagement process will continue.

3.10.2 Consultation Feedback

Issues identified during the engagement process influenced the concept design and decision making processes and will continue to do so.

In addition, the issues identified by the community and other stakeholders, including government agencies, were used to prepare detailed performance criteria and form part of SA Water’s requirements in formulating the conditions the proposed Desalination Plant Contractor will need to meet when designing, building, operating and maintaining the Plant.

Just a few examples of feedback informing the project include:

- Concerns expressed about energy use and brine discharge are being addressed through comprehensive management plans for each stage of the project – including stringent ongoing monitoring regimes.
- The chosen Contractor will be required to implement measures to maximise opportunities for local employment through ongoing liaison with industry groups, businesses and service providers.
- The chosen Contractor will be required to have a comprehensive Stakeholder Engagement Strategy which includes measures to engage the community in each stage of the project development.

Over one thousand feedback forms were returned by 31 October 2008. The aspects of the project respondents were most concerned about are summarised in Figure 3.6 with the top three concerns being: alternatives to desalination (22%), planning and process (20%), and marine issues (16%).
The following measures have been put in place to ensure consultation feedback to date informs the Project:

- A stakeholder database is being used to collate and analyse feedback from consultation activities. This information is provided to the project team;
- All consultation activities are reported to the project team on a fortnightly basis;
- Meetings with senior project manager/s to discuss consultation outcomes are conducted on a fortnightly basis;
- The Project Director prepares and circulates monthly reports on all project activities including consultation events; and
- Integrated project team meetings and briefings are conducted on a regular basis and include updates about consultation activities.

SA Water will work closely with the chosen Contractor to ensure the local community continues to have input into the project.

In addition, SA Water promotes and manages a toll free Information Line (1800 812 362) for enquiries concerning the proposed Desalination Plant. A dedicated project email site is also available at: desalination@sawater.com.au.

If further information is sought, the SA Water Customer Service staff can transfer calls to nominated project staff.
3.11 Kaurna People

Issues raised in submissions concerned ongoing engagement with Kaurna people to ensure that any cultural heritage issues are recognised and effectively managed.

3.11.1 Kaurna Consultation

The site of the ADP falls within the Kaurna Nation Territory (Kaurna Yerta) which is the ‘major land corridor’ of the four nation groups surrounding Adelaide. Consultation with the Kaurna people of the southern Adelaide Plains is represented by the Kaurna Heritage Board (KHB). Accordingly, SA Water has formally engaged the KHB to provide feedback on the proposed Desalination Plant. This process is ongoing and addresses a range of issues including impact assessment, heritage assessment, cultural awareness and promotion, education and encouraging employment opportunities.

On 20 November 2008 the Kaurna Heritage Board invited members of the proposed Desalination Plant’s project team to participate in a Kaurna Cultural Awareness Tour. The tour was organised to inform and raise awareness amongst the project team, of cultural heritage sites and places in and around metropolitan Adelaide and the ongoing connection that the Kaurna people have to both land and waters affected by the Desalination Plant.

The KHB is working with the ADP team to identify and implement potential impact management approaches. This is governed by a formal Consultation Agreement with SA Water, which includes provision for the KHB to consult with the broader Kaurna community about the proposed Desalination Plant. Potential impact management is in progress and includes the following initiatives:

- An Aboriginal Cultural Heritage Survey has been completed and informed the preparation of the EIS and the project planning process;
- Acknowledgement and agreement that a sensitive area from the top of the cliff at the proposed site to the intertidal zone will be designated as a ‘no-go’ zone for Contractors and construction activities and that tunnelling will be used in this area as a construction method to minimise disturbance;
- Preparation of formal Monitoring Agreements and associated Cultural Heritage Management Plans to engage Kaurna experts in monitoring future construction activities for the ADP; and
- Preparation of an information sheet explaining KHB engagement activities and expected outcomes of the various agreements being made with the KHB for the ADP.
3.12 Community Impacts

Submissions about the potential community impacts associated with the proposed Desalination Plant can be summarised into the following categories:

1. Social impacts – Submissions argued that the social impacts of the project have not been considered in a holistic manner and that further elaboration of the social impact mitigation strategies is required.

2. Residential areas - A map showing the nearest residential areas to the proposed site is required.

3. Housing impacts - The EIS understates potential housing impacts.

4. Child care - Due to the possible closure of several ABC Child Care Centres in the Onkaparinga area, further consideration may need to be given to the impact on child care vacancies if employees of the ADP require child care.

5. Recreation - The cliff top buffer should be wide enough to allow for the possible future development of a trail as part of the Metropolitan Coast Park.

6. RSPCA animal shelter - The RSPCA Animal Sanctuary is mentioned in the Social Impact Assessment Report (Appendix F8 of the EIS) as a neighbouring land use but is not noted in the EIS proper.

7. Impacts on adjoining uses - A description of local industry along Christie Road and Sigma Road is required to better describe the potential impacts of the proposed Desalination Plant on adjoining uses.

3.12.1 Social Impacts

The approach used was consistent with the principles and guidelines of the International Association of Impact Assessment (2003) as well as A Guide to Social Planning for Local Government in South Australia (Janet Gould & Associates, 2002) and the Social Impact Assessment Kit (Wendy Bell and Associates, 2006). The assessment approach was consistent with social impact assessments undertaken for a range of significant infrastructure projects across Australia and incorporated a comprehensive and holistic array of elements as shown in Table 3.2.
### Table 3.2 Social impact assessment approach

<table>
<thead>
<tr>
<th>Research</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature review</td>
<td>Analysing the existing social environment to establish baseline social conditions including:</td>
</tr>
<tr>
<td>Data analysis (ABS, SEIFA Index, VAMPIRE, Social Atlas, and health and community data)</td>
<td>• Preparing a demographic profile</td>
</tr>
<tr>
<td>The experience of interstate and overseas desalination projects</td>
<td>• Mapping community and governance structures and land tenure arrangements</td>
</tr>
<tr>
<td>Other projects and developments in the region</td>
<td>• Considering the compatibility of adjacent industrial, commercial and residential land uses with the proposed Desalination Plant development</td>
</tr>
<tr>
<td></td>
<td>• Identifying existing and planned recreational land uses, in particular the Coast Park</td>
</tr>
<tr>
<td></td>
<td>• Considering the economic environment and workforce and business implications</td>
</tr>
<tr>
<td></td>
<td>• Identifying social services and facilities, in particular emergency services and infrastructure</td>
</tr>
<tr>
<td></td>
<td>• Assessing access and mobility including traffic management and transport</td>
</tr>
<tr>
<td></td>
<td>Consulting with more than 2,700 members of the public as well as community groups and government agencies to identify potential social impacts and issues</td>
</tr>
<tr>
<td></td>
<td>Analysing existing social research to identify potential impacts</td>
</tr>
<tr>
<td></td>
<td>Conducting a risk assessment to determine the significance of impacts</td>
</tr>
<tr>
<td></td>
<td>Identifying appropriate management and mitigation measures</td>
</tr>
</tbody>
</table>

Social impacts associated with the project will be managed and mitigated through a range of mechanisms including:

- High levels of ongoing community and stakeholder interaction; and
- A range of environmental management plans that address possible impacts (including noise, dust, traffic, labour planning *etc* at all stages of the project delivery.

SA Water will manage potential community concerns by:

- Building an effective relationship with the Contractor and the community and developing opportunities for community involvement and participation (for instance, through community forums *etc*);
• Continuing its email and telephone hotline (refer above), points of contact for community concerns or complaints;

• Involving the community in suitable parts of the project including buffer plantings;

• With the Contractor, coordinating a range of communications, education events and tours;

• Engaging with community groups and Kaurna representatives at all stages of the project; and

• Working collaboratively with Local Members of parliament, the Cities of Marion and Onkaparinga and relevant State Government agencies on a range of community outcomes.

It is envisaged that these actions will build a positive foundation for ongoing relations with the community and allow the early implementation of environmental and social mitigation strategies prior to commencement of construction.

The Contractors for the project will be required to deliver Stakeholder Interface Management and Community Engagement plans for each phase of the project.

SA Water is working on mitigation strategies to deal with possible social impacts. For instance, SA Water has established a high standard of communication and engagement with the local community during the planning and investigation stage of the project. This community engagement program will continue with the chosen Contractor involved to ensure community issues that arise are responded to quickly and effectively. This approach will also ensure mitigation strategies continue to be fine-tuned to address any issues that arise, such as:

• Workforce strategies will be in place to ensure, where possible, workers are sourced from the local labour pool, with specific attention given to Aboriginal employment. The Contractor is required to specify plans to address employment requirements for the project;

• Housing demand will be monitored during the construction period;

• There are opportunities to further enhance local business and economic development opportunities by sourcing materials and services locally where possible. This would also assist the local area by ensuring the proposed Desalination Plant contributes to the rebuilding of local industries following the closure of the Mitsubishi factory and the Mobil Oil Refinery;

• There is an opportunity to invest in coastal walking and recreation connections currently breaking the continuity of the Coast Park in southern area; and

• The importance of the coast, waterways and trade routes to the Kaurna people are well recognised and the site of the proposed Desalination Plant provides opportunities to work closely with the Kaurna Heritage Board to invest in interpretation opportunities, implementation of the trail initiative, Kaurna community design, and community education opportunities at a proposed interpretive centre within the Plant.

Both the City of Marion and the City of Onkaparinga have undertaken strategic planning exercises and community engagement programs in recent years.
The City of Marion has prepared the Marion South Plan, which includes a number of strategies and actions for improving the appearance, functionality and accessibility of the Marion South area in and around Hallett Cove.

The City of Onkaparinga has prepared a suburb improvement plan for O'Sullivan Beach together with an Industrial Enhancement Program for Lonsdale. Where possible, the Desalination Project will integrate with these plans and work to deliver outcomes that enhance the social and visual amenity of the area.

Community participation within the suburbs of O'Sullivan Beach, Hallett Cove and Christies Beach is particularly strong in association with local schools and there are significant opportunities to build on this by providing participation opportunities for Hallett Cove South Primary, O'Sullivan Beach Primary and other schools in the regional community.

A visitors' centre is proposed within the proposed Desalination Plant site, providing information and education for local residents, students and other stakeholders. The centre will provide benefits to the local community by providing information on the process, site visits, and ongoing monitoring of impacts and outcomes. Interpretive opportunities associated with marine life, geological aspects and Kaurna heritage could also serve to enhance the local sense of place, community and education opportunities for local schools.

### 3.12.2 Residential Areas

The Social Impact Assessment Report (Appendix F8 of the EIS) identified that the proposed site is approximately 360 metres south of the nearest residences in Hallett Cove. Other residential areas in the vicinity include Hallett Cove Heights (1.2 kilometres to the north east), Reynella (2 kilometres to the east), and O'Sullivan Beach (2 kilometres to the south). Figure 3.7 shows the location of the proposed Desalination Plant and adjacent residential areas.
3.12.3 Housing Impacts

It is estimated that an additional workforce of up to 1,200 staff (approximately 500 FTE’s) will be directly employed during the 18-month construction phase of the proposed Desalination Plant. In the long term, ongoing operation and maintenance workforce requirements will be in the order of 30 staff.

While large numbers of design and construction staff are required in the short term, this is balanced by the Plant’s proposed location in southern metropolitan Adelaide adjacent to a resident workforce with a range of transport options. While some workers and their families could seek new housing options within the local community, possibly increasing housing demand to a small extent, some of the demand would be more likely to be dispersed over the broader metropolitan region.

The Real Estate Institute of SA (REISA) reported a ‘sluggish’ housing market for sales, auctions and rental properties in the Adelaide metropolitan area during the September 2008 quarter. However, the southern suburbs had lower housing costs and a higher rental vacancy rate than the metropolitan Adelaide average. While the rental vacancy rate for metropolitan Adelaide was 1.3% for the September 2008 quarter, the rental vacancy rate for the southern Adelaide metropolitan area was 1.5%.

A review of rental bond data sourced from Housing SA together with an overview of current sales and rental property advertising indicates that the housing market will absorb a reasonable increase in housing demand in the southern area related to the proposed Desalination Plant contractual workforce.

On 9 January 2009, www.realestate.com.au listed over 200 houses for sale and 176 rental vacancies in suburbs within commuting distance of the proposed Desalination Plant site, chiefly in the Onkaparinga and Marion Council areas. A review of privately advertised rental properties (houses, home units and townhouses) placed in The
Advertiser on Saturday, 3 January 2009 reflects a total of 33 vacancies in the southern area.

Accordingly, while some of the contractual workers would relocate to the southern area, it is likely that many workers currently residing in the southern Adelaide suburbs will be attracted to positions within the contractual workforce associated with the proposed Desalination Plant and/or that workers already residing in the Adelaide metropolitan area will commute to the work site.

Further, any modest increase in housing (rental or purchase) demand associated with the contractual workforce can be absorbed by the existing market in the southern area and surrounds. Notwithstanding, SA Water will ensure that the Contractor considers this matter in its initial planning process, and particularly during the peak site construction period.

3.12.4 Child Care

Child care centres provide full-day or part-time care for babies, toddlers and children under the age of six. In SA, all centres are required to be licensed. Enquiries with the Department of Education and Children’s Services (the licensing body) and child care centres within a 10 kilometre radius of the proposed site identified:

- Two ABC Child Care Centres will close in the southern area, one in Huntfield Heights and one in Aldinga;
- Most nearby child care centres have vacancies and no wait lists including: Sheidow Park, ABC Sheidow Park North, Hallett Cove, Noarlunga and Stepping Stone Christie Downs;
- Family Day Care, home-based child care services, reported approximately 58 vacancies spread across the southern suburbs as at 7 January 2009; and

Given the availability of local child care places, it is considered that existing child care services will be able to accommodate any increase in child care demand that may arise as a result of construction and operational workforces for the proposed Desalination Plant. As with Housing, SA Water will ensure that the Desalination Plant Contractor considers Child Care in its planning process.

3.12.5 Recreation

As outlined in Section 10.4.6.1 of the EIS, the Coast Park Trail currently exists in the vicinity of the site running through the City of Marion from Marino to Headland Reserve. The Port Stanvac site is currently a key social and physical barrier to the trail link from Christies Creek in the south to the northern boundary of the Onkaparinga Council area. As part of the preparation of the EIS, a recreation assessment was undertaken and one of the key issues examined was how to integrate the Port Stanvac site with the metropolitan coast and the existing trail and open space network.

SA Water acknowledges that Council’s preferred link is through the Port Stanvac site or along the foreshore and will consult with the Cities of Onkaparinga and Marion, Department of Planning and Local Government and the local community regarding possible community benefits, including trails and open space opportunities, associated with the development of the proposed Desalination Plant.
3.12.6 RSPCA Animal Shelter

The RSPCA Animal Sanctuary is located one kilometre north of the proposed site of the Desalination Plant. For this reason, it has not been deemed as a ‘neighbouring land use’ for the purposes of assessing the likely impacts of the Plant on adjoining land uses.

However, it is possible that animals at the shelter may be sensitive to noise and dust impacts during the construction phase of the project. In complying with the SA Environment Protection (Noise) Policy, SA Water will require the successful Contractor building and operating the proposed Desalination Plant to develop a Noise and Vibration Plan that will ensure that noise levels generated will not exceed the criteria set by the EPA. As a result, any noise impacts from the Plant will be minimised and/or managed so as not to cause any undue nuisance to neighbouring residents and other sensitive land users. In addition, noisy construction activities will be scheduled during normal business hours when ambient noise conditions are likely to mitigate the likely impact on animals at the shelter.

Dust impacts will be managed through the Construction Air Quality Management Plan which includes specific measures to limit dust emissions whilst ensuring compliance with the National Environmental Pollution Measure for Air Quality (NEPM), the Environmental Protection (Air Quality) Policy 1994 (SA) and the SA Environment Protection Act 1993.

3.12.7 Impacts on Adjoining Uses

The existing users along Christie and Sigma Road are primarily light industrial activities, which include the following:

- Automobile dismantlers and wreckers;
- Panel beating workshops;
- Auto repair workshops;
- Performance exhaust workshops;
- Tyre workshops;
- Scrap metal brokers;
- Boat construction and repair workshops;
- Fencing supplies;
- Joinery workshops;
- Trailer manufacture/sales;
- Plastic manufacturers;
- Light engineering workshops;
- Plant wholesalers;
- Pipe manufacturers;
- Lighting maintenance suppliers;
- Radio controlled products; and
- Waste transfer and recycling centres.
These adjoining uses generate a range of noise, vibration, dust, odour and traffic-related impacts anticipated within an industrial zone. It is highly unlikely that the proposed Desalination Plant will adversely impact on their operation, owing to the raft of environmental management measures to be implemented during the construction and operation of the Plant.

The buildings and structures making up the Desalination Plant will be located in such a way within the site so as to avoid any impacts on surrounding uses.
3.13 Terrestrial Flora and Fauna

Submissions concerning terrestrial flora and fauna impacts associated with the proposed Desalination Plant can be summarised into four broad categories as follows:

1. Habitat conservation and rehabilitation - The development of the proposed Desalination Plant should aid in the preservation, maintenance and enhancement of remnant coastal cliff vegetation for the preservation of biodiversity in connection with the surrounding landscape and with particular regard to butterfly species. In particular, temporary fencing should be placed around the coastal cliff area to protect and conserve the native vegetation within the area. Revegetation of the site should be undertaken using pre-European indigenous flora species.

2. Matters regarding the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) – The proposed Desalination Plant does not meet the objects of the EPBC Act. In addition there is a need to include listed marine reptiles (turtles) in Chapter 8 of the EIS as well as inclusion of the following species listed under the EPBC Act or by the Japanese - Australia Migratory Bird Agreement (JAMBA) which have potential to occur within the Port Stanvac Region:
   - Apus pacificus
   - Chrysococcyx basalis
   - Coracina novaehollandiae
   - Cuculus pallidus
   - Falco cenchroides
   - Grallina cyanoleuca
   - Larus novaehollandiae
   - Phalacrocorax fuscescens
   - Puffinus tenuirostris
   - Sterna bergii
   - Sterna caspia

3. Flora and fauna assessment – Submissions noted that the timing of the EBS vegetation survey in June would not have allowed for the complete range of species to be identified and that areas mapped as being in poor condition due to Sour Sob infestation in winter may actually support important annual species or native grasses. In addition, Table 8.3 in the EIS shows State and regionally listed flora occurring at the Port Stanvac site and surrounding area but should show some correlation between current and historically recorded species.

4. Regulatory compliance - SA Water should consider the Native Vegetation Act 1991 prior to any native vegetation clearance, removal or trimming. In addition recommendations from the Coastal Action Plan relevant to Port Stanvac should be considered.

3.13.1 Habitat Conservation and Rehabilitation

3.13.1.1 Butterfly Habitat
The proposed Adelaide Desalination Plant site is highly degraded through agricultural use. The site has been cropped to the edge of the coastal cliffs causing the coastal cliff vegetation to become, in many areas, highly degraded and with high levels of weed infestation (EBS 2008a).
Some remnant flora species still exist within the coastal cliff area and may provide limited habitat for butterfly species. During the flora survey, organised by SA Water and undertaken by EBS, the flora species Gahnia lanigera (Black Grass Saw-sedge), which provides habitat for the Rare butterfly species, Antipodia atralba (Black and White Skipper), was identified as occurring south of the proposed site within the existing Mobil Oil Refinery land.

As stated in Table 3.1 of the EIS, SA Water has stipulated that the coastal cliff zone comprise a ‘no-go zone’ and the Contractor must leave a 10 metre buffer from the edge of the coastal cliffs landward. In addition SA Water requires the Contractor to rehabilitate areas of non-use within the site. This may include revegetation of the coastal cliff area with Black Grass Saw-sedge and other locally indigenous species which provide habitat for fauna including butterfly species.

It is an objective of SA Water’s EIS submission that the successful Contractor, where practicable, balance the earthworks at the site, thus limiting the requirement to dispose of the excess soil offsite. A stormwater drainage line is located immediately south of the proposed Desalination Plant site on land which has been retained by Mobil. SA Water, the Contractor and Mobil will undergo negotiations regarding the extent (if possible) of rehabilitation and revegetation of this drainage line.

By not allowing development within the coastal cliff area and requiring the Contractor to rehabilitate and revegetate the site with locally indigenous species, SA Water is ensuring the native fauna habitat (including butterflies, lizards and birds) within and adjacent to the site is preserved and/or enhanced. In addition there is potential for the natural recruitment of native species from the more floristically diverse and intact vegetation within the Mobil Oil Refinery site south of the Desalination Plant site. This includes the possible natural recruitment of Black Grass Saw-sedge and other locally indigenous flora species, thus increasing the corridor of native fauna habitat including that of the Black and White Skipper butterfly.

3.13.1.2 Indigenous Species and Landscape Connectivity

As stated in Table 3.1 of the EIS it is a requirement of the successful Contractor to; ‘Protect biodiversity values of the site and avoid impacts to native vegetation and fauna.’ This includes the development of a Land Management Plan.

The Land Management Plan is to include opportunities to improve current biodiversity at the site through revegetation and rehabilitation with locally indigenous species and ongoing management of weeds to enhance existing vegetation communities. Consultation on the plan is to be undertaken by the Contractor with the AMLRNRN Board and Onkaparinga Council to ensure it integrates with broader Regional Strategies. These strategies encourage the use of locally indigenous and pre-European species to be used in rehabilitation and revegetation projects and promote providing linkages to existing native vegetation habitat throughout the local landscape (including Marino Conservation Park, Hallett Cove Conservation Park and the Field River).

Protection of the native vegetation currently occurring on site is reinforced by SA Water’s requirement that any temporary or permanent works by the Contractor within the coastal cliff area is not permitted. Protection of the native coastal cliff vegetation will be enforced by SA Water and undertaken by the Contractor and will be accomplished by placing temporary or permanent fencing around the coastal cliff area.
3.13.2 EPBC Matters

3.13.2.1 Impacts to Matters Protected by the EPBC Act


The potential impact of the ADP on EPBC listed species is determined by assessing the proposed action against the EPBC Significant Impact Guidelines. The EPBC Significant Impact Guidelines outline and define significant impact criteria for categories of nationally threatened species and other matters of environmental significance protected by the EPBC Act (including those species outlined in S248 of the EPBC Act). Broadly summarised the criteria define that an action is ‘significant’ if it:

- Leads to a long term decrease in the population;
- Reduces the area of occupancy of the species;
- Fragment an existing population;
- Adversely affects critical habitat;
- Disrupts breeding cycles;
- Detrimentally affects habitat quality;
- Leads to the introduction of invasive species;
- Introduces a disease that may affect a species; or
- Interferes with the recovery of a species.

Given that the site does not comprise key breeding and/or foraging habitat for any of the species considered in the EPBC Referral (EBS 2008a) it is unlikely that development of the proposed Desalination Plant will result in one or more of the above criteria coming into effect. Whilst several of the species listed considered in the EPBC Referral have potential to occur within the marine portion of the site, the proposed Desalination Plant is unlikely to significantly impact these species as it will not lead to a long-term decrease in population size, reduce the area of occupancy of the species, fragment existing populations or adversely affect critical habitat and the Gulf St Vincent ecosystem.

Based on the EPBC Act Referral, submitted by SA Water, the Federal Minister declared that with the implementation of the environmental management and mitigation measures outlined in the referral, the Desalination Plant would not significantly impact upon any matters of national environmental significance (refer to Appendix D), that is, it is not considered a ‘controlled action’. SA Water is committed to complying with the environmental management and mitigation measures outlined in the ADP EPBC Referral. The following are major environmental management initiatives which SA Water committed to in the EPBC Referral to minimise impacts to listed species (terrestrial and marine):
1. Baseline water quality data is being compiled prior to commencement of construction activities. This will be used throughout the lifetime of the proposed Desalination Plant as a basis to compare water quality data gained through routine monitoring events;

2. The location of the outfall pipeline and diffuser design will be cognisant of optimal dilution parameters to protect the marine environment.

3. The environmental performance criteria for the project specify that the intake structure is required to be located away from the intertidal and subtidal reef area in the mid benthic zone, which based on the marine surveys undertaken, represents a predominately bare area of relatively low species richness. In addition, the intake structure will incorporate screens to minimise entrapment and minimise intake velocities to reduce the risk of entrainment or ‘sucking’ in of non mobile larvae, with the project performance criteria establishing a maximum velocity of 0.15m/s for the design;

4. No blasting will occur in the intertidal reef area. In the event that limited blasting is required at the edge of the subtidal reef area, it will not occur during seasonal migratory movement periods for known whale species that periodically visit Gulf St Vincent. In addition a management plan will be developed and implemented to reduce impacts on cetaceans;

5. Consideration of local fish and marine organism breeding/spawning seasons will be given prior to completing prescribed marine works; and

6. The construction footprint will be reduced as far as practicable, with no work outside approved work zones or timeframes.

The Contractor employed to design, build, operate and maintain the proposed Desalination Plant must ensure they comply with the following requirements:

1. The Contractor must, at all times, exercise necessary and reasonable precautions appropriate to the nature of the work and the conditions under which the Contractor’s Activities are to be performed to protect the Environment;

2. The Contractor must provide equipment, materials, training, personnel and documentation necessary to meet the requirements of the Contract. The Contractor must comply with these requirements and must provide evidence of such compliance upon request by SA Water as a precondition of continued access to the Site;
3. The Contractor must take all steps necessary to protect the environment and in particular must provide erosion and sediment control measures required by the Environment Protection Authority (EPA) including complying with the Stormwater Pollution Prevention Code of Practice for the Building and Construction Industry (1999);

4. Prior to the commencement of the Contractors Activities, the Contractor must conduct an Environmental Risk Assessment(s) and record the outcomes in a register. A meeting must be arranged and chaired by the Contractor, with SA Water and other stakeholders (as determined by the Contractor), in attendance. The purpose of the meeting is to ensure that the environmental risks associated with the Project are identified, properly assessed and effective risk control measures developed and agreed upon;

5. The Contractor must conduct additional Environmental Risk Assessment(s) if any of the Contractors Activities change so as to have additional environmental impact(s), which are not already considered in the existing risk assessment;

6. A construction-phase Noise and Vibration Management Plan must be developed. This plan must accurately predict noise levels generated from particularly noisy activities and identify mitigation measures to minimise the impact on residents. This will include reference to activities which generate high levels of noise and vibration. As part of the Noise and Vibration Management Plan, noise and vibration monitoring must be conducted to verify that the noise levels generated are not exceeding the criteria set by the SA EPA;

7. The Contractor must plan and implement measures to ensure that all of its construction facilities and work sites (including stockpiles) are designed and operated to minimise the release of noxious emissions, exhaust smoke, odour, dust, cement dust and other substances into the atmosphere;

8. All construction vehicles must be maintained and covered as needed to prevent any loss of load, whether in the form of dust, liquid, solids or otherwise. Vehicles must be maintained and facilities installed at exit points of all unsealed areas such that vehicles will not track mud, dirt or other material onto any street or road which is opened and accessible to the public. In the event of a spill, material must be removed within 24 hours;

9. The Contractor must minimise the environmental impact of energy use by ensuring all construction activities include appropriate controls to minimise the consumption of all forms of energy (fuels, electricity);
10. Environmental monitoring must be undertaken in accordance with the requirements of any licenses or approvals and to demonstrate compliance with environmental performance criteria objectives;

11. The Contractor must conduct regular site inspections to ensure that environmental controls are in place, the risks are identified and that the Contractor's employees and subcontractors and any personnel involved in the performance of the Contractor's Activities properly implement the Contractor's EMS and Environmental Management and Monitoring Plan(s). SA Water may also conduct site inspections, which will not relieve the Contractor of its responsibilities under this section;

12. The Contractor must undertake routine and random compliance and systems audits to verify that the Contractor's Activities comply with the Contractor's EMS, Environmental Management and Monitoring Plan(s) and the relevant regulatory requirements to prevent potential environmental incidents, improve management practices and demonstrate due diligence;

13. The Contractor must assess its environmental performance and of its subcontractors and any personnel, in the performance of the Contractor's Activities. This assessment must conform with established environmental performance evaluation standards and practices and address the requirements of the Environmental Management and Monitoring Plan;

14. All necessary Approvals not obtained by SA Water must be obtained by the Contractor prior to the commencement of any of the Contractor's Activities that relate to each approval;

15. The Noise and Vibration Management Plan must minimise impacts on the marine environment and comply with Policy Statement 2.1 under the EPBC Act (interaction between off shore seismic exploration and whales);

16. The Contractor must identify strategies to minimise atmospheric emissions beyond regulatory requirements, including the National Environmental Pollution Measure for Air Quality (NEPM), the South Australian Environment Protection (Air Quality) Policy (1994) and the Environment Protection Act (1993); and

17. The Contractor must ensure any of the Contractor's Activities carried out in the marine environment minimise impacts to the marine environment including but not limited to quarantines and measures to manage the introduction or spread of marine pests.

SA Water will implement audits and procedures to ensure that the Contractor fulfils its obligations and requirements in accordance with the conditions of approval of the EPBC Act Referral.
While significant negative impacts to the identified species are considered to be low, any potential impacts will be mitigated and minimised through the implementation of the management measures outlined in the CEMMP and OEMMP.

3.13.2.2 Marine Reptiles

Discussion of marine reptiles (turtles) is included in Chapter 7 of the EIS in particular in Table 7.12, Species of conservation significance as listed under the Environment Protection and Biodiversity Act 1999 (CTH), National Parks and Wildlife Act 1972 (SA) and International Union for the Conservation of Nature, Red List (October 2008). Table 8.8 if the EIS indicates the groups of species which were considered within the EPBC Referral for the proposed Desalination Plant submitted in October 2008. The EPBC Protected Matters Search results did not indicate the potential presence of marine reptiles and therefore they were not considered in the referral.

3.13.2.3 Birds

Table 3.3 details the above listed bird species, their known habitat types and their likelihood of occurrence within the proposed site.
Table 3.3 Habitat description and likelihood of occurrence of EPBC listed species proposed for inclusion in the EIS

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
<th>Habitat Description</th>
<th>Listing under EPBC Act 1999</th>
<th>Included under JAMBA</th>
<th>Likelihood of Occurrence (results from DEH BDBSA and SA Museum Records)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apus pacificus</td>
<td>Fork-Tailed Swift</td>
<td>This species is a migrant to Australia from Siberia and northern Asia and is found throughout the mainland, particularly in the central and west. Habitat is airspace over open country, from semi-deserts to coasts and islands. They are occasionally spotted over cities and forests. They are a non-breeding summer visitor.</td>
<td>Listed</td>
<td>Migratory</td>
<td>Unlikely, species was not identified as occurring within the site during historic surveys.</td>
</tr>
<tr>
<td>Chrysococcyx basalis</td>
<td>Horsfield’s Bronze-cuckoo</td>
<td>This species ranges from South-east Asia to Australia and is widespread east of the Great Dividing Range. It is found in many woodland habitats with a range of understoreys from grasses to heath (Simpson and Day 2004).</td>
<td>Listed</td>
<td>Marine</td>
<td>Probable, however, only one sighting of this species as occurring within the project area (1999) has been made during historic surveys.</td>
</tr>
<tr>
<td>Coracina novaehollandiae</td>
<td>Black-faced Cuckoo-shrike</td>
<td>The Black-faced Cuckoo-shrike is widespread and common throughout Australia. Habitat includes almost any wooded area with the exception of rainforests and is commonly observed in suburban areas (Simpson and Day 2004).</td>
<td>Listed</td>
<td>Marine</td>
<td>Probable, five sightings of this species as occurring within the project area (1984-2002) have been made during historic surveys.</td>
</tr>
<tr>
<td>Cuculus pallidus</td>
<td>Pallid Cuckoo</td>
<td>The Pallid Cuckoo is the most widely distributed of the Cuckoos and is found throughout Australia. It is found in most open forests as well as cleared and cultivated open country (Strahan 1994).</td>
<td>Listed</td>
<td>Marine</td>
<td>Probable, however, only one sighting of this species as occurring within the project area (1976) has been made during historic surveys.</td>
</tr>
<tr>
<td>Flaco cenchroides</td>
<td>Nankeen Kestrel</td>
<td>This species is found throughout Australia including along the coastline and around offshore islands. This species prefers lightly wooded and open agricultural areas rather than dense forests (Simpson and Day 2004).</td>
<td>Listed</td>
<td>Marine</td>
<td>Probable, six sightings of this species as occurring within the project area (1984-2005) have been made during historic surveys.</td>
</tr>
<tr>
<td>Species</td>
<td>Common Name</td>
<td>Habitat Description</td>
<td>Listing under EPBC Act 1999</td>
<td>Included under JAMBA</td>
<td>Likelihood of Occurrence (results from DEH BDBSA and SA Museum Records)</td>
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<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td><em>Grallina cyanoleuca</em></td>
<td>Australian Magpie Lark</td>
<td>This species is endemic to Australasia including Timor and New Guinea and is only rarely seen in Tasmania. They are found in almost every habitat with the exception of rainforests and very arid deserts (Pizzey and Knight 1997).</td>
<td>Not Listed No</td>
<td></td>
<td>Likely, over 50 sightings of this species as occurring within the project area (1985 – 2005) have been made during historic surveys.</td>
</tr>
<tr>
<td><em>Larus novaehollandiae</em></td>
<td>Silver Gull</td>
<td>The Silver Gull is common throughout Australia and is also found in New Zealand and New Caledonia. This species inhabits any watered area and rarely occurs far from land (Pringle 1987).</td>
<td>Listed Marine No</td>
<td></td>
<td>Likely, 36 sightings of this species as occurring within the project site (1985 – 2005) have been made.</td>
</tr>
<tr>
<td><em>Phalacrocorax fuscescens</em></td>
<td>Black-faced Cormorant</td>
<td>This species is found along the southern coasts of Australia including South Australia and is commonly found in the Spencer Gulf and Bass Strait. Black-faced Cormorants frequent coastal waters and are found in large flocks in bays, inlets, rocky headlands and islands (Simpson and Day 2004).</td>
<td>Listed Marine No</td>
<td></td>
<td>Probable, however, only one sighting of this species as occurring within the project area has been made during historic surveys.</td>
</tr>
<tr>
<td><em>Puffinus tenuirostris</em></td>
<td>Short-tailed Shearwater</td>
<td>In the summer months these birds flock from northern wintering grounds to the south and southeast coasts of Australia to breeding grounds off these coasts. They inhabit the coastal waters around Australia (Lindsay 1986).</td>
<td>Listed Marine and Migratory Yes</td>
<td></td>
<td>Probable, however, only one sighting of this species as occurring within the project area (1971) has been made during historic surveys.</td>
</tr>
<tr>
<td><em>Sterna bergii</em></td>
<td>Crested Tern</td>
<td>Crested Terns are found throughout Australia and Tasmania as well as Africa and Polynesia. These species are commonly found along the coast preferring islands, and coastal waterways to inland waterways (Pringle 1987).</td>
<td>Listed Marine No</td>
<td></td>
<td>Probable, five sightings of this species as occurring within the project area (1985-2001) have been made during historic surveys.</td>
</tr>
<tr>
<td><em>Sterna caspia</em></td>
<td>Caspian Tern</td>
<td>Caspian Terns are common throughout Australasia, North America, Eurasia and Africa. This species is commonly found near the coast in extensive wetlands, on coastal and interior beaches and estuaries in both freshwater and saline environments (Simpson and Day 2004).</td>
<td>Listed Marine and Migratory Yes</td>
<td></td>
<td>Unlikely, this species was not identified as occurring within the site during historic surveys.</td>
</tr>
</tbody>
</table>
3.13.2.4 Potential Impact

As noted in the EIS the site has a history of agricultural use. Due to this, the majority of the site is comprised of cultivated paddocks with no native vegetation present. Sparse native vegetation exists along the degraded coastal cliff top (Vegetation Associations A & B, EBS 2008a).

As noted in Section 3.12.2.1 the potential impact of the proposed Desalination Plant on EPBC listed species was determined by assessing the proposed action against the EPBC Significant Impact Guidelines.

Given that the site does not comprise key breeding and/or foraging habitat for any of the species listed above (EBS 2008a) it is unlikely that development of the proposed Desalination Plant will result in one or more of the above criteria coming into effect. In addition, management measures outlined in the CEMMP and OEMMP will address potential impacts relating to the importation and spread of invasive weed species, importation and use of clean fill (i.e. does not contain contaminants which may introduce disease) as well as protecting key habitat for the regeneration of native species along the coastal cliff zone.

Whilst several of the species listed in Table 3.4 have been identified as occurring within the project site during previous surveys, the proposed Desalination Plant is unlikely to significantly impact these species as it will not lead to a long-term decrease in population size, reduce the area of occupancy of the species, fragment existing populations or adversely affect critical habitat.

In addition, based on the EPBC referral and the management measures outlined therein (refer to Section 3.12.2.1), DEWHA determined that the proposed Desalination Plant will not have a significant impact on any matters of national environmental significance and declared the action to be a ‘Non-controlled Action’.

3.13.3 Flora and Fauna Assessment

3.13.3.1 Timing of Flora Survey

The Flora and Fauna Assessment of Potential Sites for the proposed Desalination Plant at Port Stanvac is contained in Appendix F3 of the EIS.

In order to overcome the potential for overlooking the presence of native species within the site, the assessment also considered the results of historical surveys for the area (within an approximately 5 kilometre radius of the site). This data includes survey results maintained by DEH in the Biological Database of SA (BDBSA), Kraehenbuehl (1996), Friends of Port Stanvac and the SA Museum. The incorporation of this information into the assessment ensures the vegetation condition assessment was based on a comprehensive data set of survey results obtained throughout all seasons.

A separate flora survey was conducted by EBS in September 2008 which targeted the EPBC listed species *Euphrasia collina subsp. osbornii* (Osborne’s Eyebright). This species was identified in a single location within the existing Mobil Oil Refinery site. This species was not identified north of this location within the proposed Desalination Plant site.
3.13.3.2 Historic Data

At the time that EBS completed the terrestrial flora survey SA Water was considering two sites within the Port Stanvac area to construct the Desalination Plant. The two sites were the Northern site (the current site) and the Southern site which directly borders the southern boundary of the buffer land between the two sites (Refer to Figure 3.6). The northern site was the preferred option for a variety of reasons including it being a site cleared of native vegetation, thus reducing the environmental impact associated with the Desalination Plant. Due to the consideration of two possible sites EBS completed the flora and fauna assessment for both the northern and southern sites. When referring to flora survey results as outlined in Table 3.4 for the site, the site comprises the following areas:

- The proposed Desalination Plant site (approximately 20-30 hectares);
- The buffer land between the proposed Desalination Plant and the Mobil Oil Refinery land;
- The existing Mobil Oil Refinery land

In addition, the surrounding land includes an approximately 5 kilometre radius around the area outlined above.

Table 8.3 of the EIS has been updated below (Table 3.4) to reflect if a species which has been identified as occurring on site during the current EBS survey was also previously recorded as occurring on site in historic surveys. Historic data has been obtained from the Friends of Port Stanvac, Kraehenbuehl (1996) and the Biological Database of SA (BDBSA).

Table 3.4 State and regionally listed flora occurring within the Port Stanvac site and surrounding area (modified from Table 5 in EBS 2008a) [E = Endangered V = Vulnerable R = Rare U = Uncommon K = Uncertain]

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Conservation Rating</th>
<th>Survey Identified</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SA Legislation</td>
<td>Regional Ratings</td>
</tr>
<tr>
<td>Euphrasia collina ssp. osbornii</td>
<td>Osborne’s Eyebright</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Cardamine paucijuga</td>
<td>Annual Bitter-cress</td>
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<td>Sprawling Bluebell</td>
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3.13.4 Regulatory Compliance

3.13.4.1 Native Vegetation Clearance

As stated in Table 3.1 of the EIS the successful Contractor is required to ‘Comply with the requirements of the Native Vegetation Act 1991 (SA).’

The requirement for the Contractor to comply with the Native Vegetation Act 1991 includes gaining any necessary approval from the Native Vegetation Council for the clearance, removal or trimming of native vegetation. SA Water will ensure that the requirement for any clearance, trimming or removal of native vegetation is identified and approval from the Native Vegetation Council is sought in a timely manner.
Areas of Conservation

As stated in Table 3.1 of the EIS it is a requirement of the successful Contractor to: ‘Protect biodiversity values of the site and avoid impacts to native vegetation and fauna.’ This includes ensuring the following provisions are implemented:

- No removal of native vegetation is to be undertaken at the site without prior approval of SA Water;
- The design is to ensure that impacts to terrestrial flora and fauna are avoided or minimised during construction, commissioning and operation;
- Development of a CEMMP and OEMMP; and
- Development of a Land Management Plan for the site.

It is not within SA Water’s authority to re-zone the coastal cliff area as a coastal reserve, as zoning falls under the jurisdiction of the City of Onkaparinga. The Council has however presented a Development Plan Amendment to the Minister for Urban Development and Planning proposing to rezone a section of the cliffs near the site to Coastal Conservation.
3.14 Visual Amenity

Those submissions regarding visual amenity can be summarised as follows:

1. Visual assessment - The City of Onkaparinga argues that a thorough visual assessment of the proposed Desalination Plant should be based on final design site plans, elevations and landscaping plan (including a detailed species list, their height screening capability and growth expectation).

2. Artist impressions - Artist impressions of the proposed Desalination Plant from key vantage points (including the sea) have been requested to provide an indication of what the Plant may look like.

3. Landscape Plan - The City of Marion has requested that SA Water consults the local residential community to the immediate north of the proposed site to develop a landscape plan that provides an effective buffer between the Desalination Plant and the residential area. Another submission called for a policy on revegetation with local Indigenous plant species.

3.14.1 Visual Assessment

The visual assessment of the proposed Desalination Plant has been based on the concept design developed by SA Water’s technical specialists. While it is expected that the final design of the Plant will vary from the concept design, the Contractor will be required to adhere to the environmental and engineering objectives and performance criteria established by SA Water (as presented in Table 3.1 of the EIS). These objectives and performance criteria require that the Contractor's final design of the Desalination Plant protect the landscape and visual amenity values of the locality and coastline by:

- Siting buildings and structures on the site to effectively screen unsightly features from view, including incorporating some elements of balancing the cut to fill on site;
- Using muted colours (ochres and greys) for external finishes to blend into the natural landscape;
- Integrating mounding and other landforms into the broader landscape to appear as natural as possible;
- Ensuring that landscaping and screening of the Desalination Plant is undertaken, incorporating locally Indigenous species; and
- Minimising light spill during both construction and operation of the Plant.

The visual assessment that was reported in the EIS concluded that the Plant is likely to have a positive visual impact on the locality given that the proposed site is a highly modified industrial environment dominated by the existing oil refinery and associated tank structures. The following section demonstrates how the Desalination Plant will look from a number of key vantage points.

3.14.2 Artist Impressions

Artist impressions of the proposed Desalination Plant have been included in Appendix E. These provide both short-term and long-term perspectives of what the Plant structures will look like as viewed from the Hallett Cove Conservation Park/Black Cliff and from the Gulf St Vincent. The Hallett Cove Conservation Park was chosen as a key land-based vantage point given that this was the only location
assessed in the EIS as having a potentially adverse visual impact (although only in the short-term).

The artist impressions confirm the EIS finding that the visual impact of the Desalination Plant from the land is likely to be slight in the short-term and beneficial in the long-term with the establishment of screen planting. The visual impact of the Plant from the Gulf will be more apparent, although as argued in the EIS, the number and frequency of viewers will be extremely small and the visual impact deemed to be less significant as a result.

3.14.3 Landscape Plan

SA Water recognises that the Landscape (Buffer) Zone immediately north of the proposed development is intended to provide an effective buffer from industrial activities located in and around the Desalination Plant site for residents of Hallett Cove. While the successful Contractor will be responsible for developing the final landscape plan for the Desalination Plant site, the environmental performance objectives presented in Table 3.1 of the EIS requires that this plan properly screens the Desalination Plant from views from the north through the use of locally indigenous plant species and mounding that has been integrated into the broader landscape to appear as natural as possible.

In addition, the Contractor must ensure that all unsightly features of the Plant are effectively screened from view, that muted colours are used to better integrate buildings and structures into the landscape and that lighting systems are designed so as not to create light spill on adjacent areas. As a result of these contractual requirements, the Contractor’s landscape plan will effectively buffer residents of Hallett Cove from any visual impacts arising from the proposed Desalination Plant.

In addition, the Contractor will be required to adhere to the following environmental objectives and performance criteria to protect the biodiversity values of the proposed site:

- Design to ensure that impacts to terrestrial flora and fauna are avoided or minimised;
- Design to incorporate opportunities for habitat restoration and regeneration at the site;
- Development and implementation of a Pest and Weed Management Plan to enhance local biodiversity; and
- Development and implementation of a Land Management Plan that incorporates improvement to biodiversity through revegetation with locally indigenous plant species.

The Contractor will also be required to comply with relevant SA Water and State Government policies including SA Water’s Land Management Policy and associated Revegetation Guidelines as well as the State Government’s Planting Indigenous Species Policy (2003), all of which encourage the use of local indigenous species.

In addition, the Contractor will be required to consult with local Councils and the Adelaide Mount Lofty Ranges Natural Resource Management Board in implementing these objectives and criteria to ensure that revegetation initiatives are properly integrated with broader Regional strategies.
3.15 Traffic and Access Issues

Those submissions concerning traffic and access can be summarised as follows:

1. Traffic and access routes – Concerns were raised over the proposed traffic and access routes during construction and operation of the Desalination Plant.

2. Green Travel Plan - The City of Onkaparinga recommends that strategies be developed to encourage construction workers to commute to the Plant site via public transport. These strategies might include feeder buses from the Lonsdale train station or free train tickets.

3.15.1 Traffic and Access Routes

Construction vehicles are generally proposed to access the site from Lonsdale Road, turning into Meyer Road, then continuing over the rail overpass into Sigma Road and subsequently to the site of works on Christie Road (Figure 3.9: route ‘a’).

Supplementary access is being investigated so that construction vehicles can also access the site from Lonsdale Road turning into Sherriffs Road, and then along a temporary access road formed in the current vacant landholding (parallel to St Vincent Road), providing a thoroughfare from Sherriffs Road through to Meyer (Figure 3.9: route ‘c’). From this point vehicles would travel over the rail overpass of route ‘a’ to the site. This supplementary access, which is currently being negotiated with the land owner, would provide some flexibility to manage construction vehicles during peak times. Some oversized construction vehicles may need to access the site along Christie Road and the at-grade rail crossing (Figure 3.9: route ‘b’), however this is discouraged as the main access due to safety.

The Lonsdale Road / Meyer Road intersection is proposed to be signalised. Minor upgrades are proposed to be undertaken at the Sigma Road / Meyer Road roundabout to facilitate the safe turning movements of larger construction vehicles. SA Water is currently liaising with DTEI to determine the optimum solution for the Lonsdale Road / Meyer Road intersection. It is likely that following completion of the project works any signalised upgrade to the Meyer Road / Lonsdale Road intersection will remain permanently.

It is intended that the supplementary access between Sherriffs Road and Christie Road would only service construction traffic and would be removed when it is no longer required for construction purposes.

St Vincent Road reserve has become an area of native vegetation due to the efforts of the local community. In recognition of the importance of this vegetation, the establishment of an access road on the adjacent vacant landholding of route ‘c’ is proposed. SA Water is currently negotiating with the private land owners and the City of Onkaparinga regarding the alignment and leasing arrangements of this temporary access road.
An on-site formal car park will be provided for construction vehicles, which will be located on the southern portion of the site (south of the existing creek). The car park will provide approximately 550 car spaces for the construction workforce.

There will be increases to traffic movement to and from the Plant, particularly during the construction phase. The Traffic Impact Assessment Report identified that the existing road networks have sufficient capacity to accommodate the proposed construction vehicles. During the operation of the Plant there will be significantly fewer vehicles than compared with the construction phase, involving vehicles for the delivery of chemicals and removal of waste from the site.

Construction and Operational Phase traffic management plans, which include the proposed routes for the transport of waste and chemicals, will be submitted to Council for endorsement prior to approval of the CEMMP and OEMMP.

It is intended that over-dimensioned vehicles will obtain the appropriate approvals from the relevant authorities for the proposed routes prior to utilising the surrounding road network. It is envisaged that the frequency of over-dimensioned vehicles will be very low.

### 3.15.2 Green Travel Plan

SA Water recognises the potential benefits to reducing greenhouse gas emissions associated with the ADP through providing incentives for the construction workforce to utilise public transport for commuting to and from the proposed site of the Desalination Plant. SA Water has proposed that the Contractor develop a Green Travel Plan to provide a platform for the Contractor to negotiate public transport incentives for project staff with DTEI and the City of Onkaparinga.
3.16 Noise, Dust, Odour and Waste Management

A small number of issues were raised in relation to noise, odour and waste management. Many of these issues were similar in nature and were broadly related to either construction or operational impacts, as follows:

1. **Potential odour, dust, vibration and noise impacts during operation**
2. **Potential negative impacts to the adjacent community, the implementation and enforcement of mitigation measures and management plans and subsequent response to community complaints**

3.16.1 Impacts During Construction and Operation

Concerns were raised during the EIS consultation in relation to odour (in particular from desalination chemicals and screen wastes). The findings of the odour investigations and modelling undertaken to inform the EIS showed that the potential odour impacts from the operational phase of the proposed Desalination Plant will be at acceptable limits as defined by EPA Guideline 373/07 – Odour Assessment using odour source modelling. The Guideline requires an odour unit (OU) of no more than 2 OU at the nearest sensitive receptor where the population is greater than 2000 people. The findings of the odour study showed that concentrations at the site boundary were likely to be less than 2OU (see Figure 9.9, in the EIS, Odour Dispersion contours) therefore, at the nearest sensitive receptor 360 metres away odour will be within acceptable limits.

Antiscalants are added to the filtered seawater before the reverse osmosis process to minimise the inorganic scale build-up on the membrane surface. Odour from antiscalants was not considered as part of the odour investigations given that antiscalants are rejected in the saline concentrate system. Pre-treatment filters will be routinely cleaned to remove flocculation material captured during the filtration process. This sludge will be stored in accordance with EPA requirements including Bunding and Spill Management Guidelines for off-site disposal to an EPA approved waste management facility. This sludge has been considered as part of the odour assessment referred to above. Waste management and minimisation measures are outlined further in Section 3.8.4.

The results from the noise and sound pressure modelling showed that the predicted operational and construction noise emissions from the proposed Desalination Plant are able to be managed to ensure they meet the requirements of the Environment Protection (Noise) Policy (2007) criteria. The noise modelling demonstrated that the predicted construction noise levels will likely be in exceedence of the criteria for some activities at the site. However these activities are able to be managed through careful selection of equipment and hours of operation to ensure community impact is managed. The operational modelling shows that the predicted operational noise emissions for the Desalination Plant will be within the Environment Protection (Noise) Policy 2007. With careful management of construction activities construction and operational noise emissions are likely to be negligible on nearby sensitive receivers.

The results from the dust impact modelling did not predict any exceedence of the Ambient Air Quality National Environment Protection Measure (NEPM) and the Environmental Protection (Air Quality) Policy 1994, at the residential receptors during construction and operation, including consideration of potential cumulative impacts under the ‘worst case’ scenarios when compared to background concentrations. The modelling suggests that dust emissions may slightly exceed the adopted NEPM criteria (50 µg/m³) in the adjacent industrial area.
Therefore, as required by the *Environment Protection Act 1993*, all reasonable and practicable measures will be undertaken by the Contractor, though the preparation and implementation of the CEMMP to ensure dust emissions will be mitigated and, as much as possible, contained on site. It is not expected that dust emissions will be an ongoing issue once construction is complete.

The Contractor will detail mitigation measures in the CEMMP and OEMMP, including incorporating best practice construction methods to minimise noise and limiting the nature and timing of night time construction activities. Monitoring requirements will be conducted to ensure that noise, odour and dust impacts on nearby receptors are within applicable policy criteria.

Specific noise and air quality conditions will be required by the development approval relating to the design of the Plant to minimise noise impact, ensuring compliance with the relevant Environment Protection Policies and the monitoring and reporting of noise levels in adjoining residential zones once the proposed Desalination Plant is operational.

### 3.16.2 Impact on Adjacent Community

During construction and operation, potential nuisance impacts such as noise, vibration, dust and odour will be managed and monitored by the Contractor through the CEMMP and OEMMP. The management plans will detail mitigation measures to minimise potential impact of the above issues on nearby sensitive receptors. Many of these measures will be informed by the consent conditions of the Governor’s approval and will follow SA Environment Protection Policies.

The management plans will allow for a regime of regular community/stakeholder consultation regarding noise, vibration, dust and odour management. The Contractor will be required to implement a community complaints procedure to ensure that any community complaints are managed effectively. Any complaints received will be registered, and the nature of the complaint investigated and resolved.
3.17 Geology, Soils, Surface Water and Groundwater

A small number of concerns were raised during the EIS consultation in relation to geology, soils, surface water and ground water. These concerns specifically related to the geological monument at Curlew Point and the potential for groundwater impacts during construction.

3.17.1 Impacts on Geological Formations

The geological description of the cliffs and rock formed platforms of Curlew Point were described within the description of the Coastal Cliff (Section 7.2.6.2.1 of the EIS). Curlew Point is considered to be a geological monument due to its geomorphological significance to the region. Curlew Point is listed as a geological monument and contains examples of the Brachina Formation, Hindmarsh Clay, Marino Group, Cape Jervis Formation, and ABC Range Quartzite. This geological monument is approximately 1.5 kilometres from the proposed site and will not be affected by construction of the Desalination Plant. Consequently, the EIS and future CEMMP, and OEMMP document do not refer to site conservation and protection measures for Curlew Point.

3.17.2 Impacts on Groundwater

As identified in the EIS, further groundwater contamination investigation work will continue to be undertaken prior to construction to further inform the development of monitoring requirements through both construction and operation of the Desalination Plant. These investigations will further identify any potential risk to human health and/or the environment.

The Contractor’s CEMMP will include procedures to manage contaminated groundwater that may be encountered during development of the proposed Desalination Plant. The management plan will address sampling and potential for treating and disposal of groundwater if dewatering activities are required during construction and must be in accordance with EPA licensing requirements as well as legal requirements, in particular the Environment Protection (Site Contamination) Amendment Bill 2007, (SA) and the Environment Protection (Water Quality) Policy 2003, (SA).

Design mitigation measures will be implemented by the Contractor during construction of the Desalination Plant and upon operation of the plant, to minimise the risk that contaminated groundwater may leach into the intake / outlet tunnel, shaft water storages and pipelines. Testing during construction may include measures such as groundwater vapour assessment. The intake / outlet tunnel shaft will also be designed in a manner which will not allow groundwater to leach into the shaft, including separation of the groundwater aquifers immediately surrounding the shaft to mitigate any cross contamination of the groundwater between aquifers.

The performance criteria for the project specifies that the design of any below ground structures must ensure that they will not be affected by any contaminated groundwater and designed to prevent groundwater ingress. Future delineation of the existing groundwater contamination will further inform the Contractor in implementing these design features effectively.

A comprehensive OEMMP will also be required to address any ongoing requirements for monitoring or management of contaminated groundwater, including further investigation to determine if a Groundwater Monitoring Event is necessary at the site. Both the CEMMP and OEMMP will contain emergency contingency plans to...
minimise the impact of accidental exposure or migration of groundwater contamination.
4 Response to Marine Issues

The EIS submissions included a number of issues in relation to the potential marine impacts relating to the proposed Desalination Plant. These matters can be broadly separated into the following key areas:

- Marine Hydrodynamic Modelling;
- Marine Ecology;
- Water and Sediment Quality;
- Ecotoxicology;
- Dredging and blasting; and
- Marine management and monitoring.

Submissions have been classified into themes and addressed through composite responses.

The following sections outline each of the key areas and responses. Many of the marine impacts are interlinked; for example the ecotoxicology dilution rates are linked to the impacts on marine species, communities and to the dispersion characteristics of the saline concentrate. This Chapter should be read in its entirety in order to understand fully the linkages between the various issues.

The ITRP engaged to ensure the objectives of the EIS process were achieved have continued to provide advice in relation to the appropriateness of the marine investigations and SA Water’s response to marine issues.

4.1 Marine Hydrodynamic Modelling

A significant number of submissions included issues relating to the oceanography and hydrodynamics sections of the EIS (Chapter 7 of the EIS). The issues raised can be summarised as follows:

1. Modelling approach – Submissions queried the following: the modelling approach used to assess the complex mixing and dispersion processes within Port Stanvac and the wider Gulf St Vincent (GSV); the potential uncertainty in the findings of the hydrodynamic models and the potential risk of underestimating the impacts on the marine environment; the relationship between the nearfield and midfield models.

2. Oceanography – Concerns were raised in relation to: the data collected may not be sufficient to assess the impact of stratification on dissolved oxygen; dodge tides may cause lengthy periods of ‘still water’ and subsequently have a significant impact on mixing and dispersion of the saline concentrate discharge.

3. Nearfield – Concerns were raised in relation to: the nearfield modelling may have overestimated the initial dilution of the saline concentrate discharge; further sensitivity analysis is required; mixing of the discharge jet may entrain the saline plume; duckbill valves may require the diffuser to be located in deeper water.

4. Midfield – Submissions queried the following: the plume dispersion modelling overestimates mixing and dispersion; further sensitivity analysis is required;
climate change should be considered as part of the midfield modelling; the model may not be representative of the long term conditions of Gulf St Vincent; that the boundary conditions adopted in the model are not representative of the wind and density driven currents; that the potential exists for upwelling to occur onto the sensitive reef areas.

5. Whole of Gulf – Concerns were raised in relation to: the flushing and exchange of water between Gulf St Vincent and the Southern Ocean is insufficient to sustain the operation of the proposed Desalination Plant and this may lead to accumulation of salt within the Gulf; uncertainty exists in the whole of Gulf model; the timeframes used for the larval dispersion modelling may not be representative of all spawning species within the Gulf.

4.1.1 Modelling Approach

4.1.1.1 Mixing and Dispersion

The processes associated with mixing and dispersion in the marine environment are complex and thus a multi-step modelling and assessment was used.

The concentration of the existing seawater near Port Stanvac in Gulf St Vincent normally varies between 36.5 parts per thousand (ppt) and 37.8 ppt depending on the seasonal changes. The concentration of the saline discharge from the proposed Desalination Plant will vary from 60 ppt to 73 ppt depending on the process plant operation modes. At these concentrations there is a potential for the saline concentrate discharge to affect the marine environment until the saline concentrate is diluted to approximately the salt concentration occurring naturally in Gulf waters. Following dilution at the 50:1 target dilution criterion specified in the EIS, this equates to a salinity increase above ambient of approximately 0.44 to 0.73 ppt. As such, it is important to assess the mixing and dispersion of the proposed saline concentrate discharge as it enters the marine environment to determine the extent of any potential impacts and to design discharge infrastructure (the Diffuser) to ensure any identified potential adverse impacts are minimised.

The behaviour of saline concentrate discharged from the Diffuser and its subsequent dispersion into the immediate and wider Gulf waters involves a number of complex hydrodynamic/oceanographic processes that vary over a range of space and time scales. In order to encompass the complexity of the dispersion processes in the marine environment, the mixing and dispersion of the saline concentrate was considered at 3 distinct space/time scales indicated in Table 4.1.
Table 4.1 - Summary of modelling focus and approach

<table>
<thead>
<tr>
<th>Spatial Extent</th>
<th>Timescale</th>
<th>Focus of investigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nearfield</td>
<td>Diffuser port to within about 50m of the Diffuser</td>
<td>Less than 10 minutes Initial mixing and dispersion, driven by momentum of discharge, Diffuser design and characteristics of the saline concentrate discharge</td>
</tr>
<tr>
<td></td>
<td>Plume Dispersion (Midfield)</td>
<td>50 metre to &lt; 10km from the Diffuser structure</td>
</tr>
<tr>
<td>Whole of Gulf</td>
<td>Gulf-wide</td>
<td>500 metres to 100 km</td>
</tr>
</tbody>
</table>

Nearfield

SA Water’s concept design comprises a 250 metre long diffuser with 42 tee risers separated by 6 metres and each riser having two ports angled upwards and facing to the north and to the south. Flow would be discharged through the individual ports, each of approximately 0.11 metre diameter and located approximately one metre above the sea bed and angled upwards at 60º to the horizontal.

The velocity of the saline concentrate jet discharged from each port is typically 40 to 60 times greater than the mean ambient velocity resulting in a jet-like flow of the saline concentrate upwards into the marine water. During the period the jet is rising, driven by the upward momentum of the jet, the jet continually entrains surrounding seawater and the saline concentrate is diluted. When the upward momentum is fully used, the jet stops rising and begins to fall back towards the seabed. As it falls back toward the seabed the ‘collapsed jet’ continues to entrain ambient water diluting the saline concentrate. This concentrate / water mix is termed the diluted saline plume.

The extent of the nearfield or ‘initial’ mixing zone is generally defined as the point where the descending saline plume reaches the seabed. From this point, subsequent plume dispersion is generally considered to be independent of the discharge conditions due to ambient currents, turbulence and local bathymetry.

The assessment of nearfield mixing and dispersion is used primarily in the development of a concept design of the Diffuser structure that aims to maximise initial dilution of the discharged saline concentrate prior to its contact with the seabed. For this project, a design criterion has been to achieve an initial average dilution across the plume of 50:1 at the point of contact of the plume with the seabed. The nearfield modelling undertaken for the EIS has shown that the target dilution of 50:1 is achieved, in still water conditions, within approximately 30 metres of the Diffuser.

The empirical equations developed by Roberts et al. (1997) were used in the EIS assessment of nearfield mixing and dispersion. These equations are accepted as representing current best-practice design formulae for dense discharges to the marine environment, and have been shown to be a conservative estimator in the
The three dimensional hydrodynamic model ‘GETM’ has been used to assess the temporal and spatial evolution of the saline concentrate discharge beyond the nearfield zone.

**Whole of Gulf**

The removal of seawater for freshwater extraction and subsequent discharge of saline concentrate back to Gulf St Vincent has the potential to result in an accumulation of salt within the wider Gulf waters in the long term. The potential for salt to accumulate is determined by the balance between the rate at which salt is produced within the Gulf by evaporation from the water surfaces and the saline concentrate discharge and the rate of flushing or exchange of Gulf waters with the waters of the Southern Ocean. The potential for long term Gulf-wide effects on the marine environment were determined using two independent assessments. These included:

- A Delft3D hydrodynamic model (FLOW) and water quality transport model (WAQ) were used to assess potential increases in temperature and salinity; and
- A simple whole-of-Gulf flushing box model was developed to represent each of the key processes affecting salinity within the Gulf.

### 4.1.1.2 Uncertainty Associated with Modelling

The numerical modelling assessment focuses on the dispersion of the proposed saline concentrate discharge and its feedback to the Diffuser design. The numerical modelling tools used include some key components and assumptions including:

- Actual hydrodynamic processes are represented by the model equations;
- Model boundaries are sufficiently distant from the areas of interest so that broader scale phenomena does not unduly influence the results within the model domain;
- Initial conditions are adequately represented; and
- A sufficient range of environmental conditions (including worst case) are represented by the model boundary conditions.

The level of uncertainty associated with each of these components can vary, and therefore best practice recommends that a conservative approach be adopted with
ongoing checks of results and peer reviews, such as those undertaken by the ITRP. This approach ensures that the limitations of the models are identified and that any conclusions based on the model results recognise the context of these limitations to ensure a reasonable margin of error is adopted. SA Water has adopted a conservative approach in the concept design and in the preparation of the EIS document. SA Water will ensure that the Contractor’s detailed design also embraces this best practice.

**Worst Case Scenario**

Defining the worst case scenario is complex as there are a range of variable environmental conditions and dispersion characteristics. One potential combination of oceanographic and meteorological conditions that may produce low dispersion of the saline concentrate is a period of low ambient currents which would correspond to the period of lowest transport and mixing, thereby allowing the plume to maintain its character for longer than it would under normal conditions. Another suggested scenario would be a situation of strong offshore winds following a calm period at dodge tide when possible ambient stratification may be enhanced by the saline concentrate plume which may then be subject to upwelling or plume transport toward the sensitive near-shore reef areas.

The degree of certainty in the nearfield modelling has improved through the use of the Roberts *et al.* (1997) model based on similar applications and sensitivity testing where the model input parameters are varied to assess their impact on the model results.

SA Water has formed the view that the modelling work demonstrates that the proposed Desalination Plant can operate well within the design criteria. While there is always a degree of uncertainty in the model assumptions, a conservative approach has been adopted to ensure that this uncertainty is incorporated into the variability of the results. The plume dispersion modelling simulations have been forced by a period of low wind, typical shelf wave activity and tidal oscillations including three dodge tides. The model has been shown to under-predict the observed currents and hence dispersion estimates derived from the model will likewise predict less dispersion than would be observed (Section 4.1.4.5).

### 4.1.1.3 Location of the Outfall

The hydrodynamic plume dispersion modelling assesses the dispersion of the saline concentration discharge into the marine environment from specific locations at Port Stanvac and, as such, has been used to assess the impact on specific marine habitats.

The ecological constraints of the location for the Diffuser and intake structures for the proposed Desalination Plant were considered in the early concept design process. A number of key issues were considered, the most important of which was the location of the intertidal and sub-tidal reefs. The intake and outfall will be located away from the sensitive reefs within the soft bottom substrate of the mid and deep benthic zone. This zone has been shown to be absent of seagrass with minimal large macrofauna.

The hydrodynamic investigations considered both the northern and southern locations within the Port Stanvac site, showing little difference, in terms of hydrodynamics, between the two locations. The northern site was later chosen as the preferred site based on these findings and site factors. In addition, consideration has also been given to the water depth required to prevent interaction of the discharge plume with surface waters. Modelling of the concept design indicated a
rise height of approximately 13 metres under peak flow conditions. The proposed location for the Diffuser is situated in approximately 20 metres of water, with 7 metres of water above the maximum rise height. Consideration will also be given to the rise height resulting from changes to the Diffuser design, including the potential use of duckbill valves and additional bypass flow, in the final design to be undertaken by the Contractor to ensure there is no interaction of the saline concentrate discharge jet with the water surface.

These considerations facilitated the definition of an envelope for construction of the marine structures that recognised each of the constraints and consequently the EIS was completed on this basis. As a result of the uniform nature of the habitat within the envelope, it is unlikely that there will be any changes in the relative impacts associated with the final location of the marine structures.

4.1.1.4 Relationship between Nearfield and Midfield Models

The following section details the approach utilised in the set-up of the midfield model and the relationship with the findings of the nearfield investigation.

The midfield GETM model solves the conservation of momentum and conservation of volume equations on a grid of 50 metres x 50 metres in the horizontal and between 0.5 and about 2 metres in the vertical depending on the layer and total depth at the grid cell of interest. Within each cell, the salinity and temperature is uniform. The vertical component of the momentum transfer from one grid cell to the overlying (or underlying) cell is averaged over the horizontal face area (50 x 50 metres) of the cell while horizontal transfers occur through the sides (50 metres x cell height).

The GETM model also invokes the so-called hydrostatic assumption where the vertical momentum terms in the equations are simplified to linear terms. This improves numerical computation time and is applicable to most situations where the vertical momentum is considerably smaller than the horizontal momentum.

Nearfield models are generally based on empirical equations derived from the analysis of laboratory model tests and subsequent field verification. For the proposed Desalination Plant application of the nearfield model considers the dispersion from a port of 0.11 metre diameter angled upward at 60° to the horizontal i.e. the momentum has a vertical and horizontal component. This exit velocity (hence momentum) is roughly 40 times greater than the ambient velocity (and momentum). The midfield model with its 50 x 50 metre face is unable to resolve the mixing at the port scale of around 1 metre. The nearfield model is used to calculate initial dilution between the diffuser port and the point of impact with the bed which is between 35 and 65 metres and hence approximates the 50 metre cell width of the GETM model. The concept design Diffuser is 250 metres long with 42 tee risers separated by 6 metres with each riser having two ports angled upwards and facing to the north and to the south. This corresponds to 8 ports per 50 metre GETM grid cell and as the plume width at impact is similar to the port spacing it is assumed that the discharge diffuser is well represented as a line source in the GETM model. The dense saline concentrate is inserted between the seabed and 10 metres height of rise of the discharging jets to incorporate some mixing of the descending plume.

The introduction of the saline concentrate into the midfield model conserves the salt flux but is unable to resolve the small scale mixing of the discharging jet. This is because the mixing within the jet occurs at a smaller scale than the 50x50 metre of the model cells. While this issue affects the concentrations in the midfield model near the Diffuser, the dispersion smoothes the nearfield effects and provided that the saline concentrate salt flux is input to the model, then it is likely that the results
at some distance from the Diffuser is predicted correctly. This is a general issue affecting midfield modelling of outfalls. As the momentum associated with the discharge is not replicated in the midfield model, the discharge is generally distributed over an ‘apparent Diffuser’ area representing the approximate size of the nearfield zone.

This approach has been adopted in similar desalination plant outfall modelling studies. The concentration in the midfield Diffuser depends on the discharge into the Diffuser cell and the ambient currents that transport water through the Diffuser cells. Since the nearfield mixing is not resolved by the midfield model, the concentrations in the Diffuser cells are generally higher than would be expected by the nearfield model. This approach produces conservative estimates of the concentrations near the outfall.

The apparent mismatch between the nearfield model resolution and the GETM midfield model resolution is common for these types of studies. Adopting the current practice of distributing the saline concentrate discharge across a number of Diffuser (8 or 10) cells is considered to produce conservative results and hence the level of uncertainty associated with the assumptions is within reasonable bounds.

The assumptions used in the nearfield and midfield plume dispersion models are considered to be conservative as:

- There is a high likelihood that the estimated concentrations are higher than what will occur following construction and during operation of the Plant; and
- There is a low likelihood that model estimates are less than what occurs during Plant operation.

4.1.2 Oceanography

4.1.2.1 Stratification

Development of stratified layers within the water column has the potential to reduce the potential for mixing and dispersion. Temperature, salinity and dissolved oxygen profiles have been collected at Port Stanvac over the last 12 months at approximately 2 week intervals.

The vertical profiles of temperature, salinity and dissolved oxygen, collected approximately fortnightly since January 2008 (salinity available since April 2008), demonstrate that density stratification of greater than 0.1 kg/m³ (due to both temperature and salinity stratification) were observed in 3 of the 11 profiles. For all of the profile observations there was virtually no dissolved oxygen stratification indicating that the density stratified conditions had not persisted long enough to inhibit vertical transfer of oxygen and allow its depletion near the bed. All measurements taken during the monitoring period showed greater than 98% oxygen saturation.

The measurements showed very different temperature and salinity characteristics from one observation date to the next, indicating water mass changes between the measurements. The changing water mass could be attributed to a number of processes, including transport of different water around the Gulf, or measurement accuracy, but generally indicates rapid mixing and transport.

It is suggested that the tidal currents and mixing (even during dodge tides), coupled with relatively large year-round north/south density gradients in the Gulf, and
consistent wind mixing events, are sufficient to continually flush and exchange water masses around the Gulf.

It is difficult to speculate on the conditions that could lead to a stratified layer with deep water mass persisting in a location long enough to promote oxygen depletion. While it is considered very unlikely that low dissolved oxygen concentrations occur in the deeper waters off Port Stanvac, higher temporal resolution measurements of temperature, salinity and dissolved oxygen are planned to check that it does not occur. In the event that an oxygen depletion event occurs to a level of ecological significance then mitigation measures, including enhanced nearfield dilution or plant shutdown for brief periods, may be considered.

4.1.2.2 Dodge Tides

The occurrence of dodge tides within Gulf St Vincent has raised several questions in regards to the frequency and duration of dodge tide events, the conditions associated with a dodge tide and the likely impact these conditions will have on the mixing and dispersion of the saline concentrate discharge. It has been suggested that regular long periods of ‘still water’ will occur within the Gulf as a result of dodge tides and will have a significant impact on the mixing and dispersion of the saline concentrate discharge from the proposed Desalination Plant.

These concerns are addressed below by first referring to the definition of the dodge tide and highlighting variability in dodge tide water level and predicted tidal currents characteristics, and second; by presenting analyses of water level, wind and recently collected current meter data from the site around the dodge tide periods to show the degree of water movement during these periods.

Dodge Tide Water Levels

The National Tidal Centre at the Bureau of Meteorology (BoM) describes the dodge tide on its website (www.bom.gov.au/oceanography/tides/dodge/) as follows:

This is a local South Australian term for a neap tide with minimal rise and fall over the course of a day or two. While very ‘flat’ neaps (see neap tide) occur in a number of locations worldwide, the term ‘dodge’ is used only in SA. Professor Sir Robert Chapman, C.M.G., writing in the Official Yearbook of the Commonwealth of Australia of 1938, stated:

‘At spring tides the range, due to the semi-diurnal waves, is 2(M2 + S2), and at neaps, if the two are equal, or nearly equal, they practically neutralize one another and cause no rise nor fall at all. This is what happens at Port Adelaide where at this period the recording gauge shows frequently little or nothing in the way of tide, in some cases the level of the water remaining almost constant for a whole day; in other cases one small tide occurs during the day. On each side of this tide is markedly irregular both as regards time and height, and the apparent impossibility of saying when the tide will be at this particular period has presumably gained for it its name ’The Dodger’.”

The Bureau of Meteorology also provides an example of an interval of minimal tidal range at Adelaide, circled in Figure 4.1.
Since 1938 there have been significant improvements in the monitoring of oceanographic conditions, producing a more complete and higher resolution dataset. As stated above, the tides are irregular around the dodge tide and the more complete datasets may be used to further explore this behaviour within Gulf St Vincent.

The analyses of the astronomical tides incorporate a range of diurnal (once per day) and semi diurnal (twice per day) constituents with amplitudes smaller than the dominant $M_2$ and $S_2$ semi diurnal constants. The interactions of the different tidal constituents result in considerable variability in the character of the tides around neaps and hence the duration of minimal tidal movement or dodge (refer Figure 4.2).

As the tidal constituents change within the Gulf, the nature of the dodge tide also changes, i.e. different locations within the Gulf have different dodge tide characteristics.

During most neap periods the dodge phenomenon is manifest as a very small tide with significant tides immediately before and after the dodge. About twice per year (e.g. the dodge tides of May 14 and November 8 in Figure 4.2), half-way between equinox and solstice, a dodge occurs when the vertical water movement is less than 10 centimetres for over some 10 hours. Analysis of 15 years of water level observations at Port Stanvac indicates that indeed these events of less than 10 centimetres water level change over at least 10 hours do occur on average twice per year.

Despite the relatively low tidal range, significant water movement still occurs during neap or dodge tide events, driven by forces such as wind and gravity driven currents. Remotely generated oscillations such as continental shelf waves also have a significant influence within Gulf St Vincent. To further explore the variability in tidal currents during the dodge tide, an analysis of the wind and current data for Port Stanvac is presented below.
Figure 4.2 Predicted tides for 2008 (National Tidal Centre, Bureau of Meteorology http://www.bom.gov.au/oceanography/tides/dodge/oh2008pre.pdf)
Port Stanvac Wind Analysis

Currents within Gulf St Vincent are influenced by a variety of factors, including tidal movement, wind (both local and remote), temperature and salinity gradients. Wind is of particular significance as a forcing component of water movement during periods of low tidal range around neap and dodge tide events.

Table 4.2 and Table 4.3 provide an analysis of 15 years of wind time series data collected at Port Stanvac between January 1993 and October 2008. Table 4.2 shows the mean wind speed to be in excess of 5.5 m/s with little seasonal variation. A wind speed in excess of 5.5 m/s falls into the ‘moderate breeze’ category of the Beaufort scale used by meteorologists around the world for describing the effects of different wind speeds on the land and sea.

Sea conditions for the ‘moderate breeze’ category of the Beaufort scale predict ‘small waves’ of around 1 metre wave height. This demonstrates the intensity of wind within the Port Stanvac region throughout the year, and the subsequent potential for winds to play a key role in regularly driving water movement within the Gulf.

Oceanographers and sailors generally estimate the wind driven surface currents as 3% of the wind speed and deeper currents as 1% of the prolonged wind speed. The time from the commencement of a strong wind to the set up of the currents is relatively short (10 seconds to minutes) for the surface currents and generally longer (hours) for the deeper currents depending on the bathymetry and wind fetch length. For example, a 5 m/s wind blowing for more than a few hours will generate surface currents of around 15 cm/s and eventually a deeper current of around 5 cm/s.

Table 4.2 Wind speed statistics from analysis of long-term wind time series - 1/01/1993 to 31/10/2008

<table>
<thead>
<tr>
<th></th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
<th>Spring</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Wind Speed (m/s)</td>
<td>5.89</td>
<td>5.14</td>
<td>5.74</td>
<td>5.76</td>
<td>5.63</td>
</tr>
<tr>
<td>Lower 95% CI (m/s)</td>
<td>5.86</td>
<td>5.11</td>
<td>5.70</td>
<td>5.73</td>
<td>5.61</td>
</tr>
<tr>
<td>Upper 95% CI (m/s)</td>
<td>5.92</td>
<td>5.17</td>
<td>5.77</td>
<td>5.79</td>
<td>5.65</td>
</tr>
<tr>
<td>Standard Deviation (m/s)</td>
<td>2.85</td>
<td>2.84</td>
<td>3.25</td>
<td>3.04</td>
<td>3.01</td>
</tr>
</tbody>
</table>

Table 4.3 shows the cumulative percentage occurrence of wind speed at 2 m/s intervals. This shows that a wind speed of less than 2 m/s occurred for only 10 percent of the time over the 15 years of data analysed. A wind speed of 2 m/s falls into the ‘Light breeze’ category of the Beaufort scale, with sea conditions comprising small wavelets; crests of glassy appearance, not breaking and wave heights in the order of 0.2 metres. Even for this relatively low wind speed, the conditions still demonstrate some potential for wind driven water movement and subsequent mixing.
Table 4.3 Cumulative percentage occurrence of wind speed for Port Stanvac long-term wind time series data - 1/01/1993 to 31/10/2008

<table>
<thead>
<tr>
<th>Wind speed (m/s)</th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
<th>Spring</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>8.38%</td>
<td>11.01%</td>
<td>10.30%</td>
<td>9.45%</td>
<td>9.80%</td>
</tr>
<tr>
<td>4</td>
<td>27.33%</td>
<td>38.68%</td>
<td>34.97%</td>
<td>31.25%</td>
<td>33.12%</td>
</tr>
<tr>
<td>6</td>
<td>51.37%</td>
<td>64.39%</td>
<td>57.05%</td>
<td>55.04%</td>
<td>57.01%</td>
</tr>
<tr>
<td>8</td>
<td>75.59%</td>
<td>84.00%</td>
<td>74.75%</td>
<td>76.36%</td>
<td>77.69%</td>
</tr>
<tr>
<td>10</td>
<td>92.18%</td>
<td>94.11%</td>
<td>87.87%</td>
<td>90.59%</td>
<td>91.17%</td>
</tr>
<tr>
<td>12</td>
<td>98.08%</td>
<td>97.94%</td>
<td>95.95%</td>
<td>97.13%</td>
<td>97.27%</td>
</tr>
<tr>
<td>14</td>
<td>99.65%</td>
<td>99.37%</td>
<td>99.05%</td>
<td>99.20%</td>
<td>99.32%</td>
</tr>
<tr>
<td>16</td>
<td>99.96%</td>
<td>99.86%</td>
<td>99.88%</td>
<td>99.80%</td>
<td>99.88%</td>
</tr>
<tr>
<td>18</td>
<td>100.00%</td>
<td>99.98%</td>
<td>99.97%</td>
<td>99.94%</td>
<td>99.97%</td>
</tr>
<tr>
<td>20</td>
<td>100.00%</td>
<td>99.99%</td>
<td>99.99%</td>
<td>99.99%</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>100.00%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>100.00%</td>
<td></td>
</tr>
</tbody>
</table>

It is also important to consider the duration of events of low wind speeds. Whilst a wind speed of less than 2 m/s occurs for 10 percent of the time at Port Stanvac, the duration of each event where the wind remains below 2 m/s is relatively short. Table 4.4 shows that the maximum duration for wind speeds below 2 m/s is 26 hours, with a mean duration of approximately 2 hours. Similar statistics for 4 m/s and 5.5 m/s wind speeds are also presented in Table 4.4 for further comparison.

Table 4.4 Long-term wind speed duration statistics - 1/01/1993 to 31/10/2008

<table>
<thead>
<tr>
<th>Wind speed (m/s)</th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
<th>Spring</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind speed below 2 m/s</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Min Duration (Hr)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Max Duration (Hr)</td>
<td>13</td>
<td>17</td>
<td>26</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>Mean Duration (Hr)</td>
<td>1.93</td>
<td>2.09</td>
<td>2.17</td>
<td>2.02</td>
<td>2.06</td>
</tr>
<tr>
<td>Median Duration (Hr)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Wind speed below 4 m/s</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Min Duration (Hr)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Max Duration (Hr)</td>
<td>27</td>
<td>40</td>
<td>76</td>
<td>38</td>
<td>76</td>
</tr>
<tr>
<td>Mean Duration (Hr)</td>
<td>3.58</td>
<td>4.80</td>
<td>5.21</td>
<td>4.01</td>
<td>4.40</td>
</tr>
<tr>
<td>Median Duration (Hr)</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Wind speed below 5.5 m/s</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Min Duration (Hr)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Max Duration (Hr)</td>
<td>57</td>
<td>103</td>
<td>154</td>
<td>69</td>
<td>154</td>
</tr>
<tr>
<td>Mean Duration (Hr)</td>
<td>5.19</td>
<td>7.66</td>
<td>7.89</td>
<td>6.03</td>
<td>6.62</td>
</tr>
<tr>
<td>Median Duration (Hr)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Further analysis has been undertaken that shows that 85% of all events less than 2 m/s last for only 4 hours, whilst 98% are shorter than 8 hours (Figure 4.3).
An important aspect of the wind and water level variability as it affects dispersion in the deeper waters off Port Stanvac is the joint occurrence of dodge tides with low winds. The hourly wind and predicted tide records for the period 1993 to present were analysed to address this issue. For the purpose of analysis, it is difficult to define the period of a dodge tide due to the variable nature of the tidal movement surrounding the dodge tide. For this analysis, dodge tide has been defined as the two consecutive days during the fortnightly neap tides when the minimum average rate of change of predicted water levels (dh/dt) occurs. These dodge tide periods and coinciding average wind speed (over the 48 hours) are shown in Figure 4.4. Minimal vertical movement indicates the occurrence of significant dodge tides and are generally characterised by vertical velocities of less than about 1.4 m/day. As shown in the figure over the past 15 years wind speeds always exceed 2.5 m/s during the minimal range dodge tides and generally exceeded 4 m/s.
Port Stanvac Currents Analysis

The assertion that lengthy periods of ‘still water’ occur within Gulf St Vincent near Port Stanvac around low tidal range neap/dodge tide events is based on the assumption that all water movement in the Gulf is driven by tidal flow. As discussed previously, water movement in Gulf St Vincent is influenced by a range of factors, with constant movement occurring throughout the year at Port Stanvac.

Figure 4.5 shows the distribution of current speeds for the two current meter deployments from 4 June 2008 to 21 August 2008 and from 28 August 2008 to 16 October 2008. The currents presented are average velocities collected between 2.7 metres and 3.7 metres above the bottom in approximately 20 metres of water at Port Stanvac. These currents represent the likely conditions that will drive the mixing and dispersion of the saline concentrate discharge from the proposed Desalination Plant. During the period of analysis, the mean current speed is 11.2 cm/s, while for 10 percent of the time the current was below 1.1 cm/s and 90 percent of the time was below 20.8 cm/s.
The duration of low flow currents presented in Figure 4.5 indicates that low flow currents occur relatively infrequently at Port Stanvac. Current speeds of less than 2 cm/s occur for only 3% of the time (based on the current meter data collected to date).

Analysing the duration of currents below a specific current speed event provides information on whether the events are infrequent long events or frequent short events. From Table 4.5, it can be seen that the duration of current speed events less than 2 cm/s are relatively short. The maximum duration of an event less than 2 cm/s (for the period of data analysed) was approximately 40 minutes, whilst the mean duration is less than 15 minutes.

Even by increasing the threshold of current speed to 8 cm/s, the maximum event duration is still less than 10 hours. Figure 4.6 shows that 100 percent of events with current speeds less than 2 cm/s have a duration less than 1 hour and for 99 percent of events where the current speed is less than 8 cm/s, the duration is less than 4.5
hours. This demonstrates that while periods of relatively low current speed do occur, they occur only for short periods.

![Graph showing percentage occurrence and duration for current speed events less than 1 cm/s, 2 cm/s, 4 cm/s, and 8 cm/s currents.]

**Figure 4.6** Percentage occurrence and duration for current speed events less than 1 cm/s, 2 cm/s, 4 cm/s, and 8 cm/s currents

### Relationship between Dodge Tides and Currents

The analysis presented above demonstrates that while periods of relatively low tidal range variability do occur at Port Stanvac around neap tides, the occurrence of events of less than 10 centimetres water level change over at least 10 hours occur on average only twice per year.

Significant seasonal variation in wind direction occurs at Port Stanvac however. A mean wind speed in excess of 5.5 m/s for each season shows little variation in speed over the year. Low wind speeds of less than 2 m/s occur less than 10 percent of the time and for 98% of the events where winds remain consistently below 2 m/s for less than 8 hours duration. The chance of prolonged periods of low winds occurring on a dodge tide is very small. It should be noted that the average wind speed during the period of current meter data collection was slightly higher (6.2%) than the 15 year average; however, this is unlikely to have a significant impact on the current data analysis.

The results of this analysis demonstrate that despite short periods of low tidal range, significant potential exists for alternative forcing processes to drive water movement. Current measurements off Port Stanvac since June 2008 are presented in Figure 4.7, with a focus on periods of dodge or neap tides. The difference between the observed and predicted water level and current meter data demonstrates that processes other than astronomical tidal movement are of significant importance to water movement in Gulf St Vincent. It can be seen in Figure 4.7 that even around the neap tide periods significant currents exist, resulting in a consistently dispersive natural environment.
Figure 4.7 Neap tides and associated currents during Winter and Spring 2008 (Grey shaded areas represent the flood tide and white areas the ebb tide. The first four lines of the figures represent the neap tides indicated in the last line of the figure)
Dodge Tides and Plume Dispersion

The discharge will generate a small current at the point of impact of the saline concentrate discharge with the seabed. Currents associated with the volume of water discharged and the density of the diluting plume will also contribute to the subsequent dispersion.

If the ambient currents are low such as during the occasional periods of low winds around dodge tides, then there is a reduced capacity to dilute the saline discharge. An estimate of the minimum ambient current at which dilution beyond the nearfield zone can be derived by assuming the discharges at the desired dilution (i.e. $50 \times Q_d$, where $Q_d$ is the saline concentrate discharge) flows through an approximate area of twice the concept Diffuser length (500 metres) and a total depth 20 metres. For maximum discharge of 4.46 m$^3$/s this yields a velocity of about 4.5 cm/s.

It may be expected that during periods when the ambient currents drop below this value, such as for brief periods around dodge tides, then the dispersion is reduced and the plume concentrations will persist for a longer period and extend further from the nearfield zone than under regular tidal conditions.

The estimate ignores, however, the density driven component of the plume dispersion that effectively reduces the minimum ambient current required for plume dispersion. The near bottom current meter records show that the maximum duration of ambient current less than 4 cm/s was less than 2 hours and that 4 cm/s currents occur less than 12% of the time (derived from the 5 months of 10 minute records).

Figure 4.8 shows both the observed (black) and predicted (red) water level and current (longshore and cross shore) data collected at Port Stanvac. Wind speed and direction have also been included to allow comparison between the key processes contributing to the mixing and dispersion of the saline concentrate discharge at Port Stanvac.

There will be some events each year where the minimum ambient currents discussed above are not achieved for a short period. GETM modelling shows that predicted dilution drops below 50:1 for a short period at the Diffuser, but that 50:1 dilution is achieved at about 500 metres away. Thus, 50:1 is always achieved, but the footprint is larger in prolonged events of weak currents, which are relatively infrequent.
Figure 4.8 Water level, current (longshore and cross shore), and wind speed and direction data for Port Stanvac – June 2008 to October 2008
4.1.3 Nearfield

4.1.3.1 Dilution Estimates

The following section provides an overview of the nearfield investigation and discusses the appropriateness of this approach.

There are various models that have been developed to predict the initial dilution of saline concentrate discharges with the adjacent seawater. For the desalination plants at Perth, Sydney and the Gold Coast, the model developed by Roberts et al. (1997) was used; for the desalination plant at Wonthaggi the model known as Visiplume was used. The Roberts et al. (1997) model has been used in the assessment of nearfield dilution for the proposed Desalination Plant as presented in the EIS and reproduced in Figure 4.9 below.

![Figure 4.9 Schematic representation of nearfield plume dispersion](image)

Dr Jochen Kaempf of Flinders University was engaged by the City of Onkaparinga to undertake an independent assessment of the EIS in relation to the saline concentrate discharge. Dr Kaempf has used a model developed by Lee and Chu (2003) to predict the dilution of the saline concentrate discharge. The dilutions calculated by Dr Kaempf using the Lee and Chu (2003) model are significantly lower than using other models. The following sections discuss the basis for the discrepancies observed between the two modelling approaches.

Froude Number

The dilution of the saline concentrate of a discharge jet depends on a number of parameters – the velocity of the discharge \( V \), the salinity or density of the discharge concentrate \( \rho_b \), the diameter of the port \( d \), the salinity or density of the adjacent seawater \( \rho_s \), the depth of the water to the Diffuser \( Y \), the ocean current \( U \) and the rate of mixing in the ocean. To consider a ‘worst case’ situation, the ocean current is generally assumed to be zero, or close to zero.

The models developed by Roberts et al. (1997) and by Lee and Chu (2003) utilise a Froude number in the calculation of initial dilution. The Froude number is simply the ratio of the velocity of the discharge, to the velocity of a wave on the edge of the jet.
This reflects the rate of mixing between the jet and the adjacent seawater, and is determined from the following equation;

\[ F = \frac{V}{\sqrt{\frac{g (\rho_b - \rho_s)}{d} \rho_s}} \]

where \( g \) is the acceleration due to gravity.

For the purpose of this comparison, the full production rate at 40% removal efficiency during summer has been considered. The Froude number can easily be calculated for this scenario by substituting the values \( V = 6.85 \text{ m/s}; \rho_b = 1042.71 \text{ kg/m}^3; \rho_s = 1024 \text{ kg/m}^3; d = 0.11 \text{ metres and } g = 9.806 \text{ m/s}^2 \) into the above equation to yield

\[ F = 48.8 \]

Lee and Chu (2003) Model

The saline concentrate discharge from the Diffuser ports initially acts as a jet where the upward movement dominates over the gravity associated with the negative buoyancy. At the point of maximum height, the downward movement due to gravity of the heavier discharge takes over and the jet collapses to form a dense plume that plunges toward the seabed (refer Figure 4.9).

The dilution of the jet calculated by Dr Kaempf, as given by Lee and Chu (2003, equation 2.72, page 88) is determined at the maximum rise height, where the entrainment has only been calculated on the jet portion (i.e. between the port and the maximum rise height).

The dilution at the maximum rise height of the discharge jet has been determined by Lee and Chu (2003) to be equal to \( 0.384 \times F \). For the example presented above for the proposed Desalination Plant, the maximum average dilution is:

\[ \text{Dilution (D)} = 0.384 \times 48.8 \]

\[ = 17:1 \]

After reaching the maximum height, however, the discharge saline concentrate continues to rapidly entrain ambient water as the plume collapses resulting in intense additional mixing. Lee and Chu (2003) defined this stage as detrainment, the ‘discharge peeling off to form the falling part of the dense plume’. Lee and Chu (2003) state that the ‘dense plume will eventually sink back to the discharge level and spread…’ and ‘Since the most concentrated part of the plume mixes further beyond \( t_c \) [time of maximum entrainment] and on its descent the dilution is expected to be somewhat greater than estimated.’
Roberts et al. (1997) Model

The Roberts et al. (1997) equations allow for the calculation of dilution at two key points within the saline concentrate discharge plume/jet, comprising:

- $D_i = \text{the dilution at the point of impact of the plume with the seabed}$
- $D_m = \text{the dilution a distance } X_m, \text{ where the plume is independent of the discharge conditions and behaves as a gravity current}$

Roberts et al. (1997) equations have been developed based on an interpretation of results of physical modelling investigation, and calculate dilution using the formulae; $D_i = 1.6 \times F$ and $D_m = 2.6 \times F$

Figure 4.9 shows the path of the saline concentrate discharge jet as used in the Roberts et al. (1997) model, used as the basis for the dilution predictions in the EIS. The concept design considered for the proposed Desalination Plant utilised discharge ports at 60 degrees above the horizontal. This port angle is designed to give the longest jet path, and hence highest dilution, before the jet falls back to the seabed.

For the example considered above, the dilution calculated using Roberts are:

\[
\begin{align*}
\text{Dilution } (D_i) & = 1.6 \times 48.8 \\
& = 78:1 \\
\text{Dilution } (D_m) & = 2.6 \times 48.8 \\
& = 127:1 
\end{align*}
\]

Model Suitability

For the Perth Desalination Plant, the Diffuser design utilised the empirical model of Roberts et al. (1997) to specify a discharge port configuration that would most likely satisfy the environmental design criteria. The design criteria stated that the discharge Diffuser should achieve an initial dilution of 45 and that the Diffuser was to be located in sufficient water depth to avoid any surface manifestation of the seawater concentrate discharge. The preliminary design calculations were checked by physical scale modelling at the Water Research Laboratory, University of NSW. The laboratory model results compared favourably with the Roberts et al. (1997) predictive formulae and indicated a reasonable degree of conservatism had been incorporated in their equations.

Following construction of the plant, a detailed field sampling exercise of the discharge plume dispersion was carried out by the Centre for Water Research (2007) using state-of-the-art sampling equipment. Results of these surveys confirmed that the actual Diffuser was achieving greater dilution than originally predicted (WCWA, 2008), further validating the Roberts et al. (1997) formulae. Given this previous assessment and the similarities, in terms of site characteristics and physical processes, between the Perth and Adelaide Desalination Plants, the Roberts et al. (1997) model of dense plume dilution was adopted for the Diffuser concept design.

The Lee and Chu (2003) model has not been validated in the marine environment, particularly for dense saline concentrate discharges. The examples given by Lee and Chu (2003) for the calculations of dilutions, however, refer to an atmospheric application. It is acknowledged by Lee and Chu (2003) that ‘on its descent the dilution [of the plume] is expected to be somewhat greater than estimated.’
Consequently, the equations developed by Lee and Chu (2003) and applied by Dr Kaempf are not appropriate in the assessment of the dilution of dense saline concentrate plumes in the marine environment at Port Stanvac.

SA Water's Technical Specialists and the ITRP are of the view that the verified Roberts et al. (1997) formulae are consistent with best practices and have been shown to provide a representative and reliable estimate of initial dilution. These formulae have also been used in the design of the Perth Desalination Plant, the Sydney Desalination Plant, and the Gold Coast Desalination Plant.

4.1.3.2 Sensitivity Analysis

The following section presents a sensitivity analysis to provide greater understanding of critical design and construction considerations, and includes discussion of the uncertainties and confidence in the reported dilutions.

The nearfield hydrodynamic modelling investigation was undertaken to develop a Diffuser concept design and to describe initial dilution for a range of operational scenarios. As a concept design, it represents one possible Diffuser configuration aimed at producing the dilution rates of the saline concentrate necessary for protection of the marine ecosystem.

The ultimate design of the Diffuser will be undertaken by the Contractor. The Contractor will be required to demonstrate that the final design will achieve the target minimum initial dilution for the full range of operational scenarios.

As discussed previously, dilution of the saline concentrate discharge from the Diffuser is dependent on a number of variables including, the velocity of the discharge, salinity or density of the discharge concentrate, port diameter, and the salinity or density of the adjacent seawater. To assess the sensitivity of the dilution rate to variations in key design parameters, and hence the ability for the concept design to be modified to meet changes in design criteria, a sensitivity analysis has been undertaken.

The sensitivity analysis included modification of both the extraction efficiency (40% and 50%) and port diameter (0.09, 0.11 and 0.15 metres). The extraction efficiency affects the salinity/density, discharge volume and subsequently flow velocity of the saline concentrate discharge, whilst the port diameter affects the flow velocity and surface area of the discharge jet.

By varying the number of ports, the discharge velocity can be altered (i.e. the lower the number of ports, the higher the exit velocity from each port) and subsequently the target dilution rate can be achieved. Table 4.6 (40% efficiency) and Table 4.7 (50% efficiency) shows each of the key parameters used in the sensitivity analysis of the Diffuser design and nearfield dilution. The parameters modified for the sensitivity analysis have been highlighted in blue, and the subsequent dilution rate at impact with the seabed highlighted in green.
Table 4.6 Sensitivity analysis of design parameters for the diffuser structure (40% extraction efficiency)

<table>
<thead>
<tr>
<th></th>
<th>Qf</th>
<th>150</th>
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<th>150</th>
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<tr>
<td><strong>Seawater Intake</strong></td>
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<tr>
<td>Extraction Efficiency</td>
<td>a</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
</tr>
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<td>Seawater Inflow (ML/d)</td>
<td>Qo</td>
<td>Qf/a</td>
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<td></td>
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<td></td>
<td></td>
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<td>Ambient Salinity</td>
<td>So</td>
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<td>37.1</td>
<td>37.1</td>
<td>37.1</td>
<td>37.1</td>
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<td>Water temperature (deg Celsius)</td>
<td>To</td>
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<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
</tr>
<tr>
<td>Density (kg/m3)</td>
<td>Ro</td>
<td>1025.7</td>
<td>1025.7</td>
<td>1025.7</td>
<td>1025.7</td>
<td>1025.7</td>
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<tr>
<td><strong>Saline Discharge</strong></td>
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<td></td>
</tr>
<tr>
<td>Discharge (ML/d)</td>
<td>Qd</td>
<td>Qf * (1-a)/a</td>
<td>225</td>
<td>225</td>
<td>225</td>
<td>472.5</td>
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<tr>
<td>Discharge (m³/s)</td>
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<td>2.60</td>
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<td>2.60</td>
<td>5.47</td>
<td>5.47</td>
<td>5.47</td>
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<tr>
<td>Salinity Saline concentrate (ppt)</td>
<td>Sd = So / (1-a)</td>
<td>61.8</td>
<td>61.8</td>
<td>61.8</td>
<td>61.8</td>
<td>61.8</td>
<td>61.8</td>
</tr>
<tr>
<td>Temperature Saline concentrate (deg C)</td>
<td>Td = To</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
</tr>
<tr>
<td>Density Saline concentrate (kg/m³)</td>
<td>Rd(Sd,Td)</td>
<td>1044.6</td>
<td>1044.6</td>
<td>1044.6</td>
<td>1044.6</td>
<td>1044.6</td>
<td>1044.6</td>
</tr>
<tr>
<td>Density Difference (Rd-Ri) (kg/m³)</td>
<td>Rd - Ro</td>
<td>18.9</td>
<td>18.9</td>
<td>18.9</td>
<td>18.9</td>
<td>18.9</td>
<td>18.9</td>
</tr>
<tr>
<td>Reduced Gravity (m²/s)</td>
<td>go  = g x (Rd-Ro) / Ro</td>
<td>0.181</td>
<td>0.181</td>
<td>0.181</td>
<td>0.181</td>
<td>0.181</td>
<td>0.181</td>
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<tr>
<td><strong>Roberts et al. (1997) Model Estimates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port Diameter (m)</td>
<td>dp</td>
<td>0.09</td>
<td>0.11</td>
<td>0.15</td>
<td>0.09</td>
<td>0.11</td>
<td>0.15</td>
</tr>
<tr>
<td>Number of ports</td>
<td></td>
<td>42</td>
<td>42</td>
<td>20</td>
<td>84</td>
<td>84</td>
<td>40</td>
</tr>
<tr>
<td>Individual port velocity m/s</td>
<td>up</td>
<td>9.7</td>
<td>6.5</td>
<td>7.4</td>
<td>10.2</td>
<td>6.9</td>
<td>7.7</td>
</tr>
<tr>
<td>Port densimetric Froude Number</td>
<td>Fp  = up / (go x dp)</td>
<td>76.4</td>
<td>46.3</td>
<td>44.7</td>
<td>80.2</td>
<td>48.6</td>
<td>47.0</td>
</tr>
<tr>
<td>Rise Height (m above bottom)</td>
<td>Yt  = 2.2 Fp x dp</td>
<td>15.1</td>
<td>11.2</td>
<td>14.8</td>
<td>15.9</td>
<td>11.8</td>
<td>15.5</td>
</tr>
<tr>
<td>Estimated Dilution at Impact</td>
<td>Di  = 1.6 Fp</td>
<td>122</td>
<td>74</td>
<td>72</td>
<td>128</td>
<td>78</td>
<td>75</td>
</tr>
<tr>
<td>Distance to impact (m from port)</td>
<td>Xi  = 2.4 Fp x dp</td>
<td>16.5</td>
<td>12.2</td>
<td>9.2</td>
<td>9.2</td>
<td>9.2</td>
<td>9.2</td>
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<tr>
<td>Downstream layer thickness (m)</td>
<td>Ym  = 0.7 Fp x dp</td>
<td>4.8</td>
<td>3.6</td>
<td>4.7</td>
<td>5.1</td>
<td>3.7</td>
<td>4.9</td>
</tr>
<tr>
<td>Dilution at start of Downstream layer (m)</td>
<td>Dm = 2.6 Fp</td>
<td>199</td>
<td>120</td>
<td>116</td>
<td>209</td>
<td>126</td>
<td>122</td>
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<tr>
<td>Distance to start of Downstream layer (m)</td>
<td>Xm = 9 Fp x dp</td>
<td>61.9</td>
<td>45.8</td>
<td>60.4</td>
<td>65.0</td>
<td>48.1</td>
<td>63.4</td>
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<tr>
<td>Salinity at Impact (ppt)</td>
<td>Si  = (Di So + Sd) / (1+Di)</td>
<td>37.3</td>
<td>37.4</td>
<td>37.4</td>
<td>37.3</td>
<td>37.4</td>
<td>37.4</td>
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<tr>
<td>Salinity excess at impact (ppt)</td>
<td>dS = Si - So</td>
<td>0.2</td>
<td>0.3</td>
<td>0.3</td>
<td>0.2</td>
<td>0.3</td>
<td>0.3</td>
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### Table 4.7 Sensitivity analysis of design parameters for the diffuser structure (50% extraction efficiency)

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<th>Plant Production</th>
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<th>150</th>
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<tr>
<td>Freshwater Production (ML/d)</td>
<td>Qf</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>315</td>
<td>315</td>
<td>315</td>
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<tr>
<td>Seawater Intake</td>
<td>a</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Extraction Efficiency</td>
<td>Qo = Qf/a</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>630</td>
<td>630</td>
<td>630</td>
</tr>
<tr>
<td>Seawater Inflow (ML/d)</td>
<td>So</td>
<td>37.1</td>
<td>37.1</td>
<td>37.1</td>
<td>37.1</td>
<td>37.1</td>
<td>37.1</td>
</tr>
<tr>
<td>Ambient Salinity</td>
<td>To</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
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<tr>
<td>Water temperature (deg Celsius)</td>
<td>Ro</td>
<td>1025.7</td>
<td>1025.7</td>
<td>1025.7</td>
<td>1025.7</td>
<td>1025.7</td>
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<tr>
<td>Density (kg/m3)</td>
<td>Rd</td>
<td>1054.3</td>
<td>1054.3</td>
<td>1054.3</td>
<td>1054.3</td>
<td>1054.3</td>
<td>1054.3</td>
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<tr>
<td>Saline Discharge</td>
<td>Rd - Ro</td>
<td>28.6</td>
<td>28.6</td>
<td>28.6</td>
<td>28.6</td>
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<tr>
<td>Discharge (ML/d)</td>
<td>go = g x (Rd-Ro) / Ro</td>
<td>0.274</td>
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<tr>
<td>Discharge (m³/s)</td>
<td>1.74</td>
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<td>3.65</td>
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<td>Discharge</td>
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<td>1.74</td>
<td>3.65</td>
<td>3.65</td>
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</tr>
<tr>
<td>Temperature Saline concentrate (deg C)</td>
<td>Td = To</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
<td>22.4</td>
</tr>
<tr>
<td>Density Saline concentrate (kg/m³)</td>
<td>Rd(Sd,Td)</td>
<td>1054.3</td>
<td>1054.3</td>
<td>1054.3</td>
<td>1054.3</td>
<td>1054.3</td>
<td>1054.3</td>
</tr>
<tr>
<td>Density Difference (Rd-Ri) (kg/m³)</td>
<td>Rd - Ro</td>
<td>28.6</td>
<td>28.6</td>
<td>28.6</td>
<td>28.6</td>
<td>28.6</td>
<td>28.6</td>
</tr>
<tr>
<td>Reduced Gravity (m²/s)</td>
<td>go = g x (Rd-Ro) / Ro</td>
<td>0.274</td>
<td>0.274</td>
<td>0.274</td>
<td>0.274</td>
<td>0.274</td>
<td>0.274</td>
</tr>
<tr>
<td>Roberts et al. (1997) Model Estimates</td>
<td>Port Diameter (m)</td>
<td>dp</td>
<td>0.09</td>
<td>0.11</td>
<td>0.15</td>
<td>0.09</td>
<td>0.11</td>
</tr>
<tr>
<td>Number of ports</td>
<td></td>
<td>30</td>
<td>30</td>
<td>12</td>
<td>60</td>
<td>60</td>
<td>24</td>
</tr>
<tr>
<td>Individual port velocity m/s</td>
<td>up</td>
<td>9.1</td>
<td>6.1</td>
<td>8.2</td>
<td>9.6</td>
<td>6.4</td>
<td>8.6</td>
</tr>
<tr>
<td>Port densimetric Froude Number</td>
<td>Fp = up / (go x dp)</td>
<td>58.0</td>
<td>35.1</td>
<td>40.4</td>
<td>60.9</td>
<td>36.9</td>
<td>42.4</td>
</tr>
<tr>
<td>Rise Height (m above bottom)</td>
<td>Yt = 2.2 Fp x dp</td>
<td>11.5</td>
<td>8.5</td>
<td>13.3</td>
<td>12.1</td>
<td>8.9</td>
<td>14.0</td>
</tr>
<tr>
<td>Estimated Dilution at Impact</td>
<td>Di = 1.6 Fp</td>
<td>93</td>
<td>56</td>
<td>65</td>
<td>97</td>
<td>59</td>
<td>68</td>
</tr>
<tr>
<td>Distance to impact (m from port)</td>
<td>Xi = 2.4 Fp x dp</td>
<td>12.5</td>
<td>9.3</td>
<td>9.2</td>
<td>9.2</td>
<td>9.2</td>
<td>9.2</td>
</tr>
<tr>
<td>Downstream layer thickness (m)</td>
<td>Ym = 0.7 Fp x dp</td>
<td>3.7</td>
<td>2.7</td>
<td>4.2</td>
<td>3.8</td>
<td>2.8</td>
<td>4.5</td>
</tr>
<tr>
<td>Distance to start of Downstream layer (m)</td>
<td>Xm = 9 Fp x dp</td>
<td>47.0</td>
<td>34.8</td>
<td>54.6</td>
<td>49.3</td>
<td>36.5</td>
<td>57.3</td>
</tr>
<tr>
<td>Dilution at start of Downstream layer</td>
<td>Dm = 2.6 Fp</td>
<td>151</td>
<td>91</td>
<td>105</td>
<td>158</td>
<td>96</td>
<td>110</td>
</tr>
<tr>
<td>Salinity at Impact (ppt)</td>
<td>Si = (Di So + Sd) / (1+Di)</td>
<td>37.5</td>
<td>37.7</td>
<td>37.7</td>
<td>37.5</td>
<td>37.7</td>
<td>37.7</td>
</tr>
<tr>
<td>Salinity excess at impact (ppt)</td>
<td>dS = Si - So</td>
<td>0.4</td>
<td>0.6</td>
<td>0.6</td>
<td>0.4</td>
<td>0.6</td>
<td>0.5</td>
</tr>
</tbody>
</table>

The results, presented in Table 4.6 and Table 4.7 show that the target dilution of 50:1 adopted for the concept Diffuser design can be achieved over a range of Diffuser configurations.

Further sensitivity analysis has been undertaken to show the relationship between discharge/port diameter and dilution rates, and is presented in Figure 4.10. From this figure, it can be seen that there is a linear relationship between port diameter/discharge and dilution rates. It is noted that should the higher port diameters be utilised in the final design, fewer ports would be required to increase the discharge velocity from each port and subsequently achieve the target dilution rates. Where required, bypassing can also be used at lower flow rates to ensure that the 50:1 target dilution is achieved. The potential staged construction approach between the 50 GL and 100 GL per year production allowed for the blockage of 50
percent of the ports at the initial stage to ensure the target dilutions are achieved. To allow for comparison of port diameter with dilution rates, changes to the number of open ports have not been included in the figure below.

![Graph showing relationship between port diameter and dilution](image)

**Figure 4.10 Relationship between port diameter and dilution for freshwater production rates between 150 and 315 ML/d – 40% extraction efficiency with 84 ports.**

The above analysis demonstrates the flexibility of designs for Diffusers in meeting the required target dilution. The ultimate dilution criteria will be set by the EPA and as such the Diffuser will ultimately be designed to meet this dilution rate.

SA Water has adopted a conservative approach in the concept design and in the preparation of the EIS document and will also ensure that the Contractor’s detailed design embraces this best practice.

The empirical model of Roberts et al. (1997) utilised was also used for the design of the Perth Desalination Plant and subsequently tested following construction of the Plant using a detailed field sampling exercise. Results of these surveys confirmed that the actual Diffuser was achieving greater dilution than originally predicted (WCWA, 2008), further validating the Roberts et al. (1997) formulae.

Consequently, SA Water believes that by utilising the Roberts et al. (1997) model, as used by the Perth Desalination Plant, the Sydney Desalination Plant, and the Gold Coast Desalination Plant, confidence can be given to the dilutions reported.

### 4.1.3.3 Mixing between the Discharge Jet and Ambient Water

In terms of salinity levels, the highest rate of dilution of the discharge jet is achieved when the salinity concentration is greatest between the jet and the ambient water. Where the plume thickness around the Diffuser is greater than the height of the port off the seabed, the potential exists for re-entrainment of saline concentrate into the discharge stream after discharge from the Diffuser structure.
Re-entrainment in the context of the above issue refers to the entrainment of the plume surrounding the Diffuser structure back into the discharge jet as it leaves the Diffuser port. This may occur when the thickness of the plume adjacent to the Diffuser, \( Y_L \) (refer Figure 4.9) exceeds the height of the discharge port risers.

The nearfield modelling assessment indicates that the typical plume thickness in the vicinity of the Diffuser structure is likely to be between 2 and 4 metres, whilst the riser height from the concept design was specified at 1 metre above the seabed. As such, the potential exists for re-entrainment of the plume into the discharge jet for the first 1 to 3 metres of the plume trajectory.

The concept design of the Diffuser achieves a plume trajectory, represented schematically in Figure 4.9, with an average rise height \( Y_t \) of approximately 10 metres and distance to point of contact with the seabed of 10 to 12 metres. Whilst re-entrainment of the discharge may occur in the initial 1 to 3 metres of the jet, this is a relatively small percentage of the total plume trajectory. If 3 metres of a 20 metre long jet/plume is in the field of diluted saline concentration at the 50:1 target dilution, then 15% of the total length entrains the 50:1 (0.02%) diluted saline concentrate. As such, the net effect is less than 1% reduction in nearfield dilution. In addition, the majority of entrainment of ambient water into the discharge jet occurs higher up in the plume trajectory.

It is also important to consider the likely salinity concentration of the plume that would be in contact with the discharge jet. The plume surrounding the Diffuser would be composed of saline concentrate discharge that had already undergone rapid mixing and dispersion as it was discharged from the Diffuser ports. As such, the plume would have minimal impact on the dilution rates and subsequent salinity concentrations achieved.

Each of the above factors demonstrate that whilst the potential does exist for re-entrainment of saline discharge into the discharge jet for the concept diffuser design, it is unlikely to have any significant impact on the dilution results presented in the EIS.

This issue will however be considered in the detailed design and related investigations to be undertaken by the Contractor.

*Local bathymetry around the diffuser*

Close inspection of the bathymetric soundings in the vicinity (within approximately 500 metres) of the proposed Diffuser location indicates the bottom slopes generally offshore with some flow interleaving features parallel to the shore. Within the accuracy of the bathymetry (0.1 metres in the vertical direction) it appears there may be some depressions of up to 100m diameter and 0.1 metres deep. Given the current patterns in the area and weak stratification, the water in these depressions is not separated from the main water column but is continuously flushed. Hence, it would be unlikely to support a small water mass residing in these areas for more than a few hours during the occasional periods of weak currents.

### 4.1.3.4 Duckbill Valves

The primary aim of a Diffuser is to maximise the initial dilution of the saline concentrate discharge, and hence reduce any potential impacts on the marine environment. The installation of duckbill valves was considered as part of the concept design as an option for enhancing initial dilution under low flow conditions. It has been suggested that duckbill valves will increase the ‘footprint’ of the saline concentrate discharge, and will require the Diffuser to be located in deeper water than proscribed in the concept design.
Duckbill valves are made of an elasticised rubber compound and the duckbill opening expands in response to the discharge through the port. The duckbill valves are useful for preventing ingress of seawater and marine organisms during Plant shutdown and maintenance and can enhance the nearfield dilution, particularly at low flow when the opening is narrow maintaining high exit velocities.

In the context of the discharge of saline concentrate, the ‘footprint’ can be defined as the area where a specific dilution is achieved. The use of duckbill valves results in a higher exit velocity, and subsequently an enhanced rate of mixing. As such, the distance taken to achieve a specific dilution actually decreases when compared to the open-ended port (at the same discharge), effectively reducing the ‘footprint’.

It should be noted that this is a comparison of the potential use of duckbill valves for the concept design only. There are a number of parameters that affect the dilution achieved from the discharge of the saline concentrate into the marine environment and, as such, alternative Diffuser designs may achieve similar dilution rates without the use of duckbill valves.

The increase in the rise height and distance to impact of the plume discussed above are also dependant on the valve characteristics and would be assessed prior to valve selection to ensure the potential increase in rise height/distance to impact is appropriate for the final design.

Duckbill valves have been used for the dispersion of saline concentrate discharge at the Penneshaw Desalination Plant on Kangaroo Island since 1998.

4.1.4 Midfield

4.1.4.1 Plume Dispersion

The modelling approach adopted in the EIS is summarised in Section 4.1.1 of this document. In this section, issues associated with far field modelling (Appendix D1 of the EIS) are addressed, particularly the issues raised following the work undertaken by Kaempf (2008). Following review of the report submitted by Kaempf (2008), SA Water’s response addresses the following:

1. Methodology for introducing the brine discharge into the hydrodynamic model; and

Introduction of saline concentrate discharge into midfield models

Kaempf (2008) quoted from the EIS that ‘model results are not valid close to the location [of the Diffuser]’ and then further extends this statement in his submission to conclude that the results are ‘therefore invalid for the whole domain’. The statement from the EIS identifies that the model results are not valid close to the model discharge location as within this region the model assumptions are invalid. However, this does not reflect an inaccuracy in the overall findings of the plume dispersion modelling beyond the modelled Diffuser region. Hydrodynamic models such as GETM (used in the EIS) and COHERENCE (used in an idealised manner by Kaempf) both invoke the hydrostatic assumption that the vertical velocities and accelerations are small when compared to those in the horizontal direction. The saline concentrate discharge through the Diffuser ports is predicted to have velocities in excess of 5 m/s with the maximum horizontal velocities ~0.5 m/s thus violating the hydrostatic assumption. As such, it was concluded in the EIS that the
midfield plume dispersion model results were not valid for the nearfield region, but beyond this region the model results provide a reasonable representation of the saline concentrate dispersion.

Concerns have also been raised by Kaempf (2008) that the GETM model results were ‘manufactured’ to meet the dilution criteria. For the set-up of the GETM model, reference was made to the nearfield modelling results to determine the region affected by the Diffuser configuration. The nearfield modelling indicated that a 200 to 250 metre long diffuser provided the most appropriate configuration for the concept design. Under this scenario, the saline discharge would reach 13 metres vertically and would impinge on a region approximately 35 metres wide on each side of the Diffuser. The saline concentrate discharge, being denser than the receiving Gulf waters would collapse to the bottom when the initial momentum of the jet is reduced. This process is well represented in Figure 2d of Kaempf’s 2008 report. Consequently, there are no ‘shadow’ zones as suggested by Kaempf (2008).

Hence, the methodology adopted for introducing the brine discharge in the presence of a Diffuser is a good approximation to the real configuration. This methodology is also similar to that used for modelling discharges from other desalination plants in Australia (e.g. both Western Australia plants and in Victoria).

When the brine discharge is mixed with the ambient water, the resulting diluted water is more dense than the surrounding water and, as a result of gravity, the mixed water will sink to the bottom. This occurs within a single time step in the midfield model resulting in the formation of a higher saline bottom water along the sea bed which is transported by the prevailing currents. Median dilutions predicted by the GETM model indicated that the 1:50 dilution contour extended 100 metres either side of Diffuser (Figure 4.11) whilst the 1:100 dilution contour extended up to 350 metres from the diffuser. The results of the nearfield modelling for 84 ports (see Table 4.6) indicated that at 48 metres from the Diffuser (impact distance), the dilution, under stationary conditions using Roberts et al. (1997) method was 1:78. Thus the GETM model predicts dilutions which are lower than that predicted by the Roberts et al. (1997) model and thus is deemed to provide a conservative approach.

![Figure 4.11 Median dilution isopleths along a north-south vertical transect across the diffuser. The diffuser is located at 1000m and the rectangles represent model grids (horizontal scale 50m).](image-url)
Comment on the modelling approach provided by Kaempf (2008)

The following comments refer to the modelling approach adopted by Kaempf (2008):

- An idealised model configuration was used by Kaempf (2008) which included idealised bathymetry and hydrodynamic assumptions. The model was forced using idealised tides only (see below), all other forcing processes, such as local and remote wind forcing, were neglected. The model was not validated using observations. Kaempf (2008) indicates that the maximum near-bed velocity in the model was 0.16 m/s. ADCP data collected from the Diffuser located near the proposed Diffuser site indicated that the current velocities were almost uniform through the water column with the near-bed currents reaching speeds in excess 0.35 m/s i.e. more than double the values predicted in the Kaempf (2008) model. This will have major implications for the mixing and transport of the saline concentrate discharge.

- The tidal conditions prescribed by Kaempf (2008) are highly idealised. By using only 2 semi-diurnal tidal constituents (M₂ and S₂) - a condition which does not occur in nature - Kaempf (2008) has overstated the influence of the dodge tides – refer Section 4.1.2.2 for more details. Using only these semi-diurnal tidal constituents and idealised bathymetry (neglecting local and remote wind effects and topographic effects) results in symmetric tidal currents with no net movement i.e. currents oscillate back and forth but there is no net transport of water away from the area. Thus the evolving plume is advected back and forth across the Diffuser and plume transport away from the discharge site is not represented in this model application. This is contrary to the conditions experienced at the site. Analysis of the current data and previous modelling studies has indicated that there is a persistent net movement of water due to wind and other tidal action. Thus the idealised hydrodynamic conditions used by Kaempf (2008) are unrealistic and significantly underestimate the true variability of the currents and dispersive characteristics of flows off Port Stanvac.

- Introduction of the saline concentrate in the GETM model was designed to conserve both volume and mass (salt flux) but cannot conserve momentum associated with the discharging saline concentrate. It appears, however, that the model configurations used by Kaempf (2008) do not take into account volume of the discharge (equation 3 of Kaempf, 2008) and thus volume is not conserved and hence it is likely Kaempf's model may significantly underestimate dispersion of the saline concentrate.

- Kaempf (2008) neglects the effect of the diffuser and the associated mixing at the sub-grid scale, i.e. the discharge was added to the bottom cells of the model undiluted. The same method was adopted by Kaempf for the Victorian Desalination Plant saline concentrate dispersion estimates. In their response to the Kaempf (2008b) submission, the proponent demonstrated that the simplified model configurations used by Kaempf (2008b) to assess the proposed Victorian plant were unrealistic.

4.1.4.2 Comparison of Model Period with Long Term Data

The plume dispersion model utilised two six week periods in the assessment of mixing and dispersion of the saline concentrate discharge into the marine environment.

Occurrence statistics of winds during the model period 1 May 2006 to 16 June 2006 are compared to the long term (15 year) monthly statistics in Figure 4.12. Wind
speeds during the modelled period are generally lower than typical May and June long term occurrence statistics. It is concluded that the modelled period is conservative in terms of wind forcing.

Tidal conditions are regular, with semi-diurnal, diurnal, fortnightly and monthly tidal constituents dominating, and hence the 6 week period of May/June 2006 is considered representative of the long term record. Low frequency sea level oscillations associated with remotely forced coastal trapped waves are also present in the water level data used as the model boundary conditions. These oscillations are considered typical of the longer term variability.

The lighter winds during the 2006 model period as compared to the long term winds are also likely to produce weaker mixing and dispersion estimates and hence this period of record is likely to produce conservative estimates of plume dispersion.

Figure 4.12 Comparison of long term monthly wind statistic with modelled period.

4.1.4.3 Climate Change

Increases in temperature and evaporation and reduction in freshwater inflow will potentially impact on the natural processes within the Gulf, resulting in a gradual increase in Gulf salinity. The impact of climate change on the Gulf has been assessed at the whole-of-Gulf scale (refer Appendix D4 of the EIS). However, it has been suggested that climate change scenarios should be addressed in the modelling of plume dispersion.

Plume dispersion modelling examined the impact of the brine discharge through the use of salinity as a conservative tracer. Here, the dilutions were calculated using a cell close to the model boundary as a reference. Thus the dilutions are relative to this reference value. Any changes to this reference value as a result of climate change will be small compared to the difference between the ambient water and
discharge salinity. Hence, changes to the dilution would not be expected under a climate change scenario. Similarly, tidal conditions, the main forcing of the hydrodynamics within the Gulf will not change. Thus the influence of climate change on the plume dispersion characteristics will be minimal.

4.1.4.4 Boundary Conditions

Concerns have been raised that the open boundary condition adopted in the midfield plume dispersion model may not allow for the correct representation of wind, tidal and density forced currents

Specification of boundary conditions, i.e. conditions outside the model domain is essential for numerical model applications. In the case of the mid field model, there were several open boundaries: north, south and west as well as the sea surface. At the sea surface wind stress and air-sea transfer of heat and water was specified using meteorological data collected at Port Stanvac and Adelaide Airport. At the north, south and west boundaries, water levels, salinity and temperature was specified. The salinity and temperature values were obtained from data collected during the Adelaide Coastal Waters Study and included monthly mean values. For the 6 week model runs undertaken, the salinity and temperature was assumed to change in a linear manner from one month to the next.

The only water level recording station near the site is located at Port Stanvac and is maintained by the National Tidal Centre. Historical data on tidal constituents were available from two stations located close to the northern (Brighton) and southern (Port Noarlunga) boundaries. These tidal constituent data were used to define the amplitude and phase differences between the boundary and at Port Stanvac. The western boundary was specified through linear interpolation of the tidal conditions along the southern and northern boundaries. Using these relationships, the water level data recorded at Port Stanvac could be transformed to the open boundaries. The water level record includes the different components of water level variability of which the astronomical tides play a dominant role. In addition, non-tidal components of the water level, mainly due to meteorological effects such as storm surges and remotely generated continental shelf waves, are also included. The model runs undertaken were forced by the measured total water levels at Port Stanvac and thus included both local (e.g. tides) and remote (e.g. continental shelf waves) signals.

It was suggested that the model boundary conditions would be better prescribed through application of a Flather boundary condition. The Flather boundary condition is a combination of an externally specified elevation and velocity and its application requires external water level and current variables. Normally, Flather conditions are used in nested model applications where results from a larger model setup provide the elevations and velocities required at the smaller nested model boundaries.

Velocities at the boundaries were not available for the present study and instead of specifying a velocity at the boundary, a time-varying elevation gradient constructed using the differences between north and south boundaries was applied. The success of this method depends on the accuracy of the alongshore elevation gradient and could only be validated using current measurements within the study domain. As there was a reasonable agreement between the measured and predicted currents it is concluded that this method of specifying boundary conditions was sufficient and included both local and remote forcing.

By using the measured water levels and the measured winds to specify wind stress at the sea surface, the effects of winds were included in the model forcing.
Salinity and temperature at boundaries were specified using monthly values. A flow-relaxation method was also adopted where the salinity and temperature over a band of 4 points next to the boundary is a linear combination of an external specified solution (monthly climatology) and the internal model solution. The weighting factor was a hyperbolic tangent. This method represents an improvement over the normal zero-gradient method and allows for the local development of baroclinic features.

4.1.4.5 Model Validation

The hydrodynamic model was validated using the following data sets:

1. Current measurements obtained off Hallett Cove Beach (as part of the Adelaide Coastal Waters Study). This instrument (an Aanderaa RCM9 acoustic current meter) was deployed 2 metres above the seabed in a total water depth of 5 metres. Data were available for both summer (5 February to 5 March) and winter (7 May to 13 July) during 2004.

2. Current Measurements from an Acoustic Doppler Current Profiler (ADCP) deployed close to the diffuser site in a water depth of 21m since June 2008. Data from the first deployment, from 4 June 2008 to 21 July 2008 was available for model validation. The ADCP recorded currents at 1 metre depth intervals through the water column every 10 minutes.

Sea level data from Port Stanvac, operated by the National Tidal Centre, was used to force the model along the open boundaries. Comparison between predicted levels at the Port Stanvac site within the model domain and observations indicated satisfactory model performance in terms of water level.

Results from the above validations, in terms of comparison between measured and predicted currents, were presented in Appendix D1 of the EIS (Figures 29 and 30). As an addition to these results time series comparisons between the observed and predicted currents (north-south and east-west components) at the ADCP site for July 2008 at the surface (17m above seabed), mid-depth (10m above seabed), and near-bed (4m above seabed) are presented in Figure 4.13, Figure 4.14 and Figure 4.15.

The results reflect those observed from the previous model validations described in Appendix D1 of the EIS. The model generally under-predicts the maximum current magnitude in both flood and ebb directions where a pronounced diurnal inequality is present when compared to the measured currents. This diurnal inequality results in the model and observed currents showing a good correlation during a single tidal cycle but the model under-predicts the measured currents in the subsequent tidal cycle. This is present through the whole water column (Figures 4.14 et seq.). The strong diurnal inequality was also present in the tidal data recorded at Port Stanvac and as the model is forced using the tidal data, the predicted currents also reflect the diurnal inequality.

A comparison between the measured and predicted tidal amplitudes was also presented in Appendix D1 of the EIS. This indicated that although there was a very good correlation between the model and observations for the two main semi-diurnal tidal constituents, the model over-predicted the diurnal components. The measured tidal elevations at Port Stanvac were used to force the model and the predicted currents have similar tidal conditions with respect to diurnal and semi-diurnal components. It was concluded that the current field reflected a different forcing, particularly at the diurnal frequency compared to the elevations. This finding has been confirmed by subjecting the ADCP current measurements and Port Stanvac elevations to spectral analysis (refer Figure 4.16).
Spectra for both currents and elevations indicate peaks at the same frequency bands: low frequency (3-20 days) due to remote and local meteorological forcing; and the main tidal bands, diurnal (~24 hours) and semi-diurnal (~12 hours). The relative amount of energy contained in each of the bands is similar for the low frequency and semi-diurnal bands but differs for the diurnal band (refer Table 4.8). The currents contain 5% of the total energy in the diurnal band, whilst the elevations contain 27% of the total energy. This confirms the previous finding (Appendix D1 of the EIS) that within the study region, the tidal currents have a lower diurnal component in the currents when compared to the elevations. This is probably due to a whole of Gulf standing wave oscillation at the diurnal frequency that cannot be readily represented in a sub-Gulf scale model domain. The diurnal signal is present in the elevations but is absent from the current due to the proximity of the location to an anti-node. As the hydrodynamic model was forced using water levels at Port Stanvac the higher diurnal water level component was present in the model results. The validation could only be improved by undertaking hydrodynamic model runs nested within a model of the whole Gulf region so that resonant diurnal tidal processes occurring within the whole Gulf are appropriately represented. Nonetheless this slight mismatch between the model and the observations effectively leads to a lower model current variability than observed current variability and hence leads to conservative dispersion predictions.

<table>
<thead>
<tr>
<th></th>
<th>Elevation</th>
<th>Currents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low frequency (3-10 days)</td>
<td>11 %</td>
<td>10 %</td>
</tr>
<tr>
<td>Diurnal (~24 hours)</td>
<td>27 %</td>
<td>5 %</td>
</tr>
<tr>
<td>Semi-diurnal (~12 hours)</td>
<td>54 %</td>
<td>57 %</td>
</tr>
</tbody>
</table>

Table 4.8 Percentage of energy contained in the low frequency, diurnal and semi-diurnal bands in the tidal data at Port Stanvac and the surface currents recorded by the ADCP
Figure 4.13 Time series of observed and predicted (a) north-south components and (b) east-west components of surface currents (17m above sea bed) at the ADCP current meter location for July 2008.

Figure 4.14 Time series of observed and predicted (a) north-south components and (b) east-west components of mid-depth currents (10m above sea bed) at the ADCP current meter location for July 2008.
Figure 4.15 Time series of observed and predicted (a) north-south components and (b) east-west components of near bed currents (4m above sea bed) at the ADCP current meter location for July 2008.

Figure 4.16 Spectral analysis of elevations and surface currents recorded for the period 4/06/2008 to 21/07/2008.
4.1.4.6 Upwelling

Wind driven upwelling at Port Stanvac may result from a combination of southerly winds and the effect of the earth’s rotation (Coriolis force). Upwelling is the process by which water is moved upwards, usually along a sloping sea bed in response to wind stress at the surface moving surface waters offshore (the ‘Ekman Spiral’). Wind driven upwelling usually occurs over relatively large regions. Winds with a southerly component at Port Stanvac occur during the summer months where the dominant wind direction is from the south-east quadrant (Appendix D1 of EIS).

Current measurements from the proposed outfall site (see Appendix D5 of EIS) showed instances where the maximum near-bed onshore currents were 0.10 m/s. At the location of Port Stanvac the coastline changes direction and thus the onshore component of the current will also contain a component due to flow curvature at this site. Calculations of the speed of a gravity current resulting from the saline discharge have been estimated to be ~0.10 m/s which will cause flow down slope offshore. This offshore gravity current is similar to the maximum observed near-bed onshore current. The gravity current will flow offshore due to the sea bed gradient and thus will be acting against the wind driven upwelling current flow.

Based on the above points (absence of sustained southerly winds, presence of an offshore direct gravity current at the sea bed) it may be concluded that the potential for onshore travel of the diluted plume upslope towards the coast as a result of wind driven upwelling is small.

4.1.4.7 Plume Dispersion Offshore

The saline concentrate discharge, although diluted with the ambient water through the action of the Diffuser, has a higher salinity and hence higher density than the ambient water and forms a dense plume near the seabed. Due to the slope of the seabed this dense plume will be transported offshore through the action of gravity. The currents in the region are dominated by the tides. The interaction between the tidal currents at the seabed results in the formation of a velocity gradient close to the sea bed which generates turbulence and is an efficient vertical mixing mechanism.

Although a dense plume is formed due to the saline concentrate discharge with a tendency to be transported offshore, the action of the tidal currents rapidly mixes this plume with ambient water such that the plume is not distinguishable from the ambient water beyond a few kilometres of the discharge. Numerical model predictions indicate that the 1:100 dilution contour (or salinity excess of approximately 0.3 ppt above the ambient 36.5 to 37.8) extends up to 2 kilometres from the Diffuser for less than 10% of the time. Thus the plume water will not affect the salinity in the deeper central Gulf areas which are greater than about 5 km from the diffuser.

4.1.4.8 Sensitivity Analysis

Dispersion is a combination of small scale turbulent mixing and larger scale transport by net currents. A process based model such as GETM has only a few parameters which can be adjusted to ‘tune’ the model. The model uses a turbulence closure scheme to simulate the diffusive transport in preference to the traditional diffusion coefficient. Usually, if there is a poor correspondence between observations and model predictions, then it is more likely that the model forcing or bathymetry has not been prescribed correctly. Hence, as there are no parameters that need to be prescribed, a traditional sensitivity analysis is not appropriate. The issues addressed in the sensitivity analysis are:
1. Difference between predicted and measured currents (distribution);

2. Whether prolonged low current speed events and their effects are adequately addressed;

3. The effect of desalination extraction efficiency on plume dispersion; and

4. The effect of model setup on plume dispersion estimates.

The comparison of near bed predicted and observed currents presented in Appendix D1 of the EIS (Figures 29 and 30) indicate that the model current distribution is biased toward low flows when compared with the observed currents distribution. In the model validation, it was found that due to a discrepancy between tidal elevations and currents at the diurnal frequency, the model underestimated the current at every other tidal cycle. The model results are sensitive to the selected domain which is a compromise between resolution and model run-time. The resultant bias toward lower predicted currents suggests that the model will under-predict the dispersive characteristics and hence provide conservative results, where conservative may be interpreted as the model derived concentration (e.g. salinity) distributions being biased toward higher concentrations.

The currents near Port Stanvac are driven mainly by tidal forces, surface wind forcing and more subtle density driven flows that generally cause deeper waters to flow southward and near surface water to flow northward. It is recognised that the tidal currents are lowest during dodge tides and that the dodge tide characteristics vary from neap to neap such that the 'flattest' dodge tides last about 10 hours and occur roughly twice per year. Analysis of the long term (15 year) wind data indicates the extended periods in which low winds seldom occur with the mean duration of winds less than 4 m/s of 4.5 hours and the maximum period of winds less than 4 m/s of 76 hours. Winds during the 'flatter' dodge tides between 1993 and 2008 were always greater than 2.5 m/s. The autumn 2006 model run incorporated three dodge tide events during two of which the winds were relatively strong and the third event incorporated a low wind situation. The model runs incorporate a reasonable representation of the low currents during the dodge tide with low winds. Hence, the sensitivity of model to these forcing terms is represented within the modelled period. The likelihood that extreme calm period conditions (i.e. calmer periods than those observed during the 1993 to 2008 period of wind observations) could produce lower flows than predicted by the model is very low.

To investigate sensitivity of different extraction conditions an additional model run was undertaken with the extraction at 50% efficiency. Due to the lower flows at 50% efficiency, a 200 metre Diffuser was modelled and the results of the 6 week model run in terms of the average plume footprint area are presented in Table 4.9. The footprint area is defined by the area covered by the 90th and 75th percentile occurrences (derived from the 6 weeks of hourly model results) of the 100 fold dilution. At the 90th percentile, there is no change in footprint area between results of the 50% extraction and 45% extraction efficiencies. At the 75th percentile of the 100 fold dilution, the footprint area shows a slight decrease for the six week run and a slight increase for the dodge tide run.

The sensitivity of the GETM midfield model primarily results from the model domain and boundary forcing conditions and the method of introduction of the saline discharge into the model. The model domain and boundary conditions have lead to an underestimate of the diurnal inequality in the predicted currents. The method of introducing the saline discharge also introduces a level of uncertainty to the results near the diffuser because the model is unable to resolve the sub-grid scale mixing associated with the flow from the Diffuser ports. These issues lead to underestimates of the dispersion and hence the model results are deemed to be
conservative. Further analysis of the effect of these issues on dispersion of the ultimate Diffuser design will be undertaken during the next stage of the study.

Table 4.9 Areas covered by the 90th and 75th percentile for the 1:100 dilution for 45% (250m diffuser) and 50% extraction efficiency (200m diffuser)

<table>
<thead>
<tr>
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<th>50% efficiency</th>
<th>45% efficiency</th>
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<tr>
<td></td>
<td>6 week</td>
<td>Dodge tides</td>
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<td></td>
<td>simulation (m²)</td>
<td>(m²)</td>
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<tr>
<td>90th Percentile</td>
<td>0</td>
<td>82500</td>
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<tr>
<td>75th Percentile</td>
<td>0</td>
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4.1.5 Whole of Gulf

4.1.5.1 Flushing and Exchange

Flushing and water exchange between Gulf St Vincent and the Southern Ocean is influenced by the general water transport processes that affect circulation and the smaller scale turbulent motions that mix water of different characteristics. The combined effects of circulation and turbulent mixing determine the Gulf’s flushing characteristics.

The time taken to exchange Gulf waters with the Southern Ocean waters is termed the flushing time. Flushing time is difficult to measure directly and is generally inferred from tracer measurements such as salinity.

Bye and Kaempf (2008) estimate the flushing time of Gulf St Vincent to be about 3 to 4 months. This is the approximate time for the entire volume of water in the Gulf to exchange with oceanic water through Investigator Strait and Backstairs Passage. The relative importance of each process and the resultant flushing and exchange vary both in time and space around the Gulf. As a result of proximity to the ocean, the southern regions of the Gulf have a shorter flushing time when compared to the northern region.

The importance of flushing and exchange between the Gulf and ocean is highlighted through an assessment of exchange processes. Evaporation removes fresh water from the Gulf leaving the original salt in the Gulf waters and causing a local increase in salinity. This increase is balanced by the rate of flushing and fresh water input. If evaporation was the only process affecting salinity concentrations (i.e. if flushing did not occur) then the salinity in the northern region of the Gulf would increase by more than 11% per annum. This would result in a doubling of salinity in the northern Gulf after about 7 years. As such, it is evident that significant volumes of water are exchanged between the Gulf and the ocean to maintain salinity levels within the Gulf.
For the purposes of examining the proposed Desalination Plant in the context of natural environmental processes, the increase in salinity concentration from the extraction of freshwater, by both evaporation and the desalination process, may be presented as a load. This is effectively the weight of concentrated salt from evaporation and desalination that would need to be exchanged with ocean waters to maintain salinity levels within the Gulf.

The whole Gulf has a volume of 206,700 GL and, at average ocean salinity of 36.5 ppt, equates to 7.678 billion tonnes of salt. Evaporation of 12,000 GL/annum of fresh water equates to a production of 0.445 billion tonnes of salt, whilst the extraction of 100 GL/annum of freshwater by the proposed Desalination Plant equates to 0.004 billion tonnes of salt (Figure 4.17). The installation of the proposed Desalination Plant at Port Stanvac would effectively require an additional 0.05% of salt by weight to be flushed from Gulf St Vincent. This is an insignificant amount in the context of the whole of Gulf and natural exchange processes, particularly given the average flushing time is considerably shorter than one year.

![Figure 4.17 Salt load for Gulf St Vincent, evaporation loss and ADP freshwater extraction (billion tonnes)](image)

A useful insight into the likely impacts of a desalination plant discharge on the Gulf waters may be derived from the application of a simple flushing box model. The box model describes the exchange processes between the ocean, desalination plant, atmosphere, rivers and the Gulf.

A series of equations was developed to represent each of these processes (refer Appendix D4 of the EIS). By substituting typical values into these equations, an estimate of the wider Gulf salinity concentration before and after the introduction of the Desalination Plant may be derived. A mass balance for the whole of Gulf gives the pre-desalination salinity as 36.711 ppt after a flushing time of 4 months. This is compared to a post-desalination (100 GL extraction) salinity of 36.714 ppt, corresponding to a 0.003 ppt increase in wider Gulf salinity; an increase below the resolution of most oceanographic instruments.
Port Stanvac is located in the mid to southern region of the Gulf and, as such, the flushing time is likely to be shorter than for the overall Gulf as Port Stanvac is located nearer the ocean than the bulk of the Gulf waters. As such, the above calculated salinity increase is likely to be a conservative estimate, i.e. it is expected that salinity increase on the wider Gulf will be less than the predictions above.

From these findings, it was concluded that the flushing and exchange of water between Gulf St Vincent and the Southern Ocean is sufficient to ensure negligible accumulation of salt within the Gulf as a result of the proposed Desalination Plant. The relatively small increase in salt load from the saline concentrate discharge (compared to natural processes) and a whole of Gulf flushing rate of 3 to 4 months will allow for the sustainable operation of the proposed Desalination Plant within Gulf St Vincent into the future even under climate change scenarios.

4.1.5.2 Uncertainty of Whole of Gulf Models

Concerns have been raised that insufficient data is available in respect to the validation of the whole of Gulf hydrodynamic model (Def3D FLOW) and assessment of long-term changes in ocean currents potentially induced by changes to the Gulf salinity.

To provide further assurance, SA Water undertook a further Whole-of-Gulf flushing box model study to provide a conservative assessment and verification. As discussed above, the flushing box model assesses the Gulf-wide salinity pre and post desalination and describes the relative importance of each of the exchange processes represented.

The results of the flushing box model assessment show that only minor increases (0.003 ppt) in Gulf-wide salinity will occur as a result of the operation of the proposed Desalination Plant, well below the detectable limit of most monitoring equipment and significant less than the natural variability within the Gulf.

It is also noted, that some submissions concurred with the findings, given the correlation to the flushing box model results and the dominance of evaporation and seasonal variation in salinity levels.

4.1.5.3 Larval Dispersion

A range of marine species spawn within Gulf St Vincent, each with individual spawning and larval movement characteristics. Concerns have been raised that the timeframe for the larval advection is not representative of the full range of ecosystems within the Gulf.

The results presented were intended to provide an indication of the potential change in larval movements due to the introduction of the proposed Desalination Plant. Present understanding of breeding and larval behaviour for the range of species that spawn in the Gulf is very limited. Results presented indicate that the proposed Desalination Plant will have negligible effect on pathways in the wider Gulf.

It is suggested that some individuals from populations of some species that spawn within a few tidal excursions (~20 kilometres) of the inlet may be drawn into the inlet, however the probability of this decreases with distance from the inlet. A monitoring program is proposed to assess the occurrence and numbers of individuals drawn into the inlet. Results of this monitoring will be interpreted to further assess whether there is a significant effect (refer Section 4.6).
4.1.5.4 Presentation of Whole of Gulf Results

Figure 6.5 of the Salt and Heat Budget report (Appendix D3 of the EIS) presents a time series comparison of predicted salinity pre and post introduction of the proposed Desalination Plant saline concentrate discharge. The scale of the figure demonstrates little change between pre and post installation. From a practical perspective, salinity instruments can resolve about 0.001 ppt to an accuracy of 0.05 ppt. Given this level of uncertainty in salinity, SA Water considers the graph scales are appropriate to demonstrate the small change to salinity.

Concern has been raised that no figure has been included that shows the predicted impact of climate change.

The climate change scenario is implemented in the water quality transport (WAQ) model by increasing the temperature and evaporation rate and reducing rainfall and runoff contributions. This process is implemented gradually over the 50 years period. As discussed in Appendix D3 of the EIS, the modelled climate change scenario results in an increase in the water temperature of 2.5°C and a minor increase in salinity in the northern part of the Gulf for both pre and post Desalination Plant scenarios. The box model indicated an increase in Gulf-wide average salinity of 0.07 ppt in the absence of the proposed Desalination Plant. The negligible increase in salinity of 0.003 ppt due to the introduction of the plant was found to be the same for both the present case and the climate change case.

It has been suggested that finer scale resolution should be used for the current vector plots in Figures 6.9-6.11 (Appendix D3 of the EIS) and should also be presented for dodge tides.

A simple estimate of the depth averaged current associated with the discharge of 4.46 m³/s spread over an area of 1000 metres wide by 20 metres deep gives a current of 2.3 mm/s and hence this small difference is not detectable in the figures. Currents at dodge tide are likewise affected by wind and residual flows with general water speeds of greater than 3 cm/s, so again the figures will show only small differences in velocity vectors for pre and post proposed Desalination Plant conditions.
4.2 Marine Ecology

Concerns were raised by respondents in relation to the potential impacts on the marine ecology of Port Stanvac and the wider Gulf St Vincent. These concerns can be broadly grouped as follows:

1. Impacts upon marine species and communities; and

Where the response discusses a predicted risk level, this is as identified within the EIS (Appendix C13 of the EIS). A risk assessment process was completed to identify hazards, causes and likelihood/consequence of risks and to identify potential environmental impacts associated with the construction and operation of the proposed Desalination Plant.

4.2.1 Impact on Marine Species and Communities

A large number of comments were received in relation to the potential for impacts upon marine species and communities. These can be broadly separated into the following:

1. Potential impact to marine habitats and marine species at Port Stanvac and the wider Gulf St Vincent;
2. Impact of entrainment on species in the Port Stanvac area (including fisheries species);
3. Potential effects of the proposed Desalination Plant on food webs (entrainment and entrapment; ecosystems);
4. The ADP exclusion zone and potential beneficial impacts on marine species;
5. Potential for introduction of marine pests during construction and operation;
6. Operational noise impacts on marine species; and
7. Potential entanglement of marine fauna in moorings lines and other construction activities.

4.2.1.1 Potential impact to marine habitats and marine species at Port Stanvac and the wider Gulf St Vincent.

Concerns were raised in relation to the proposed Desalination Plant impacting on the marine habitats and species of the Port Stanvac area during construction and operation. These concerns related to a number of potential impacts, many of which were outlined within the marine environment section of the EIS (Chapter 7). Many of the construction issues relate to the options of a full tunnel or a hybrid tunnel and the consequential dredging and blasting impacts of the hybrid option.

A number of respondents during the EIS consultation advised that the full tunnel offers the least environmental impacts associated with the construction and, as such, should be the preferred option. Regardless of the option chosen for detailed design, the Contractor will be required to meet the performance criteria as detailed within Table 3.1 of the EIS. If dredging or blasting is included within the preferred option, then the Contractor will also be required to apply for a Dredging Licence through the EPA. As part of this process, the Contractor will be required to provide a Dredging Environmental Management Plan (DEMP) which will detail mitigation and management measures to reduce, remove or mitigate potential impacts. More
A number of different mitigation measures have been employed in order to ensure that the marine communities are not adversely impacted:

- The outfall Diffuser will be situated offshore within the mid to deep benthic zone away from the sensitive cliff, intertidal and subtidal reefs;
- The placement of the outfall within this zone also ensures that the saline concentrate is not discharging upon the sensitive intertidal and subtidal reefs;
- The area into which the saline concentrate will discharge is predominantly sandy bottom substrate with little macrofauna present which is widely represented elsewhere within Gulf St Vincent; and
- The hydrodynamic modelling has also demonstrated that the saline concentrate will disperse offshore down the natural incline of the seabed rather than dispersing towards sensitive reef areas.

The location of the proposed Desalination Plant and its associated intake and outfall structures was a significant mitigation measure when considering the potential impacts. A number of different mitigation measures have been employed in order to ensure that the marine communities are not adversely impacted.

The mitigation measures related to the intake design are discussed within the entrainment section below. Other mitigation measures include the Diffuser design and location. Of key consideration was the absence of seagrass in the saline concentrate zone of influence where the dilution achieved is greater than 100:1 (EIS s.7.3.2.2. and appendices C5 to C7 of the EIS). The habitat mapping also informed the location of the intake and outfall structures in the mid and deep benthic zones which will minimise potential for impacts upon the important cliff, intertidal and subtidal reef areas, as there will be no requirement for disturbance of the cliff or intertidal reef and minimal disturbance of the subtidal reef.

The area into which the saline concentrate will discharge is predominantly sandy bottom substrate without large macro-invertebrates as widely represented elsewhere within Gulf St Vincent. The bivalve ‘living fossil’ *Neotrigonia margaritacea* has been recorded offshore from the Port Stanvac location (approximately 4 kilometres offshore) where its population density seems to be greater within the deep water. Neither the SARDI infauna survey nor the geotechnical work recorded this species at Port Stanvac. Furthermore, results from hydrodynamic modelling have shown that its known location is outside of the area of influence and is not expected to be affected by the operation of the proposed Desalination Plant.

The oceanography of the site has been shown to demonstrate good dispersion characteristics and mixing which will ensure good dispersal from the outfall Diffusers. The hydrodynamic modelling has also demonstrated that the saline concentrate will disperse offshore down the natural incline of the seabed rather than dispersing towards sensitive reef areas.

Another key measure ensuring that the saline concentrate will be diluted and dispersed adequately is the derivation of safe dilution factors through the initial ecotoxicological testing. Lastly, marine management and monitoring will be undertaken throughout the detailed design process, construction activities and operation of the proposed Desalination Plant so that the potential impacts are mitigated, managed and monitored. Further details of the management and monitoring of these marine systems are outlined in Section 4.6.
4.2.1.2 Impact of entrainment on species in the Port Stanvac area (including fisheries species)

Concerns have been raised during the EIS consultation process that the operation of the proposed Desalination Plant has the potential to impact upon marine species within the Port Stanvac area and wider Gulf St Vincent through the intake of seawater and subsequent entrainment of non-motile larvae and juveniles. Entrainment occurs through the intake of seawater to the Desalination Plant and non-motile species are at greatest risk of entrainment as they are unable to propel or swim away.

Respondents specifically raised entrainment of commercially and recreationally important fish larvae as being of particular importance. The Commercial Blue Crab Pot Fishery and Western King Prawn fisheries are licensed in the vicinity of Port Stanvac and have raised concerns that the fishing resource should not be compromised by the proposed Desalination Plant.

An inventory of important coastal fisheries habitats in SA has not listed Port Stanvac (Bryars, 2003) as an important nursery habitat for commercial or recreational fisheries species. Small pelagic fish species, such as whitebait and pilchards could occur in the region but were not included within the EIS assessment as Port Stanvac is not known to be an important nursery area for these species (Bryars, 2003). These species are more likely to be transient rather than resident to the Port Stanvac area.

The majority of the organisms entrained are likely to be phytoplankton (unicellular algae) as these tend to be the dominant biota in the water column. However, microzooplankton will also make up a constituent part. Micro-zooplankton form an important food source for meso-zooplankton in the in the absence of suitably sized phytoplankton cells, and, by consuming the smaller size classes of phytoplankton, making available to higher trophic levels areas of primary productivity that would otherwise be unavailable.

Estimating the ecological impacts of the intake structure on fish populations and other aquatic life is a complex undertaking. As well as the necessity of obtaining reliable estimates of entrainment numbers, there is the overall lack of understanding of marine species population dynamics. Different species have different life histories, different susceptibilities and different growth trajectories. The susceptibility of marine species to entrainment depends on factors relating to the intake itself such as design, location and capacity in addition to the individual characteristics of the specific species.

SARDI was commissioned by SA Water to undertake a study examining the plankton species present and estimating population size in order to clarify the potential impact of processing large volumes of seawater for the desalination process. The aim was to determine the abundance and diversity of plankton in the Port Stanvac region, and provide an assessment of the potential impact of entrainment on fishery species, protected taxa (defined by National Parks and Wildlife Act and EPBC Act) and the local food web in the area. The results from this work will inform the detailed design and monitoring programs, provide verification and assist with development of mitigation measures for the design and operation of the proposed Desalination Plant.

As part of this plankton study, SARDI have also been requested to examine how the entrainment of plankton species will impact on the food web in the Port Stanvac area. This may include the measure of primary and secondary productivity in the region and will provide a more accurate indication of the importance of the phytoplankton and zoo-plankton in the area to the food web.
Other mitigation measures to reduce entrainment have been considered at two different scales. At the scale of the entire Gulf St Vincent the following considerations in relation to the proposed Desalination Plant at Port Stanvac may reduce the likelihood of entrainment of larvae:

- The Port Stanvac location is not a known nursery or spawning ground for commercial or recreational fisheries species. There are a number of juvenile and larval fisheries taxa that have been identified (Bryars 2003) as being present in the Seacliff to Sellicks Beach region but it is not known if these species occur in the water column at Port Stanvac, as the information is at the regional level and is not site specific.

- There are no known breeding or spawning areas for species of conservation significance within the Port Stanvac area.

- Generally the currents within the Gulf St Vincent move north up the west side of Gulf St Vincent in a clockwise direction. In conjunction with this, water from the southern tip of the Fleurieu Peninsula moves north and is subsequently moved into the centre of the Gulf due to the influence of the Myponga eddy. As such, circulation around the Gulf has the potential to transport longer-lived larvae over a wide area. This also means that it is unlikely that longer-lived larvae, if spawned within the Port Stanvac area, will stay concentrated near the intake as they will be moved by the currents.

- The EIS presented a particle tracking model as a preliminary method of examining larval dispersion (described in Appendix D3 of the EIS). The model examined a limited number of larval input pathways to provide an indication of the potential change in larval movements and numbers upon introduction of the proposed Desalination Plant. The preliminary results indicated that the proposed Desalination Plant would have a negligible effect on larval movement pathways in the wider Gulf.

- The potential impacts upon the marine populations within the Gulf St Vincent as a whole should be placed within an overall larval survivorship context. Typical natural mortality rates of larval producing organisms (in relation to reproduction and survivorship) have been estimated at 99.9% and 98% for larvae and juveniles respectively. This means that 100,000 larvae will likely produce 100 juvenile fish which in turn would produce only 2 adult fish (Raimondi, 2003). This work is supported in studies with cod in a closed system which showed that average mortality was 23% per day for the first 10 days with only 120 individual cod larvae surviving to one year from 18 million larvae (Kristiansen, 2006).

At the local scale, the mitigation measures include:

- Placement of the intake within the mid to deep benthic zone thereby reducing the likelihood of entraining reef species as many of these species tend to have low larval dispersal characteristics.

- The use of a velocity cap intake design (as presented in the concept design) as studies on Californian desalination plants have shown this design reduces entrapment of larvae and eggs against the grill by 80-90% by converting the vertical flow into horizontal flow at the intake entrance which fish then avoid.

- The intake velocity (i.e. the speed at which the seawater enters into the intake) has also been reduced to 0.01m/s within 10 metres of the intake.
structure, which is less than background current flows (99% of the time) thereby allowing motile species to avoid the intake.

The SARDI study (as detailed above) will inform the detailed design and monitoring programs. This, in conjunction with the intertidal and subtidal reef surveys and the benthic infauna surveys, will provide a good baseline of species present within the Port Stanvac area which will assist in providing a clear picture of those species likely to be impacted by entrainment. Further details in relation to marine management and monitoring through construction and operations are presented in Section 4.6.

4.2.1.3 Potential effects of proposed Desalination Plant on food webs (entrainment and entrapment; ecosystems).

The Marine Ecological Characterisation Study (Appendix G) lists a wide variety of species which have distinctly different life histories, feeding groups, movements and other functional aspects of their basic biology. Determining how different aspects of the desalination process may impact on specific functional processes within ecosystems is difficult to measure, often requiring prolonged experimental investigations and considerable knowledge of the behaviour of organisms. There are methods which have been developed as ‘ecoassays’ (sensu Fairweather, 1999) to determine ecosystem functionality, and these could be incorporated into an operational monitoring program, although site specific ecoassays would need to be developed.

Baited remote underwater video cameras are proposed as a tool for monitoring the types of predators (particularly fish) that may be present on the subtidal reefs. Although fish surveys were conducted during the Marine Ecological Characterisation Study (Appendix G), fish behaviour around divers often leads to a bias in the types of fish that are identified. Baited video cameras overcome this issue and provide an assessment of the top predators associated with the subtidal reef. Disruption in the food web often has flow on effects which lead to a reduction in species diversity and abundance of top end predators.

Entrainment of larvae and the effect this will have on local food webs is a difficult topic to investigate, often open to conjecture dependent on the knowledge availability of specific organisms. Studies may show that a certain number of organisms are entrained per day, but it is difficult to interpret what this may mean when the diversity is likely to be great (small numbers of lots of different organisms) and the majority of the larvae are unlikely to survive to metamorphosis under normal conditions. In order to provide baseline information plankton surveys will be undertaken in the Port Stanvac region to provide further data for those species at the lower end of the food web.

4.2.1.4 The proposed Desalination Plant exclusion zone and potential beneficial impacts on marine species.

Submissions raised the possibility that restricting fishing within the proposed ADP exclusion zone may have beneficial impacts on marine species in the same way that the restricted status of the Mobil Oil Refinery site may have increased local biodiversity at the Mobil / Port Stanvac site. Dutton and Benkendorff (2008) noted that the high species diversity of molluscs, echinoderms and red algae may, in part, be due to the protection provided by the existence of an exclusion zone at the southern end of the Port Stanvac region. The exclusion zone around the Port Stanvac jetty will remain and as such will likely continue to provide additional protection to the intertidal species present on the southern foreshore of the Port Stanvac Oil Refinery.
The ADP will seek an exclusion zone which may assist in maintaining the values of
the current exclusion zone. Recommendations from DTEI have highlighted the
requirement for a new exclusion zone to keep large vessels safely clear of the
intake and outfall structures and pipes at depths of less than 18 metres.

The exclusion zone would prohibit the operating of vessels, both private
commercial, within the vicinity of the works. This would assist in mitigating the
potential for any damage to the intake and outfall structures or impact to raw water
quality. The exclusion zone is proposed to be monitored by the plant operator, with
offending vehicles photographed and reported to DTEI for the subsequent issuing of
than infringement notice.

The marine exclusion would be nominally 1.2 kilometres wide and extend offshore
up to 2 kilometres. The zone would be denoted by markers in accordance with
marine navigation requirements, and recorded on marine navigation charts.

Section 4.6 further details the surveys which will be undertaken to monitor the
marine communities throughout construction and operations and, as such, will
provide important baseline data which will aid in ascertaining whether exclusion
zones of this size can add to biodiversity values.

**4.2.1.5 Potential for introduction of marine pests during construction
and operations**

A number of comments were received in relation to the potential for the introduction
of marine pest species during construction works. Concerns were also raised that
the proposed Desalination Plant could contribute towards changes in the marine
community composition that would thereby render it more susceptible to marine
disease or invasive species.

The potential for spreading of existing marine pests along the coastline due to
dredging and construction vessels entering the Port Stanvac region from other
marine areas pose a risk of introducing marine pest species. This is particularly true
of vessels entering SA and Gulf St Vincent from other States.

The Australian Quarantine and Inspection Service (AQIS) is the lead agency for the
management of ballast water risks in Australia. A Ballast Water Management Plan
will be developed with reference to AQIS guidelines and the Australian Government
Ballast Water Decision Support System in conjunction with DTEI, the governing
body for Ballast Water Management Plan approvals. This management plan will
include specifications regarding routine monitoring of vessels.

A National System for the Prevention and Management of Marine Pest Incursions is
scheduled for implementation in 2009 and includes pre-border, border and domestic
measures to minimise the risk of new introductions and the spread of marine pests
in Australia. Any management plan developed by the Contractor will take into
account this new system once implemented.

The CEMMP and OEMMP will also address the issues of potential pest and disease
introductions and will include mitigation measures to prevent these events. Marine
monitoring in the region will continue during the construction phase, which will target
known marine pest species (including *Caulerpa racemosa* which has been raised as
concern by some respondents) based on the National Introduced Marine Pest
relation to the management and monitoring throughout construction and operations
detailed in Section 4.6.
Fundamental to the concept and final design is the underpinning environmental driver of maintaining and supporting a healthy aquatic ecosystem. This includes ensuring the rapid dispersion of the saline concentrate to minimise potential issues such as localised toxicity due to elevated salinity concentrations and adequate dissolved oxygen concentrations at the seafloor. In turn, this will prevent changes in ecosystem dynamics that could potentially increase susceptibility to marine diseases or invasion of marine pest species.

4.2.1.6 Operational noise impacts on marine species

Operationally, the intake pumps are likely to be the main noise sources from the proposed Desalination Plant but these are situated more than one kilometre from the intake. The Diffuser outlet will operate under gravity conditions and will therefore produce very little noise and vibration. As shown in the EIS, any potential operational noise is likely to be within natural background levels within metres from the intake/diffuser ports.

Measures designed to minimise and monitor underwater noise levels during the operation of the Plant will be included within the OEMMP, which will be developed in consultation with the EPA.

4.2.1.7 Potential entanglement of marine fauna in moorings lines and other construction activities

The likelihood of marine fauna (mammals and turtles) becoming entangled in mooring lines during construction was considered negligible in the EIS marine risk assessment (Appendix C13 of the EIS), particularly for marine turtles which are considered as rare transients to Gulf St Vincent waters. Mitigation measures will be implemented in the CEMMP, and if required, the Dredge Environmental Management Plan (DEMP) to further minimise chance occurrences of fauna entanglements. These measures will include for example, shortening lengths of mooring lines as far as practicable and implementation of responses procedures.

If dredging is required, the Contractor will be required to apply for and hold a dredge licence from the EPA. Licence requirements will include an environment management and monitoring program. Part of this will be the requirement for a DEMP which will need to assess and manage the potential risk to the marine mammals during dredging activities. This may include mitigation measures such as marine mammal spotters being employed and an exclusion zone established whereby dredging stops if a marine mammal is spotted within 500 metres of the dredging vessel.

The Contractor will also be required to develop a CEMMP and OEMMP (as detailed in Section 4.6), which will also provide for the protection of flora and fauna during construction and operation of the proposed Desalination Plant. These documents will be prepared in consultation with the EPA.

4.2.2 Marine Risk Assessment and Analysis

Three submissions related to the marine risk assessment and analysis presented within the EIS. These can broadly be classified into two issues:

1. The risk assessment presented in the EIS was considered too broad; and
2. The marine risk assessment provided limited consideration of biological communities in the whole of Gulf St Vincent.
These issues are discussed further in the following sections.

4.2.2.1 Risk assessment presented in the EIS was considered too broad.

The marine risk assessment and analysis presented within the EIS was a consolidation of risks identified through Government workshops, meetings and internal SA Water risk and hazard workshops. It is acknowledged that risk assessment is a subjective tool and, as such, is used to focus upon key issues. The table presented in the EIS focused upon those potential impacts relevant to the Port Stanvac site.

The risk assessment utilised in the EIS was an adaption of the Marine Protected Areas Program risk assessment which was developed by DEH in conjunction with other Government Agencies and non-Government organisations within SA. This assessment considers a wide array of parameters from water quality and ecosystems to food webs and biodiversity (including protected species). As such, it was deemed more appropriate than focusing solely on water quality as presented within the National Water Quality Management Strategy.

The proposed monitoring program recommended by the ITRP and adopted by SA Water will incorporate both water quality and ecosystem health monitoring (refer Section 4.6). In this way it can be ensured the measures will be in place to protect both water quality and ecosystem health and integrity.

Mitigation strategies were outlined in Appendix C13 of the EIS. Detailed mitigation strategies appropriate to the final design will be fundamental in the development of the CEMMP and OEMMP. These will be developed in consultation with the EPA. This will include the development of specific trigger criteria including alert and action levels.

4.2.2.2 The marine risk assessment provided limited consideration of biological communities in the whole of Gulf St Vincent

Concerns were raised that the marine risk assessment provided limited consideration of biological communities in the whole of Gulf St Vincent especially in light of Adelaide Coastal Waters Study (ACWS: Fox et al., 2008) highlighting the continued degradation of these systems (particularly seagrasses).

A complete summary of the Gulf St Vincent marine communities was not included within the EIS as the DAC Guidelines focused the EIS marine biological assessment on the Port Stanvac area. However, the whole of Gulf St Vincent was considered in relation to the saline concentrate dispersal. It should also be noted that there are no seagrass beds within the Port Stanvac marine construction area and the hydrodynamic modelling has demonstrated sufficient mixing and dispersion occurs to return salinity concentrations to near ambient levels before reaching seagrass habitats.

The ACWS and Reef Health monitoring programs concluded that the pertinent issues in relation to degradation of seagrass and reef ecosystem were sedimentation (turbidity) and increased nutrients (such as total nitrogen). As discussed within Section 4.3 (Water Quality) there will be negligible impacts through the desalination process on these issues. The CEMMP and OEMMP will also monitor the health of the marine system with mitigation measures and identifiable trigger values being central to this process.
4.3 Water and Sediment Quality

Concerns were raised during the EIS consultation in relation to water and sediment quality. In summary, the key issues were as follows:

- Validity and rationale of the water quality testing undertaken to inform the Adelaide Desalination Project.
- Potential saline concentrate discharge impacts on receiving water quality.

4.3.1 Validity and rationale of the water quality testing undertaken to inform the Adelaide Desalination Project

A water quality monitoring program was conducted off the coast of Port Stanvac to provide environmental baseline data on the chemical and biological constituents of the seawater in the region. This was previously reported within the EIS. This monitoring program has continued and an updated report is provided in Appendix H.

The chemical and biological constituents of seawater vary considerably along the metropolitan coast (Gaylard, 2004). In determining whether the saline concentrate discharge will have an impact on the water quality in the Port Stanvac area, knowledge is required on the ambient background concentrations of the various chemical and biological constituents in order to develop an understanding of the natural variability. This allows for greater scientific rigour when assessing the environmental performance of the proposed Desalination Plant.

The chemical and biological parameters selected for the water quality monitoring were based on the Australian and New Zealand Guidelines for Fresh and Marine Waters (ANZECC, 2000) and Environment Protection (Water Quality) Policy (EPA, 2003) for defining the environmental qualities of a water body. The exception was the selection of the water quality parameters associated with proposed intake sites. These parameters were chosen in relation to potential operational issues associated with the extraction of freshwater from seawater through the desalination process. The following parameters currently being monitored are detailed in Table 4.10. The results presented in the Water Quality Characterisation Study (Appendix H) provide a preliminary assessment of the data collected from the first nine months of the monitoring program. SARDI and the EPA have provided review of the preliminary report and these comments will be addressed and incorporated in the final report.

In conjunction with recommendations from the ITRP, SA Water intends to extend the water quality profiles further along the coast to obtain baseline information on a variety of parameters (including salinity, dissolved oxygen, pH, chlorophyll a, turbidity and water temperature). This will commence in February 2009.

SA Water is committed to maintaining a high standard of environmental baseline data to assist in the development of the proposed Desalination Project.
Table 4.10 Water quality parameters being measured at Port Stanvac

<table>
<thead>
<tr>
<th>Fortnightly</th>
<th>Monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water column profiles conducted 0 m, 500 m 5 km and 15 km, north and south of Port Stanvac</td>
<td>Composite water samples taken 1.5 km from shore, 0 m and 5 km north and south of Port Stanvac</td>
</tr>
<tr>
<td>• Conductivity</td>
<td>• Salinity (Dissolved solids calculation (DSC) and TDS by electrical conductivity)</td>
</tr>
<tr>
<td>• pH</td>
<td>• Total Suspended Solids</td>
</tr>
<tr>
<td>• Chlorophyll a</td>
<td>• Colour (true @ 456 nm)</td>
</tr>
<tr>
<td>• Dissolved oxygen</td>
<td>• Nutrients (TN, NOx, TKN, FRP, NH4, TP)</td>
</tr>
<tr>
<td>• Turbidity</td>
<td>• Total organic carbon</td>
</tr>
<tr>
<td>• Water temperature</td>
<td>• Chlorophyll a</td>
</tr>
<tr>
<td></td>
<td>• Plankton species and abundance</td>
</tr>
<tr>
<td></td>
<td>• Metals (Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Th, Zn)</td>
</tr>
<tr>
<td></td>
<td>• Ion balance</td>
</tr>
</tbody>
</table>

4.3.2 Potential Discharge Impacts on Receiving Water and Sediment Quality

A number of issues were raised in relation to the potential impacts upon water and sediment quality. The comments were varied in subject matter and related to issues such as turbidity, increased nutrient levels, dissolved oxygen levels and copper. The issues are as follows:

1. Discharge from the proposed Desalination Plant potentially increasing nitrogen loads and turbidity levels in the Port Stanvac area.
2. Discharge from the proposed Desalination Plant contributing to the potential acidification of the Gulf, as a result of climate change.
3. Potential reduction of dissolved oxygen at the seabed as a consequence of the saline concentrate discharge.
4. Potential reduction of dissolved oxygen in the saline concentrate due to the addition of sodium bisulphite or sodium metabisulphite as part of the treatment process.
5. Potential for methane, hydrogen sulphide and nutrients to be released from the sediments as a result of saline concentrate interactions at the sediment interface.
7. The potential formation of halogenated organic compounds from the introduction of chlorine as biocide in the desalination process.
8. Naturally elevated copper levels in the intake waters concentrate through the desalination process and are released in saline concentrate.

This section should also be read in conjunction with the ecotoxicology section (Section 4.4).
4.3.2.1 Discharge from the desalination plant potentially increasing nitrogen loads and turbidity levels in the Port Stanvac area

As identified within the Adelaide Coastal Waters Study (ACWS: Fox et al., 2008), there is agreement that nitrogen and turbidity are major issues associated with the Adelaide metropolitan coast. However, the potential for the proposed Desalination Plant to contribute to the nitrogen and turbidity issues of Gulf St Vincent is negligible.

The major chemical constituent of the saline concentrate is salt. There may be a small percentage of clarified backwash or sludge supernatant (2-5%) mixed within the saline concentrate which has the potential to influence turbidity concentrations. Generally the turbidity of the saline concentrate is low (<5 Nephelometric Turbidity Units (NTU)) but this is dependent on the ambient turbidity in the region of the intake. The Environmental Protection (Water Quality) Policy criteria value for marine discharges is 10 NTU.

The saline concentrate may also contain residual concentrations of antiscalants and polymers. However, the antiscalants used in the desalination process generally do not contain nitrogen. Polymers used for solids clarification may contain extremely low concentrations of nitrogen, although 99% of the polymer residuals will be removed from the sludge ‘cake’ and subsequently disposed of appropriately offsite. Accordingly, there will be negligible concentrations of nitrogen added to the local marine ecosystem through the desalination process.

Total nitrogen will also be measured in the intake and discharge streams as part of the operational performance monitoring program for the proposed Desalination Plant. This monitoring will ensure elevations of nitrogen and turbidity issues within the discharge streams will not be elevated above agreed EPA discharge limits.

4.3.2.2 Discharge from the desalination plant contributing to the potential acidification of the Gulf, as a result of climate change.

The saline concentrate discharged from the proposed Desalination Plant will not influence the pH of Gulf St Vincent. If the pH reduces in the Gulf due to the climate change process (8.1 to 7.9 by 2050 as forecasted by CSIRO, 2007) this will reduce the use of chemicals in the pre-treatment of feedwater (seawater) in the desalination process.

Feedwater is generally ‘conditioned’ before passing through the membranes, utilising acidic ferric salts (to improve particle removal) and acid (e.g. hydrochloric or sulphuric acid) to assist in the optimisation of the coagulation process, when adopting conventional pre-treatment techniques. If a membrane pre-treatment process is utilised, the feedwater is dosed with lower concentrations of coagulant and acid. The result of this conditioning process is that the saline concentrate may have a higher concentration of H⁺ ions in solution which lowers the pH.

However, seawater has a high buffering capacity, which means there is a strong resistance to changes in pH. This is due to high concentrations of bicarbonate ions in solution, which maintain the pH of seawater between 8.0-8.3. Even though there are additional H⁺ ions added to the saline concentrate, the desalination process also concentrates the bicarbonate ions extracted from the feedwater. Once the saline concentrate is discharged into the marine environment the pH will rapidly return to ambient concentrations.

The pH levels within the discharge from the proposed Desalination Plant are similar to those from existing fresh water inputs into Gulf St Vincent. From existing data it is known that within 100 metres of the discharge point from these point sources, the
seawater pH is 8.1 even though the discharge can range from 7.1 to 7.4. This reflects the likely scenario for the proposed Desalination Plant.

In order to ensure there is no decrease in pH associated with the saline concentrate discharge, the operational monitoring program will measure pH in the surrounding marine environment adjacent to the Diffuser to ensure that concentrations are compliant with Environment Protection (Water Quality) Policy criteria values. pH will also be measured within the plant (by online monitors) which will also ensure no significant changes within the process itself.

4.3.2.3 Potential reduction of dissolved oxygen at the seabed as a consequence of the saline concentrate discharge.

The RO desalination process separates dissolved ions/salts (such as sodium, chloride, sulphate and magnesium), thereby producing both a fresh water stream containing little salt (< 500 µg/L), and a concentrated salt stream. RO membranes do not, however, extract dissolved gases, such as oxygen, nitrogen and carbon dioxide and these gases pass through the membranes freely. As such, there is no significant change in the dissolved oxygen (DO) concentration between the ambient seawater inflow and the saline concentrate discharge.

DO saturation concentration decreases however, with increasing salinity but increases with increasing pressure. During the pressurised RO process, the saline concentrate tends to become supersaturated with oxygen until it is depressurised to atmospheric pressure, before release to the outfall pipe. At this point the DO concentration varies approximately between 6.1 and 7.0 mg/L, dependent upon water temperature and salinity.

Once the saline concentrate discharges through the Diffuser into the marine environment, it rapidly mixes with ambient seawater in the nearfield zone (generally less than 50 metres from the diffuser) and the diluted plume be will be at least 0.6 ppt above the ambient salinity when it settles onto the seafloor (based on a minimum initial dilution of 50:1). This will form a layer on the seafloor in the vicinity of the Diffuser, which continues to mix with ambient seawater as it is dispersed by local currents. If the saline concentrate plume remains stagnant for extended periods of time or ‘pools’ in depressions on the seafloor then vertical mixing may be inhibited and the near bottom layer may become depleted of DO due to microbial consumption of oxygen at the seabed. Based on data collected every two weeks over the past 12 months, there is no indication of localised depletion of ambient oxygen at the seabed as a result of natural stratification.

The hydrodynamic modelling and in situ current data obtained in the area suggests that it is highly unlikely that the diluted saline concentrate plume will remain stationary or stagnant. The bathymetry in the region also shows that there are no large depressions on the seafloor within which the saline concentrate may ‘pool’.

Therefore the risk of dissolved oxygen depletion of the dispersing plume, particularly if the saline concentrate maintains an oxygen concentration of approximately 6 mg/L, is considered very low.

To provide greater assurance that the saline concentrate disperses as predicted environmental boundaries, it is proposed to incorporate in situ monitoring of salinity near the seabed and provide real time data to monitor dissolved oxygen and salinity concentrations. In the event that the monitored behaviour of the discharge plume is outside forecast values, mitigation measures will be activated.
4.3.2.4 Potential reduction of dissolved oxygen in the saline concentrate due to the addition of sodium bisulphite as part of the treatment process.

Sodium bisulphite (or sodium metabisulphite) is added during the pre-treatment process to remove free chlorine and bromine before the feedwater passes through the RO membranes. Sodium bisulphite is an oxygen scavenger and has the potential to reduce the dissolved oxygen concentration in the saline concentrate discharge. It is important to maintain high levels of oxygen in the discharge to minimise impacts to the receiving environment, therefore control of the addition of sodium bisulphite/sodium metabisulphite is required in the desalination process.

The use of in-line sensors monitoring oxygen concentration will be an important quality control process for ensuring the saline concentrate is adequately oxygenated before being discharged into the marine environment.

4.3.2.5 Potential for methane, hydrogen sulphide and nutrients to be released from the sediments as a result of saline concentrate interactions at the sediment interface.

The chemical processes required to release methane, hydrogen sulphide and nutrients are dependent upon the bacterial composition present in the sediments. Surface marine sediments are generally composed of aerobic bacteria. These bacteria consume organic matter as food and convert the organic phosphorus to phosphate ($\text{PO}_4^{3-}$) and the organic nitrogen to ammonia ($\text{NH}_4^+$). If oxygen is present, ammonia can be oxidised to nitrate ($\text{NO}_3^-$), and oxidised iron can tie up the phosphate as ferric phosphate.

If oxygen reducing conditions occur, the nitrate can be reduced back to ammonia and the ferric iron to ferrous iron, which cannot hold onto the phosphate. The phosphate may then be released back into the water. This has the potential to convert the bacterial community in the sediment from aerobic to anaerobic with the by-product of anaerobic activity being the production of hydrogen sulphide and/or methane gas.

Reducing conditions are linked to low oxygen concentrations and high levels of organic materials in the sediment. Neither of these conditions is expected in the vicinity of the proposed Desalination Plant Diffuser. Dissolved oxygen concentrations of the saline concentrate are discussed in Section 4.3.2.3. Monitoring measures are also outlined in this section and Section 4.6.

4.3.2.6 Process chemicals used in the desalination process

A detailed discussion of the process chemicals used in the desalination process was provided in Appendix C2 of the EIS for the proposed Desalination Plant.

As part of the EIS process, ecotoxicity testing of the saline concentrate is required in order to assess the potential for impact upon marine species. It is important to note that the specific chemicals used will depend on the Contractor’s final design preference. Part of the Contractor’s requirements are to provide a risk assessment of the likely impact and fate of the process chemicals on both the terrestrial and the marine environments. The use of chemicals outside those presently tested will require further toxicity studies.

The saline concentrate discharged into the marine environment will be required to comply with the conditions stated in the EPA licence.
4.3.2.7  The potential formation of halogenated organic compounds from the introduction of chlorine as biocide in the desalination process

Intermittent chlorination is typically performed at the marine intake structures and at the seawater pump station to control marine growth. Chlorine, as either chlorine solution (generated using chlorine gas) or commercial liquid sodium hypochlorite is normally used at concentrations below 10 mg/L as Cl₂ equivalent (active chlorine). The duration of dosing can be as often as 1-2 hours per day, to as little as 1-2 hours per week. Such dosing will increase the chloride concentration by a negligible amount (<5 mg/L).

The active chlorine has the ability to oxidise organic matter and, in turn, the chlorine is converted into chloride ions. While the organic matter is broken down into oxidised decomposition products, a small amount (1-2%) of the chlorine forms carbon-chlorine bonds. This reaction creates a variety of chlorinated organic by-products (halogenated by-products or HBPs) in particular the production of hypobromite (OBr⁻) due to the high concentration of bromide in seawater.

The basic equation is:

\[ \text{NaOCl} \rightarrow \text{Na}^+ + \text{OCl}^- \]

Then

\[ \text{OCl}^- + \text{Br}^- \rightarrow \text{OBr}^- + \text{Cl}^- \]

Hypobromite generally adheres to organic particles due to its negative polarity and is removed in the flocculation process in the clarification / DAF pre-treatment of the feed water and disposed of appropriately offsite in the sludge ‘cake’.

Remaining free chlorine and bromine will be removed in the pre-treatment process using sodium bisulphite, and will therefore not form part of the saline concentrate discharge.

The Contractor may use different pre-treatment processes to initially treat the feedwater. If this is the case, a risk assessment will be required to determine the likelihood of compounds such as hypobromites being discharged into the marine environment.

4.3.2.8  Naturally elevated copper levels in the intake waters concentrate through the desalination process and are released in saline concentrate

Concerns have highlighted the potential for the naturally elevated copper levels found offshore in the ambient seawater to be concentrated in the treatment process and finally discharged back into Gulf St Vincent in the saline concentrate.

While the EIS acknowledged the potential for copper to concentrate during the desalination process, it also identified the likelihood of such an occurrence to be negligible as the majority of the copper is removed (flocculated into the sludge) in the pre-treatment of the feed water (seawater). This results in the copper concentrations in the saline concentrate being substantially lower than ambient concentrations found offshore. The sludge cake is then dried and disposed of appropriately offsite.

The Contractor may use different pre-treatment processes to initially treat the feedwater. If this is the case, a risk assessment will be required to determine the likelihood of copper being discharged into the marine environment.
Copper is an essential trace element for both plants and animals; however in high concentrations it can be toxic. Copper will adhere to organic matter, sediment and suspended solids and is generally not bioavailable at ambient seawater pH levels (Gaylard, 2004). In addition, the total aqueous concentration of metals is not a good predictor of bioavailability as the metal's speciation greatly affects its availability to aquatic organisms. It should be noted that copper concentrations measured in the Water Quality Characterisation Study (Appendix H) represent total concentration rather than free copper. It is the free (dissolved) copper in solution that is bioavailable to marine organisms. Dissolved total copper concentrations will also be measured in the future water quality programs to provide ongoing assurance in respect to this matter.

### 4.3.2.9 Pollutant transport of desalination process chemicals

A detailed discussion of the process chemicals used in the desalination process and their fate was provided in Appendix C2 of the EIS for the proposed Desalination Plant. This incorporated key chemical equations and changes that may occur in the chemical composition of the saline concentrate as a result of the process chemicals used in the desalination process.

A detailed literature review was conducted to assess the ecotoxicological effects of the various chemicals used in the desalination process. The effect of bioaccumulation of different chemicals in marine organisms was also discussed in Appendix C2 of the EIS, although it was noted that overall the information is generally limited.

Bioaccumulation is an important direct link between the external contaminant concentrations in the sources and the potential effect of contaminants at various levels of biological structure and function. Chronic ecotoxicology tests provide some confidence that chemicals present in the saline concentrate are not likely to bioaccumulate in the local marine biota. There are other methods such as ecoassays (sensu Fairweather 1999), developed for estuarine environments, which could be utilised to further validate the ecotoxicology tests.

Targeted monitoring of chemicals is required to predict any likely impacts. This will be required during the detailed design phase of the proposed Desalination Plant as specific knowledge of the chemicals to be used becomes known.
4.4 Ecotoxicology

A number of concerns were raised in relation to the ecotoxicological aspects of the proposed Desalination Plant. These concerns could be broadly separated into the following headings:

1. Potential for impact from the saline concentrate (and its constituents) upon the marine ecology of Port Stanvac and Gulf St Vincent.

2. Ecotoxicity testing program.

3. Linkage between plume extent at the required ecotoxicological safe dilution factor and marine habitat.

4. Ecotoxicity impacts from the drilling mud utilised during construction of the proposed Desalination Plant.

4.4.1 Potential for impact from the saline concentrate (and its constituents) upon the marine ecology of Port Stanvac and Gulf St Vincent.

A number of different mitigation measures have been employed in order to ensure that the marine communities are not adversely impacted by the saline concentrate:

- The outfall Diffuser will be situated offshore within the mid to deep benthic zone away from the sensitive cliff, intertidal and subtidal zones;
- The area into which the saline concentrate will discharge is predominantly sandy bottom substrate with few large macro-vertebrates present, which are widely represented elsewhere within Gulf St Vincent;
- The placement of the outfall within this zone also ensures that the saline concentrate is not discharging into the sensitive intertidal and subtidal reefs; and
- The hydrodynamic modelling has also demonstrated that the saline concentrate will disperse offshore down the natural incline of the seabed rather than dispersing towards sensitive reef areas.

Another key measure ensuring that the saline concentrate will be diluted and dispersed adequately is the derivation of safe dilution factors through the Phase 1 ecotoxicological testing.

Toxicity testing was carried out in order to assess the potential biological impacts saline concentrate (and any residual chemicals contained within the concentrate) may have upon marine organisms. The testing involved exposing a number of different marine organisms to a range of concentrations of the saline discharge and recording the organism’s response. The tests comprised a mixture of acute tests (defined as a rapid adverse effect by a substance in a living organism) and chronic tests (a biological response to exposure to a toxicant that takes a prolonged period to appear and persists for a prolonged period).

A number of tests were also carried out on samples of saline containing different antiscalants (which are used during the desalination process to reduce the formation of scale upon the membranes) to assess what influence the antiscalants may have upon toxicity. As stated within the EIS, previous toxicity testing undertaken for other desalination plants has also confirmed that salinity is the primary driver of potential effects on marine systems. However, residual chemicals that may be present from the desalination process were also considered during the Phase 1 ecotoxicological testing program.
The results presented within the EIS comprised a series of (5) trophic levels and presented an Acute to Chronic Ratio (ACR) of 2.5 to 1. This value was considered to be conservative in light of data from other desalination plants (the ACR is discussed in the next section). This testing was carried out on water collected at Port Stanvac.

Table 4.11 Ecotoxicology tests undertaken for the EIS based upon acute and sub-chronic testing in Phase 1 ecotoxicological testing program.

<table>
<thead>
<tr>
<th>Species</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Nitzschia closterium</em> (undertaken by CSIRO CECR)</td>
<td>Microalgae 72-h algal growth inhibition test (sub-chronic)</td>
</tr>
<tr>
<td><em>Ecklonia radiata</em></td>
<td>Kelp 72-h macro-algal germination assay (sub-chronic)</td>
</tr>
<tr>
<td><em>Heliocidaris tuberculata</em> (Sea urchin)</td>
<td>Echinoderm 1-h sea urchin fertilisation success (sub-chronic)</td>
</tr>
<tr>
<td><em>Heliocidaris tuberculata</em> (Sea urchin)</td>
<td>Echinoderm 72-h sea urchin larval development test (sub-chronic)</td>
</tr>
<tr>
<td><em>Mimachlamys asperrima</em> (Doughboy scallop)</td>
<td>Bivalve 48-h larval development (sub-chronic)</td>
</tr>
<tr>
<td><em>Allorcestes compressa</em></td>
<td>Amphipod 96-h acute toxicity test (acute)</td>
</tr>
<tr>
<td><em>Seriola lalandi</em> (Yellow kingfish)</td>
<td>Fish 96-h larval fish imbalance test (acute)</td>
</tr>
</tbody>
</table>

The ecotoxicology investigations presented within the EIS produced conservative dilution rates (in the form of protective concentrations) required to protect 95% of marine species. The dilution rates ranged from 11:1 to 26:1 for the ambient pH tests and 11:1 to 12:1 for the pH adjusted discharge. It should be noted that a 65:1 dilution factor was identified as being required for the chlorinated / dechlorinated sample at pH ambient but, as identified in the EIS, this result is believed to be an artefact of sampling error as the results were inconsistent and were not observed in the pH adjusted sample. The result was likely due to free chlorine remaining and not having been neutralised during the laboratory simulation of the chlorination / dechlorination process. Further testing of pilot plant chlorinated / dechlorinated samples was undertaken in order to confirm this was a laboratory testing error and confirmed the anomalous result was not due to the chlorinated / dechlorinated concentrate.

4.4.2 Ecotoxicity Testing Program

A number of issues highlighted through the EIS consultation related to the ecotoxicity program. Particular concerns included:

1. Applicability of Acute to Chronic Ratio of 2.5:1.
2. Ongoing and future ecotoxicology testing.

4.4.2.1 Applicability of Acute to Chronic Ratio (ACR) of 2.5:1.

The results presented within the EIS comprised a series of acute and sub-chronic toxicity tests. The species selected satisfied the requirements of the ANZECC / ARMCANZ (2000) guidelines for the assessment of toxicants in receiving waters, in having at least 5 species from four trophic levels as part of the testing suite. These tests provided a range of acute and chronic / sub-chronic endpoint toxicity...
measurements which were used in the derivation of the discharge and toxicity trigger values.

As there were both acute (i.e. the fish and amphipods) and chronic (the remaining four species) toxicity tests, an acute to chronic ratio (ACR) was needed to convert the acute tests / data to estimates of chronic toxicity (as required to compile a Species Sensitivity Distribution curve). A conversion factor of 2.5 to 1 (acute to chronic ratio) was applied based on a data collation and review of the academic literature (where no ACR greater than 2 were found) and laboratory testing carried out for other desalination plants in Australia (Victoria Desalination Plant also utilised an ACR of 2.5).

ACR are useful in the event that only acute data is available. Validation tests have now been developed with applicable species that have allowed chronic tests to be undertaken for all future ecotoxicological testing. As such, there is no need for acute to chronic ratios to be utilised. These chronic tests remove the requirement of ACR calculations and provide a more robust and applicable Species Sensitivity Distribution (SSD) and hence dilution ratio. The testing is detailed further within the next section and Table 4.12.

### 4.4.2.2 Ongoing and future ecotoxicology testing.

As committed by SA Water in the EIS, ecotoxicology tests have been undertaken to continue to provide additional assurance and input to the detailed design process. These additional tests are based upon chronic tests (as detailed within Table 4.12) which utilise desalinated water from the Port Stanvac Pilot Plant (at a recovery rate of 45%). The purpose of these tests is to allow a Species Sensitivity Distribution (SSD) curve to be calculated on chronic and sub-chronic species tests which would therefore not require acute to chronic ratios (ACR).

<table>
<thead>
<tr>
<th>Species</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Diopatra dendata</em></td>
<td>Polychaete worm 14 day growth and survival test</td>
</tr>
<tr>
<td><em>Ecklonia radiate</em></td>
<td>Macroalgae 14 day growth and survival test</td>
</tr>
<tr>
<td><em>Heliocidaris erythrogramma</em> (Sea urchin)</td>
<td>Echinoderm 10 day metamorphosis endpoint test</td>
</tr>
<tr>
<td><em>Mimachlamys asperrima</em></td>
<td>Bivalve 48-h larval development</td>
</tr>
<tr>
<td><em>Allorchestes compressa</em></td>
<td>Crustacean 14 day growth and survival test (extending to 20 day)</td>
</tr>
<tr>
<td><em>Nitzschia closterium</em> (undertaken by CSIRO CECR)</td>
<td>Microalgae 72-h algal growth inhibition test</td>
</tr>
<tr>
<td>TBC</td>
<td>Fish 14 day growth and survival test</td>
</tr>
</tbody>
</table>

It should be noted that for many of the tests detailed in Table 4.12 no ecotoxicological testing protocols have been previously developed for native SA species. The setting up of testing protocols is time consuming and requires careful validation using reference toxicants. The chronic tests currently underway consist mainly of 48-hour to 14-day growth and survival tests.

Comments were raised as to why seagrass ecotoxicology testing was not undertaken as seagrasses were acknowledged in the ACWS to be a dominant biota
in some areas of Gulf St Vincent (Fox et al., 2008). As stated in the EIS and the Marine Ecological Characterisation Studies (Appendix C5 to C7 of the EIS), no seagrasses were located in the saline concentrate zone of influence (where the dilution achieved is greater than 100:1). Should seagrasses be identified during monitoring SA Water will include development of seagrass ecotoxicity testing protocols as there are currently no established seagrass acute or chronic tests.

The current round of ecotoxicity test results will be based solely on chronic results and, as such, are effective conservative predictors of the likely impact on the marine communities. Testing is also being undertaken on saline concentrate that has undergone the chlorination / dechlorination process within the Pilot Plant. This has been carried out in order to re-test the anomalous chlorinated / dechlorinated results reported during the EIS for the ambient pH test.

The chronic tests are currently underway and once completed will aid in the derivation of SSD and protective dilution ratios. The results will be provided to the EPA on completion.

4.4.2.3 Ecotoxicology results

As committed by SA Water in the EIS, ecotoxicology tests have continued in order to provide additional assurance and input to the detailed design process. These additional tests have been based upon chronic tests which utilised desalinated water from the Port Stanvac Pilot Plant (at a recovery rate of 45%). As discussed above, the use of chronic tests has removed the requirement for Acute to Chronic Ratio (ACR) calculations and has provided a more robust and applicable Species Sensitivity Distribution (SSD) and hence dilution ratio.

The interim ecotoxicology safe dilution results presented below are based on tests using five species that passed rigorous quality assurance and quality control (QA/QC). The species that passed QA/QC include the following: polychaetes (worms), macroalgae (seaweed), echinoderms (sea urchins), bivalve (scallops), and amphipods (crustaceans). Two species did not meet QA/QC parameters; microalga (phytoplankton) and fish, and were not included in safe dilution calculations. The results of ecotoxicology testing are presented in Appendix F, and are summarised below:

- Safe dilutions for the saline concentrate with and without antiscalant was 10:1 for complete toxicity neutralisation, while the pH adjusted saline concentrate with and without antiscalant demonstrated a safe dilution of 13:1 and 11:1 respectively.
- Both the backwash supernatant and dechlorinated membrane pre-treatment chemically enhanced backwash samples required safe dilutions of 7:1 and 8:1 respectively indicating low toxicity.
- The saline concentrate samples will be tested again with the microalga assay to confirm the current results and ensure that all QA/QC criteria are met, and all protective concentrations and safe dilutions will be recalculated after the repeat 14 day chronic fish tests are completed with a new batch of fish.

The current results are based on chronic tests and are considered effective conservative predictors of the likely impact on the marine communities. These preliminary dilution rates are within the required performance criteria for the diffuser of a dilution (prior to reaching the seabed) of 50:1.
Future works will include toxicity testing of the saline concentrate once the proposed Desalination Plant is operational to validate the results. The Contractor will also be required to test any chemicals or discharges that are outside of those tested by SA Water. Furthermore, testing is also likely to include whole of effluent toxicity testing on a suite of organisms in order to ascertain whether there are synergistic or combined effects from the chemicals utilised during the desalination process. Monitoring of ecotoxicity utilising chronic tests will also be carried out on a regular basis as described in the CEMMP and OEMMP.

4.4.3 Ecotoxicity impacts from the drilling mud utilised during construction of the proposed Desalination Plant

As detailed within Section 7.4.2.7 of the EIS, the tunnel boring machine will utilise bentonite as a drilling fluid to lubricate and cool the drill cutting head. Bentonite is a term used to describe naturally occurring very fine clay minerals comprising a mixture of potassium, calcium, aluminium, iron and magnesium silicates. Bentonite is used in cement, adhesives, ceramic bodies, cosmetics and cat litter. They are widely used within the tunnelling industry as they form a highly gelatinous and viscous fluid when mixed with water. This fluid is ideal to use as a lubricant as clay is a natural material with low toxicity. As such no toxic effects on the marine environment are expected with the use of this drilling fluid.
4.5 Dredging and Blasting

A number of concerns were raised in relation to dredging and blasting during construction. These concerns can broadly be categorised in to the following themes:

- Sediment and turbidity issues during construction.
- Impacts on marine environment from dredging and blasting.

4.5.1 Sediment and turbidity issues during construction

Marine systems, particularly those adjacent urban areas, have the potential to contain contaminants within marine sediments due to historical pollution events including stormwater runoff. Specifically, the proposed Desalination Plant site is in close proximity to the disused Mobil Oil Refinery which has raised concerns over potential hydrocarbon risks from historic water table contamination and particular risks associated with possible dredging activities.

The potential for sediment and debris from construction activities to impact upon surrounding marine ecosystem was discussed in Chapter 7 (Section 7.2.4.3) of the EIS with reference to the subtidal, mid and deep benthic zones.

Sediment testing was undertaken to identify potential contamination risks in the marine environment within the proposed Desalination Plant area. Results of the sediment assessment were compared against National Ocean Disposal Guidelines for Dredge Material (NODGDM) 2002 and no contaminants of concern were identified. Results of the sediment analysis were also consistent with previous investigations within the area conducted during previous dredging works (undertaken by DEH for beach replenishment purposes between 1992 to 1998) in confirming the absence of sediment contamination.

Given the adopted NODGDM guidelines are specific to ocean disposal, it is believed the guideline levels are conservative in this instance and are intended to be guide for contaminant levels as opposed to specific targets. It is noted that some laboratory reporting limits (LORs) for particular contaminants including some polycyclic aromatic hydrocarbons (PAH) and heavy metals were above guideline levels. Furthermore, the disposal of sediments to an appropriate land based facility is the preferred EPA disposal method.

Sediment particle size testing was also undertaken within the area to assess the potential for fine sediments to generate turbidity issues as a result of dredging events during construction. Results indicated a high proportion of silt and clays within the top layers of sediments within the proposed Desalination Plant area. The accumulation of fine sediments will be considered prior to construction activities including dredging or entrenchment.

Should the Contractor choose a construction method which includes dredging then the Contractor will be required to undertake further sediment characterisation of both contaminants of potential concern and sediment size distribution within the proposed dredge pocket. The Contractor will also be required to apply for a dredge licence through the EPA and, as part of this process, will be required to submit a DEMP in order to manage and mitigate potential dredging and blasting impacts. This DEMP will be required to contain mitigation measures to be employed in the event of a sediment plume or related incident.
4.5.2 Impacts on Marine Environment from Dredging and Blasting

The EIS considered a concept design and presented the worst-case scenarios in relation to likely environmental impacts in order to be conservative. The concept design for the marine structures includes two options for the construction of the intake and outfall conduits linked to the proposed Desalination Plant. These options are a hybrid tunnel option (HTO) and a full tunnel option (FTO). These options have different requirements in relation to dredging and blasting. A number of different construction options are being considered. In the event that dredging is required this is an activity requiring licensing by the EPA under Schedule 2 of the Development Assessment Act.

A dredging licence will be required in the event that dredging is necessary for either design option. A dredge licence will address the risks associated with dredging including the risk of plumes, indicative plume modelling, and the effects sedimentation and turbidity will have on marine environments. Dredge licensing is controlled by the EPA and will be required for all construction and maintenance dredging activities. SA Water currently holds a 5 year dredging licence under the Environment Protection Act 1993, initiated in 2008 as part of a the Pilot Desalination Plant. However, as a condition of the contract, the dredging licences will be required to be obtained by the successful Contractor.

Monitoring criteria values for suspended solids and turbidity will be adopted in the DEMP prior to any dredging event and will be agreed under licence and in consultation with the EPA.

It is recognised that the proposed timeframe restrictions to avoid the effects of dredging and blasting on marine fauna are significantly limiting in regards to construction. No blasting should occur within the marine mammal migration season, approximately May to November, and consideration should be given to not undertaking dredging within recruitment periods for key reef species (July to December). The Contractor will therefore be limited to the construction conditions outlined in the contract.

The Contractor will nominate a preferred construction option and will be required to adhere to the performance criteria as detailed in Table 3.1 of the EIS.

The effects of blasting on surrounding marine environments during construction are discussed in Chapter 7 of the EIS. The requirement of blasting is dependent on the method utilised by the Contractor. The use, storage and transportation of explosives will be carried out in accordance with:

- Mines and Works Inspection Act 1920; and
- Explosives Act 1936.

SA Water is committed to avoid any blasting through the cliff or intertidal reef zones. In the event that the hybrid tunnel option is chosen, a small amount of localised blasting may be required if there is no practical alternative. This is due to the tunnel requiring stability where it surfaces requiring a rock base as opposed to sediment. In the event that blasting is required, all mitigation measures listed in the EIS will be implemented, as well as restrictions in blasting duration (limited to a period of four weeks outside the migratory season). This minimal blasting will however have a short term localised impact upon turbidity and local marine species.

Potential sources of construction noise in the marine environment include tunnelling, blasting, drilling, dredging and rock removal (as discussed in Chapter 7 of the EIS).
All measures designed to minimise and monitor underwater noise levels during the construction of the Plant will be included within the CEMMP.
4.6 Marine Management and Monitoring

A variety of issues were raised in relation to marine management and monitoring arrangements. These issues can be broadly summarised into the following categories:

- Construction in the marine environment.
- Baseline monitoring.
- Future monitoring.

Dredging and blasting are discussed further within Section 4.5 and marine exclusion zones are discussed within the fisheries section (Section 4.2.2).

4.6.1 Construction in the Marine Environment

The successful Contractor will be required to investigate, in detail, potential impacts on the marine environment from construction activities. As detailed in Table 3.1 of the EIS, this will need to include appropriately locating marine structures to minimise impacts upon the marine environment, including the intertidal and subtidal reefs. A CEMMP will be developed containing specific plans and procedures to address:

- Construction method, including marine access such as use of existing jetty infrastructure and beach landings and material supply;
- Assessment of the likely construction impacts, including impacts on the existing shipping lanes, and strategies to manage impacts;
- Dredging, including best practice measures to minimise dredge footprint, sediment and turbidity control, management of spoil (including spoil disposal) and timing of dredging to avoid dodge tides and recruitment periods for key reef species;
- Construction marine noise management;
- Water quality monitoring during marine works;
- Marine pest management; and
- Contingency, spill management and emergency response plan.

The CEMMP and OEMMP will be developed to identify, assess, manage and mitigate all potential environmental risks associated with the construction and operation of the proposed Desalination Plant. As stated in Table 3.1 of the EIS, the successful Contractor must meet environmental objectives which aim to minimise the environmental impacts associated with the construction and operation of the Plant. Many of these requirements directly relate to mitigating impacts to the marine environment and upholding the principal objectives of the *Environmental Protection (Water Quality) Policy 2003*, through EPA licensing.

The CEMMP and the OEMMP must also ensure all relevant legislative requirements are addressed. Table 5.2 of the EIS provides a list of all key State legislation relevant to the ADP.

4.6.2 Baseline monitoring

Submissions have queried the adequacy of research lack of understanding of the existing local marine environment at the time of the EIS submission.
A range of environmental investigations were undertaken to provide a basis for planning the proposed Desalination Plant and for assessing the potential environmental effects. The investigations provided information about the marine environment adjacent to Port Stanvac. The outcomes of investigations led to the development of the proposed Desalination Plant environmental performance objectives and design requirements. These requirements are incorporated into the concept design and must be included in the final design, to minimise potential environmental impacts associated with the Desalination Plant at Port Stanvac.

The coastal and marine investigations undertaken to inform the proposed Desalination Plant included:

- Flora and Fauna Investigations (including a Coastal Cliff Survey);
- Marine Habitat Map;
- Marine Ecological Characterisation Study (Ongoing);
- Bathymetry and Sidescan sonar;
- Seismic Survey;
- Marine Water Quality Characterisation Study (Ongoing);
- Feral or In Peril Survey;
- Hydrodynamic Plume Dispersion Modelling;
- Underwater Acoustic Assessment;
- Larval Entrapment and Entrainment Literature Review;
- Salt and Heat Budget and Particle Tracking Investigation for Gulf St Vincent;
- Environmental/Sediment Sampling and Testing;
- Mobile Marine Species Review;
- Infauna and Meiofauna Assessment;
- Near Field Dilution and Outfall Hydraulics Investigation;
- Flushing Box Model and Winter 2008 Current Measurements;
- Ecotoxicity Evaluation of ADP Saline Concentrate and Process Chemicals; and
- Acoustic Doppler Current Profiler study measuring current velocity.

The results from the monitoring program presented in the Water Quality Characterisation Study (Appendix H) replace the preliminary results presented in the EIS.

The initial marine habitat survey, undertaken by the Department of Environment and Heritage, was extended a further 2 km offshore into the deeper water to classify the benthic habitat in this region (Appendix I). Macroalgal communities, predominantly red algal species on unconsolidated substrate (1136 Ha) and bare sand (538 Ha), were recorded as being the dominant habitats in the region (Table 4.13). Small patches of dense *Halophila* sp. beds were found at a depth of 23 metres. *Halophila* is an annual/perennial marine herb, a seagrass, commonly known as paddle weed found in a range of habitats throughout the Gulf (Womersley, 1984).

Appendix I shows the DEH habitat survey and bathymetric survey, shown with the marine construction envelope presented in the EIS (Figure 3.4). During the recent
extension to the habitat survey, bathymetry in the region was confirmed to gently slope from 18.5 metres to 27.5 metres depth, from north to south. It was noted that there were no obstacles or trenches that would influence plume dispersion beyond that previously ascertained in modelling studies.

Table 4.13 Spatial extent of benthic habitats in the vicinity of Port Stanvac.

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Spatial extent (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare sand</td>
<td>538</td>
</tr>
<tr>
<td>Continuous medium seagrass</td>
<td>43</td>
</tr>
<tr>
<td>Continuous dense seagrass</td>
<td>17</td>
</tr>
<tr>
<td>Patchy sparse seagrass</td>
<td>23</td>
</tr>
<tr>
<td>Patchy medium seagrass</td>
<td>16</td>
</tr>
<tr>
<td>Patchy dense seagrass</td>
<td>3</td>
</tr>
<tr>
<td>Patchy sparse algae on unconsolidated substrate</td>
<td>1136</td>
</tr>
<tr>
<td>Patchy medium algae on unconsolidated substrate</td>
<td>800</td>
</tr>
<tr>
<td>Continuous low profile reef</td>
<td>105</td>
</tr>
<tr>
<td>Patchy, low profile reef</td>
<td>45</td>
</tr>
<tr>
<td>Medium profile reef</td>
<td>35</td>
</tr>
<tr>
<td>Patchy sparse filter feeders</td>
<td>12</td>
</tr>
</tbody>
</table>

The Contractor is required to undertake further surveys in order to add to this knowledge and to build a detailed and appropriate baseline to determine whether the environmental performance objectives of the proposed Desalination Plant are being achieved. This will likely utilise a Before-After/Control-Impact (BACI) model. The BACI approach is a widely utilised and recognised method for measuring the potential impact of a discharge, disturbance, or event on the marine species communities of a system. Such effects can be analysed by measuring conditions before a planned activity and then comparing the findings to those conditions measured after; an approach that is applicable for comparing the affects of anticipated future activities.

Baseline monitoring that will likely be undertaken by the Contractor is detailed in Table 4.14.
Table 4.14 Proposed monitoring program for baseline studies

<table>
<thead>
<tr>
<th>Monitoring Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intertidal Reef</strong></td>
<td>Four quarterly surveys at about 20 sites, including five reference sites, prior to construction commencing.</td>
</tr>
<tr>
<td><strong>Subtidal Reef</strong></td>
<td>Four quarterly surveys of benthic flora and fauna on the subtidal reef at about 20 sites or transects (including reference sites), prior to construction commencing, with permanent study sites being defined.</td>
</tr>
<tr>
<td><strong>Baited Remote Underwater Video</strong></td>
<td>Two seasonal video fish lure surveys at three sites to monitor local fish populations associated with subtidal reef and soft sediment communities prior to construction commencing.</td>
</tr>
<tr>
<td><strong>Infauna Survey</strong></td>
<td>Two surveys of the macrofauna and meiofauna in the soft sediment at 20 sites (including five reference sites) with multiple samples at each site to characterise variability, prior to construction commencing.</td>
</tr>
<tr>
<td><strong>Water Quality Profiles</strong></td>
<td>Water column profiling at 100 metres, 500 metres and 5 kilometres north and south of the diffuser location, and three reference sites, to measure: salinity (conductivity); dissolved oxygen (DO); pH; chlorophyll a; turbidity and water temperature at water depths 5, 10, 15, 20 and 25 metres. Water quality surveys to be undertaken monthly prior to construction.</td>
</tr>
<tr>
<td><strong>Ecotoxicity testing</strong></td>
<td>Complete full set of ecotoxicity tests and analysis of results to confirm minimum initial dilution.</td>
</tr>
<tr>
<td><strong>Current metering</strong></td>
<td>Complete full 12 months of current meter monitoring at proposed intake / diffuser location (will be completed June 2009).</td>
</tr>
<tr>
<td><strong>Plankton sampling</strong></td>
<td>A study to characterise the plankton encountered on site is needed to better assess the issue of entrainment and other impacts upon the pelagic environment.</td>
</tr>
</tbody>
</table>

### 4.6.3 Future Monitoring

A number of queries raised during the EIS consultation were in relation to the proposed management and monitoring during construction and operations of the proposed Desalination Plant. These queries can be broadly categorised under two headings:

1. **Construction and Operational Management and Monitoring Plans.**
2. **Trigger points and chemical monitoring.**

#### 4.6.3.1 Construction and Operational Management and Monitoring Plans

As committed to by SA Water in the EIS, environmental management is to be addressed during all phases of the proposed Desalination Plant including design, construction and operation. To support this, the Contractor is required to develop and implement an Environmental Management System (EMS) in accordance with internationally recognised standard AS/ANZ ISO 14001:2004. This EMS will establish the overall framework for achieving the environmental performance objectives for the proposed Desalination Plant, including compliance with approval.
conditions and regulatory requirements. The EMS will also set out the reporting of environmental performance, including reporting of compliance with approvals and licences, reporting of monitoring outcomes and the implementation and effectiveness of environmental management measures for the proposed Desalination Plant.

The EMS will be supported by Environmental Management and Monitoring Plans for specific project stages addressing both the construction and operational phase of the Desalination Plant. These plans will describe the environmental management requirements, processes and activities during the contract. In establishing these detailed plans, the Contractor must address the requirements of the project environmental performance criteria, regulatory requirements, EPA licence requirements and specific management and mitigation measures identified during the environmental assessment process. A draft CEMMP is included in Appendix B.

As the surveys undertaken to date were based on the concept design, the Contractor will also be required to undertake marine studies specific to their detailed design. For example, if dredging is required then sediment validation testing will be required within the proposed dredge pocket.

In conjunction with the ITRP, a marine monitoring program building upon the marine environmental studies offshore has been established to monitor the potential impacts from the proposed Desalination Plant. This is in addition to the baseline program detailed previously. The program is broadly separated into four components.

1. **Construction Planning** to document the work done to manage marine pests and minimise impacts during site surveys (including drilling and geophysical surveys);

2. **Construction Monitoring** to document the types and extent of impacts during construction, including accidents and un-planned incidents;

3. **Post-construction Monitoring** to document the recovery from any identified construction impacts; and

4. **Operational Monitoring** to establish whether the actual impacts are the same as predicted and expected, and to identify any additional impacts that may be occurring.

The likely studies for these four stages are shown in Tables 4.15 to 4.18 respectively.
Table 4.15 Proposed monitoring program for construction planning studies

<table>
<thead>
<tr>
<th>Geophysical surveys</th>
<th>Offshore surveys of depth of sediment and related geophysical matters.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offshore drilling and probing</td>
<td>Offshore drilling and probing of sediment and rock to define construction conditions for intake, tunnel and diffuser.</td>
</tr>
<tr>
<td>Dredging Surveys</td>
<td>Documenting seabed characteristics in areas proposed to be dredged, sediment/turbidity monitoring proposals, turbidity trigger levels; management of spoil from dredging works, and timing of dredging (to avoid dodge tides and recruitment periods for key reef species if possible).</td>
</tr>
<tr>
<td>Marine Noise</td>
<td>Baseline measurement of marine noise on three occasions prior to construction.</td>
</tr>
<tr>
<td>Marine Pests</td>
<td>Schedule of work to follow quarantine procedures to prevent spread of marine pests, including inspections and cleaning of vessels and equipment (as necessary) including auditing of inspections and documentation on offshore equipment.</td>
</tr>
</tbody>
</table>

Table 4.16 Proposed monitoring program during offshore construction

<table>
<thead>
<tr>
<th>Intertidal Reef</th>
<th>Continue quarterly surveys for approximately 20 sites, including five reference sites.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtidal Reef</td>
<td>Continue quarterly surveys of benthic flora and fauna on the subtidal reef for about 20 sites or transects, including study and reference sites.</td>
</tr>
<tr>
<td>Baited Remote Underwater Video</td>
<td>Continue seasonal video fish lure surveys at three sites to monitor local fish populations associated with subtidal reef and soft sediment communities.</td>
</tr>
<tr>
<td>Infauna Survey</td>
<td>Two surveys of the macrofauna and meiofauna in the soft sediment at 20 sites (including five reference sites) with multiple samples at each site to characterise variability.</td>
</tr>
<tr>
<td>Marine Noise</td>
<td>Measurement of marine noise during offshore drilling, offshore excavation and installation of intake and pipes (every 2 months or during periods of peak activity).</td>
</tr>
<tr>
<td>Water Quality Profiles</td>
<td>Measure turbidity at least twice per day during dredging or seabed excavation operations, to define extent of plume and peak turbidity levels.</td>
</tr>
<tr>
<td>Marine Pests</td>
<td>Continue work to follow quarantine procedures to prevent spread of marine pests, including inspections and cleaning of vessels and equipment including auditing of inspections and documentation on offshore equipment.</td>
</tr>
<tr>
<td>Spills and accidental releases</td>
<td>Monitor and record of any spills or accidental releases of oils or other materials to the ocean</td>
</tr>
</tbody>
</table>

**Table 4.17 Proposed post-construction monitoring program (suggest for 12 months following completion of the construction of the marine works)**

<table>
<thead>
<tr>
<th>Intertidal Reef</th>
<th>Four quarterly surveys at about 20 sites, including five reference sites, from commissioning.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtidal Reef</td>
<td>Four quarterly surveys of benthic flora and fauna on the subtidal reef at about 20 sites or transects, including permanent study sites and reference sites.</td>
</tr>
<tr>
<td>Baited Remote Underwater Video</td>
<td>Two seasonal video fish lure surveys at three sites to monitor local fish populations associated with subtidal reef and soft sediment communities.</td>
</tr>
<tr>
<td>Infauna Survey</td>
<td>Two surveys of the macrofauna and meiofauna in the soft sediment at 20 sites (including five reference sites) with multiple samples at each site to characterise variability.</td>
</tr>
<tr>
<td>Water Quality Profiles</td>
<td>Water column profiling at 100 metres, 500 metres and 5 kilometres north and south of the diffuser location, and three reference sites, to measure: salinity (conductivity); dissolved oxygen (DO); pH; chlorophyll a; turbidity and water temperature at water depths 5, 10, 15, 20 and 25 metres. Water quality surveys to be undertaken monthly after commissioning for 12 months.</td>
</tr>
<tr>
<td>Plankton</td>
<td>A study to characterise the plankton encountered on site is needed to better assess the issue of entrainment and other impacts upon the pelagic environment</td>
</tr>
</tbody>
</table>

**Table 4.18 Proposed operational monitoring program**

<table>
<thead>
<tr>
<th>Brine characteristics</th>
<th>Measure salinity, temperature, DO, pH of brine discharge on a continuous basis. Take three 8-hour composite samples each month and analyse for metals and residual process chemicals including HBPs for 24 months (frequency may be reduced thereafter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecotoxicity</td>
<td>Establish whole of effluent chronic toxicity testing using composite 8-hour sample of brine discharge every three months for the first 12 months or if there are changes to the desalination treatment process. Thereafter quarterly testing should be undertaken.</td>
</tr>
<tr>
<td>Diffuser Performance Validation</td>
<td>In situ monitoring at sites, west, north and south of the diffuser using an instrument package on the seafloor that records conductivity, temperature, dissolved oxygen, current speed and current direction every 10 minutes. The dilution achieved at the edge of the mixing zone will</td>
</tr>
</tbody>
</table>
be established under a range of current, tide, wind and discharge conditions. The instruments will allow for real time processing of data using telemetry based technology, to constantly monitor the plume dilution, and will be deployed for a period of 12 months after commissioning (as for the Gold Coast desalination plant).

**Plankton Sampling**
Collect seawater samples from the intake on three occasions per day at 2 weekly intervals for the first 12 months of operations. Water samples to be sieved and phytoplankton species composition determined.

**Marine noise monitoring**
Two noise surveys of the operating plant to confirm that noise from intake pumps and related equipment is not detectible.

**Audit of Monitoring**
Within 18 months of commissioning, review of all monitoring data by an independent specialist group to establish whether or not the environmental predictions in the EIS were correct, if any further issues of concern are apparent and the appropriate long term monitoring program. Audit to be conducted in cooperation with the EPA.

### 4.6.3.2 Trigger points and chemical monitoring

Section 3.3.4 of the EIS detailed the continuous water quality monitoring which will be carried out at different locations within the desalination process to safeguard the environment, water quality and equipment during the operation of the Desalination Plant.

Prior to the operation of the proposed Desalination Plant, ecological trigger values will be derived as part of the EPA licence, using the criteria values in the *Environment Protection (Water Quality) Policy 2003*. When a trigger value is exceeded, it will initiate a set of predefined management actions, including further monitoring or changes in Plant operation, which includes the option of Plant shutdown if there is a serious breach of the licence.

The saline concentrate discharge will also be required to comply with the discharge licence as agreed with the EPA.
5 Conclusion

This Response Document forms a key part of the EIS process. Government Agencies and the Public have made submissions on the basis of the EIS lodged with the Department of Planning and Local Government on 11 November 2008 as part of the public exhibition period that ended on 24 December 2008.

SA Water has reviewed submissions from the Public and Government Agencies and has addressed issues and concerns in this Response Document. Every attempt has been made to respond to all of the issues raised that are related to the proposed development and within the scope of the EIS Guidelines.

A number of technical and scientific studies have been ongoing to further validate our understanding of the marine environment in and around Port Stanvac to ensure that the proposed Desalination Plant will not have any adverse impact on marine ecosystems and the environment in general. Further information from these studies has also been provided in the report to further inform the responses to issues and concerns.

It is a requirement of the Construction and Operation process that the successful Contractor will need to prepare and adhere to management plans that will define performance criteria. A draft CEMMP is included in Appendix B that has been prepared based on the concept design and represents SA Water’s commitment for minimum acceptable standards to be adopted by the successful Contractor.

SA Water is committed to ensuring that the proposed Desalination Plant will not have any adverse social, environmental and economic impacts by specifying a comprehensive and holistic set of environmental and engineering performance objectives and criteria to be achieved for the proposed development.
### Glossary

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AARD</td>
<td>Aboriginal Affairs and Reconciliation Division of the SA Department of Premier and Cabinet</td>
</tr>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ACR</td>
<td>Acute to Chronic Ratio</td>
</tr>
<tr>
<td>ACWS</td>
<td>Adelaide Coastal Water Survey</td>
</tr>
<tr>
<td>ADCP</td>
<td>Acoustic Doppler Current Profiler</td>
</tr>
<tr>
<td>ADP</td>
<td>Adelaide Desalination Project</td>
</tr>
<tr>
<td>ANZECC</td>
<td>Australian and New Zealand Environment and Conservation Council</td>
</tr>
<tr>
<td>AQIS</td>
<td>Australian Quarantine and Inspection Service</td>
</tr>
<tr>
<td>Argillites</td>
<td>Fine grained sedimentary rock</td>
</tr>
<tr>
<td>ARI</td>
<td>Annual Recurrence Interval</td>
</tr>
<tr>
<td>ARMCANZ</td>
<td>Agriculture and Resource Management Council of Australia and New Zealand</td>
</tr>
<tr>
<td>ASR</td>
<td>Aqua Storage and Recovery</td>
</tr>
<tr>
<td>BACI model</td>
<td>Before-After/Control-Impact model</td>
</tr>
<tr>
<td>Backstairs Passage</td>
<td>Stretch of water lying between Cape Jervis and Kangaroo Island in South Australia</td>
</tr>
<tr>
<td>Bathymetry</td>
<td>The measurement of the depth of the ocean floor from the water surface; the oceanic equivalent of topography</td>
</tr>
<tr>
<td>BDBSA</td>
<td>Biological Database South Australia</td>
</tr>
<tr>
<td>Benthic Biota (Benthos)</td>
<td>Organisms living in or on the seabed</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>The variety of different species, the genetic variability of each species, and the variety of different ecosystems that they form</td>
</tr>
<tr>
<td>Cake</td>
<td>Pre-treatment waste</td>
</tr>
<tr>
<td>CEMMP</td>
<td>Construction Environmental Management and Monitoring Plan</td>
</tr>
<tr>
<td>Coastal Cliff Zone</td>
<td>The area extending vertically from the top of the cliff to the edge of the horizontal intertidal reef</td>
</tr>
<tr>
<td>Coastal Conservation Zone</td>
<td>A zone to conserve the biodiversity values of the coast which would facilitate rehabilitation of remnant coastal vegetation at Port Stanvac</td>
</tr>
<tr>
<td>Concept Design</td>
<td>As detailed in the concept design for the Adelaide Desalination Project report prepared by Connell Wagner</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Conductivity</td>
<td>A measure of the ability of water to conduct electrical current. It is directly related to the total dissolved substances in the water</td>
</tr>
<tr>
<td>Contract</td>
<td>The contract for the DBOM of the Desalination Plant</td>
</tr>
<tr>
<td>Contractor</td>
<td>The successful proponent selected by SA Water to design, build, operate and maintain the Desalination Plant</td>
</tr>
<tr>
<td>CPB</td>
<td>SA Coast Protection Board</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
</tr>
<tr>
<td>DAC</td>
<td>SA Development Assessment Commission</td>
</tr>
<tr>
<td>DBOM</td>
<td>Design, Build, Operate and Maintain</td>
</tr>
<tr>
<td>Deep Benthic Zone</td>
<td>Marine area found at depths 18 m and greater. The habitat is characterised by areas of unconsolidated sand, shell grit and course sediment that is sparsely inhabited</td>
</tr>
<tr>
<td>DEH</td>
<td>SA Department for Environment and Heritage</td>
</tr>
<tr>
<td>DEMP</td>
<td>Dredging Environmental Management Plan</td>
</tr>
<tr>
<td>Desalination</td>
<td>The process of removing salts and other minerals from seawater so that it can be used for drinking water</td>
</tr>
<tr>
<td>DETI</td>
<td>South Australia Department for Energy, Transport and Infrastructure</td>
</tr>
<tr>
<td>Development Act</td>
<td>SA Development Act 1993</td>
</tr>
<tr>
<td>DEWHA</td>
<td>Commonwealth Department of the Environment, Water, Heritage and the Arts</td>
</tr>
<tr>
<td>DFC</td>
<td>SA Department for Families and Communities</td>
</tr>
<tr>
<td>Diffuser</td>
<td>An outlet designed to break up the flow of brine into small streams and ‘jet’ these streams into a large volume of surrounding seawater with sufficient velocity to mix and disperse the brine rapidly and effectively</td>
</tr>
<tr>
<td>Discharge</td>
<td>The saline concentrate that will be emitted from the outfall pipe into Gulf St Vincent</td>
</tr>
<tr>
<td>Dissolved Oxygen (DO)</td>
<td>The amount of oxygen freely available in water and necessary for aquatic life and the oxidation of organic materials</td>
</tr>
<tr>
<td>Dodge tide</td>
<td>A period of minimal tidal movement (defined in Section 4.1.2.2)</td>
</tr>
<tr>
<td>DPA</td>
<td>Development Plan Amendment</td>
</tr>
<tr>
<td>DPC</td>
<td>SA Department of Premier and Cabinet</td>
</tr>
<tr>
<td>DTED</td>
<td>SA Department of Trade and Economic Development</td>
</tr>
</tbody>
</table>
DTEI SA Department for Transport, Energy and Infrastructure
Dual Reticulation Supply of drinking water and recycled water
DWG Desalination Working Group
DWLBC SA Department of Water, Land and Biodiversity Conservation
EBS Environmental Biodiversity Services
Ecotoxicology A study of the harmful effects of chemical compounds on species, population and the natural environment
EIS Environmental Impact Statement
Entrainment The drawing of fish and other aquatic organisms into an intake system
Entrapment When fish and other organisms get caught on screens or physical barriers of intake pipes
EOI Expressions of Interest
EPA Environment Protection Authority
EPBC Act Environment Protection and Biodiversity Conservation Act of 1999
ETSA Electricity Trust of SA
FTE Full Time Equivalent
GETM General Estuarine Ocean Model
GL Gigalitres
GSV (Gulf) Gulf St Vincent
Habitat Survey Flora and Fauna Survey of Marine and Terrestrial Environments
Hydrodynamic modelling Allows water movements, speeds and directions to be simulated on a computer to give a representation of how the estuary processes work and predicts how future processes (as a result of sea level rise or changes to flood defences) might behave
Hypobromites The bromide ion in the oxidation state (BrO)
Iconic marine species Marine species that are well known in South Australia, such as the Leafy Seadragon
Independent Verifier Is a person or an organisation, owing no obligations to any of the parties to a contract other than to perform the role of independent verifier who is required to confirm by investigation as necessary, the validity of claims by the parties
Infrauna Living in the sediment or sand under the seafloor
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intertidal Reef Zone</td>
<td>The area between the high and low water mark of a spring tide. It is defined as the rocky platform, approximately 100m in width running along the section of coastline adjacent to the Port Stanvac oil refinery.</td>
</tr>
<tr>
<td>Investigator Strait</td>
<td>Stretch of water between Kangaroo Island and the lower southern stretch of the Yorke Peninsula.</td>
</tr>
<tr>
<td>IPR</td>
<td>Indirect Potable Reuse</td>
</tr>
<tr>
<td>ITRP</td>
<td>Independent Technical Review Panel</td>
</tr>
<tr>
<td>JAMBA</td>
<td>Japan-Australia Migratory Birds Agreement</td>
</tr>
<tr>
<td>KHB</td>
<td>Kaurna Heritage Board Inc.</td>
</tr>
<tr>
<td>LMP</td>
<td>Land Management Plan</td>
</tr>
<tr>
<td>Macroalgae</td>
<td>A classification of algae that are defined according to the size of the plant where the body of the plant is large enough to be observable to the eye. Macroalgae is also known commonly as seaweed.</td>
</tr>
<tr>
<td>Macrobenthic</td>
<td>Large benthos (e.g. crabs and starfish).</td>
</tr>
<tr>
<td>Major development</td>
<td>As defined by the Development Act 1993 (SA).</td>
</tr>
<tr>
<td>Marine Environment</td>
<td>The saltwater environment.</td>
</tr>
<tr>
<td>MASMS</td>
<td>Metropolitan Adelaide Stormwater Management System.</td>
</tr>
<tr>
<td>Meiofauna</td>
<td>Small benthic invertebrates that live in both marine and fresh water environments, loosely defines a group of organisms by their size, larger than microfauna but smaller than macrofauna.</td>
</tr>
<tr>
<td>MFS</td>
<td>Metropolitan Fire Service.</td>
</tr>
<tr>
<td>Microbiological</td>
<td>Relating to microorganisms and their life processes.</td>
</tr>
<tr>
<td>Mid Benthic Zone</td>
<td>The marine area between the depths of 12 and 18 metres that is broadly defined by large areas of bare sand.</td>
</tr>
<tr>
<td>ML</td>
<td>Megalitres</td>
</tr>
<tr>
<td>MSF</td>
<td>Multistage Flash.</td>
</tr>
<tr>
<td>MWh</td>
<td>Megawatt hours</td>
</tr>
<tr>
<td>Nationally Listed Species</td>
<td>Species considered Extinct, Endangered, Vulnerable, Migratory or Marine in accordance with the EPBC Act 1999.</td>
</tr>
<tr>
<td>National Water Initiative</td>
<td>A shared commitment by Australian Governments to increase efficiency of Australian water use.</td>
</tr>
<tr>
<td>NEPM</td>
<td>National Environmental Pollution Measure.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>NODGDM</td>
<td>National Ocean Disposal Guidelines for Dredge Material</td>
</tr>
<tr>
<td>Non-potable reuse</td>
<td>Treatment of wastewater for irrigation, agriculture and industrial use</td>
</tr>
<tr>
<td>NRM</td>
<td>Natural Resource Management</td>
</tr>
<tr>
<td>OEMMP</td>
<td>Operational Environmental Management and Monitoring Plan</td>
</tr>
<tr>
<td>Pelagic Biota</td>
<td>Organisms living in open water</td>
</tr>
<tr>
<td>Planktonic Biota (Plankton)</td>
<td>Free-floating or weakly swimming organisms, including microscopic plants and animals, less than 1 millimetre in size, living in open water</td>
</tr>
<tr>
<td>Plant</td>
<td>Adelaide Desalination Plant</td>
</tr>
<tr>
<td>Port Stanvac</td>
<td>Located 30 km south of the Adelaide CBD on the eastern side of Gulf St Vincent in South Australia. The Port Stanvac site is partly occupied by a ‘mothballed’ oil refinery</td>
</tr>
<tr>
<td>ppt</td>
<td>Parts per thousand</td>
</tr>
<tr>
<td>PIRSA</td>
<td>Primary Industries and Resources South Australia</td>
</tr>
<tr>
<td>Primary Production</td>
<td>The amount of carbon and other nutrients assimilated by plants</td>
</tr>
<tr>
<td>Potable</td>
<td>Water of sufficiently high quality to be classified as ‘Drinking Water’</td>
</tr>
<tr>
<td>Proterozoic</td>
<td>A geological era from 2,400 million years to 570 million years</td>
</tr>
<tr>
<td>PWC</td>
<td>Public Works Committee</td>
</tr>
<tr>
<td>PWCM</td>
<td>Permanent Water Conservation Measures</td>
</tr>
<tr>
<td>REISA</td>
<td>Real Estate Institute of South Australia</td>
</tr>
<tr>
<td>Regionally Listed Plant Species</td>
<td>Species that are considered Extinct, Endangered, Threatened, Vulnerable, Uncertain, Rare or Uncommon within the Southern Lofty Botanic region</td>
</tr>
<tr>
<td>RO</td>
<td>Reverse Osmosis</td>
</tr>
<tr>
<td>Saline Concentrate</td>
<td>A liquid by-product of the desalination process that has a higher concentration of suspended and dissolved materials (particularly salt) than intake seawater due to the salt concentrating effect of the reverse osmosis system</td>
</tr>
<tr>
<td>Salinity</td>
<td>The dissolved salt content of a body of water</td>
</tr>
<tr>
<td>SARDI</td>
<td>SA Research and Development Institute</td>
</tr>
<tr>
<td>SA Water</td>
<td>SA Water Corporation</td>
</tr>
<tr>
<td>Scope 1 Emissions</td>
<td>Includes direct emissions from sources within the boundary of an operation</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Scope 2 Emissions</td>
<td>Includes indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation</td>
</tr>
<tr>
<td>Scope 3 Emissions</td>
<td>All indirect emissions that are a consequence of an organisation’s activities but are not from sources owned or controlled by the operation</td>
</tr>
<tr>
<td>Seabed</td>
<td>The ground under the sea</td>
</tr>
<tr>
<td>Seawater Discharge</td>
<td>The waste stream that will be emitted from the outfall pipe into the Gulf St Vincent (or saline concentrate)</td>
</tr>
<tr>
<td>Sediment</td>
<td>Used to describe soils found in the marine environment</td>
</tr>
<tr>
<td>SEIFA</td>
<td>Socio-economic Index for Areas</td>
</tr>
<tr>
<td>Seismic surveys</td>
<td>A means of estimating the structure and different features, such as faults, in the ground below the seabed surface</td>
</tr>
<tr>
<td>SMP</td>
<td>Safety Management Plan</td>
</tr>
<tr>
<td>SSD</td>
<td>Species Sensitivity Distribution</td>
</tr>
<tr>
<td>State Listed Species</td>
<td>Plant and animal species considered Endangered, Vulnerable or Rare within South Australia in accordance with the National Parks and Wildlife Act 1972</td>
</tr>
<tr>
<td>Substrate</td>
<td>An underlying surface or a sub-stratum where an organism grows or is attached</td>
</tr>
<tr>
<td>Subtidal Reef Zone</td>
<td>The area defined as the medium to low profile reef that extends from the low water mark to a depth of 12 metres</td>
</tr>
<tr>
<td>Terrestrial Environment</td>
<td>The land environment</td>
</tr>
<tr>
<td>Thermocline</td>
<td>A transition layer of water in the ocean, with a steeper vertical temperature gradient than that found in the layers of ocean above and below</td>
</tr>
<tr>
<td>Trophic Webs</td>
<td>The feeding relationships of organisms in a community. A ‘food chain’ is a simplification of a trophic web</td>
</tr>
<tr>
<td>Turbidity</td>
<td>A measure of water cloudiness caused by suspended solids</td>
</tr>
<tr>
<td>VAMPIRE</td>
<td>Variance Modelled Posterior Inference with Regional Exponentials</td>
</tr>
<tr>
<td>Water Proofing Adelaide</td>
<td>SA Government 20-year strategy for water proofing Adelaide</td>
</tr>
</tbody>
</table>


Bryars, S. (2003): An Inventory of Important Coastal Fisheries Habitats In South Australia. Fish Habitat Program, Primary Industries and Resources South Australia, Government of South Australia, Adelaide.


